GIS 604

M.Sc. Geo-informatics

FORMULATION OF PROJECT
&
RESEARCH METHODOLOGY

DEPARTMENT OF REMOTE SENSING AND GIS
SCHOOL OF EARTH AND ENVIRONMENT SCIENCE
UTTARAKHAND OPEN UNIVERSITY
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Formulation of Project & Research Methodology

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OBJECTIVES

After reading this book you should be able to:

- Examine the advantages and disadvantages of GIS by reviewing each of the three components of the GIS terminology: geographic, information, and system.
- Understand the relationship between conceptualizing and comprehending the big picture and the value of logical and physical data models.
- Learnt to establish project objectives and define critical concepts and parameters for a study question.
- Discover how to define research objectives.
- Understand how researchers choose to do their work.
- Understand research methods and techniques they choose to use.
- Use research methods appropriate for the subject and set their studies up for success because of how it was made.
- Explain what is the purpose of the research?
- Explain where will the research be conducted?
- Explain what kind of information is required?
- Explain where can I get the information I need?
- For how long will the research be conducted?
- How will the sample design be created?
- What data gathering procedures will be used?
- What method will be used to analyze the data?
- What format will the report be written in?
- Explain the methods of data collection and management
- Gain knowledge about types of data
- Understand the processing and analysis of data
- Gain knowledge about interpretation and report writing
- Learn about the directions, trends, and emerging applications of spatial technology

INTRODUCTION

This book is a description of GIS, in which learners are going to learn all about the GIS in a very refined manner. This book covers the advantages and disadvantages of GIS by reviewing of the three components of the GIS terminology that is geographic, information, and system. It also helps to understand the relationship between conceptualizing and comprehending the big picture and the value of logical and physical data models. This book throws light upon the project objectives and define critical concepts and parameters for a study question. It helps the learners to define research objectives, research methods and techniques. This book helps in to define the purpose of the research , types of data ,kind of information required, sample designing, data collection, processing and analysis of the data, report writing and interpretation . At last this book is going to help the learner to learn about the directions, trends, and emerging applications of spatial technology with many examples, maps and diagrams.

UNIT 1 - SPATIAL CONCEPTUALIZATION AND IMPLEMENTATION

This chapter will examine the advantages and disadvantages of GIS by reviewing each of the three components of the GIS terminology: geography, information, and system. You will understand the relationship between conceptualizing and comprehending the big picture and the value of logical and physical data models. You will learn to establish project objectives and define critical concepts and parameters for a study question. Additionally, you will discover how to define research objectives. Once the essential variables for a research project are identified, you can use the guidelines in this chapter to implement them, emphasizing spatial analysis in GIS.

The best way to understand GIS is to break down the terminology and practice applying GIS to various analyses. How can your area of interest and associated data be placed within a GIS context, and how can GIS technology be used to enhance your data analysis and comprehension? To establish this understanding, we will go over GIS in detail, letter by letter, before discussing data conceptualization.

The G in GIS

The geographic component of GIS is intuitive, perplexing, and challenging to master simultaneously. We all develop an early understanding that the locations of people and places can be marked on a map and that connections can be made between these locations from an early age. We may lack a firm grasp of the scientific basis for mapping—the numerous issues surrounding scale, coordinates, and control datums. Apart from mapping professionals, very few people have a thorough conceptual understanding of the mathematical algorithms that underpin these concepts and the potential for errors caused by various combinations and interactions of such data.

Fortunately, the majority of these underlying issues are addressed for us by the GIS software, so a thorough understanding of them is not required. However, it is critical that you understand a few fundamental concepts, even if you do not understand how they work. Consider this analogous to knowing the difference between a CD player and an MP3 player—you know that these are two different tools with distinct strengths and weaknesses, but selecting the appropriate one does not require you to understand their internal workings. What is critical is that you know which format to request so that the medium chosen is compatible with the player you own. GIS has been used to locate and manage natural resources and is widely adopted by business and marketing professionals. While GIS is highly beneficial for social science research, it has not been used as frequently in this field. Numerous social science studies examine social, economic, cultural, and survey data to answer questions: Do pregnant women with higher education or wealth receive better prenatal care? Perhaps more probing questions would inquire about the proximity of prenatal clinics to public transportation, child care, and so forth. Using census data, you may conduct a statistical analysis of census block groups and prenatal care levels, but you may overlook a crucial locational component. When combined with other map-based location data (e.g., where are the blocks located about other critical components?), a complete understanding of the causal relationships can be obtained. Additionally, from a practical standpoint, the geographic feature can assist in determining the optimal location and allocation of scarce resources to help improve the situation.

In reality, almost all data collected by researchers about people, communities, and environments can be linked to a specific geographic location. For instance, you could survey people at their homes or within a specific geographic unit, such as a census block or city of residence. Each of these locations is readily mappable. Additionally, if privacy is a concern, you can engage in data aggregation, which involves masking specific, personal information using a more significant geographic unit. In short, if you can answer the question, "How was data collected?" then GIS is an appropriate tool for storing and analyzing data.

Difficulties with the G

The geographic context may be challenging to collect because pinpointing the exact location of a piece of data on the ground is not always accessible or permissible for privacy reasons. When mapping people, we face an additional challenge: individuals may relocate, be homeless, or may otherwise be difficult to associate with a specific location. However, because geographic data are at the heart of GIS, knowing a location of some kind is a necessary part of the GIS process (even if the area must be spatially degraded or removed from its exact, accurate site). For instance, if you are conducting a study of homeless individuals, it may be more appropriate to define their location at the neighborhood level rather than at a specific street address. Additionally, even in studies with map-able areas, privacy concerns may necessitate data degradation. In other words, even if you have respondents' specific addresses, you may wish to degrade the data to census blocks, neighborhoods, or even the city level to maintain the necessary level of privacy for ethical research. Choosing the appropriate level of spatial detail is a critical step in the GIS process.

Conceptually mapped features, such as data about perceptions, ideas, or interactions (figure 1.1), are likely to be more challenging to map; however, they are just as important in research as physical locations. For instance, social networks or interactions between individuals can be mapped so that emotionally connected people are conceptually close. In contrast, those who are only casual acquaintances are mapped at a greater distance. The lines connecting individuals may represent social distance rather than actual geographic distance on a map. On such maps, dubbed cartograms, the distance between mapped data is scaled to some other variable or index value. In the case of social ties, this could indicate a relationship's strength [1].

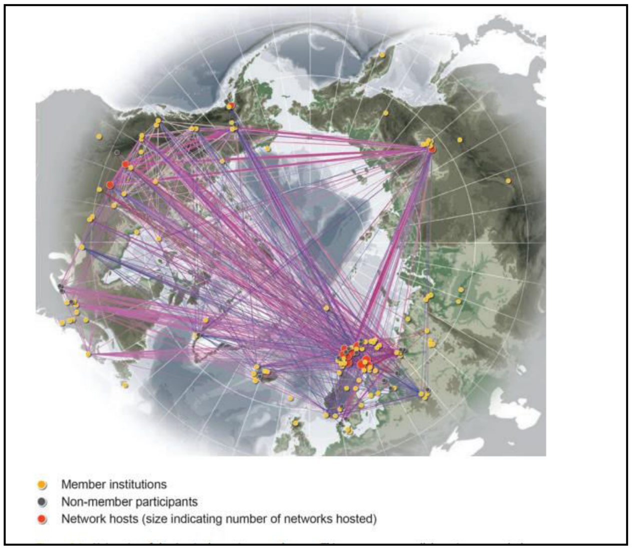

Figure1.1University of the Arctic's thematic networks map. This map presents collaboration networks between higher education and research institutions in the northern hemisphere. The map illustrates the networks of activity and the geography that these networks cross [2].

A second difficulty with GIS mapping is the inherent variability in time and space. The majority of data is gathered as a snapshot in time. We face a more difficult task in obtaining data over time to map changes or trends in the data with confidence. Additionally, because many of the objects we map—particularly individuals—move over time, there is an additional analysis dimension. Do we locate a survey respondent using her home address or her place of employment, or do we use the location of the individual at a particular time of day or week? The research question would heavily influence this decision; there are no predetermined answers.

You can convert static map data to dynamic data using computer animation. However, this mapping method is still constrained by the difficulty and expense of collecting data at a high frequency (temporal scale) and by software limitations regarding the rapid incorporation of data collected. Fortunately, only a few applications in social science require accurate real-time analysis. As a researcher considering GIS as an analysis tool, your primary objective should be to make such decisions before collecting data. Additionally, you must take into account the spatial representation of your data. Often, privacy is of the utmost importance in research. Typically, researchers aggregate data to conceal individual data points representing individual respondents. Lumping, or degrading, data in this manner entails a significant trade-off: the true, raw data may be permanently lost, rendering it unusable for future research. As a result, researchers may amass an enormous amount of redundant data when a simple reclassification of existing data into different but equally valuable combinations would have enabled them to investigate new questions. Consider the population of Uttarakhand 13 districts. The districts vary considerably in size.When researching these districts, you should consider a variety of categorization schemes. Consider the following example, which uses thirteen different district categories, as illustrated in Figure 1.2.

Figure 1.2 An example of categorical classifications for the size of cities. Size classes can be defined in various ways, depending on the objectives and preferences of the map author.

Organizing your data into these categories directly impacts the analysis's outcome. Ideally, you will have access to the actual numbers, allowing you to make an informed decision. If not, the metadata should specify how each category was assigned to cities. Typically, your GIS software comes preconfigured with default settings for categorizing and representing data, as illustrated in Figure 1.3, which Population density of Uttarakhand. The data categorization follows ArcGIS's (a popular GIS software package produced by Esri) defaults—five categories based on the dataset's natural breaks.

