

Information Technologies in Urban Development and Spatial Planning

СКИФ



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Аннотация

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Unit №1

URBAN PLANNING AND GIS

Urban planning is one of the main applications of GIS. Urban planners use GIS both as a spatial database and as an analysis and modelling tool. The applications of GIS vary according to the different stages, levels, sectors, and functions of urban planning. GIS is an operational and affordable information system for planning. It is increasingly becoming an important component of planning support systems. Recent advances in the integration of GIS with planning models, visualisation, and the Internet will make GIS more useful to urban planning. The main constraints in the use of GIS in urban planning today are not technical issues, but the availability of data, organisational change, and staffing.

1. THE USE OF GIS IN URBAN PLANNING

Since the early 1980s, there has been a marked increase in the installation of GIS in different levels and departments of urban and regional governments in the developed countries, notably of Europe and North America. With the further decrease in the price of computer hardware and software, the use of GIS has emerged in urban planning in the developing countries in the 1990s. GIS is increasingly accessible to planners and is now an important tool for urban planning in developed and developing countries alike.

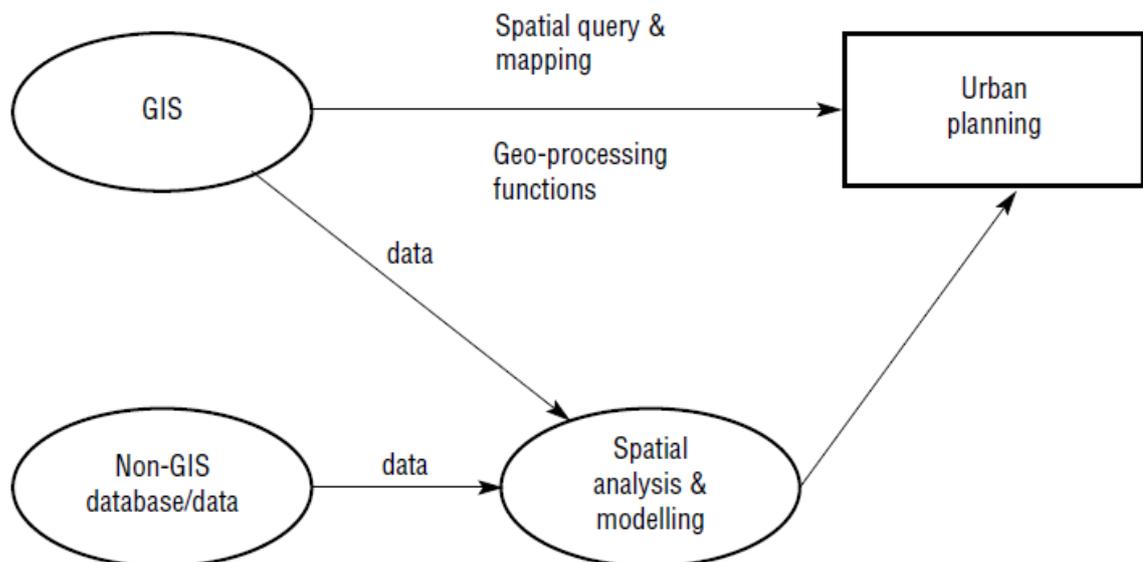


Fig 1. GIS and urban planning.

GIS is just one of the formalised computer-based information systems capable of integrating data from various sources to provide the information necessary for effective decision-making in urban planning. Other information systems for urban planning include database management systems (DBMS), decision support systems (DSS), and expert systems. GIS serves both as a database and as a toolbox for urban planning (Figure 1).

In a database-oriented GIS, spatial and textual data can be stored and linked using the georelational model. Current GIS support efficient data retrieval, query, and mapping.

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Planners can also extract data from their databases and input them to other modelling and spatial analysis programs. When combined with data from other tabular databases or specially conducted surveys, geographical information can be used to make effective planning decisions. As a toolbox, GIS allows planners to perform spatial analysis using geoprocessing functions such as map overlay, connectivity measurement, and buffering. Of all the geoprocessing functions, map overlay is probably the most useful tool. This is because planners have a long tradition of using map overlay in land suitability analysis which is itself an important component in urban planning.

Database management, visualisation, spatial analysis, and spatial modelling are the main uses of GIS in urban planning. GIS is used for the storage of land use maps and plans, socioeconomic data, environmental data, and planning applications. Planners can extract useful information from the database through spatial query. Mapping provides the most powerful visualisation tools in GIS. It can be used to explore the distribution of socioeconomic and environmental data, and display the results of spatial analysis and modelling exercises. Spatial analysis and modelling are used for spatial statistical analysis, site selection, identification of planning action areas, land suitability analysis, land use transport modelling, and impact assessment. Interpolation, map overlay, buffering, and connectivity measurement are the most frequently used GIS functions in spatial analysis and modelling. The use of the above functions varies according to different tasks and stages of urban planning. The many benefits in using GIS in urban planning include (Royal Town Planning Institute 1992):

- improved mapping – better access to maps, improved map currency, more effective thematic mapping, and reduced storage cost;
- greater efficiency in retrieval of information;
- faster and more extensive access to the types of geographical information important to planning and the ability to explore a wider range of ‘what if’ scenarios;
- improved analysis;
- better communication to the public and staff;
- improved quality of services, for example speedier access to information for planning application processing.

2. THE USE OF GIS IN DIFFERENT FUNCTIONS AND STAGES IN URBAN PLANNING

Urban planning involves many functions, scales, sectors, and stages. In general, the functions of urban planning can be classified into general administration, development control, plan making, and strategic planning. General administration and development control are relatively routine planning activities, whereas plan making and non-routine strategic planning are undertaken much less frequently. The scale of the planning area covered can range from a whole city, to a sub-region of a city, a district, or a street block. The most frequently involved sectors of urban planning are land use, transport, housing, land development, and environment. At each scale of planning there are different stages:

- the determination of planning objectives;
- the analysis of existing situations modelling and projection;
- development of planning options;
- selection of planning options;

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- plan implementation;
- and plan evaluation, monitoring, and feedback.

Different functions, scales, sectors, and stages of urban planning make different uses of GIS.

The use of the data management, visualisation, spatial analysis, and modelling components of GIS varies according to different functions of urban planning (Figure 2(a)). Data management, visualisation, and spatial analysis are used more in the routine work of urban planning. General administration employs mainly data management and visualisation. Finally, development control uses the visualisation and spatial analysis functions of GIS most. The more routine general administration and development control work of urban planning includes:

- management of land use records;
- thematic mapping;
- planning application processing;
- building control application processing;
- land use management;
- land availability and development monitoring;
- industrial, commercial, and retail floor space recording;
- recreational and countryside facility planning;
- environmental impact assessment;
- contaminated and derelict land registers;
- land use/transport strategic planning;
- public facilities and shops catchment area and accessibility analysis;
- social area and deprivation analysis.

Visualisation, spatial analysis, and spatial modeling are the most frequently used GIS functions in plan making. Webster (1993, 1994) shows that there are significant differences in the degree of GIS use in the description, prediction, and prescription planning process (Figure 2(b)).

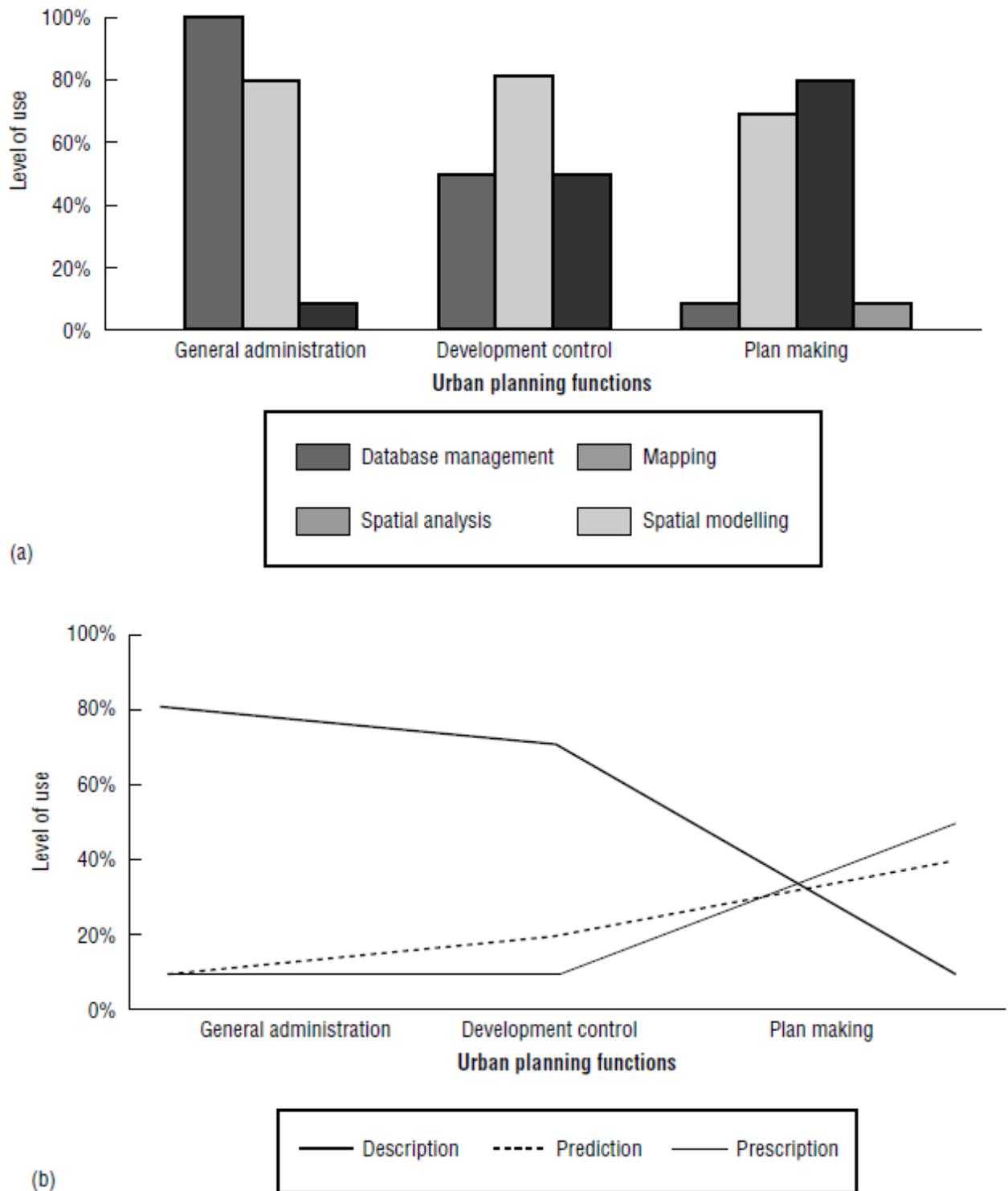


Fig 2. (a) Use of GIS functions in urban planning; and (b) their importance for description, prediction, and prescription functions in three types of urban planning activity.

Raster data are more useful for citywide strategic planning, because large areas are involved and high resolution is not required. The processing of raster data is much faster than that of vector data, especially in map overlay and buffer analysis. On the other hand, vector data are generally used for district and local action area planning because of the need for very high resolution analysis. There are many applications of GIS in the land use, transport, housing, land development, and environmental sectors. Key examples

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include site selection and land suitability analysis. In contrast, network analysis and route selection are most frequently used in transport planning, and environmental planning and management use buffer and overlay processing.

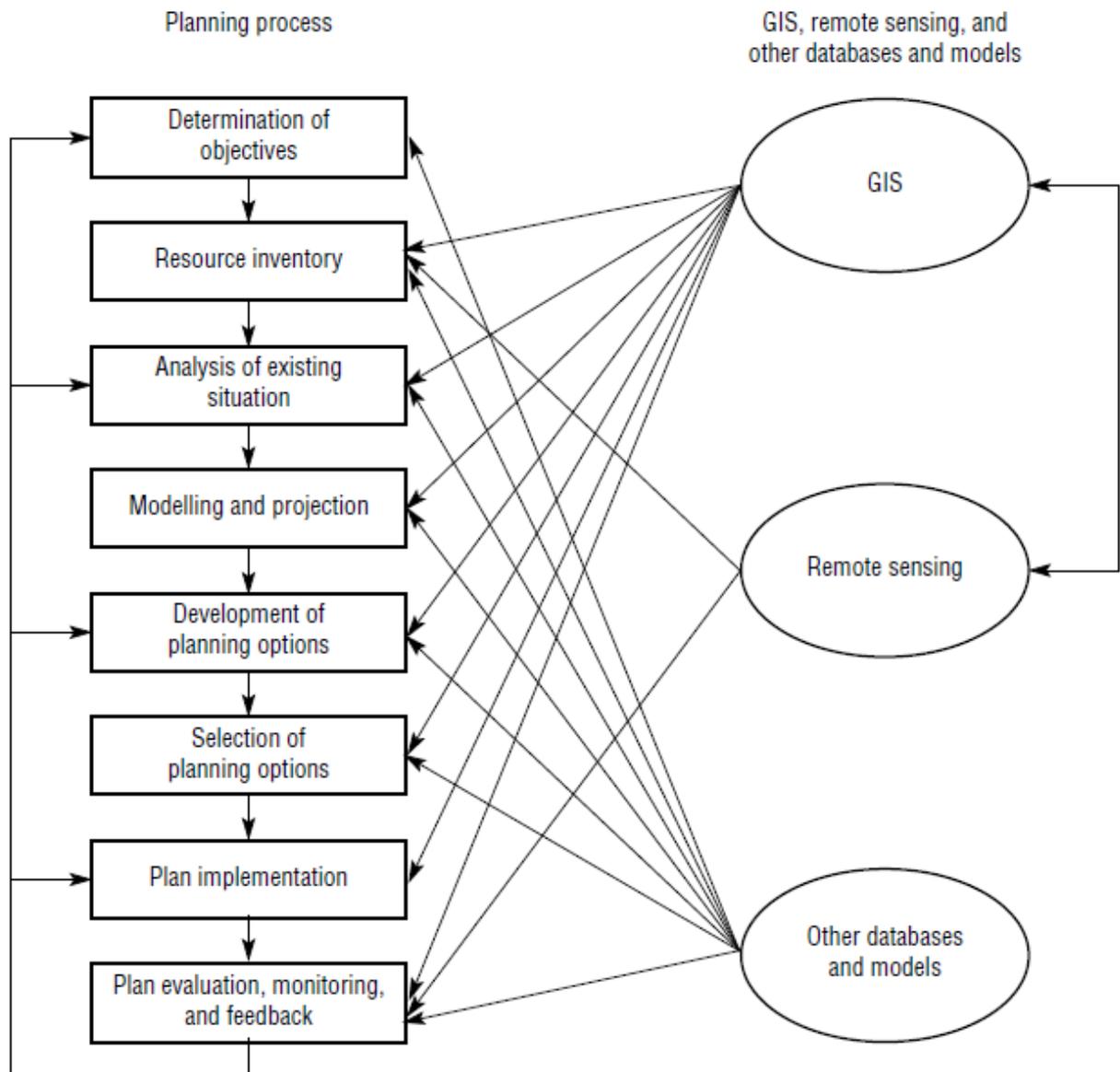


Fig 3. Integration of GIS, remote sensing, and other databases and models in the planning process.