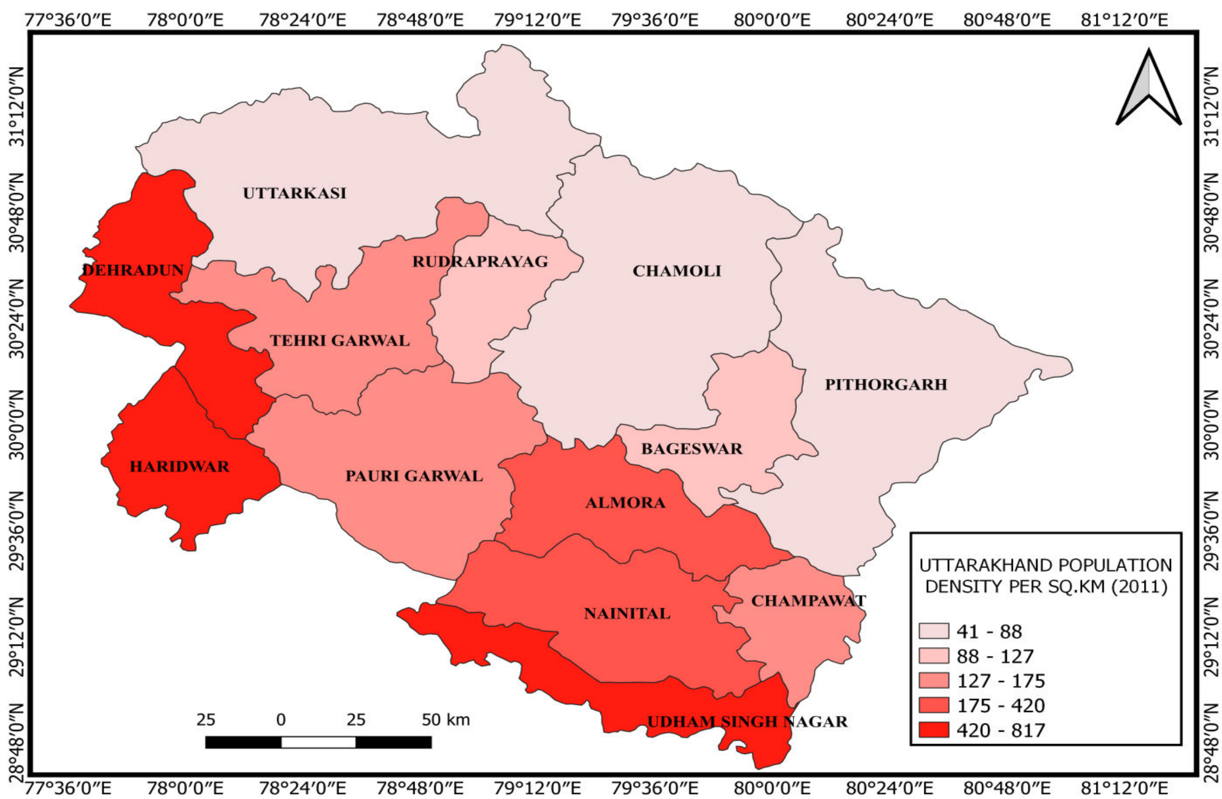

Fig1.3 A map of populations symbolized using default settings in ArcGIS. This map illustrates the population density of thirteen districts of Uttarakhand.

While using the software's default settings may result in an attractive map, they may not be appropriate for your study's data and objectives. As a result, it is critical to comprehend and define data categories that make sense for your purposes. Perhaps there are legal or regulatory definitions of city sizes that you should consider. Alternatively, there may be a statistical justification for how you examine your data. Naturally, changing the categories modifies the map and the analysis results.

The map in figure 1.4 retains the two categories of population but categorizes them using a geometric interval.

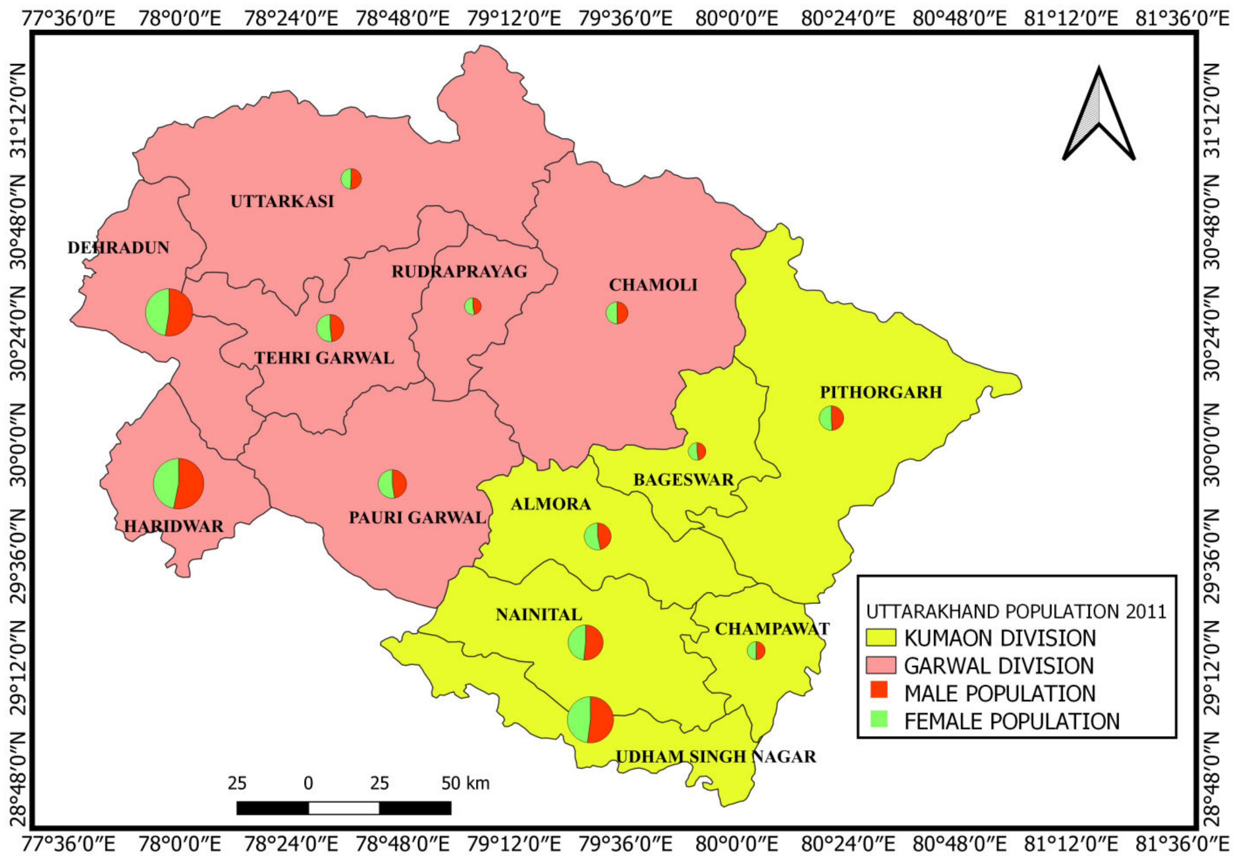

Figure1.4 A map with population sizes symbolized using geometric categorization in ArcGIS.

While these examples are drawn from the same dataset, they each uniquely present the data. If you receive data that has already been classified, you may discover that it is difficult or impossible to use the data in a study with a different set of questions. For instance, the person who created the original dataset may consider a medium-sized town a small town in your study. Another straightforward example of data degradation is categorizing income levels, a common practice in survey research. Categorical data, such as $15,000 and $15,001–35,000, do not enable a subsequent study to distinguish between individuals earning between $20,001 and $30,000. While it is possible to link people or ideas to specific locations in a mapping context, data are more frequently collected by larger geographic regions, such as census blocks or other political boundaries; however, a census block does not reveal the internal distribution of data within the census block (e.g., are the households evenly distributed throughout the area, or is a clustering of the households concealed by the simplified data?).

Where data is provided in a definite format that does not meet your requirements, you may need to locate an alternative data source or even collect your primary data. Degraded data cannot be recategorized to answer new or different questions. Of course, these are not trivial issues to address, as anonymity is required for many social science questions; however, when data are maintained in near-original, detailed form, the possibilities for analysis both within and outside the GIS are significantly increased.

Expanding the G

Attitudes, ideas, social networks (connections between people), and an infinite number of other human constructs should be viewed as equally valid as the latitude and longitude of a data point on the ground. Numerous opportunities, limited only by the researcher's imagination, will enable GIS systems to expand into realms not previously imagined by the software's traditional geographies. The remaining question is how to develop an appropriate mapping context for concepts such as social interaction, community desirability, and social ties. Creating an index value or relationship between data points that can be used in place of physical distance as it has traditionally been mapped is one way to visualize data in a mapping context. Visualizing data entails presenting it in a graphical format.

The I in GIS

The information component of GIS is related to the software's database component.

Databases are specialized computer programs used to store, organize, and retrieve data. GIS software packages can read data from almost any data management and analysis software and interact with it directly. A certain amount of data translation may be required to facilitate the transfer of an existing research database to a GIS software package. Numerous fundamental baseline datasets necessary to answer a question are already available in GIS-compatible formats.

Data from the US Census and numerous state and local-level datasets are accessible online or by visiting the appropriate government office.

Numerous university sources, as well as a variety of private firms, also provide GIS-ready data. Multiple datasets are freely available, including a diverse set of spatial data from government agencies and other organizations. Additionally, you can purchase a variety of commercial databases. These databases are typically used to compile specialized data that is not readily available from other sources. Retail data is frequently updated and is likely already compatible with your GIS software.

Choosing between free and commercial data is frequently a matter of personal preference and experience. Esri provides users with a diverse collection of free and commercial datasets optimized for use with ArcGIS. Numerous additional third-party providers sell a diverse range of economic, infrastructure, business, and social data.

Commercial data is vetted for accuracy and presented in formats compatible with widely used GIS software applications. Many freely available sources are similarly prepared, while others may require additional effort and manipulation to be compatible with a specific GIS package. Choosing a data source may simply be a matter of financial constraints. If you lack the resources to purchase data or collect new data on your own, you may need to look into free options. Of course, if you use freely available data, there may be a trade-off in the time required to prepare the data for analysis, or the data may simply not be available.

Naturally, you can also use your data, whether it was gathered through a survey, an interview, an observation, or almost any other method. Indeed, as long as the data is intended to be stored digitally on a computer, it will be accessible to a GIS regardless of the software used. Indeed, with a bit of foresight, perhaps through one or two additional questions or notations on the datasheet, you can easily collect data to integrate it into a GIS.

Extending the I

To make information more accessible to GIS, it is necessary to organize and structure data stored in advance and code and format data. These tasks are not unique to GIS; they apply to all data collection and analysis. Computers and geographic information systems (GIS) enable additional storage. The computer's multimedia capabilities will allow you to connect photographs, sound bites, movie files, and scanned information, allowing for significant raw data preservation and thus the preservation of complete, detailed information.

For instance, you could tape an entire critical informant interview or oral history or videotape a traditional dance. (A key informant is someone knowledgeable about the issue or topic under investigation. Oral history is a qualitative research method in which the researcher collects the stories and histories of individuals associated with a particular location, event, or issue.) You can convert these records to sound and video computer data files and link them to a GIS map. The complete recording becomes available when a user clicks on the location associated with a video or sound file on the GIS map.

Data from open-ended surveys or interviews that have been coded or summarized for analysis purposes are simultaneously available in their entirety to a researcher who may choose a different coding scheme or analysis at a later date. Coding data entails assigning a meaningful symbolic numbering system to the answers contained in the data. For instance, researchers collecting responses on a 1 to 5 rating scale may reserve an additional code to represent questions skipped by the respondent, with 0 or 99 being the most frequently used codes for this purpose.

Thus, in addition to the numerous analytical and data presentation benefits discussed in this text, the GIS can be used to store a variety of digital datasets gathered during a specific study. If these data can be preserved in their raw form, they can be used in future analyses in new and different ways.

Suppose you consider how your data will be used in the future as you build your library of GIS datasets. In that case, collecting and coding data can significantly extend the life and utility of any individual dataset. Additionally, the majority are familiar with entering data into a computer for analysis.

The S in GIS

The system required to conduct development and analysis in GIS is comprised of a variety of hardware and software components, as well as individuals capable of putting these components to work. These capabilities are likely to be available at most academic institutions and government agencies, and many private consultants. Costs and training requirements for developing a GIS from scratch vary significantly. It would help if you considered the trade-offs between performing GIS work independently and delegating specific tasks to a more highly trained GIS analyst. Whichever path you take, you must ensure that everyone involved in the GIS understands the data structure and format required to achieve compatibility with the least amount of effort.

Difficulties with the S

Geographic information systems (GIS) were primarily developed with traditional geography. Since GIS's inception, its application and capabilities have expanded across various disciplines and applications in both the public and private sectors. These systems, however, are constrained by the map data model, which is composed of points, lines, and polygons. This model presupposes that all data can be linked to a distinct, discrete location and that explicit boundaries between data categories can be drawn. Of course, many datasets are not as well defined, particularly those containing social science data, which are typically less geographically specific, either because the data must be degraded for privacy reasons or because social science research typically involves analyzing conceptual maps rather than geographic maps.

Although efforts have been made to develop fuzzy GIS systems that allow for less precise locations and boundaries, these systems are not yet widely available.

As a result, existing GIS data models may not be adequate for the analysis. You may be forced to devise a novel solution to fit non-discrete data into a discrete data model. One caution is that it is easy to let the software's capabilities dictate the type of analysis you perform or the type of analysis you never attempt. This is one reason why researchers in specific social science fields have been slower to incorporate GIS technology into their research than researchers in the natural sciences (who have been doing so for approximately fifty years). Nonetheless, GIS quickly established a niche in social science applications, most notably as a tool for collecting, storing, and analyzing 1970 US Census data.

For two simple reasons, the early years of GIS were devoted to natural resources. In the 1960s, natural resource managers in Canada pioneered GIS technology by mapping vast amounts of data. It is relatively straightforward to map the location of a forest that does not move or change rapidly, and a computer is an excellent tool for this task.

Developing methods for mapping non-discrete data, such as mobile human populations, concepts, and attitudes, which are more typical of social science research, would later explain why GIS has taken significantly longer to gain widespread use by certain researchers.

Furthermore, unlike modern GIS systems, early GIS systems were prohibitively expensive and difficult to use. This made GIS a challenging technology to bring to small community groups or individuals. A researcher was frequently required to liaise between the data provider and the GIS analysis system. Even today, a researcher wishing to leverage the additional capabilities of a spatial analysis must be familiar with spatial data characteristics, a diverse range of data types, spatial and topological analysis, and spatial modelling. Social scientists must be able to discuss the application of GIS technology to their data, even if they hire GIS experts to develop the databases, conduct the analysis, and output the results from the GIS. Fortunately, powerful personal computers are now reasonably priced (particularly in comparison to the computers of the 1960s and 1970s, when GIS technology was in its infancy). When combined with more user-friendly GIS software, the technology becomes significantly more accessible. You can now address any spatial analysis questions that previously required a GIS specialist's expertise.

Learning the ins and outs of any GIS programme and the fundamental underlying concepts remains a lengthy process. However, with some time and effort spent learning the basic concepts and organization of GIS and spatial analysis, you can make significant progress toward answering exciting and vital research questions using research methods.

As GIS has gained popularity, so has the number of trained GIS professionals. Thus, if your questions or analysis extend beyond your own experience, you can seek assistance from various sources. GIS experts can be found at local universities, community and technical colleges, and government agencies. In many areas, GIS user groups meet regularly to exchange ideas, answer questions, and demonstrate new projects or the capabilities of their preferred GIS software.

The creator of your GIS software can often provide information about these local groups and connect you to online user communities that can assist you.

Conceptual data model: Incorporating GIS

The conceptual model abstracts the analysis objectives from reality and converts them to a spatial conceptualization.

This task entails determining the analysis's critical components and identifying the necessary data. Consider the accessibility of prenatal care for low-income families at public health clinics to illustrate the conceptualization process.

Numerous datasets would be beneficial for this type of analysis. The conceptualization phase is where you begin identifying appropriate data by working through your analysis's "thought problem." Determining data layers entails more than simply stating, "I require layer 'X' for my study"; it also entails specifying what must be included in the database to conduct your analysis.

What information do you require in this case? You'll need some demographic data, perhaps from the most recent US Census, to understand socioeconomic characteristics and location (down to the census block level). Additionally, a clinic location map is necessary. If no such map exists in a GIS format, you must investigate alternative methods for creating this layer (e.g., geocoding an existing map by street address). If detailed information about clinics is available, it may be possible to identify those in the database that offer prenatal care services more precisely. If clinic data is unavailable, you will need to conduct field research to create your database.

Remember to include a base map; you'll need it to determine the appropriate scale for the analysis.

Are you examining clinics in a single city, a region, or a country? Assume, for this example, that the study is conducted at the neighborhood level. Perhaps the most appropriate and up-to-date map would be a city street map from a local city or county planning department.

Finally, and most conceptually challenging, you must develop a working definition of accessibility that you can use throughout your study. We suggest a few possibilities here, but your analysis will undoubtedly include additional conceptualizations. Transportation is one aspect of accessibility. Given that a sizable portion of the population in this study is expected to rely on public transportation to get to the clinic, route maps and schedules may be critical data. Additionally, there may be issues with time-related accessibility, such as work schedules, the ability to take time off work, school start and end times, etc. How do these time and transportation constraints affect clinics' location and hours of operation? These issues are social-psychological and are related to an individual's willingness to go to the clinic. How far are potential clients willing to travel, and how much time are they willing or able to spend at the clinic?

The list could be extended to include access to knowledge. Are prospective clients aware of the clinics' availability? Are clinic employees fluent in the languages spoken by the populations they serve? Are printed materials at a client-friendly reading level? What about clinic funding? Is the clinic capable of meeting the demand? How long are individuals detained in the waiting room? Are clients aware of the health coverage options available to them, and are they capable of navigating the paperwork required to obtain it? Suddenly, what appears to be a simple concept balloon into something extremely complicated; this is, of course, the nature of social science research.

Numerous concepts in this laundry list are spatial, particularly those about the client base's location and access to the clinic. Are people likely to arrive from their homes or their places of employment? By examining the willingness to travel, it may be possible to develop some rational values. For instance, if you determine that an individual is willing to travel one hour on public transportation, you can convert that time into a map of bus routes within an hour of clinics. Thus, the concept of willingness (along with a series of variables contributing to its operationalization) is transformed into a map with a distinct spatial component. In other words, the GIS is used to combine a collection of concepts into something that can be analyzed more easily.

When working through thought exercises like this one, it can be beneficial to draw a diagram or write an outline of your concept. Having a visual representation of your concept helps you organize other critical information, such as the type and source of data you will need to create or locate to complete your study. If your analysis's conceptualizations result in datasets that cannot be found from an existing source, you'll better know how much new data collection will be required.

This is also an excellent time to assess the study's feasibility. Investing time early in the development process to reevaluate each component of your developing model can save significant time, money, and energy later in the analysis. After all, there is no point in including data that contribute only a negligible amount to the overall model or introduce significant uncertainty into the final results. As with any study, relationships between variables should make conceptual and practical sense. Several possible questions to consider at this point include the following:

• Will the model's output be sound?
• Can actual, on-the-ground decisions be made based on the model's output?
• Are the data's relationships statistically significant?

After considering each component, the availability of data, your ability to create it, and the model's general use, you're ready to move beyond thought problems.

However, keep in mind that until you have resolved the thought problem, it is probably not a good idea to proceed with GIS analysis. Many people overlook this stage of the GIS process and waste time, money, and effort on dead-end analysis paths. Once you are satisfied with the conceptual model, you can proceed to the logical data model's third phase of abstraction.

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UNIT 2 - DEFINING THE RESEARCH PROBLEM

What is a Research Problem?

In general, a research problem is a problem that a researcher faces in either a theoretical or practical setting or wants to solve. A research problem sets the direction of study, particularly pertaining to a certain topic or discourse area. Climate change and sustainability, for example, or examining unequal land resource holdings between classes, could all be subjects that the research problem focuses on. A research problem that is well-defined, clear, and goal-oriented keeps researchers, stakeholders, and institutions focused on actionable results.

- There must be a person or a researcher group who is having problems or problems.
- There must be some goal(s) to work toward. There is no problem if you don't want to have one.
- There must be alternate means (or courses of action) for achieving the desired objective(s). This means that a researcher must have at least two available means, as he cannot have a problem if he does not have a choice.
- A researcher's mind must remain open to doubt regarding the alternative selection process. This means that research must address the relative efficacy of potential alternatives.
- The difficulty must be related to some environment(s).

Thus, a research problem asks a researcher to figure out the best way to deal with a given situation, or to figure out the best way to reach a goal in a given environment. Many things could make the problem more difficult. For example, the environment may change, which could make it less efficient or more valuable to do something. All of these things, or at least the most important ones, can be thought about in the context of a research question. A research challenge will explain: in addition to detailing the topic and/or opportunity, it will outline:

- why the area/issue needs addressing,
- why area/issue seems important,
- key parameters of the research study,
- appropriate reporting framework for the outcomes, and
- the overall benefit of doing so (whether to society as a whole or other researchers and projects)

Selecting the Problem

The research question that will be studied must be very carefully chosen. Tasks are hard, even though they don't seem that way at first. A research guide might be able to help with this. Generally, the researcher comes up with a problem on their own, but it can be decided based on the need or contemporary problem for the region.

Most of the time, a very common topic should not be chosen. New knowledge is hard to add. A novice researcher should not choose controversial topics. It is best to avoid problems that are excessively specific or broad. The study topic should be familiar and viable for easy access to research materials or information sources. It is hard to say how a researcher should come up with study ideas. A researcher should contact an expert or university professor doing a related study. He may also read current literature and analyse how procedures and ideas might be applied to different challenges. Other factors to consider when selecting a topic include the subject's importance, the researcher's skills and competence, the associated costs, and the time factor. To put it another way, before settling on a particular subject, a researcher should ask himself the following questions:

- Given researcher background, is researcher well prepared to do the research?
- Is the study financially feasible for researcher/institute?
- Can the essential cooperation be obtained from those who must participate in research as subjects?

If all of these questions are answered affirmatively, one can be sure that the study is feasible.

A preliminary investigation must be undertaken before selecting a problem. This may not be essential if the scenario calls for a similar study to that which has previously been conducted. But if the topic of study is new and doesn't have a well-developed set of methods, a quick feasibility study should always be done. If the research subject is chosen properly in accordance with the preceding ideas, the research will be a labour of love rather than a monotonous battle. Working zeal is indeed essential. For the researcher to go through all the trouble needed for the study, the chosen subject or problem must be interesting and take up a lot of the researcher's thoughts.