The role of GIS also varies in different stages of the urban planning process. For example, GIS is more useful in modelling and development of planning options than in the determination of planning objectives. The different stages in the urban planning process can be generalised as the determination of objectives, resource inventory, analysis of existing situations, modelling and projection, development of planning options, selection of planning options, plan implementation, and plan evaluation, monitoring, and feedback (Figure 3). GIS can only provide some of the data and techniques that are needed in different stages of the urban planning process. Any GIS also has to work with other databases, techniques, and models at different stages of the planning process.

2.1 RESOURCE INVENTORY

Geographical information, when integrated with remote sensing, can save time in collecting land use and environmental information. Remote sensing images are becoming an important source of spatial information for urban areas. They can help to detect land use and land use changes for whole urban areas (Barnsley et al 1993). In particular, stereoscopic pairs of digital aerial photographs can be used to derive 3-dimensional CAD models of buildings for dynamic visualisation of a city, or for direct import into a GIS database.

2.2 ANALYSIS OF EXISTING SITUATIONS

GIS can help to store, manipulate, and analyse physical, social, and economic data of a city. Planners can then use the spatial query and mapping functions of GIS to analyse the existing situation in the city. Through map overlay analysis, GIS can help to identify areas of conflict of land development with the environment by overlaying existing land development on land suitability maps. Areas of environmental sensitivity can be identified using remote sensing and other environmental information.

2.3 MODELLING AND PROJECTION

A key function of planning is the projection of future population and economic growth. GIS can be used for prediction and projection. Spatial modelling of spatial distributions makes it possible to estimate the widest range of impacts of existing trends of population, and of economic and environmental change. For example, a range of environmental scenarios can be investigated through the projection of future demand for land resources from population and economic activities, modelling of the spatial distribution of such demand, and then using GIS map overlay analysis to identify areas of conflict. Using socioeconomic and environmental data stored in GIS, environmental planning models have been developed to identify areas of environmental concern and development conflict. GIS can also be used to model different development scenarios. It can show the modelling results in graphic form, making them easy to communicate with the decision-makers. Planners can use such information to formulate different planning options and help guide future development so that they avoid such conflicts.

2.4 DEVELOPMENT OF PLANNING OPTIONS

Land suitability maps are very useful in the development of planning options. They can be used to identify the solution space for future development. The association of spatial optimisation models with GIS can help to formulate and develop planning options which try to maximise or minimise some objective functions. The simulation of different scenarios of development with GIS can help in developing planning options.

2.5 SELECTION OF PLANNING OPTIONS

The final selection of a planning option is increasingly a political process, but planners can provide technical inputs to this process in order to help the community in making their collective choices. The integration of spatial and non-spatial models within GIS can help to evaluate different planning scenarios. The use of GIS with multi-criteria decision analysis can provide the technical inputs in the selection of planning options.

2.6 PLAN IMPLEMENTATION

GIS can be used in the implementation of urban plans by carrying out environmental impact assessment of proposed projects to evaluate and minimise the impact of development on the. Following such work, remedial measures can be recommended to alleviate the impacts.

2.7 PLAN EVALUATION, MONITORING, AND FEEDBACK

When used together with remote sensing, GIS can help to monitor the environment. It can, for example, be used to monitor land use changes. It can also examine whether land development is following the land use plan of the region, by overlaying a land development map produced from the analysis of remote sensing images on the land use plan. In addition, GIS can be used to evaluate the impact of development on the environment to see whether adjustments of the plan are needed. GIS can also be used in the monitoring and programming of land development.

3. GIS, SPATIAL DECISION SUPPORT SYSTEMS (SDSS), AND PLANNING SUPPORT SYSTEMS (PSS) IN URBAN PLANNING

A PSS, as first advocated by Harris (1989), is a combination of computer-based methods and models that support planning functions. PSS comprise a whole suite of related information technologies (e.g. GIS, spreadsheets, models, and databases) that have different applications in different stages of planning. The ways in which the planning process may be supported by PSS are shown in Figure 4. GIS are becoming important components of PSS by virtue of the geoprocessing, graphic display, database and modelling capabilities they possess.

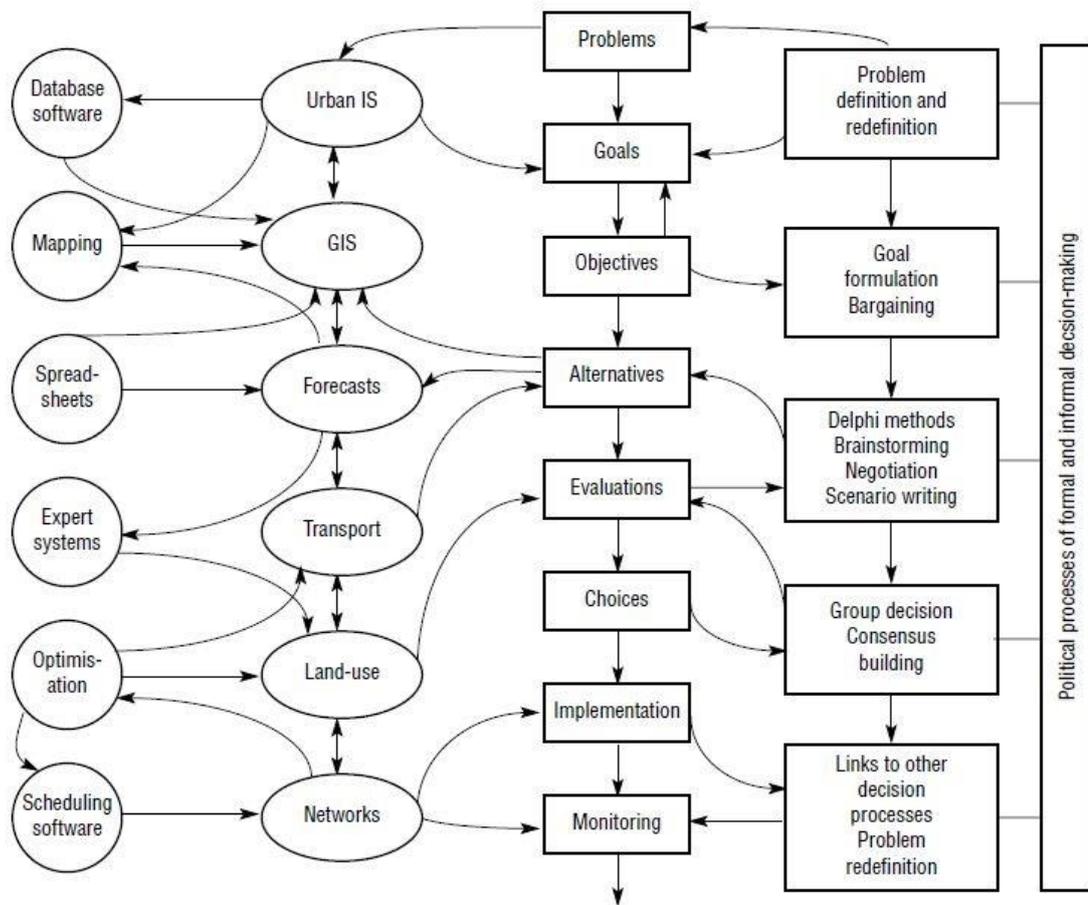


Fig 4 The planning process supported by a formal computation desktop PSS.

However, a PSS cannot consist of a GIS alone. It must also include the full range of the planner's traditional tools for economic and demographic analysis, forecasting, environmental modelling, transportation planning, and land-use modelling. It should also include other technologies such as expert systems, decision support aids (e.g. multi-criteria decision analysis), hypermedia systems, and group decision support systems.

4. TRENDS AND FACTORS INFLUENCING THE USE OF GIS IN URBAN PLANNING

4.1 TRENDS IN THE USE OF GIS IN URBAN PLANNING

The main weakness of GIS in urban planning is their linkage with urban planning models. There are different strategies for linking planning models with GIS. They range from loosely-coupled, to tightly-coupled and fully-integrated architectures.

Integration based on the loosely-coupled architecture involves importing and exporting data between GIS and planning models (Figure 5(a)). Data are exported from a GIS and transferred to an external program for execution. The modeling results may be sent back to GIS for display and further analysis. Tightly-coupled architecture integration involves writing programs within the GIS environment, avoiding explicit data transfer between software packages (Figure 5(b)).

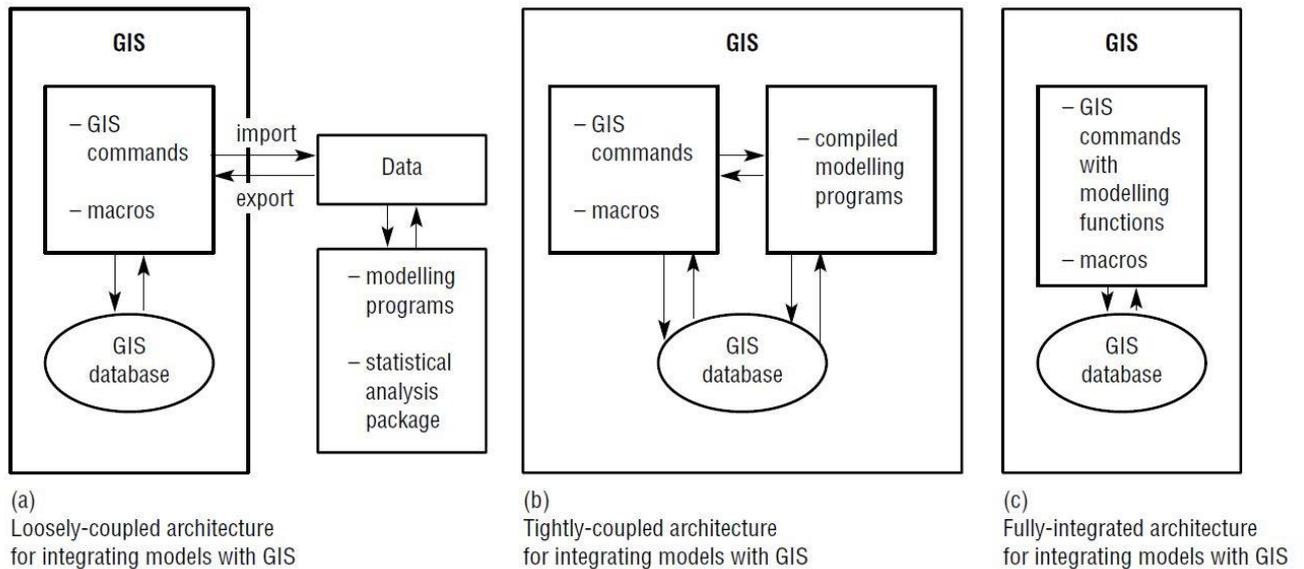


Fig 5 Integration of models with GIS: (a) loosely-coupled; (b) tightly-coupled; and (c) fully-integrated architecture.

Today the loosely-coupled architecture is the most commonly used in the integration of planning models and GIS. The California Urban Futures Model uses the loosely-coupled approach in the integration of GIS with models. It makes use of GIS extensively for data manipulation and displaying the results of external modeling packages. Such an approach is also used in multiple criteria decision-making planning methods. The tightly-coupled approach has been used for residential location modelling in the Buffalo, USA region. Currently, there is an increasing trend toward the development of fully integrated planning models in GIS. For example, location-allocation and spatial interaction models are now in ARC/INFO. This saves the users from programming the models themselves. However, until most of the commonly used planning models are fully integrated in GIS, there is still a need for loosely-coupled and tightly-coupled architectures.

Data visualisation is a very valuable GIS function in a planning decision support system and the development of user-friendly data visualisation functions has made GIS more useful to planning.

The integration of multimedia data types and the use of GIS in the Internet/Intranet environment (especially the World Wide Web, WWW) are some of the recent GIS developments that have had great impacts on urban planning. The incorporation of images, videos, aerial photographs, and sound within GIS can increase the planners' comprehension of the planning problem that they are analysing. The integration of GIS with virtual reality can enable planners to examine the space that they are planning more realistically. The Internet and intranets are useful for communicating design ideas. The use of GIS in the Internet and WWW environment can also facilitate the dissemination of planning information and enhance citizen participation in the planning process. Unlike the past in which citizens had to go physically to the town hall to examine plans, they can now see them in their offices and homes via the Internet at any time.

4.2 FACTORS INFLUENCING THE USE OF GIS IN URBAN PLANNING

The use of the GIS in urban planning does not depend solely on the development of new GIS software and hardware. Indeed these considerations may be amongst the least important in influencing whether GIS is used in urban planning in a city. The status and character of the organisation, data, state-of-the-art of planning, and staff are more important factors.

4.2.1 ORGANISATION

No matter how sophisticated and advanced it is, a decision support system is useless if it is not being used by decision-makers. Studies on the applications of GIS repeatedly show that staff and organizational factors are more important than technology in successful applications of GIS. There are three sets of conditions that are important in effective implementation of GIS:

1. an information management strategy that identifies the needs of users and takes account of the resources at the disposal of the organisation;
2. commitment to, and participation in, the implementation of any form of information technology by individuals at all levels of the organisation;
3. a high degree of organisational and environmental stability (Campbell 1994; Masser and Campbell 1991). GIS that are most likely to be used are those that can deal with identifiable problems. More complex applications are less likely to be developed than simple ones.

4.2.2 DATA

There has been a misconception that hardware, software, and human resources are major constraints on the use of GIS in urban planning in the developing countries. In fact, the availability of up-to-date data is the most important bottleneck in preventing GIS from being used effectively in the developing countries. There is an urgent need to establish an institutional framework to ensure that the required data are regularly collected and updated.

4.2.3 STATE-OF-THE-ART OF PLANNING

With the rapid growth of GIS, there is a shortage of human resources even in the developed countries. The shortage of skilled personnel is currently very severe, especially given the number of cities and regions in the developing countries that can benefit from GIS.

CONCLUSION

With the increase in user friendliness and the number of functions of GIS software, and the marked decrease in the prices of GIS hardware, GIS is now an operational and affordable information system for planning. It is increasingly becoming an important component in the planning support system. Recent advances in the integration of GIS with planning models, visualisation, and the Internet will make GIS more useful to urban planning. Today, the main constraints on the use of GIS in urban planning are not technical issues, but the availability of data, organisational change, and staffing.

Unit №2

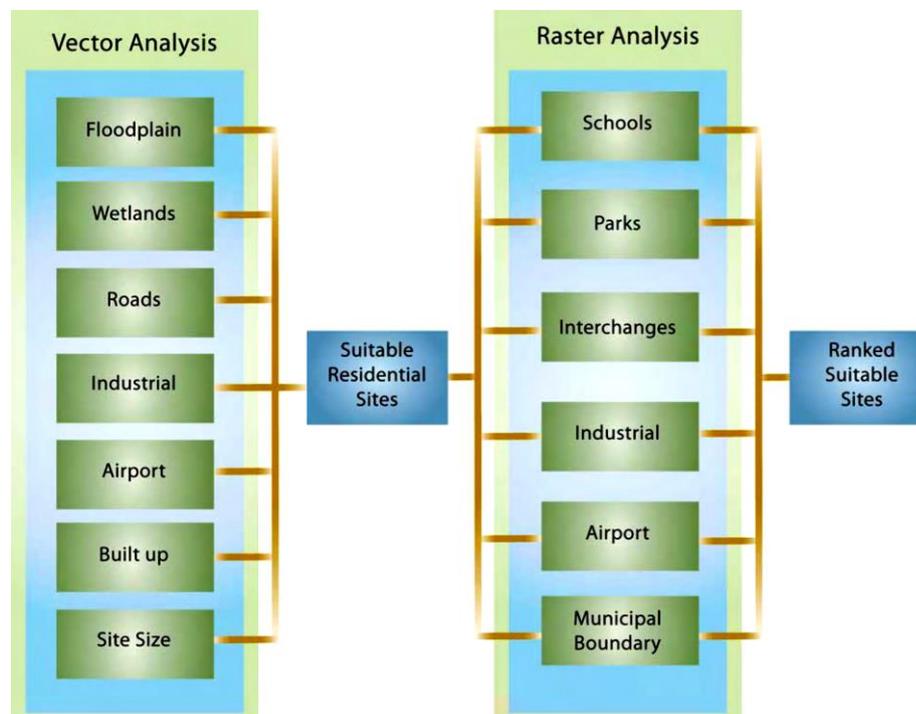
EFFECTIVE GROWTH MANAGEMENT

The main issues addressed at the Unit :

1. General information
2. Purpose of the Study
3. Site Selection Criteria
4. Analytic Procedures
5. Vector-Based Analysis
6. Raster-Based Analysis
7. Conclusion

1. GENERAL INFORMATION

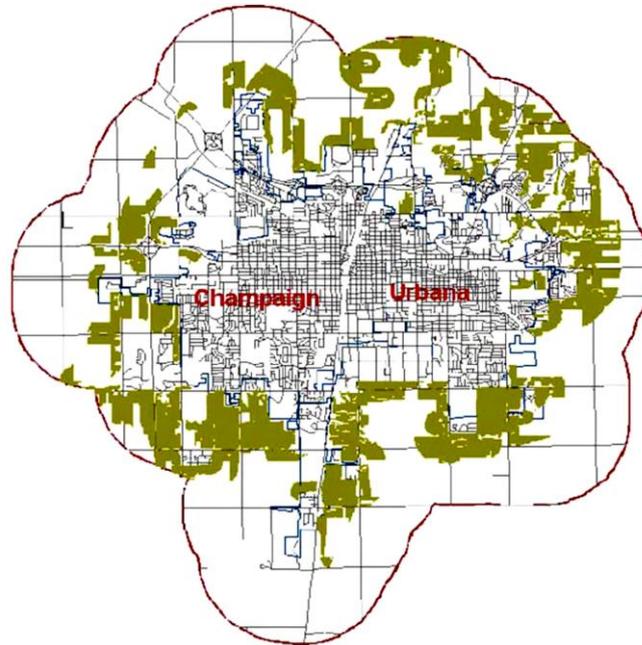
GIS allows for multiple criteria evaluation (MCE). This analysis is mainly characterized by allocating weights to assessment criteria for suggesting and ranking alternatives. GIS spatial planning support tools have an important advantage—changing the valuation criteria to visually illustrate and depict the implications of different spatial decisions and alternatives is convenient. The capabilities needed for decision making readily available in a single system make GIS a great tool for integrating in planning processes. This article describes a study that showed how GIS spatial analytical tools can be used to effectively shape decisions that foster urban growth management.



Overview of the analytical procedure

2. PURPOSE OF THE STUDY

The study identified desirable locations for anticipated low-density residential projects in the Champaign–Urbana region, Illinois. The analysis was based on two almost contradictory approaches and compared the resulting maps.



Map resulting from vector-based analysis showing sites initially identified as suitable for low-density residential development

The sites were analyzed and evaluated according to two scenarios. The first scenario was based on the developer's point of view and took into account the purchasers' preferences. This scenario considered the developer's preferences pertaining to economic and marketing factors. To that end, the developer was interested in maximizing profit and minimizing the cost of the development and paid little or no attention to environmental concerns. The second scenario was based on the environmentalists' point of view, which is the opposite of the first scenario. In this scenario, sites were ranked and evaluated on potential for engendering environmentally friendly development. In this regard, protecting the agricultural and forest lands and maintaining the integrity of the environment were the most decisive factors in influencing environmentalists' criteria and decisions.

Site-specific selection factors.

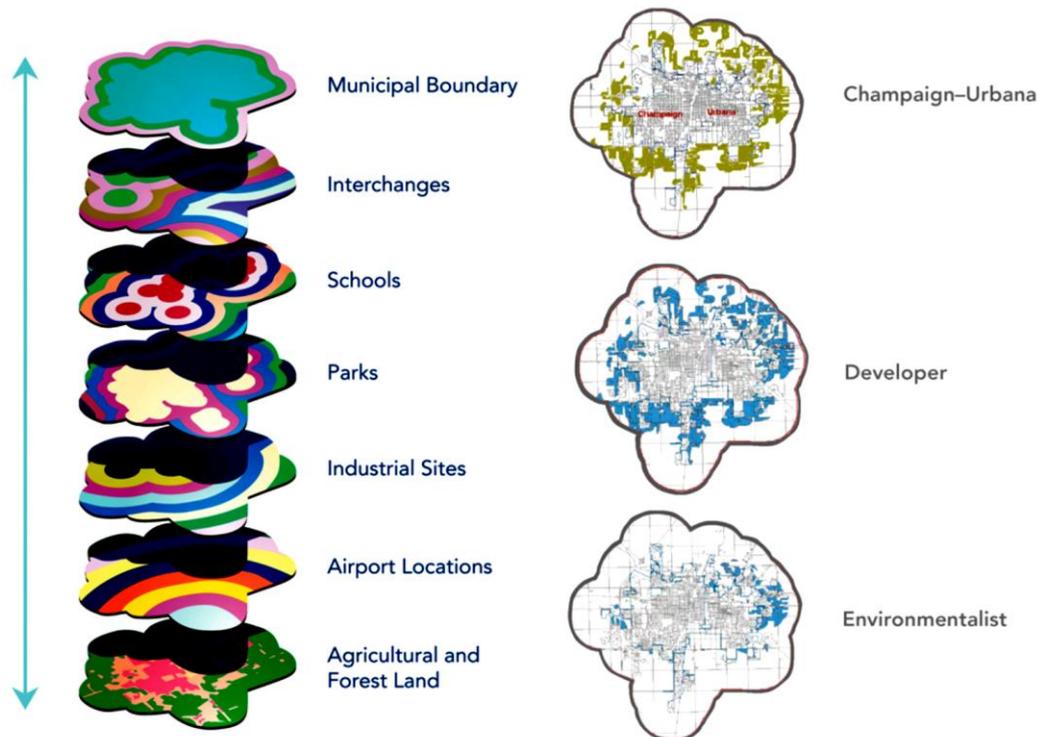
Factor	Requirements
Location in 100-year floodplain and/or wetland areas	The site must avoid floodplain designated areas or areas that have high runoff rates to prevent any environmental hazards.
Soil type	The site must avoid soils with low bearing strength or poor drainage.
Topography	Avoiding sites that have steep terrains reduces the cost of site grading. Constructing on steep slopes means that a tremendous amount of site grading is necessary for adequate drainage and sewage systems.
Site size	The site should be of a minimum size to increase the overall project profitability.

External site selection factors

Factor	Requirements
Proximity to the existing urbanized areas	The site should be connected to existing residential areas with a high growth potential. This condition ensures that the site is adequately served by the existing facilities and infrastructure. A desirable distance from the nearest built-up areas should not exceed a half mile.
Environmental legislation compliance	To preserve the environmental quality of the area, the site must avoid environmentally sensitive sites and open spaces.
Accessibility	The site must be accessible and well connected by the transportation network to ensure that the commute time required for work, entertainment, or shopping trips does not exceed 30 minutes.
Proximity to industrial and landfill sites	A minimum distance of one mile from landfill and industrial locations and other noxious land uses must be secured to prevent noise and eliminate the immediate threat of chemical emissions harmful to public health.
Airport location	A minimum distance of one mile from the airport, located to the south of the Champaign-Urbana region, was deemed sufficient to avoid adverse impacts of airport noise.

3. SITE SELECTION CRITERIA

The site selection suitability analysis conducted for the study included weighing the different factors in both scenarios and ranking desirable sites. The outcome of both scenarios was evaluated and analyzed based on features of the site and features of the surrounding area.



The raster layers used in raster analysis

4. ANALYTIC PROCEDURES

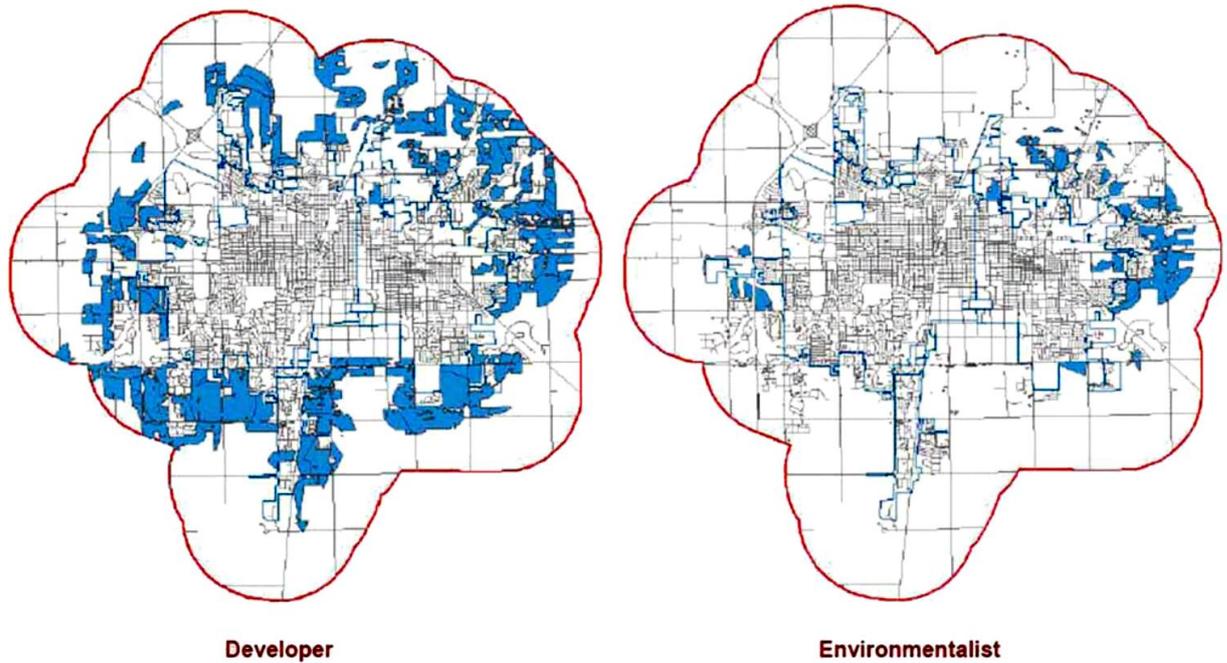
The analytic steps conducted in this study were combined into two major categories: vector analysis and raster analysis.

5. VECTOR-BASED ANALYSIS

Using vector-based geoprocessing tools, the final layers were juxtaposed on one map that showed sites initially identified as suitable for low-density residential development. At this stage of the analysis, the output did not reflect either the developer's or the environmentalist's concerns.

6. RASTER-BASED ANALYSIS

This analysis considered the two scenarios, introduced in the beginning of the study, that represented a developer's viewpoint and an environmentalist's viewpoint. All layers were classified according to a 10-category color scale for consistency purposes.



Maps illustrate ranked sites based on developer and environmentalist preferences

7. CONCLUSION

The findings from this study were mapped and provided a comparison of the results obtained from both scenarios. Suitable areas for the low-density residential development in the developer's scenario cover a significantly larger portion of the region than the environmentalist's conservative scenario. Because developers typically do not pay a great deal of attention to environmental factors, many more areas were proposed for development. Conversely, environmentalists' efforts to preserve the natural resources of the region greatly limited the amount of land perceived as suitable for future development.