Necessity of Defining the Problem

It is said that a problem well-stated is half-solved. In order to distinguish between important and irrelevant data, the inquiry topic must be well stated. A researcher can avoid being sidetracked if the problem at hand is well defined. Consider the following questions before you answer them: What kind of information will be gathered? What aspects of the data should be looked into further? To what extent are these linkages to be studied. What methods should be employed? In addition to these and other concerns, a clear definition of the research problem is necessary before the researcher is able to properly design his strategy and find answers to all of these concerns and questions. For any study to proceed, it is imperative that the research question is correctly defined. In fact, defining an issue is often more important than finding a solution to it. Research design and subsequent steps can only be developed if a clear definition of the research problem is established.

Technique Involved in Defining a Problem

First, let us explore the following question: What does it mean when someone desires to describe a research problem? Possibly the answer lies in the need to clearly define the issue at hand and the Identifying a problem involves selecting the parameters for a given investigation. This is an enormous task. To avoid getting lost in a research endeavour, proceed with caution. Standard research entails creating a question and developing techniques and procedures for explaining it to define a research problem, either for oneself (the researcher) or for another person, organisation, or authority (the guide, the person, organization, or management in question). A discussion topic may not be testable, so this approach rarely delivers definitive conclusions.

Properly stating a research problem is crucial for every research study and should never be rushed. However, in practice, this is usually disregarded, leading to a plethora of issues down the road. Consequently, it is important that the study problem be specified properly, with equal weight being given to all relevant points. It is necessary to perform the following steps in order to accomplish this:

- a broad statement of the problem;
- an understanding of the nature of the problem;
- a review of the available literature; the development of ideas through discussion; and
- the formulation of a workable proposition for the research problem.

Each of these issues would benefit from a succinct explanation.

- A general statement of the issue: To continue, the circumstance should be articulated broadly, either from a practical standpoint or from a scientific or philosophical one. The researcher must immerse himself totally in the subject matter on which he desires to raise a question. It is regarded wise to perform some field observation in the case of social research. Thus, the researcher may conduct a preliminary survey, sometimes known as a pilot survey. The researcher may next state the issue directly or seek advice from the guide or subject expert in order to fulfil this assignment. Frequently, the guide paints a broad picture of the problem and leaves it up to the researcher to narrow it down and explain it in operational terms. The issue can be stated adequately if an executive authority issues a directive. In broad terms, the problem may involve several uncertainties that must be resolved by rational reasoning and reframing the situation. Simultaneously, one must examine the viability of a certain solution, which should be represented in the formulation of the problem.
- Recognize the nature of the problem: The next stage in characterizing the problem is to properly comprehend its genesis and nature. The most effective technique to comprehend the issue is to speak with those who raised it in order to ascertain how and why it was raised in the first place. If the researcher has expressed the issue directly, he should reconsider all of the circumstances that influenced his decision to make such a broad statement about the scenario. To have a deeper

understanding of the nature of the issue at hand, he can engage in discussion with others knowledgeable about the subject or similar issues. Additionally, the researcher should take into account the context in which the subject will be investigated and comprehended.

- Surveying and examining the available literature: Prior to establishing the research problem, it is necessary to scan and study the available literature. This necessitates the researcher's familiarity with pertinent field theories, reports, and records, as well as with all other pertinent literature. He must commit an adequate amount of time to reviewing prior research on similar topics. This is to ascertain the availability of data and other materials for operational purposes. "Frequently, knowing what data are available assists in narrowing both the problem and the technique that could be employed." [2]. This also aids the researcher in evaluating if there are any gaps in the theories, if the existing theories applicable to the subject under study are inconsistent with one another, or if the outcomes of numerous studies do not follow a pattern compatible with theoretical predictions, and so forth. All of this permits a researcher to make new advances in the advancement of knowledge, i.e., to progress beyond the established premise. Studies on related topics might help identify the types of obstacles that may develop in the current study, as well as possible analytical limitations. Occasionally, these researches may reveal beneficial and even creative approaches to a present problem.
- Creating ideas through dialogue: Oftentimes, a discussion about an issue generates useful knowledge. This type of exercise has the potential to generate a plethora of new ideas. As a result, researchers must consult their peers and others with appropriate experience in the same subject or dealing with similar challenges. Frequently, this is referred to as an experience survey. Individuals with substantial expertise can shed insight on many areas of the researcher's proposed study, and their suggestions and opinions are frequently invaluable. They aid him in concentrating his efforts on particular facets of the field. Discussions with such persons should not be confined to devising a solution to the specific issue at hand. They should, however, provide a discussion of the problem's overall approach, possible methodologies, and prospective solutions.
- Formulation of a workable proposition for the research problem: The researcher should now sit down and restate the research problem into a viable proposition. Once the nature of the problem has been defined, the environment (in which the problem must be studied) has been defined, discussions about the issue have taken place, and the available literature has been surveyed and examined, rephrasing the problem in analytical or operational terms is not difficult. The researcher restates the research problem as precisely as feasible in order to make it operationally viable and to aid in the development of working hypotheses.

Along with the preceding considerations, the following points must be considered while defining a research problem:

(a) Technical terms and words or phrases having particular meanings should be defined explicitly in the problem statement.

(b) The fundamental assumptions or postulates (if any) underlying the research problem should be explained unambiguously.

(c) A succinct summary of the investigation's utility (i.e., the problem selection criteria) should be presented.

(d) When defining the problem, the researcher must also examine the period and data sources' appropriateness.

(e) When defining a research problem, it is necessary to specify explicitly the scope of the investigation or the parameters within which the problem will be researched.

ILLUSTRATIONS

1. The RS and GIS data will be processed in open source QGIS software to explore morphometric features of the Pindar River watershed (Fig 2:1) in the Chamoli and Bageshwar districts of Uttarakhand in order to prioritize sub-watersheds and design a management plan to combat land degradation for future management and conservation. The SRTM DEM (Shuttle Radar Topography Mission Digital Elevation Model), which has a spatial resolution of 30 m, will be used for delineating the watershed.

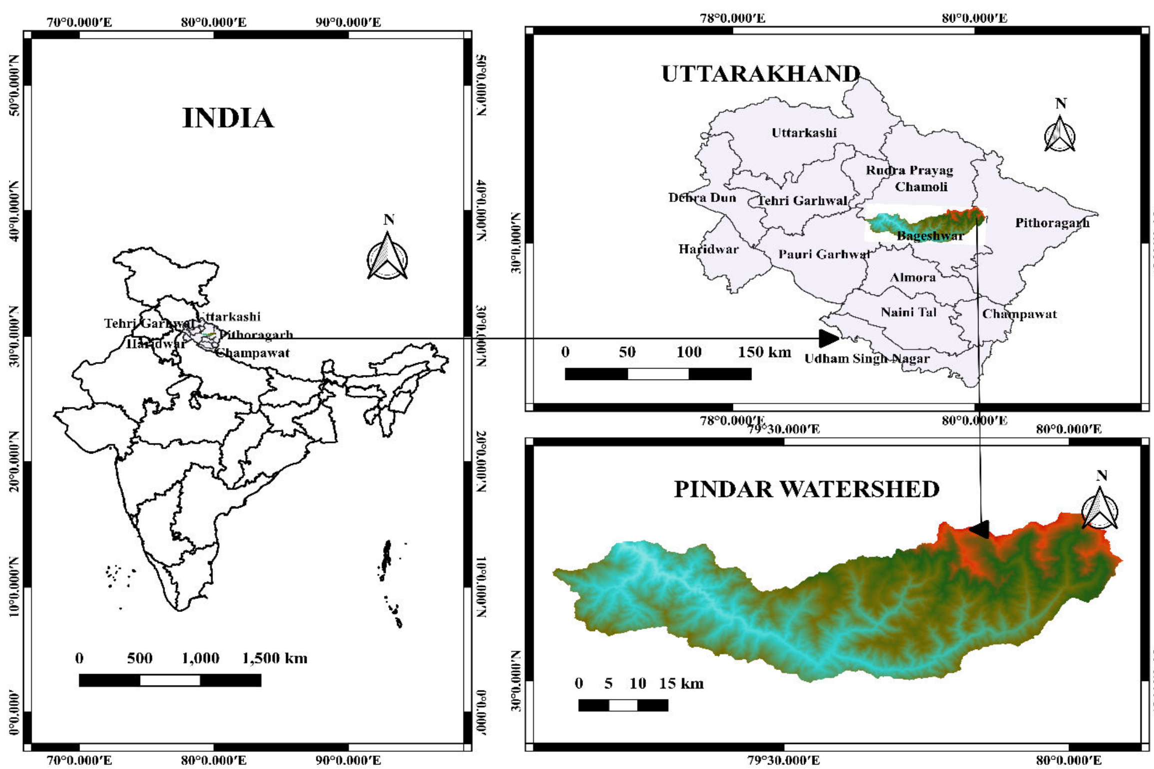

Fig 2.1: Location of Pindar watershed

Further Landsat 9 data will be used for assessing the LULC data of the watershed.

2. Another example can be stated as follows:

Assume the following provides a comprehensive overview of a research problem: "Application of GIS in biomass resource productivity"

Because the question does not clarify the type of productivity being referred to, it is unclear in this form. Which areas are related? In terms of productivity, what time period is being discussed? Given these ambiguities, the statement or query is significantly too wide to be analyzable. Rethinking and debating the subject may help restrict the question to: "Assessment of biomass resource productivity in Upper Ganga Watershed between 2000 to 2020"

This latter version of the problem is obviously superior to the older version, as all conceivable ambiguities have been eliminated. Rethinking and rephrasing the problem further may reveal a deeper operational basis for it.

Numerous words, such as 'biomass productivity,' 'productivity time interval,' and so on, must be defined precisely in this formulation. Additionally, the researcher must ensure that the researcher has access to all necessary data. Assume that statistics for one or more of the entities are unavailable for the time under consideration. Additionally, the period's suitability must be examined. Thus, when defining a research problem, a researcher must consider all important elements. Large volume of data needed for geoinformatics based research problems: data about the terrain, topography, land use land cover, soil water, mineral, flora, fauna, temperature, and hydro meteorological data etc.

To summarize, the process of defining a research problem frequently follows a sequential pattern: the problem is stated broadly, ambiguities are resolved, and the subsequent thinking and rethinking results in a more specific formulation of the problem that is both realistic in terms of available data and resources and analytically meaningful. This all culminates in a well-defined research challenge that is operationally relevant and capable of setting the framework for the development of working hypotheses and techniques for resolving the issue.

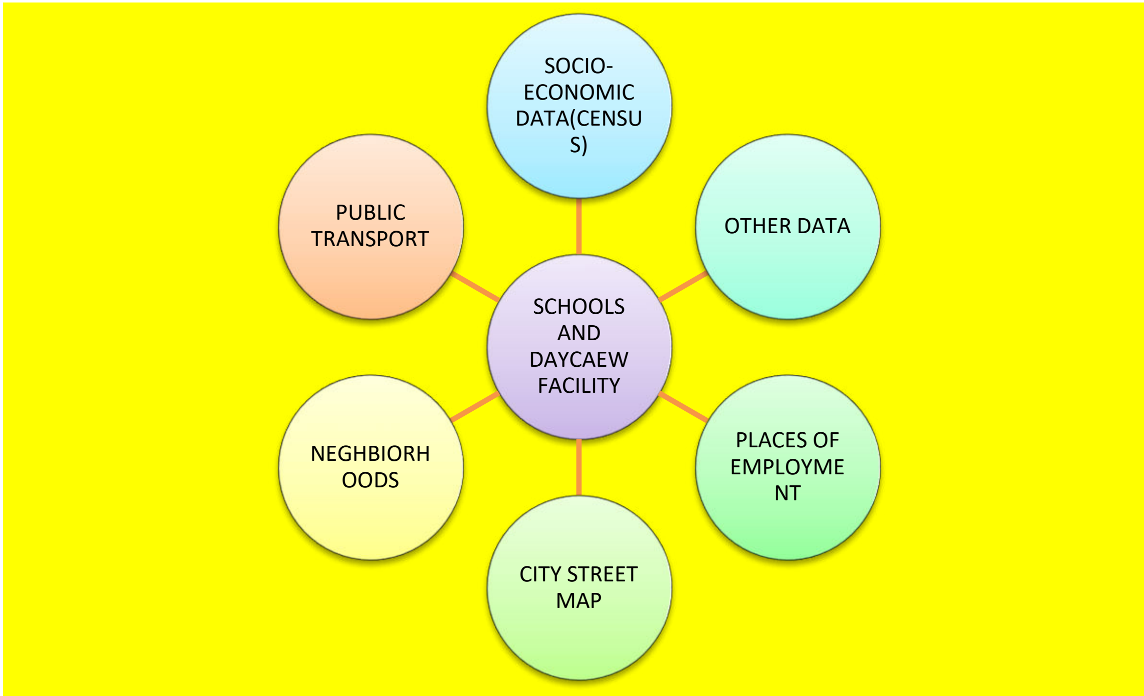

Fig 2.2 Sketching out the components of the conceptual model can significantly assist in identifying and organizing the information that will be necessary to complete a GIS analysis.

Term or concept definition is critical to developing a sound research project. This is particularly true of terms used to describe phenomena. We recommend that you conduct a thorough literature review before embarking on any research project to be familiar with how various terms are defined by others. Any concept you wish to name or investigate almost certainly has a given name, and many ideas have multiple and, at times, conflicting definitions. The first step is defining your concept by identifying it, naming it, and explaining it. A literature review enables a researcher to understand the relationships between various variables better. After placing your dependent variable, conducting a literature review will aid in explaining the relationships between the multiple variables. This is particularly useful when examining relationships between variables that have not been studied previously.

You learned about the strengths and weaknesses of each letter in the GIS in this chapter. Additionally, you gained knowledge of conceptualization and the appropriate questions to ask as you initiate the conceptualization of a spatially based research project. Additionally, you discovered which questions to ask to inquire about data and analysis to assist you in moving forward with your project. You,

Additionally, you learned about the conceptual framework, which serves as a helpful guide for conceptualization.

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UNIT 3 - RESEARCH DESIGN

PERSPECTIVE ON RESEARCH DESIGN AS A WHOLE:

Research design is how researchers choose to do their work. It's the framework for the research methods and techniques they choose to use. Allows researchers to use research methods appropriate for the subject and set their studies up for success because of how it was made.

The preparation of the research project design, often known as "research design," is a severe problem that follows the process of defining the research problem. A research design is a set of decisions on what, where, when, how much, and how an inquiry or research project will be conducted. An experiment, survey, correlation, semi-experimental, or review is all a type of research. The design of a research topic tells you what kind of research it is and what kind of research it isn't (experimental design, research problem, and descriptive case study).

In truth, the research design is the conceptual framework for conducting research; it is the blueprint for data collection, measurement, and analysis. As a result, the method describes what the researcher will accomplish, starting with formulating the hypothesis and its operational implications through data analysis. More specifically, the design selections are based on the study's purpose.

(ii) What is the purpose of the research?
(iii) Where will the research be conducted?
(iv) What kind of information is required?
(v) Where can I get the information, I need?
(vi) For how long will the research be conducted?
(vii) How will the sample design be created?
(viii) What data gathering procedures will be used?
(ix) What method will be used to analyze the data?
(x) What format will the report be written in?

Considering the design mentioned above decisions, the overall research design can be divided into three parts: (a) the sampling design, which concerns the method of selecting items to be observed for the given study; (b) the observational design, which concerns the conditions under which the observations are to be made; and (c) the statistical design, which concerns the question of how many items are to be observed and how the information and data gathered will be analyzed.

Based on what has been discussed thus far, the following are the key characteristics of a research design:

It's a strategy that identifies the sources and types of data relevant to the research question.
(ii) It is a strategy that specifies the data collection and analysis method.
(iii) It also includes time and cost budgets, as most investigations are completed within these parameters.

In a nutshell, a research design must include:
(a) a clear definition of the study problem;
(b) processes and techniques to be employed for data collection;
(c) a budget for the research and
(d) methods to be used in the processing and analyzing of data.

PURPOSE OF THE RESEARCH DESIGN: The purpose and criteria for developing a research design, determining causality conditions, and using research design as a variance control are discussed. A research design's objective is to provide a framework for assessing the cause-and-effect linkages between independent and dependent variables. The classic controlled experiment is an excellent example of a well-designed study. The authors identify factors that impair the evaluation of the experimental treatment's effect (internal validity) and its generalizations (external validity). Variance sources can be reduced by omitting a variable, randomizing it, matching it, or integrating it into the design. A research project should be organized in such a way that
(1) it answers the research questions,
(2) those extraneous elements are controlled,
(3) that the degree of generalization possible is valid [2].
Research design is vital because it makes it easier for the different parts of the research to go smoothly, making research as efficient as possible and yielding the most information with the least effort, time, and money. We need a blueprint (or more commonly called a map of the house) to build a better, more economical, and more beautiful place, just like we need a research design or a plan for our research project before we start collecting and analyzing data. Research design is planning out how to get the data you need and explore it, considering the study's goal, your resources, and your available time and money. A lot of thought should be put into the research design because a mistake could significantly impact the project.
Research design has a significant impact on the reliability of the results drawn from the research. As a result, the study's design is the foundation of the whole project.
As long as the need for a well-thought-out research design isn't always clear to many people. This problem isn't given the attention it needs. Many researchers don't do what they're supposed to do, so they don't work out. They may even come up with false conclusions.
Thoughtlessness when planning the research project could make the whole thing pointless. It is, therefore, essential to make sure that an efficient and appropriate design is in place before starting research. The procedure helps the researcher put together his ideas to make it easier to look for flaws and inadequacies in his work. Such a design can even be shared with other people so that they can give their opinions and critiques. In the absence of such a plan, it will be hard for the critic to provide a full review of the proposed study.

INDUCTIVE VERSUS DEDUCTIVE APPROACH

1. **Inductive Approaches and a Few Illustrations**

Inductive research begins with collecting data related to the researcher's topic of interest. After collecting a significant amount of data, the researcher will take a break from data collection, stepping back to acquire a bird's eye view of her data. At this step, the researcher examines the data for patterns and works to construct a theory to explain them. Thus, inductive researchers begin with a collection of observations and then progress from those specific experiences to a more general set of assertions about those experiences. In other words, they go from empirical evidence to theory or from the particular to the universal.

There are a lot of good examples of inductive research, but we're only going to look at a few of them. Katherine Allen, Christine Kaestle, and Abbie Goldberg did a fascinating study recently in which they used an inductive method (2011). This study's three people are Allen, K. R., Kaestle, C. E, and Goldberg, A. E. (2011). The way boys and young men learn about menstruation of how boys and young men learn about menstruation. Allen and her team looked at the written stories of 23 young men who talked about how they learned about menstruation, what they thought about it when they first learned about it, and what they believe now. By looking at all 23 men's stories, the researchers developed a general theory about how boys and young men learn about this part of girls' and women's bodies. They say that sisters play a significant role in boys' early understanding of menstruation. Menstruation makes boys feel a little different from girls, and as they get older and start dating, young men begin to have more mature views on menstruation.

People who work with homeless young people look at data from the real world to figure out how best to help them meet their needs. The authors looked at data from focus groups with 20 young people at a shelter for the poor. They came up with suggestions for people who want to use applied interventions to help homeless kids. The researchers also came up with ideas for people who might want to do more research on the subject. As a result of their analysis, Ferguson and her colleagues came up with a set of hypotheses that they could test. Most deductive investigations start: with a group of testable ideas [3].

The following are some examples of deductive approaches and how they work:

People who do deductive research do the steps for inductive study in the opposite order. They start with a social theory that they think is interesting, and then they look at data to see if it backs up the theory. Because they move from a more general level to one that is a lot more specific, these People usually think of scientific research as being done with a deductive method. The researcher looks at what other people have done, reads existing theories about what they are studying, and then tests hypotheses from those theories. Figure.1 "Deductive Research" shows how to do research with a deductive method.

We discussed how not all researchers use a deductive approach in the previous discussion. However, many do, and there are a lot of good examples of this type of research in the news right now. Look at a few of them next.

King, Messner, and Baller studied how US law enforcement responds to hate crimes. There are many things to think about when discussing hate crimes today, law enforcement, and the history of racial violence [4]. The authors came up with their hypothesis after reading about previous research and theories on the subject. Next, they looked at data on states' lynching histories and how they responded to hate crimes. Overall, the authors found that their theory was correct.

Melissa Milkie and Catharine Warner did another deductive study in 2011. Milkie, M. A., and Warner, C. H. did this study (2011). People who work in classrooms and the mental health of first graders go together. A study in the Journal of Health and Social Behavior looked at how different classroom environments affected first graders' mental health. It looked at how different classroom environments affected first graders' mental health. Based on previous research and theory, Milkie and Warner thought that destructive classroom features, like a lack of basic supplies and even heat, would cause kids to have destructive emotions and be bad at school. In their study, the researchers found that policymakers should pay more attention to the mental health outcomes of kids' school experiences, just like they pay attention to academic results [5].News about Milkie and Warner: The American Sociological Association sent out a press release about their Association: American Sociological Association (2011). Study: Children who have a terrible classroom environment have a hard time with their mental health [6].

The primary distinction between inductive and deductive reasoning is that inductive reasoning is concerned with developing a theory. In contrast, deductive reasoning is concerned with testing an existing approach.