This study provided an example of how GIS could be used to support planning tasks and help make better decisions regarding real-world planning issues and develop communities more effectively. It emphasizes the role of GIS in urban growth management practice and land-use planning decision making. The study argued for the full utilization of GIS in ways that maximize its contribution to the planning practice instead of limiting its application to mapmaking and cartography only.

Unit №3

GIS IN A KNOWLEDGE DOMAIN: BRINGING GIS TO OPERATIONAL INTEGRATION IN SPATIAL PLANNING

1 Introduction

Knowledge in many domains evolves rapidly and often depends upon the context of one's task situation, including one's support community (Senge, 1990)

The assertion that organisational issues are just as important as technical sophistication in the development of GIS within spatial planning is a recurring theme in the GIS & planning literature (Harris 1989, Couclelis 1991, Worrall & Bond 1996,). Despite this recognition until recently there has been little research into how these issues may be overcome and to bring GI technology more firmly within an operational context in spatial planning. In a comprehensive review of the contribution of Geographic Information Science to Urban and Regional planning Zorica Nedovic-Budic states that:

"While the scientific progress in building tools to support planning process is impressive, there has been little effort to provide practical guidance on strategic information management, to institutionalise information and decision support tools and to transfer the technology to planning settings"(Nedovic-Budic, P 81.)

Recent advances within organisational and management science concerning the role of information systems to organisational decision making and the character, form and use of knowledge in those process may provide the required guidance.

2 Spatial Planning – A Wicked Problem

The use and meaning of the term Spatial Planning has developed through time in response to the particular legal, socio-economic, political and cultural forces of a country or region.

Definitions of spatial planning are often specific to each EU Member State and are commonly not directly transferable from one situation to another. This is true even where the same term is used in the same language in different countries. Despite this the term "Spatial Planning" has been adopted by the European Commission as a neutral generic term, which does not equate precisely to any one of the member state systems for managing spatial development.

Spatial Planning can be defined as methods used, largely by the public agencies,

- to influence the future distribution of activities in space;
- to create a more rational territorial organisation of land uses and the linkages between them;
- to balance demands for development with the need to protect the environment, and to achieve social and economic objectives
- to co-ordinate the spatial impacts of other sectoral policies;
- to achieve a more even distribution of economic development between regions than would otherwise be created by market forces.

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This beguilingly straightforward definition of Spatial Planning belies its complexity regarding its object (a particular project), its process and indeed its purpose. Spatial planning encompasses national and trans-national planning; regional policy; regional planning; and detailed land use planning. Implicit within the term is the need for integration between the *spatial* planning process and the *sectoral* planning process. There is a fundamental difference between planning systems, which integrate social and economic planning with spatial development policy and those primarily concerned with controlling land use and development.

Thus Spatial Planning is about spatial decision processes at a variety of scales. The Rational model of decision-making identifies four phases of activity which when implemented in the real world are of mediated by conditions of ‘Bounded Rationality’ where ‘sufficing’ decisions are put in place. (Simon 1991).

The four phases of the Rational Model are:

Intelligence: Searching for conditions calling for a decision “What is the problem?”

Design: Finding and evaluating decision alternatives “What can we do?”

Choice: Selecting the most acceptable alternative “Which is the best option?”

Execution Implementing and monitoring the decision

& Review:

Which gives rise to conceptualisations of decision-making process such as the diagram below:

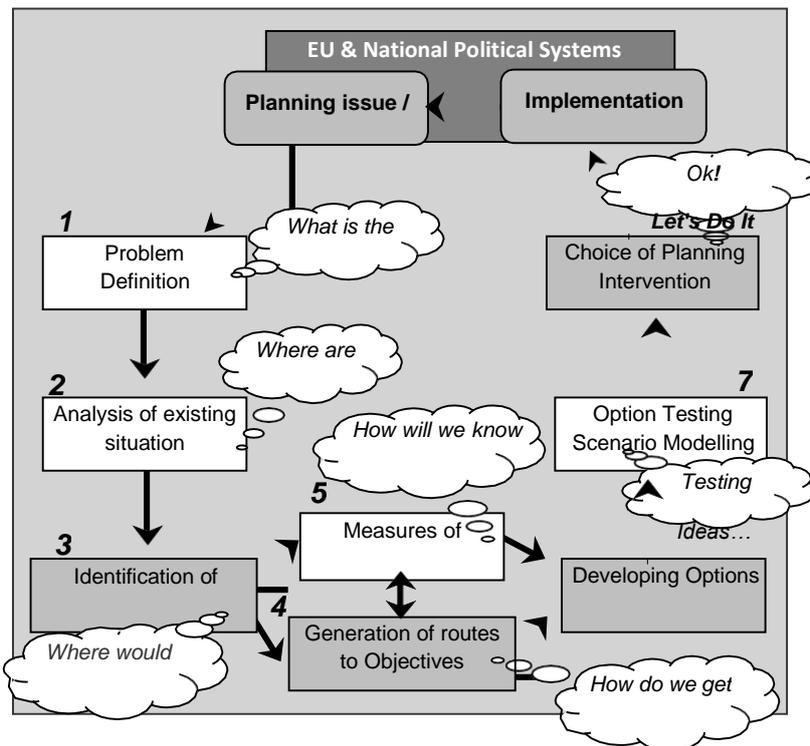


Figure 1. Rational Model of Spatial Planning Decision making

However as indicated, Spatial Planning has additional factors that compound its articulation including:

Multiple Scales of space, time and organisations

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Multiple Actors with different social, political and economic interests, positions and perceptions of individual and groups

Multiple Objectives concerning environment, socio-political, economical and cultural goals

Multiple Criteria with input from sectors and activities that include agriculture, forestry, marine, economy, landscape, retail, health, social, culture, ecology together with the law and bureaucratic procedures.

It is through representations of the environment, the project and of society that decision makers base their judgements. As such spatial planning cannot be divorced from its social and relational context and the difficulties in identifying how these contexts function is apparent from when we examine spatial planning problems whether at a local scale concerning for example in waste management and site selection or at broader scales when designing national spatial plans.

The difficulties associated with many spatial planning decisions can be firmly placed into Rittel and Webbers (1984) classic characterisation of 'Wicked Problems' where the problem:

- Cannot be easily defined, making it difficult for all stakeholders to agree on what problem to solve
- Require complex judgements about the level of abstraction at which to define the problem
- Have no clear stopping rules (usually when resources run out)
- Have better or worse solutions, not right or wrong ones
- Have no objective measure of success
- Have no given alternative solutions – these must be discovered
- Often have strong moral, political or professional dimensions

While perhaps not all spatial planning problems can be characterised strictly under these criteria, there are many examples at regional, national and European scales which can; including managing rural settlement policy - a topical Irish example; or spatial policies concerning Nuclear waste management at the European (Global) scale.

3 Current uses of GIS assist Spatial Planning

Harris (1989) described the principal functions of planning as:

Operational functions: Day-to-day routines of plan implementation and administration.

Management Functions: Managing environmental, cultural and social resources.

Strategic Functions: Interventions that directly and deliberately affect socio-economic processes.

Communication Functions: Keeping the public and political systems informed and involved.

The 'strategic' function has most bearing in spatial planning, but the other functions have important contributions to make nonetheless. Attempts to assist these planning functions have been made through four principal clusters of GIS activity they are:

- i. **GIS databases to assist planning actions**
- ii. **Coupling of geographic information technologies with urban and regional modelling**

iii. Development of Planning Support Systems (Spatial Decision Support Systems SDSS)

iv. Potential to facilitate discourse and participation in the planning process

i) GIS databases

Application of GIS databases in spatial planning is most commonly associated with resource management, operational control and undertaking focused scientific enquiry. Data management reduction, automated mapping and data visualisation are common activities and there are many convincing examples of individual analysis that demonstrate the descriptive and interrogative powers of GIS in planning related activities (Longley et al. 1991).

Much effort has been expended into construction of such databases often at the expense of analytical capabilities especially in socio-economic processes (Worral & Bond 1996, Nedovic-Budic, 2000). Despite these difficulties GIS databases have made significant contributions to the operational practice in spatial planning which should not be overlooked.

ii) GIS – Modelling & Simulation Activities

In an effort to overcome predictive deficiencies sustained research has focused on expanding GIS capabilities to include urban and regional modelling and more sophisticated spatial analysis capabilities (Longley & Batty 1996). The impact of a model based GIS in spatial planning has been uneven (Worral & Bond 1996), but notable exceptions have been associated with retail and service location/allocation together with micro-simulation demographic analysis, albeit sometimes in the relatively narrow confines of profitable location detection for business. (Birkin et al. 1999). Although use of urban and regional models has a long history, with a particularly fruitful period during the 1960's, their relative paucity within spatial planning has as much to do with changing organisational demands and emphasis as it does on difficulties associated with data, computation, simulation and mathematics as the planning process and practice engaged in the political arena as much as the scientific (Couclelis, 1991).

iii) Spatial / Planning Decision Support Systems

Planning support systems are envisaged as an integrated tool based on multiple technologies. In addition to standard GIS functionality of spatial data management, analysis and communication capabilities such systems are seen to extend beyond current GIS technology. They should incorporate “tools for sketch planning, model building, scenario building, evaluation, lineage tracking, and plan-based action” (Hopkins, 1999 p. 333). Furthermore, reflecting requirements for wider input to the spatial planning process ongoing developments in planning support systems should facilitate multi-agent based spatial planning (Ferrand 1996). Such systems endeavour to enable multiple input to the decision process and allow for “Spatial Negotiation” to provide Collaborative Spatial Decision Support (CSDM). Internet development has spurred much interest in such systems and an operational example was developed in the GeoMed project (Schmidt-Belz et al., 1998).

In the GeoMed project the authors clearly identified the benefits of a system that provided both access to information and the opportunity of input to a wide range of stakeholders in the planning process. It is worth noting however that the authors noted particular difficulties with integrating the system with current working procedures in the

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pilot organisations. This is a common problem with Planning Support Systems that has more to do with how the organisations treat the information provided than with technical issues (Schmidt-Belz et al., 1998).

iv) Public participation and facilitation

Related to the goals of collaborative systems in planning but more focused on access to information as opposed to purely technological innovation, the concern here is on communication and dissemination. Positive contributions resulting from WEB based mapping initiatives need to be contrasted against difficulties in accessing GIS data and competencies faced by non-profit, non-government organisations. Building on issues associated with accessibility and cost, concerns have also been expressed about how the social construction of GIS may be at odds to its use by non-conforming social groups, (Sieber, 2000).

Unit №4

KNOWLEDGE MANAGEMENT (A CONTEXT FOR USE OF GEOGRAPHIC INFORMATION IN SPATIAL PLANNING)

The main issues addressed at the Unit :

1. General information
2. Knowledge Drivers
3. Knowledge Assets
4. Organisations – knowledge management and gis in spatial planning

1. GENERAL INFORMATION

- Where does the information used in Spatial Planning organisations derive?
- How is it created?
- Who manages it?
- Who controls it?
- How is it evaluated and how are judgements made on it?
- How is it stored and retrieved?
- And perhaps most importantly of all how is it communicated to other individuals and organisations?

Given that spatial planning is indeed a complex process, these questions are not easily answered. GIS is certainly one component of the sum of knowledge used in the spatial planning, but it is naïve to consider that codified information held by current Information technology configurations will ever encompass its entirety. Equally, we must bear in mind that information in itself is inherently valueless; we must apply some form of judgement to make sense of it and to put it to use.

The transformation of data and information has been visualised within a hierarchy (fig.1).

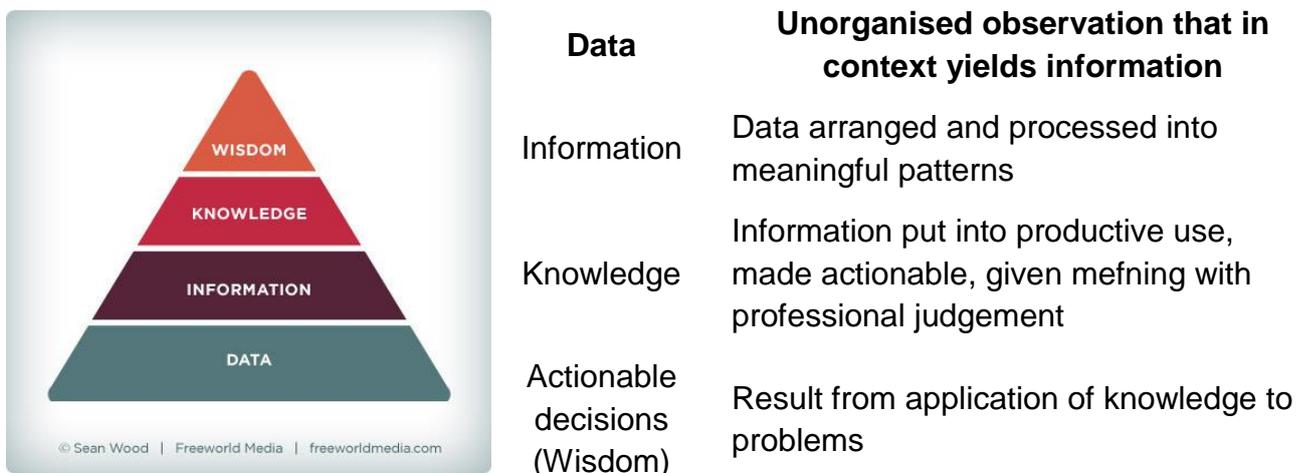


Figure 1. The Knowledge Hierarchy (Skryme & Amidon, 1997)

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In one form or another organisations concerned with spatial planning apply their knowledge to reach decisions. The Knowledge Hierarchy is a useful means of demonstrating the relationships between data, information and knowledge. However, we must bear in mind that the ‘meaning’ put on to information will vary according to context. Knowledge created in one context may have little or no relevance in another context, and if it is to be transferred between contexts it is likely to require interpretation and adaption.

Knowledge management aims to provide a basis for evaluating these issues. Knowledge management for organisations is about understanding and managing the contexts where knowledge is created for the organisation, how it is transferred, utilised and applied through the organisation and ultimately how it is reused and stored to assist the organisation achieve its objectives.

Proponents for the use of GIS and the wider utilisation of GI in spatial planning often state that GIS will assist better decision-making but fail to identify how. Certainly rigorous analysis of well-controlled data can form part of a convincing argument when making a case for a landfill site selection process for example. But this is absolutely no guarantee that the site will be chosen by the decision makers, (Cantwell 1999).

2. KNOWLEDGE DRIVERS

As a wide-ranging branch of management science Knowledge Management covers many concepts and perspectives that have a bearing on the utilisation of GIS within organisations. Organisations have always been concerned with how they manage their knowledge and many of the activities being promoted under the guise ‘knowledge management’ have been used by organisations for a long time. Nonetheless Knowledge Management does have its own distinct identity and a number of factors have come together to place knowledge high on the agenda for many organisations. Perhaps the most important is the recognition that knowledge and information have become the most valuable commodities in post-industrial societies. And to thrive in the turbulent competitive environment of commercial and non-commercial organisations demands a more structured approach to managing what the organisation does and how it does it. (Senge 1990, Morgan 1997, Stewart 1997).

The principal drivers that have generated interest in knowledge management are:



Figure 2. Knowledge Drivers (Quintas & Jones 2001)

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Fundamental to the practices associated with Knowledge Management is the recognition that knowledge within organisations exists in different forms and can be retained by individuals or groups. Cook and Brown identified four distinct forms of knowledge and that each should have equal standing when considering how these are put into practice (Cook & Brown, 1999). The division rests on whether knowledge is explicit or tacit and whether it is retained at a group level or individual level.

	Individual	Group
Explicit	Concepts	Stories
Tacit	Skills	Genres

Figure 3. Four forms of Knowledge, (Cook & Brown, 1999)

The distinction between Tacit / explicit knowledge arises from work of Michael Polanyi where Explicit knowledge can be expressed in a formal and systematic language and is often shared as scientific formulae, or specifications (Polanyi 1983). In contrast tacit knowledge, is of no less importance in the context of using knowledge in ‘the real world’, and concerns personal perceptual concepts and often consists of subjective insights or intuitions. It is rooted in actions, procedures, values or emotions (Nonaka et al. 2000). Polanyi neatly describes the difference between each by illustrating that it is tacit knowledge that is required to ride a bicycle and explicit knowledge to know where to cycle it (Polanyi 1983).

3. KNOWLEDGE ASSETS

Of particular interest in Knowledge Management are the processes that occur within organisations that create, convert and utilise types of Knowledge. Nonaka describes the Wealth From Knowledge Organisation value dependent on intellectual capital Knowledge Interdependence Cross-boundary reliance between organisations for information Technology Potentials and limits of information systems and management Human Resources People own knowledge and drive organisational memory Organisational Learning Continuous regeneration of knowledge base within organisations Innovation Advantage through knowledge creation, sharing and application Knowledge Management Individual Group Explicit Tacit Concepts Skills Stories Genres David Moore GIS in a Knowledge Domain Page 9 process through the SECI1 model whereby different types of interactions between individuals within an organisation and between different organisations can embed knowledge in the organisation. In the SECI process, (Nonaka et al., 2000) individuals may share Tacit knowledge through informal ‘Socialisation’ (e.g. two planners meeting discussing their experiences concerning rural housing policy implementation over a pint at lunch); this information may become explicit through articulating it by ‘Externalisation’ (e.g. as a result the lunching planners agree to express

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their ideas into a memo for the Planning Services Director). The significance of this explicit knowledge is assessed through the ‘Combination’ process (e.g. The Planning Services Director initiates a query of planning applications held in the GIS of the organisation to test the Planners ideas). The final stage ‘Internalisation’ occurs when as a result of examination from the Combination exercise the initial ideas are embodied into the organisation (e.g. The methods of assessing rural housing applications is altered within the planning authority) The process is visualised as a never ending spiral, that upgrades it self constantly and takes place both inside and outside the organisation. Nonaka goes on to demonstrate how different knowledge assets may be garnered from each part of the SECI process:

Tacit to Tacit	Tacit to Explicit
Experiential knowledge assets Tacit knowledge through shared experience · Skills and know-how of individuals · Commitment, Energy Trust · Trust, Values, Beliefs	Conceptual knowledge assets Explicit knowledge articulated through images, maps, symbols and language · Planning concepts/theory · Policy frameworks · State of the environment
Routine Knowledge Assets Tacit knowledge routinized and embedded in actions and practices · Know-how in daily operations · Planning procedures in practice · Organizational Culture	Systematic knowledge Assets Systematized and packaged explicit knowledge · Development Plans / reports · GIS Databases · Manuals
Explicit to Tacit	

Figure 4. Knowledge Assets (After Nonaka et al. 2000)

These models provide a useful description how organisations concerned with spatial planning may use a variety of process to inform their decision-making processes. Geographic Information systems seek to codify our knowledge of the world through computer based representations. In doing so we lose details of the context of that information. Stahl (1993) demonstrated how transformation of knowledge from tacit to explicit to formally codified representations in computer form leads to a separation of the tacit knowledge that underpins collective understanding and perception of the world (“Hermeneutic presence”) from its symbolic representation which allows application of abstract concepts and scientific analysis (fig.5).

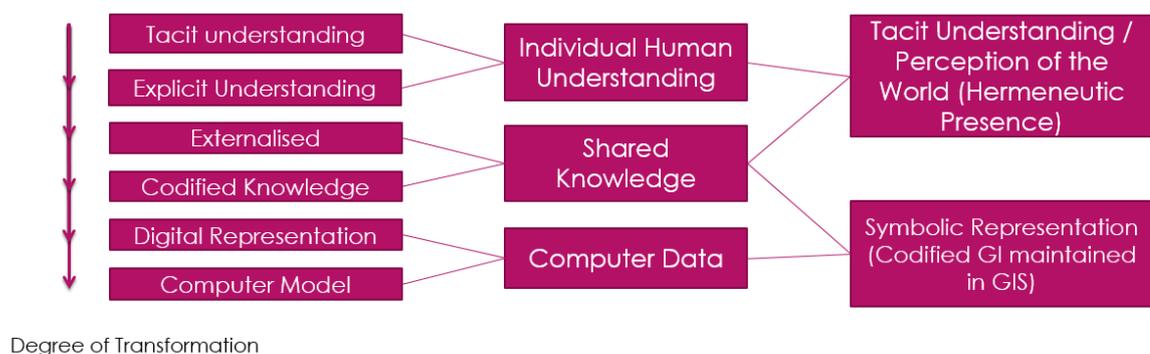


Figure 5. Transformation of Knowledge from tacit to explicit to computer based models and types of representations. (After Stahl 1993, quoted in Shum 2001, p14.)

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At each level in the transformation process an ontological change occurs that “distort knowledge and alienate it from the person possessing it in particular ways, effecting a gradual shift in definition of knowledge and expertise from an ability to a symbolically encoded fact” (Shum p.15). The implications for GI in spatial planning are that while computers support the task of making knowledge more explicit and therefore more shareable they can distort knowledge and distance it from the people who need it and perhaps created it.

4. ORGANISATIONS – KNOWLEDGE MANAGEMENT AND GIS IN SPATIAL PLANNING

It is known that an appreciation of organisational cultures, structures and processes is vital for successful implementation and utilisation of GIS (Longley et al. 2000). It is the contention of this paper that this appreciation must extend to include how knowledge is used within organisations to better understand the impact of GIS in Spatial Planning. The argument is that by introducing GIS into the organisation there are knock-on impacts into how the organisation manages its knowledge and to the competencies of the organisation. It is how Geographic information flows and is communicated using within the organisations that determines the success of GIS within the organisations.

The importance of clearly demarcating organisational processes that are affected by the introduction of GIS is common within GIS literature. Less commonly asserted is the need to reevaluate the entire transformation system or ‘value chain’ of the organisation. Azad (2000) shows how business processes must be linked the ‘value chain’ of using the example of a Land Administration organisation. He argues that emphases on business/organisational process are needed to ensure GIS activities in land administration are focused on the strategic mission of the organisation. Core processes must be prioritised and attention paid to missioncritical parts of process. In essence the author argues that use of GIS necessitates a reevaluation of the organisations systems, and by implication the reengineering of those processes where required.

Of particular interest in this paper are the Strategic functions identified by Harris that most directly rely on how the organisation gains knowledge using GIS. Hendricks (2000) demonstrated the types of organisational learning that can be affected by the extensive use of GIS. He distinguishes four types of organisational learning portrayed below:



Figure 6. Types of Organisational Learning (Hendricks, 2000)

He demonstrated that GIS was both a useful learning tool but also acted “as tools for linking individual people and departments and for communicating between them”.

The value of GIS to organisations can therefore be measured against its ability to crossover organisational boundaries.

Unit №5

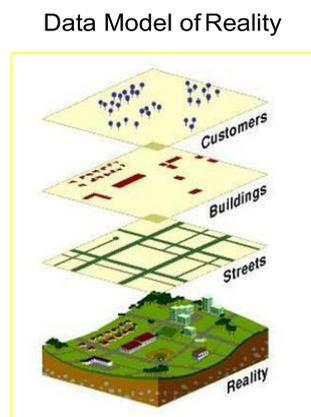
INTRODUCTION TO GIS USING ARCGIS DESKTOP 10

A GIS (Geographic Information System) is a powerful tool used for computerized mapping and spatial analysis. A GIS provides functionality to capture, store, query, analyze, display and output geographic information.

For this seminar we will be using ArcGIS Desktop 10, the newest version of a popular GIS software produced by ESRI. This course is meant to teach some fundamental GIS operations using ArcGIS. It is not meant to be a comprehensive course in GIS or ArcGIS. However, we hope this seminar will get you started using GIS and excited about learning more.

Definition of GIS

A computer-based system that stores geographically referenced data, links it with non-graphic attributes (data in tables) allowing for a wide range of information processing including manipulation, analysis and modeling. A GIS also provides for map display and production.



1. Components of ArcGIS Desktop 10

1.1. ArcMap, ArcCatalog, (and ArcToolbox)

ArcGIS Desktop is comprised of a set of integrated applications, which are accessible from the Start menu of your computer: ArcMap and ArcCatalog.

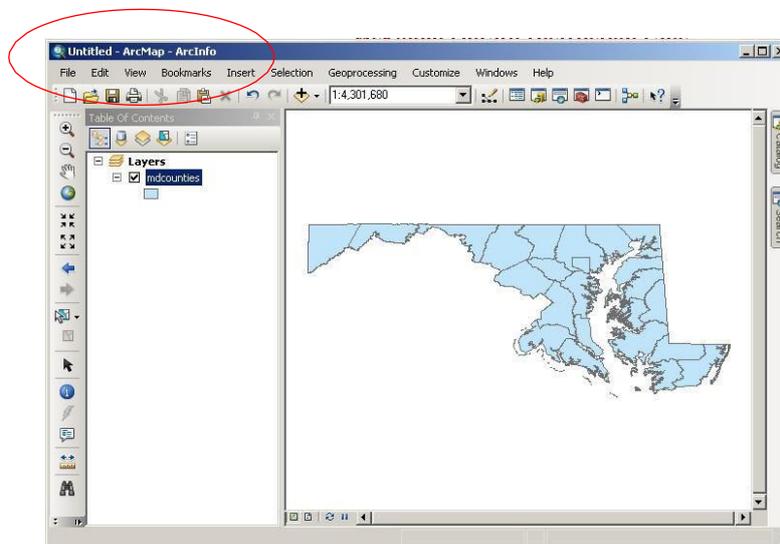
- ArcMap is the main mapping application which allows you to create maps, query attributes, analyze spatial relationships, and layout final projects.
- ArcCatalog organizes spatial data contained on your computer and various other locations and allows for you to search, preview, and add data to ArcMap as well as manage metadata and set up address locator services (geocoding).
- ArcToolbox is the third application of ArcGIS Desktop. Although it is not accessible from the Start menu, it is easily accessed and used within ArcMap and

ArcCatalog. ArcToolbox contains tools for geoprocessing, data conversion, coordinate systems, projections, and more. This workbook will focus on ArcMap and ArcCatalog.

1.2. Software Products (Licensing Levels)

ArcMap is made up of three software product levels: ArcView, ArcEditor, and ArcInfo. These products share a common architecture but provide increasing levels of functionality. ArcView provides the base mapping and analysis tools. ArcEditor provides all ArcView capability and includes additional processing and advanced editing. ArcInfo provides all ArcEditor capability plus advanced analysis and processing. While these levels are crucial to consider when purchasing software, it is also important to be aware of the limitations of the level you are using. We are using the ArcInfo level.

Look at the menu bar at the top of the window in either ArcMap or ArcCatalog to see which level you have.