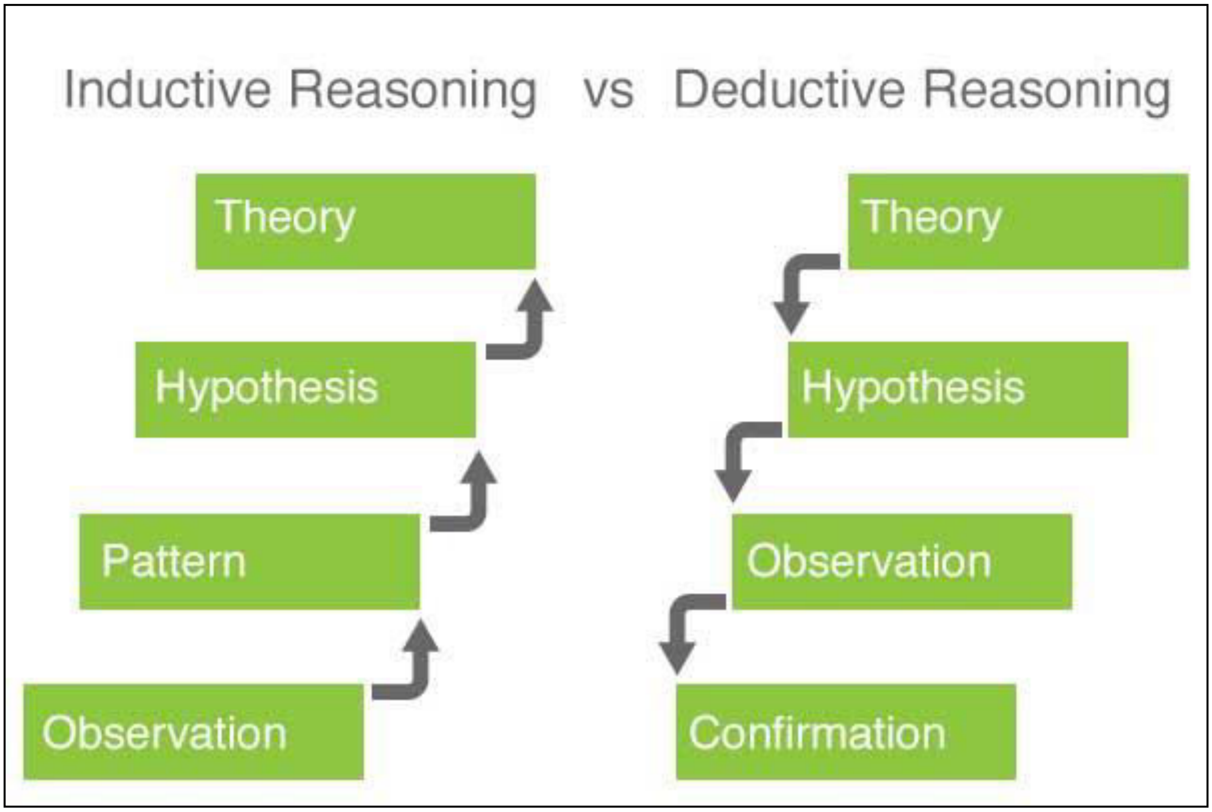


Fig.3.1 Steps of the Inductive and Deductive approach [7]

Inductive reasoning moves from specific observations to broad generalizations, and deductive reasoning moves the other way, going from particular words to broad generalizations first.

When there is little or no previous literature on a subject, inductive research is frequently used because there is no theory to test. Three stages comprise the inductive approach:

Observation

- A flight operated by a low-cost airline is delayed.
- Fleas are present on dogs A and B.
- Elephants depend on water to exist

Observation Pattern

- Another twenty flights operated by low-cost airlines have been delayed.
- All dogs observed have fleas.
- All observed animals require water to survive.

Create a hypothesis or a broad (preliminary) conclusion.

- Low-cost airlines are notorious for their delays.
- Every dog has fleas.
- Water is required for the existence of all biological life.

The disadvantages of an inductive approach

While an inductive conclusion can never be confirmed, it can be invalidated.

The disadvantages of a deductive approach

Deductive reasoning's conclusions can only be valid if all of the inductive study's premises are true and the words are defined clearly[8].

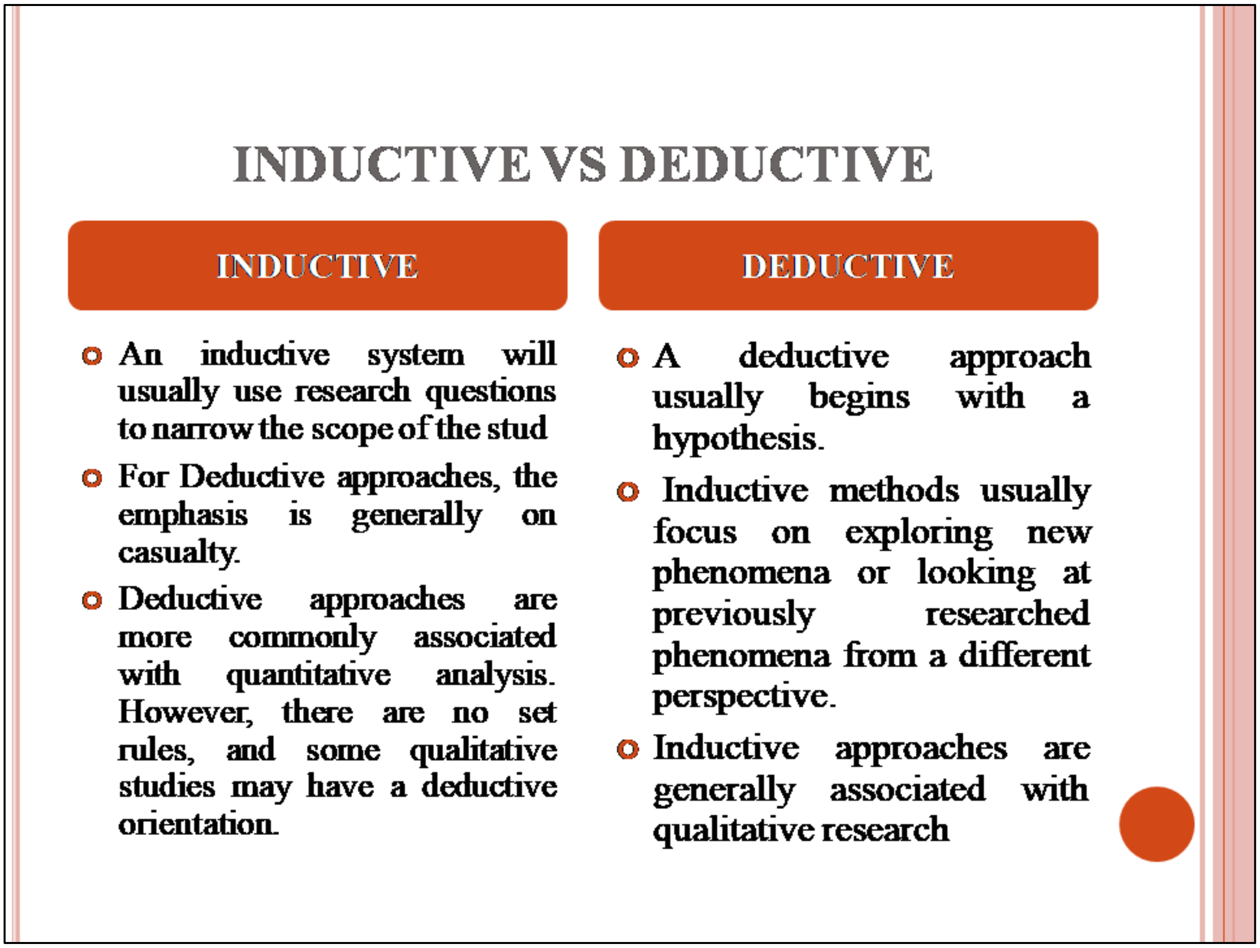


Fig.3.2 Difference between Inductive and Deductive approaches

One specific inductive approach frequently referred to in research literature is grounded theory, pioneered by Glaser and Strauss.

This approach necessitates the researcher; to begin with a completely open mind without any preconceived ideas of what will be found. The aim is to generate a new theory based on the data.

Once the data analysis has been completed, the researcher must examine existing theories to position their new approach within the discipline.

Grounded theory is not an approach to be used lightly. It requires extensive and repeated shifting through the data and analyzing and red-analyzing multiple times to identify a new theory. It is an approach best suited to a research project where the phenomena to be investigated have not been previously explored.

The most crucial point to bear in mind when considering whether to use an inductive or deductive approach is the purpose of your research; secondly, the methods best suited to either test a hypothesis, explore a newly emerging area within the discipline or answer specific research questions [9].

Stages of geospatial research for deductive research

When researchers employ a deductive research model, they have a specific idea or hypothesis in mind that they wish to investigate during the research process. We developed ten steps for the research process, which is a modification of the eight steps associated with the scientific method[10].

1. Decide on a subject.
2. Clearly define the issue
3. Conduct a review of the literature.
4. Construct a hypothesis.
5. Organize your thoughts into a conceptual framework
6. Decide on your research methods.
7. Compile and organise the data.
8. Reconcile (verify) the data.
9. Conduct an analysis of the data.
10. Communicate the results.

1. Decide on a subject: The first step in researching is selecting a subject. As a researcher, your topic may have already been chosen for you by an employer, an organization, a funding agency, or a foundation that hired you to conduct research. If you select your topic independently, choosing a subject or issue those interests you are good.

Maintaining a journal of potential research topics is a good idea. You can use this journal to jot down research ideas or thoughts as they occur to you. Maintain a journal for a month and then return to it to look for emerging themes. By reviewing your thoughts and ideas over an extended period, you may discover one or two new pictures and developed options for further study. Naturally, it would help if you also considered time constraints. If you are a student, can you complete your studies in a semester, or will they take the form of a graduate thesis, requiring additional time?

What is your time frame if your project is related to your professional role or position?

Are you constrained by a budget or policy cycle? Is this research being conducted in response to a pressing need, or is it undertaken for long-term planning purposes?

Additionally, it is prudent to choose a subject that is study able. For instance, you may find it interesting to compare nontraditional sexual practices throughout the world but may have difficulties collecting primary data on this subject. Consider the prior work that has been done on the subject, if any, when determining the feasibility of a particular topic. Additionally, you should consider how you will locate and collect the data required for the analysis. Generally, you can identify some existing, pertinent data on your subject. This step is critical for determining feasibility. You want to avoid conducting research in a vacuum without consulting previous research practices, geographic areas where your topic has been studied, and prior research findings on your topic. Once you've chosen a case, you can consider a study location, perhaps something close to home that you can visit. Consider which relevant variables can be collected in space and what analytical boundaries are appropriate for exploring the data when determining how a GIS fits your topic.