1.3. Data Management – ArcCatalog

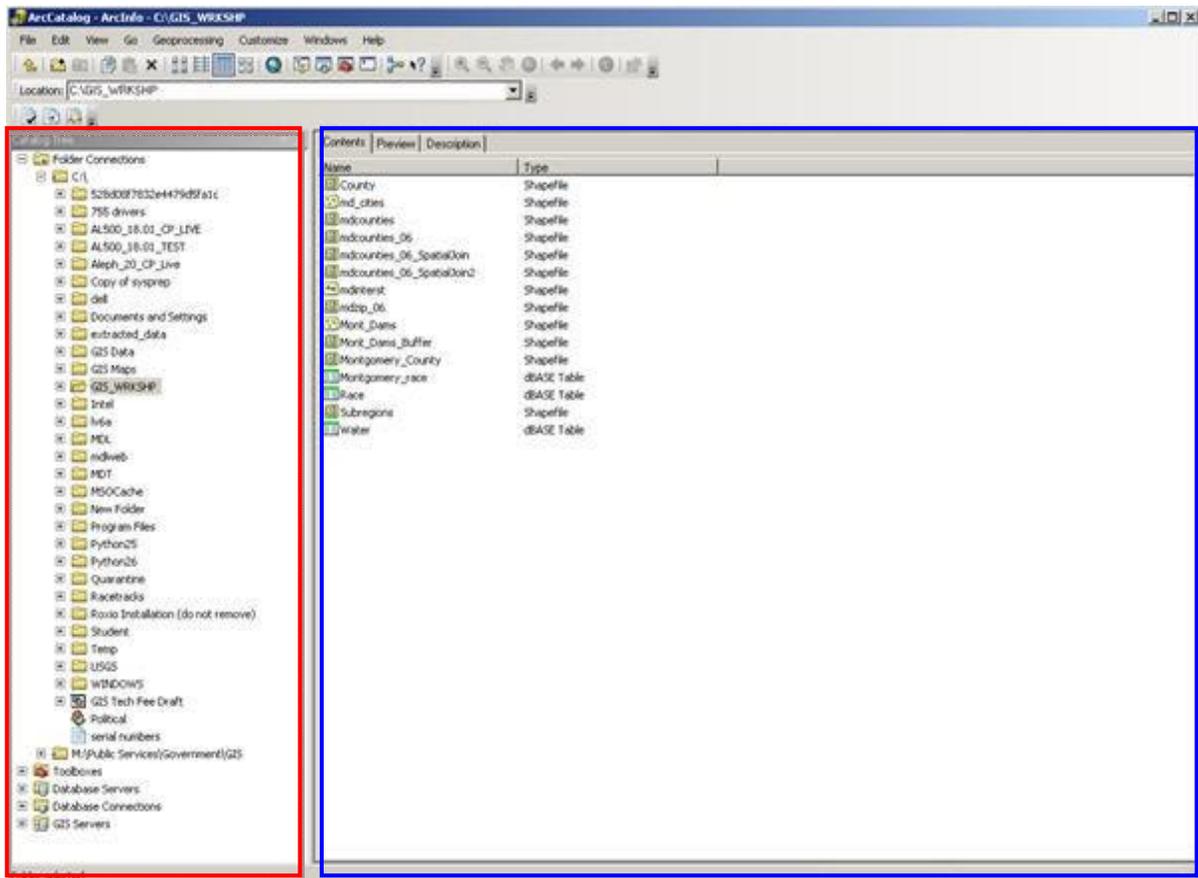
Searching and Content

Finding and using data is at the center of any GIS project. Let's get started by opening ArcCatalog:

1. Double-click with the left mouse button on the ArcCatalog icon on the desktop, or from the Windows Start menu, select 'Programs' > 'ARCGIS' > 'ArcCatalog'



After opening the software, you will be greeted by screen like this one:



The left side of the screen lists a set of possible locations for data in the *Catalog Tree*. Don't worry if yours does not look exactly the same. It is easy to add directories for data by clicking on the 'Connect to folder' icon on the top left toolbar. 

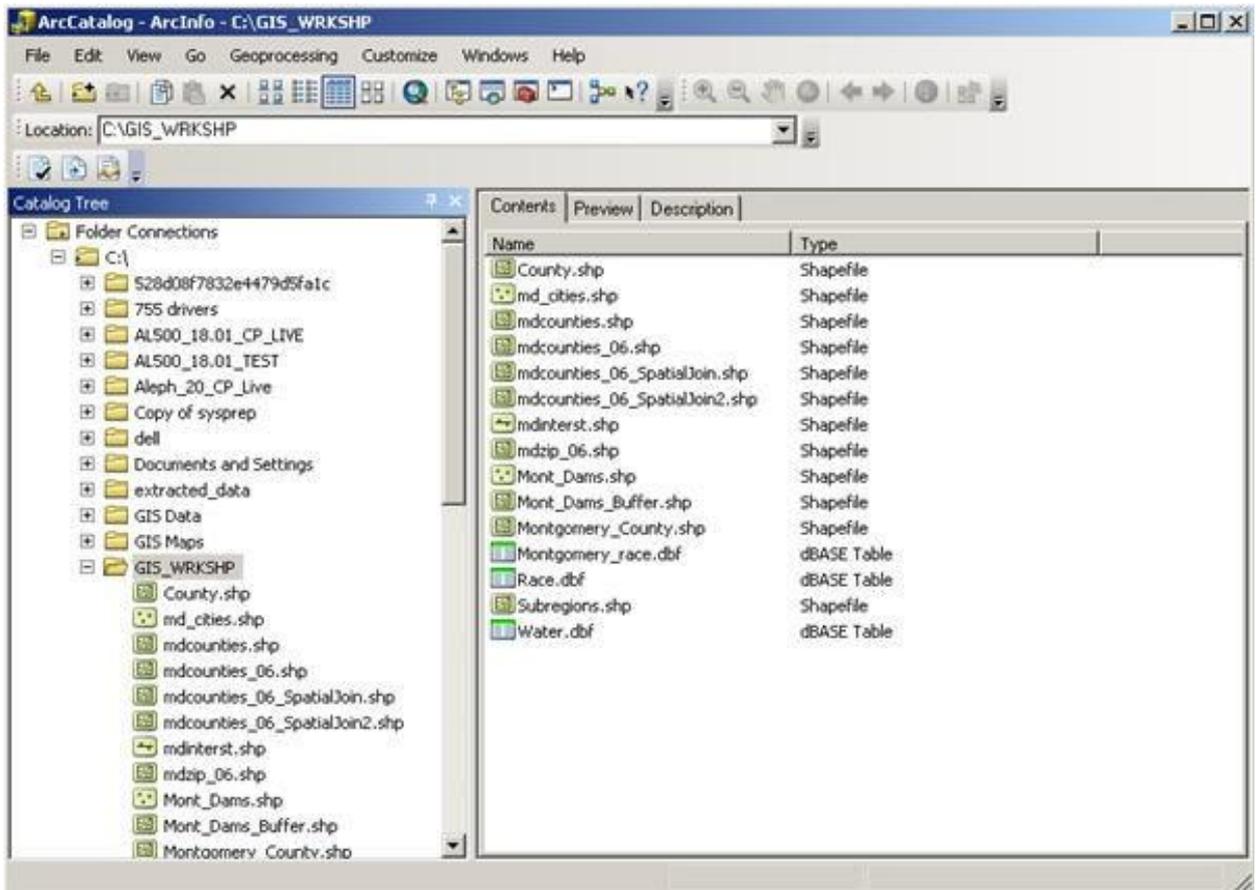
1.4. Common GIS File Types

Image formats – ArcGIS accepts and uses a variety of image files (.tiff, .jpg, .jp2, .png, etc).

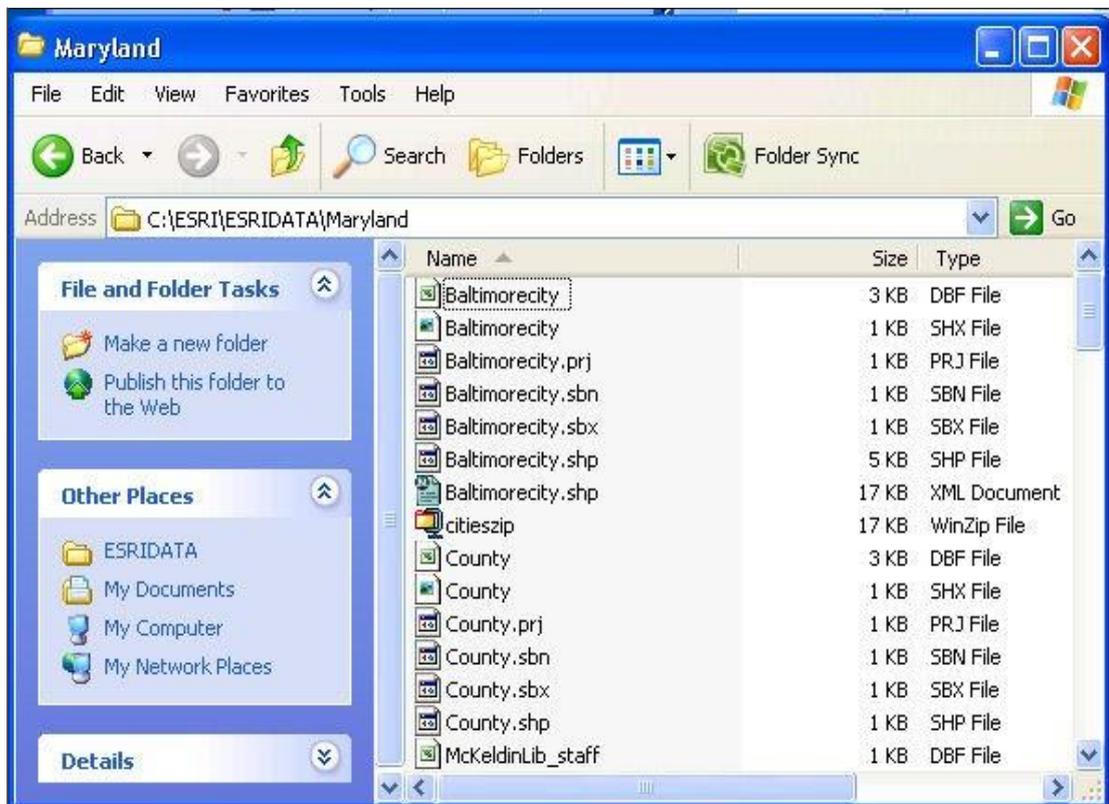
Text files (with x,y coordinates) Many others...

From the catalog tree on the left side, navigate to C:\ESRI\GIS_WRKSHP\. You will see a list of shapefiles. The .shp extension of the file means that these files are in shapefile format and thus can be read by ArcGIS. Although this is not the only file format ArcGIS can read, it is a popular format.

1. To view file extensions, navigate to 'Customize' > 'ArcCatalog Options' > and under the 'General' tab unclick 'Hide file extensions' and hit 'OK'.



NOTE: This is what shapefiles look like in Windows Explorer – a combination of 3 to 7 individual files make up one shapefile. You should view GIS data in ArcCatalog.



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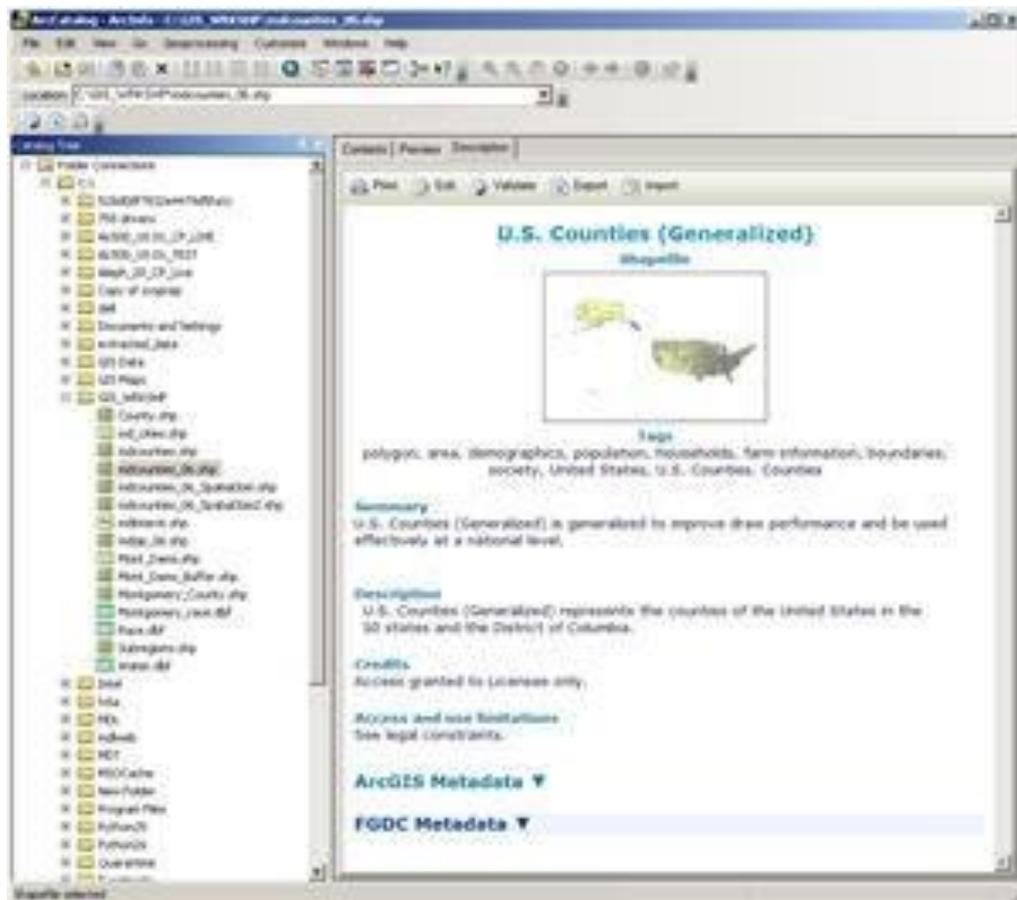
2. After locating data, it is possible to preview it before adding it to ArcMap. Click once with the left mouse button on mdcountries.shp and then select the 'Preview' tab.

This will allow you to look at the mdcountries file. We will return to these files later.

1.5. Metadata

Metadata is loosely defined as "data about data." This is important, especially in a geospatial context, because it contains information about the source, author, creation, and geographic referencing. ArcCatalog allows you to view and manage metadata.

1. Click on the 'Description' tab.



This section provides a description of the files, spatial information, and a list of all of the attributes associated with the file.

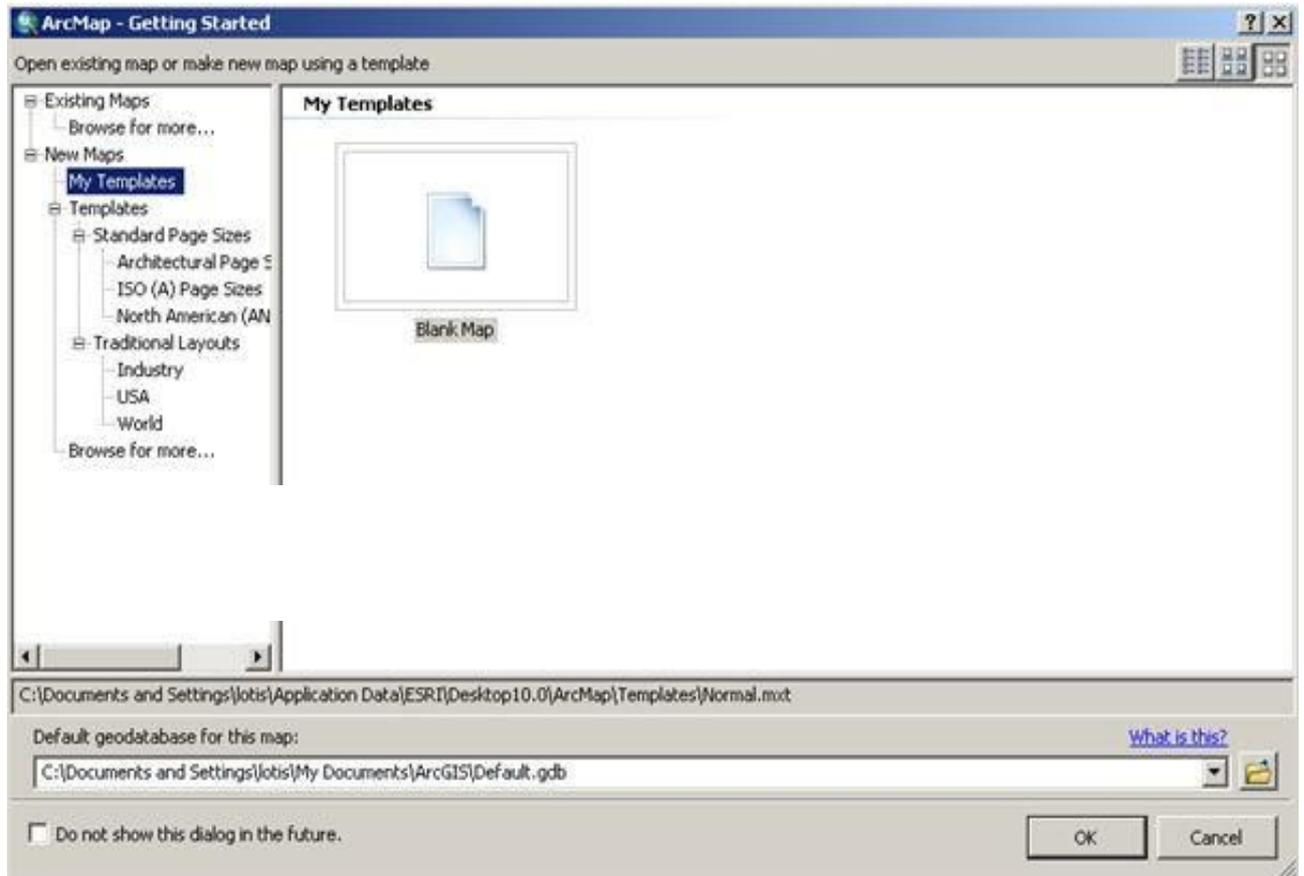
2. Organization of ArcMap

ArcMap can be opened from multiple locations. This time, we will open it from ArcCatalog. It can also be opened from the start menu or an icon on the desktop.

2.1. Beginning with a Blank Project

1. From ArcCatalog, click on the ArcMap icon: 

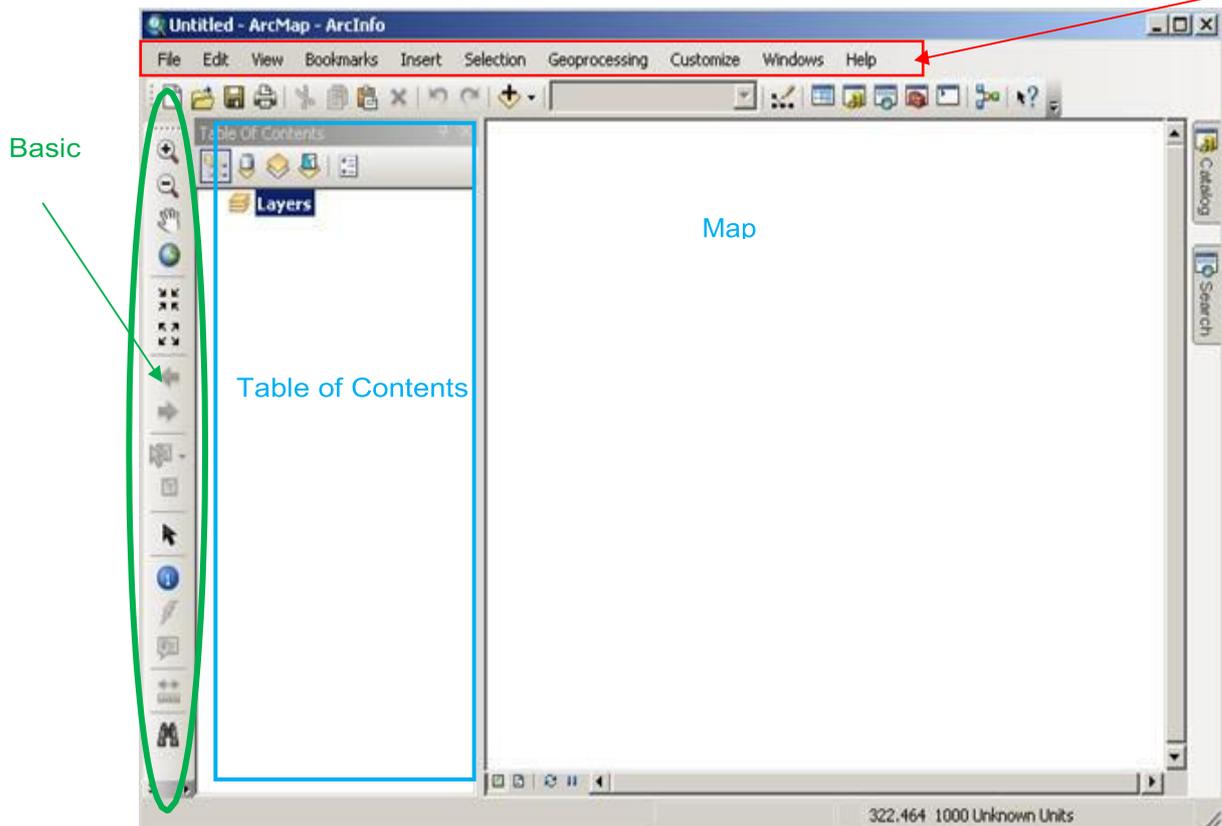
Upon opening ArcMap you may see the following startup window:



This is a new feature with version 10 of ArcGIS software that allows you to make a shortcut to your most-used data location. Since we're just beginning, we are going to skip this option and simply use the default. Click on Cancel.

ArcMap makes a default geodatabase in the C:\My Documents\ArcGIS folder. Now you will be in a new, blank document in ArcMap.

This area is known as the Map Display. This display area is where map features are drawn.



When you begin, the menu bar changes to show the menu functions available. You can change the way the ArcMap looks by moving or hiding toolbars. Docking toolbars in another location can be done by clicking on the vertical gray bar at the left edge or top and dragging it to a new location.

To hide or show toolbars, click 'Customize' (on the menu bar) > 'Toolbars' and check or uncheck the name.

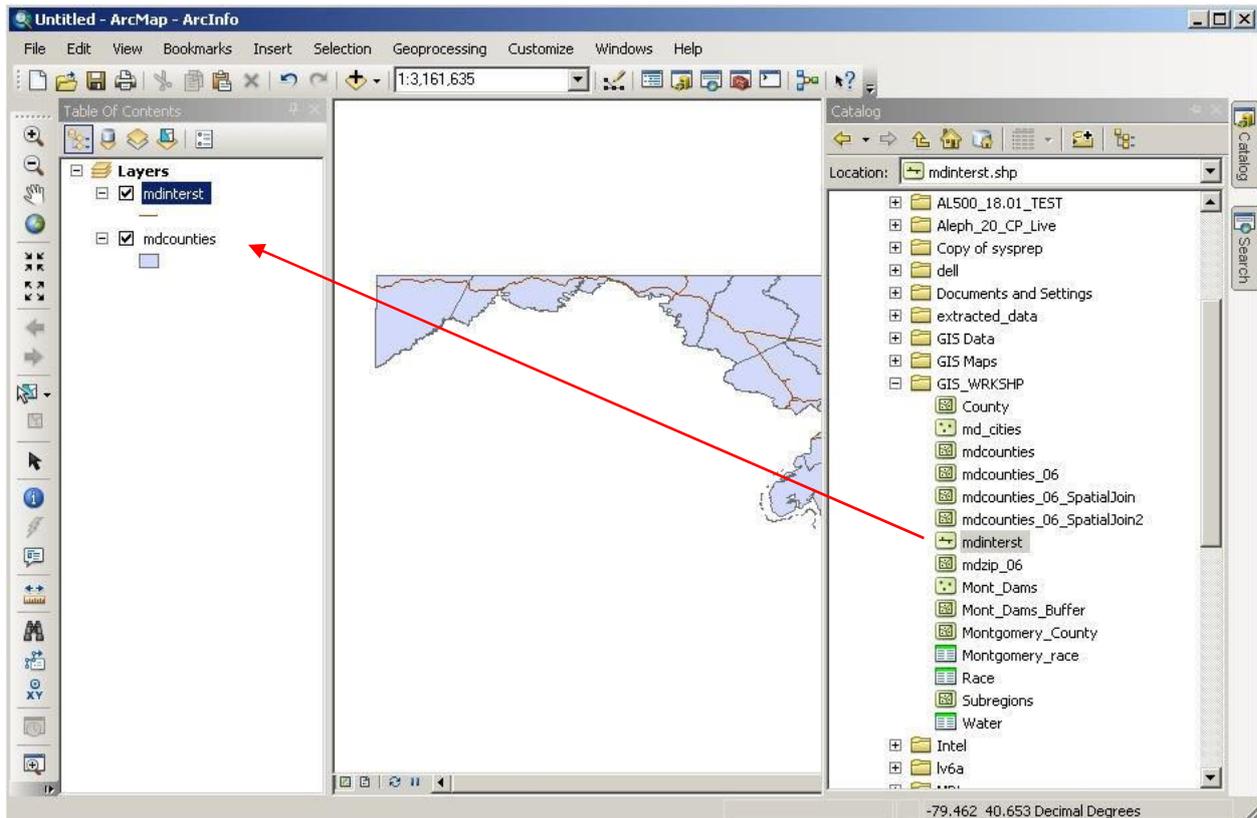
Any changes made to the interface will be kept and applied every time you use ArcMap. Please note that some toolbars are dependent upon the license level. Some toolbars and extensions will be visible, but the user will not be able to access the functionality if they do not possess the required license.

At this point, most of the icons of the button bar and tool bar are grayed out because we do not have any data in our view. Let's add data to see what functions are available to us.

2.2. Adding Data through ArcCatalog

There are two main ways to add data. We will begin with adding two data files – md_cities.shp and md_interst.shp – from ArcCatalog.

1. Click on the 'ArcCatalog' tab icon at the top right of the display. You will see the catalog tree.
2. Navigate to the data you want to add. For us, that is under Folder Connections C:\ESRI\GIS_WRKSHIP
3. We will add two layers: md_interst and md_counties. Drag and drop it into the Table of Contents under Layers.

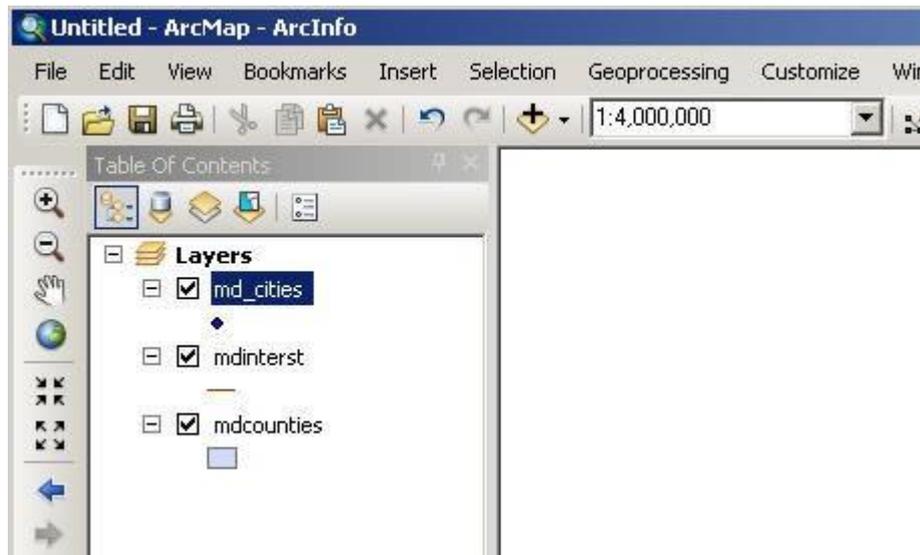


2.3. Adding Data through ArcMap

In addition to ArcCatalog, it is possible to add data directly through ArcMap.

1. Select the 'Add Data' button.  If you selected the drop-down, choose the first option, Add Data. Or, from the menu bar, select 'File' > 'Add Data' > 'Add Data'.
2. Change directories until you find C:\ESRI\GIS_WRKSHP\
3. Select md_cities.shp and click the 'Add' button.

On the left-hand side of the view the three selected layers are displayed in the view's table of contents. Each layer has a little check mark in the box to its left. This means they are "turned on" and being displayed. If you uncheck them, that layer is no longer visible.



The colors of your layers and their order may differ from the example on the instructor's screen, but you should have all three datasets. Each of these layers contains geometric objects that represent some real world entity. Points are used in the md_cities layer to represent Maryland cities. (At a larger scale cities could be represented by polygons.) Lines are used in the md_interst layer to represent the interstate highways in Maryland, and polygons are used in the mdcounties layer to represent Maryland counties.