2. Clearly define the issue: You should think more specifically about how you can narrow your topic when describing the problem. A good, solid definition of the problem will help you focus your research as you work on the project. We recommend creating a problem statement that includes the four components listed below:

1. An overview of the subject
2. Demonstrated relevance or significance by citing established literature
3. Background information on your topic
4. A specific problem associated with a particular issue or research hypothesis

To incorporate a GIS into your problem definition, you must first consider what units of analysis you wish to compare. Do you want to look into a problem by looking at different groups of people who live in other places? Would it be more appropriate to study the same group over time? It is critical to know how you intend to investigate your research question—what groups, geographic locations, and issues your study will involve. Once you've identified these issues, you can start collecting pre-existing GIS data related to your topic, creating data about your case, or both.

3. Conduct a review of the literature: A literature review is an essential next step in the academic research process.

Even if you are not conducting academic research, a review of some of the relevant literature will help to inform and support the approaches to the topic that other researchers have used, which is essential when trying to persuade colleagues. The literature review should present relevant information from a wide range of sources. Broad thinking is critical when dealing with an interdisciplinary topic where one source does not adequately address all of the issues you want to investigate in your analysis. Because GIS-based projects, by definition, draw on information from a wide range of disciplines, a review of several areas of literature may be required.

For example, suppose you use a GIS to analyze gaps in a community's public transportation system. In that case, you should look into literature from fields as diverse as sociology, psychology, transportation, and GIS. Such sources may aid your understanding of who uses public transit and how public transportation systems are designed and routed, how GIS is used in modelling systems and behaviours, and possibly other areas. Figure 3.3 depicts how geographic information systems (GIS) can describe public transportation in Bangaluru City.

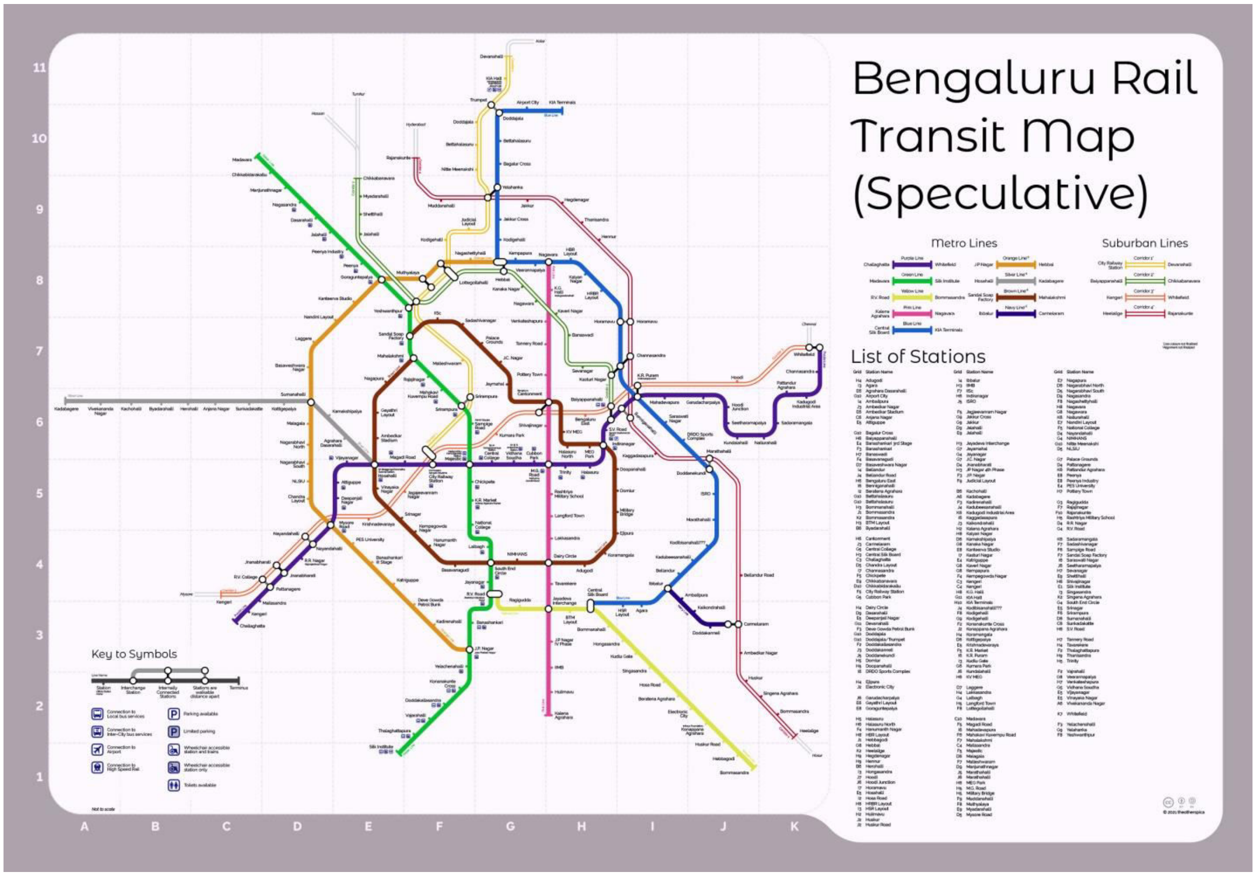


Fig.3.3 A speculative rail transit map of Bangaluru[11].

Finally, reviewing how others have thought about modelling or analyzing data in a spatial context—even if they never used a GIS—will help you develop an appropriate model to implement in a GIS. (It is worth noting that researchers have been thinking about questions spatially for many years. One of the earliest published examples is the presentation of Dr John Snow's research in London in the mid-1800s. Although GIS was not invented until more than a century later, the design of Snow's analysis would be simple to implement in a GIS today. Visit the Center for Spatial Integrated Social Science website's section on classic research for more classic examples of spatial concepts in social sciences)[12].

Make sure to include a thorough review of the relevant information that pertains to your topic when writing a literature review. This entails looking for pertinent information from a variety of sources. It is always a good idea to include a variety of sources in your literature review, such as journals, books, news articles, and websites. When relying on website information, check the references and credentials because they may not have been vetted for quality and credibility. It is up to you, the researcher, to critically evaluate the sources of information you find on the internet or elsewhere before deciding which ones to use.

When reviewing the literature, try to find studies on your topic using a GIS. This information may inspire you to incorporate a GIS into your research.

When searching for these studies in the literature related to your research, use "GIS" or "geographic information systems." This approach is generally more successful than going to GIS journals and looking for information specific to the discipline you are analyzing; however, this approach can sometimes yield good resources.

Your literature review should include common themes, specific ideas and concepts, and relevant debates about your problem statement. A thorough literature review can provide information about research methodologies, study designs, and variables directly pertinent to your study. You will also discover that the literature can assist you in justifying or legitimizing the methods you will employ in your research.

4. Construct a hypothesis: A researcher or group of researchers is guided by a question or issue they believe is worth investigating or needs to be addressed somehow. Regardless of your motivation, a hypothesis will help show your research question. A hypothesis is simply a reasonable idea about the research that you believe explains the situation, or it may be the underlying basis of debate about the topic. In other words, your research hypothesis is an educated guess about what you might find, but its validity has yet to be proven.

Consider the most important aspects of your proposed topic when developing your hypothesis. A hypothesis is an educated guess about potential relationships between variables. You've narrowed your issue enough to form a hypothesis when you can express your thoughts about the research or analysis in a single sentence. Your hypothesis should clearly state the main idea or crux of your research project. In other words, a hypothesis is simply a statement that conveys what you might discover or the current state of a series of events.

A hypothesis is something that can be tested, explored, and investigated further.

The following hypotheses have a spatial component and can be effectively analyzed in a GIS:

- A higher proportion of poor people than wealthy people live in polluted areas.
- When newcomers move to a rural area, they tend to congregate in areas with people from similar socioeconomic backgrounds.
- Individuals with a college education have lower AIDS rates.
- People who have strong social ties to their communities are more likely to participate in local governance.

Fig 1 The Plant

Figure 3.4 A Bhopal Gas tragedy[13].

Every hypothesis should include a single dependent variable and one or more independent variables.

In the first hypothesis, census data could be overlaid with pollution data from the Environmental Protection Agency's Toxic Release Inventory database using a GIS. The census data would provide socioeconomic information, and you could define (using whatever criteria you deem appropriate) which areas are polluted.

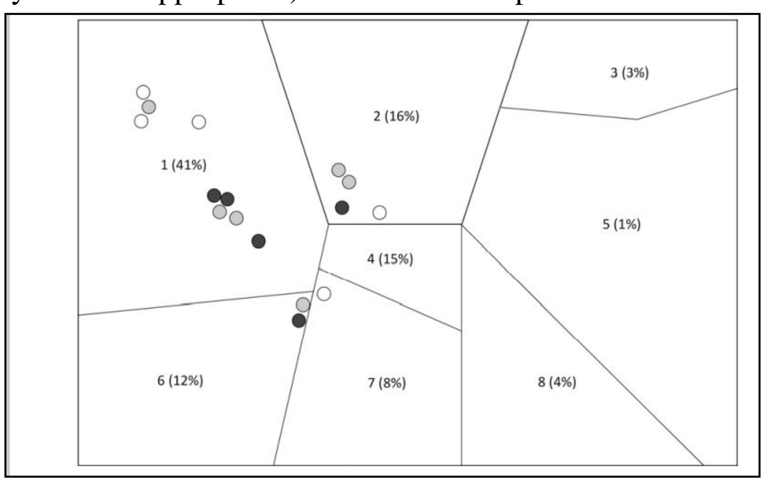


Fig 3.5 Facilities registered on the Environmental Protection Agency's Toxic Release Inventory are recorded as point locations in the database. Information regarding the specific pollutants released is also recorded. These are coded on an ordinal scale from low toxicity (white circles) to high (black circles). Assume that the polygons on the map represent the census tracts with a specified percentage of the population classified as poor (as defined from census data). We could use the GIS to determine if there is a statistical difference based solely on the point locations of facilities releasing toxic waste (do they fall in the census tract or not?) or based on other spatial concepts such as nearness or adjacency.

Several things may become apparent when looking at the spatial distribution of pollution sources in Figure3.5. First, the majority of the mid-and high-pollution facilities are clustered to the map's left of centre in polygons 1, 2, and 7. If the centre of the map (polygon 4) were the historic city centre, industrial facilities, particularly older, higher-polluting facilities, would have grown up around it.

Newer, cleaner facilities may be expected to sprout up on the city's outskirts over time. Second, you'll notice that facilities are generally located on the left side of the map, with no on the right (polygons 3, 5, and 8). Finally, while the central polygon (polygon 4) contains no points and polygon seven has only one light polluter, several other sources of pollution are just across the line in the adjacent polygons (polygons 1, 2, and 6). This example will be discussed further as we progress through the remaining stages of research. As an exercise, consider the other three hypotheses presented earlier and any others you are interested in investigating. As you operationalize this for your spatial data analysis in each scenario, what factors should you consider?