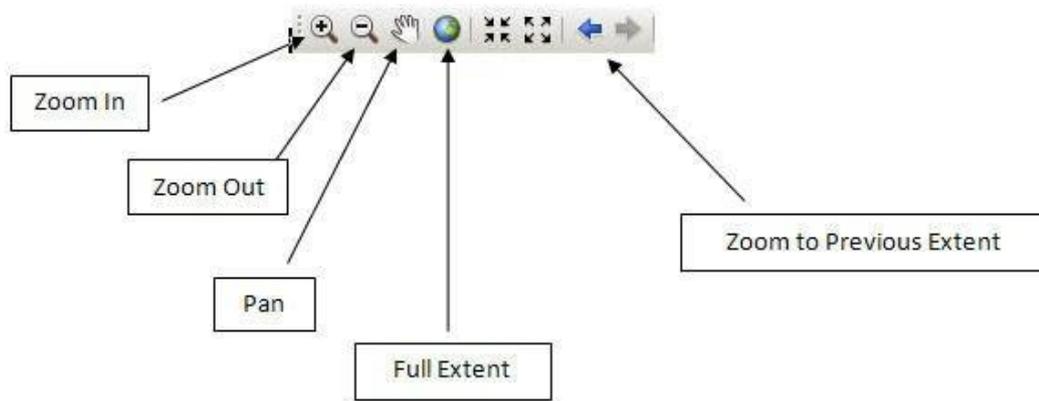
Notice how most of the button and tool bar functions are available to us now. Also notice the scale display next to the Add Data button.

This display tells you what the scale value is of the current view. If it displays the value '1: 2,922,847' that means that every one unit on the map is equal to 2,922,847 units in the real world. As you zoom in and out of the map the scale will change dynamically. Scale is an important concept in computer mapping. The scale of the map often determines the amount of information that can be shown without the map becoming too busy.

Also notice the position display at the bottom right of the screen. As you move the cursor around the view these units change dynamically according to your cursor's position. Your map units are likely in decimal degrees.

2.4. Moving Around the Map Display

Now let's examine ways of zooming in and out and panning. The Tools toolbar contains eight buttons that provide zooming functions and allow you to define a custom view of the layer data. Some of the most useful ones are illustrated here.



Zoom In – zooms the view window in to a user-defined area. To use:

1. Select the Zoom In tool with the left mouse button. Notice the cursor changes to the magnifying glass with the + sign icon.
2. Go to one corner of the area you would like to zoom in on and click with the left mouse button. While holding down the mouse button, move the cursor to the opposite corner that defines the area you want to magnify.
3. Release the mouse and the view window should zoom in to your defined area and redraw.

Zoom Out – zooms the view window out from the point clicked. To use:

1. Select the Zoom Out tool with the left mouse button. Notice the cursor changes to the magnifying glass with the - sign icon.
2. With the left mouse button click the area of the map you want to zoom out from. The view window should zoom out, centering on the area that you clicked.

Pan – moves all the view layer layers in the direction you move your mouse. It is a useful tool when viewing data that is larger than the view window, and you do not want to change your scale or loose detail by zooming out. To use:

1. Select the Pan tool with the left mouse button. Notice the cursor changes to a hand.
2. Click a spot on the view with the left mouse button, and while holding down the button move the mouse away from the direction you want to move the view and release the button. The view should move and redraw the view in the new location once the mouse button is released.

Full Extent – zooms the view window to the full extent of all layers shown in the view. This is very handy when you want to get back to the way things looked when you first added the layer.

Zoom to Previous Extent – zooms the view window back to the previous view window extent.

Practice using the zooming and panning tools to view the Maryland data. You may also zoom in and out by using the wheel on your mouse. You can always return to the initial view by pressing the 'Full Extent' button; so don't be afraid to move around!



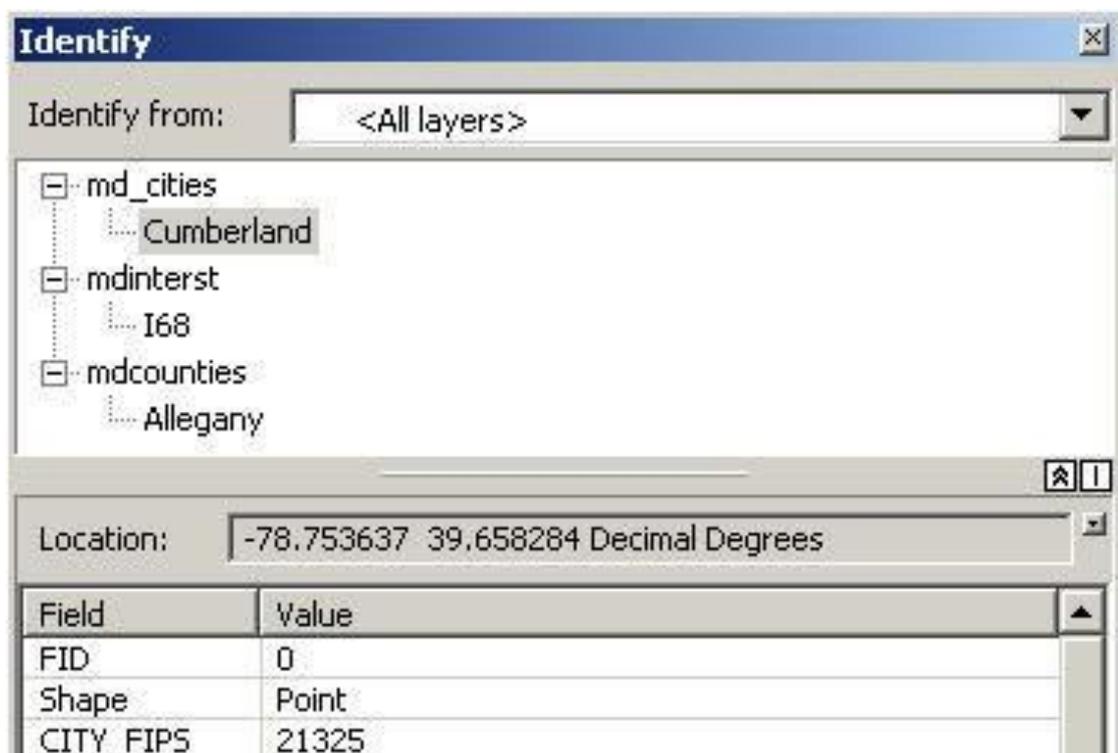
2.5. Identifying Objects

Now let's examine the *identify tool*. This tool helps us to identify the objects of a layer. It is located on the Tools toolbar and it has the icon with the letter i in a blue circle. This tool will display the attributes of a particular layer object. These attributes are actually located in a table that we will discuss later.

To use the identify tool: 

1. Click the identify tool with the left mouse button. Your cursor changes to a cross hair with the i icon.

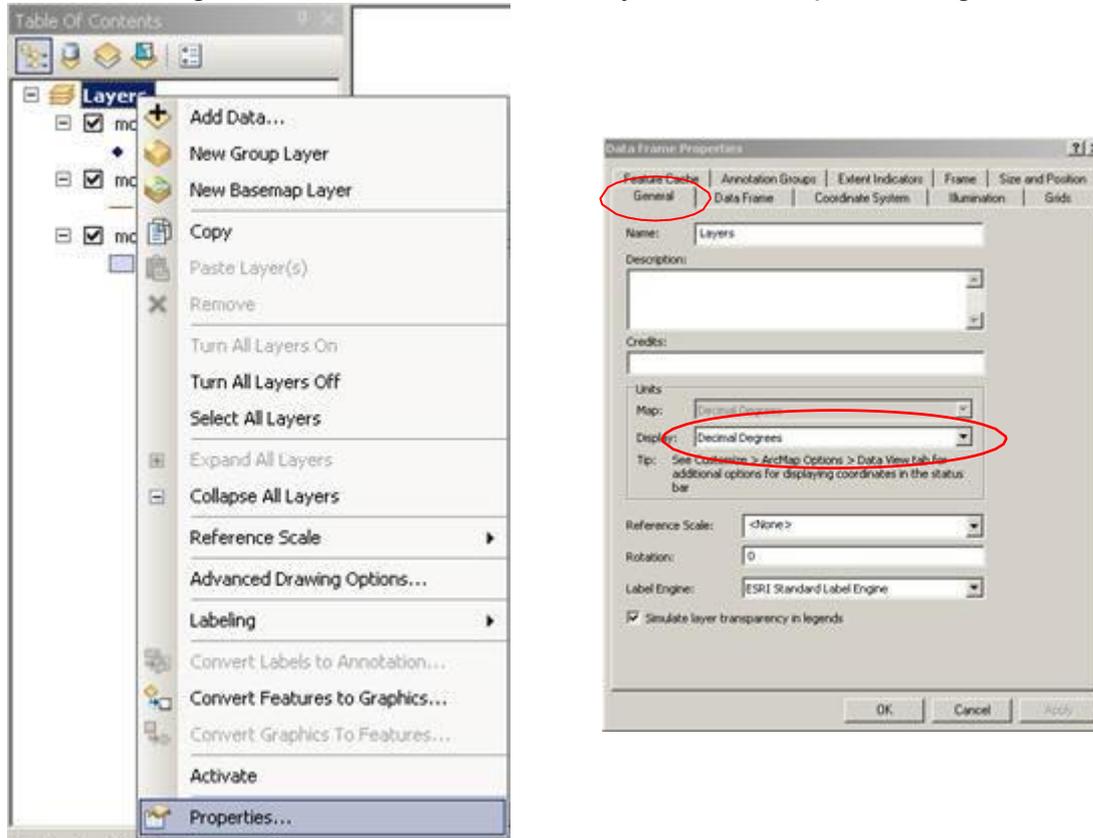
When you click on a feature in the map, the Identify Results window will open and you can choose what layers you would like to be able to identify or see what you have identified.



2.6. Setting Map Units, Display Units and Map Projection

One of the very first things that you should do after adding data is to set the map and display units. It is also a good idea to set the projection (if desired) at this stage as well. Setting these units will allow you to measure distances or compute areas. Display units should also be set if you are planning to create a map layout with a distance scale. To set the map and display units:

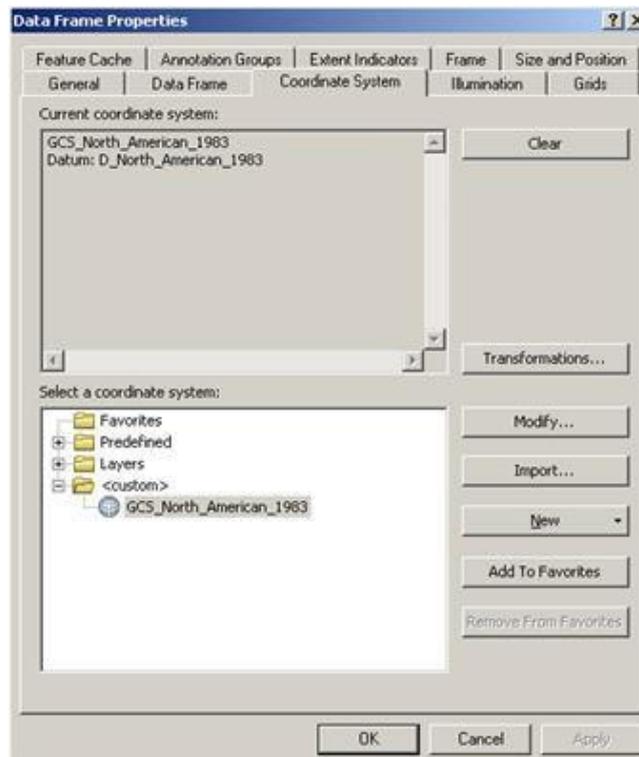
1. Right click on the *data frame* 'Layers' at the top of the legend and scroll down to



'Properties.'

The 'Data Frame Properties' dialog box pops up. You should be in the 'General' tab. Take a look at the 'Units' portion of the dialog box. As you can see, the map units are already determined in this case, but you can choose what units you would like to use for display. The map units here are "decimal degrees" because all of the ESRI data is shipped in decimal degrees. Not all data is in decimal degrees. Some data, especially images, are in other map units such as meters.

1. Let's change our display units to "Miles".
2. Because our data is in decimal degrees, it is considered unprojected. We want to give our view a standard projection. For Maryland, the Maryland State Plane 1983 NAD projection is typically used. Let's set our data frame to this projection.
3. Click on the 'Coordinate System' tab.



Notice that it states that our current coordinate system is a geographic coordinate system, which is not projected.

Let's select a projected coordinate system.

1. Click on 'Predefined'.
2. Click on 'Projected Coordinate System'.
3. Scroll down and click on 'State Plane'.
4. Click on 'NAD 1983 (Feet)'.
5. Scroll down and choose 'NAD_1983_StatePlane_Maryland_FIPS_1900 (Feet)'.
6. Click 'Apply' and then 'OK'.

2.7. Measuring in the Map Display

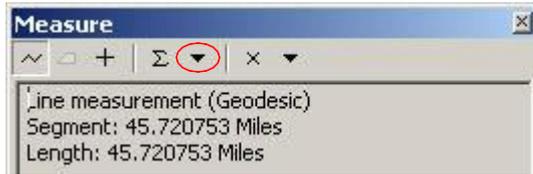
Now that we have set the map and display units, let's make some measurements. On the tools toolbar there is a button that allows you to measure elements of the layers. The *measure tool* is the button having the icon composed of a question mark within an arrow over the ruler.



1. Click the measure tool with the left mouse button. Your cursor changes to an L-shaped ruler with cross hairs and you get a pop-up window.
2. Move the cursor to the point on the map where you want to start measuring and click.
3. Now move the cursor to the point where you want to stop measuring and double-click.

Information Technologies in Urban Development and Spatial Planning

Observe in the window the measurement you just made. This measurement is composed of a segment length and total length. It also indicates the display units of measurement. To change the units, click on the drop-down arrow next to the sum symbol.



You can take measurements that are composed of multiple segments that do not follow a straight line. To do so:

1. Click the measure tool with the left mouse button.
2. Move the cursor to the point on the map where you want to start measuring and click once.
3. Now move the cursor to the next point along your defined path and click once. The first segment is defined.
4. Now move to the second point along your defined path and click once. The second segment is defined.
5. Repeat this process until you reach the point where you want to stop, and double-click.

Try measuring different parts of Maryland. What is the length of its border along the Mason- Dixon line? How wide is the Chesapeake Bay near Baltimore? What is the length from the Prince George's County side of Washington, DC to its opposite end in Montgomery County?

If you wish to measure in some other format (for example, kilometers instead of miles), you can also go back to the data frame > 'Properties > and change the display units.