5. Organize your thoughts into a conceptual framework: What is a conceptual model? As previously stated, a conceptual model or framework is a working theoretical model that explains your worldview. In essence, it is your opportunity to identify key variables in your study, explain the relationships between these variables, and explain the sequence and flow of relationships using arrows. Once you've finished your literature review, you should have no trouble developing this framework. A conceptual framework differs from a literature review in that it directs the research process for your particular project. The conceptual model establishes factors critical to your study and shows the predicted relationships between critical variables to all who read your analysis. Brainstorming is an effective method for developing a conceptual model or framework. You could begin by writing down the most important aspects of your paper research.

Then, draw circles around these objects and use arrows to show how these variables are related to one another. As you identify your essential variables, you can decide what type of contextual, geographic, or other information will help you study the relationships between them. When determining relationships between variables in your study, consider how geographic information can help you better understand these relationships. Consider the previous example of poverty and pollution. Given the spatial distribution of polluting facilities on the map, we'd like to think about what the actual locations mean in terms of our hypothesis: Is the presence of a facility within a polygon all that matters, or do sites have an impact on people for some distance (possibly in a neighbouring polygon)? If there is a distance effect, how does the mode of transport (via air, water, or solid waste) affect the distance and direction of the impact? What about the poverty statistics?

Is the distribution of people in the census block equal, or does housing cluster in specific polygon areas? The list could go on, but the point is to think beyond what is directly visible, such as points falling inside detailed polygons, to consider other factors or mechanisms that may be important in determining the validity of your hypothesis.

A GIS is extremely useful for establishing how different variables relate. Some GIS software programmes include a flowchart tool for developing your analysis approach and running your model once filled with data and analysis functions. Even if the flowchart is only drawn on paper, it can help you develop a systematic or holistic approach to a particular issue under consideration.

For instance, suppose that you are conducting a study about an individual's attitudes about environmental issues. You may hypothesize that the nature of the community and its geographic location (e.g., proximity to unspoiled natural features, such as state or national parks or wilderness areas) influence community concern about environmental issues. Your conceptual framework would then incorporate the geographic variable of park and wilderness proximity into your model (Figure3.5). Using a GIS, you could map the locations of these natural features and overlay socio-demographic characteristics and residents' levels of environmental concern to see if there are differences.

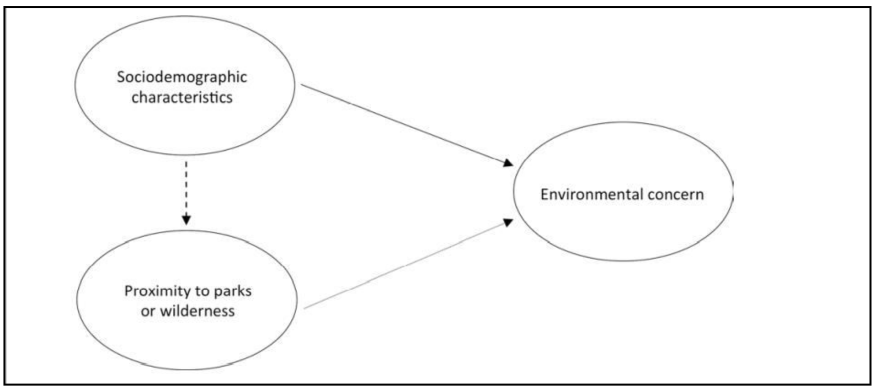


Figure3.6 An example of a conceptual model or framework for environmental concern. Socio-demographic factors, such as age, race, gender, and income, might relate to where individuals choose to live (dashed arrow) and their environmental concerns (solid hand). Proximity to parks or wilderness is also expected to influence the environmental situation (dotted arrow).

6. Decide on your research methods: What factors should be considered when selecting a research method? First, consider the project goal and the data types that will be most useful in meeting it. Will you be able to use existing data, or will you need new data (or both)? Should your study's data be quantitative or qualitative (or both)? What will the scope of your research be? Local, regional, national, or global analysis can be conducted, or any combination of the four levels. Will you perform a descriptive study of a single area or compare multiple research locations? Are you planning to use one or more data collection and analysis methods?

If time and money permit, it is sometimes advantageous to incorporate multiple research methods into your topic study because various methods add a greater empirical angle to your study. Triangulation, also known as cross-examination, is a popular approach that involves studying the same phenomenon using three different research methods. Triangulation provides the researcher with more options for gathering information on the topic. When data collected using multiple methods all point to the same result, your confidence in your results grows.

As a result, you could approach your problem or issue using various methods, such as surveys, key informant interviews, external or participant observation, and a review of historical or archival data. You could incorporate a geographical component into one or more of these methods.

7. Compile and organize the data: When using a GIS as a research tool, collecting and preparing data for analysis can be critical to the research process. Data analysis and organization take time in any research; for GIS-based projects, you can spend 75 to 80 per cent of your time and effort collecting, creating, or converting data to ensure that everything is ready for analysis. We don't just mean making stuff up when saying "creating data." Data may exist in hard-copy formats (paper maps, field notes, etc.) but not necessarily in a computerized, GIS-compatible format because GIS technology is relatively new to some disciplines. The researcher may need to be persistent and creative when looking for potential data sources. It is not uncommon to come across multiple sources of what appear to be the same data, so it is critical to review and evaluate each prospective dataset before deciding on the best source of information for your specific study. Of course, not all data you may require will be available, so you may have to collect your data for use in GIS analysis. Data collection is one of the most enjoyable aspects of the research process for many social scientists. This is the stage of the research process in which researchers actively implement ideas that had previously only existed in their minds (and, ideally, had been committed to paper during the two previous stages of the research process).

Data collection can take many different forms. It could entail going out into the field to meet with the people in your study or thoroughly examining secondary data.

This could entail distributing and collecting surveys or travelling to a remote location to conduct a case study. Data collection is the part of the research process that drew many of us into natural or social sciences in the first place, and it's always been our favourite part. The data collection process should begin with a clear understanding of (1) what types of data are required for testing the hypothesis, (2) where to find this information (agencies, corporations, universities, etc.), and (3) identified geographic components that best fit within the study. Given the technological age and security concerns, some organizations and agencies are hesitant to share detailed geographic information. A wealth of free, pre-existing geographic information, on the other hand, is available from a variety of data providers, libraries, government agencies, Internet resources, and others. Where you look for information is determined by the geographic features you seek.

8. Reconcile (verify) the data: Because a GIS uses technology to use data obtained without leaving your office, it is theoretically possible to complete an entire analysis without leaving your desk. However, it would be naive to believe that such an analysis would be without flaws (especially given the variable quality, scale, projections, data formats, and so on). Even if you can obtain all of your data without fieldwork, it is good to conduct ground-truthing at crucial points throughout the process. When using GIS, you should always ensure that you ground truth to ensure that the data you're using is relevant to your question and validate that the results obtained in the GIS match what you find in the field. (It should be noted that by necessity, ground-truthing of results occurs after the analysis, but we discuss it here because the issues are similar for both input data and results.) In most cases, ground-truthing entails physically travelling to the location of the study to obtain a visual of the data or results. Alternative sources may be used to cross-validate your data against a second, reliable source in situations where physically visiting the site is difficult. For example, suppose you are researching urban development patterns. In that case, you may be able to use current aerial photography or satellite images to confirm whether or not a specific location has been developed. If you can go to the field, you should bring a map representing the data you will use in your GIS analysis and ensure that your maps are valid and accurate. Of course, you can't check everything, but simply spot-checking or sampling from the map can help you start with good data. In our pollution example, we discussed how ground truthing can help answer questions about the type of pollution and where it travels. Observing a smoke plume from a factory, for example, may reveal that the smoke is primarily carried in one direction by a prevailing wind. A drive through each census block, on the other hand, could tell you whether the residents are evenly distributed within the polygon or if they are clustered in specific areas.

Finally, ground truthing is critical when evaluating the results at the end of an analysis. The majority of GIS-based studies will identify specific locations as having met the criteria. Again, spot-checking in the field can help you determine whether the results appear correct and make sense. If your study is large, you may want to spot-check several sites to assess the overall accuracy of the analysis (e.g., if nine out of ten results are correct when checked on the ground, you can estimate accuracy at 90 per cent). The topic of accuracy assessment in spatial data analysis could fill an entire book, so we'll mention it here and encourage those interested in looking into it further on their own.

9. Analyze the data: You must return to your primary research question and conceptual framework in the research process. The type of data you have collected and prepared in the GIS will influence the form of analysis you choose. Some analysis tools only work with vector data, while others only work with raster data. Of course, you can perform a wide range of operations with either. Furthermore, you will almost certainly use statistical analysis if you collect quantitative data. Many commonly used descriptive statistics are available in GIS software. However, it is common to enlist the help of other statistical programmes for some aspects of the analysis. This is accomplished by extracting essential information from the GIS using spatial tools and exporting the raw numbers into a programme such as SPSS, S-PLUS, R, or Excel to further analyze the data before returning it to the GIS to create maps of the results.

Working with qualitative data may require using a program explicitly designed for qualitative analysis, such as Hyper RESEARCH by Researchware, NVivo, or ATLAS.ti. After you've identified your essential variables, you can decide what kinds of contextual or geographic information will help you study the relationships between these variables. You can then use various methods to evaluate the geographic information you gathered as part of your research.

Regardless of the data type, the most important thing to remember is to let your project dictate the analysis rather than allowing the software to drive the study simply because it has a menu option or a button. You will need to fine-tune your conceptual framework at this stage because it will serve as your guide in the analysis.

10. Communicate the results: This is possibly the most crucial step in the entire research process for applied research.

You can disseminate results in two ways and to two different audiences: laypeople and scientific community members. If you want to share your findings with the general public, you should package them in a way that is simple to understand and free of scientific jargon.

We've discovered that writing a report discussing the methods and highlighting the main findings is the most effective. Consider creating a visual presentation that can be given in various settings and highlights both your research methods and your main results. Suppose you want to share your findings with the scientific community. In that case, you should probably write a paper for submission to a scientific journal and possibly present your findings at a professional conference.

Because it allows for the presentation of data in a visual format, GIS can be beneficial in sharing your results. The most common optical output is a map, but GIS can also provide production as charts or graphs or animated or interactive maps if done as an interactive presentation.

Unsurprisingly, any of these visualizations can be helpful in various contexts—" a picture is worth a thousand words.

Grounded theory: GIS using an inductive approach: As a researcher, you can also use an inductive model in your research design. This method begins with a different set of steps than the traditional deductive method. An inductive approach starts with data and progresses to eliciting themes and patterns. The theory is then developed based on this data.

Grounded theory is an inductive research method distinguished by data collection and theory generation sequence. It is referred to as "grounded" because of its close relationship to the reality that the data represents. This method of inductive research is qualitative. Grounded theory is an appropriate research method for evaluating case studies, transcripts, oral histories, and archival data.

Glaser and Strauss (1967) coined the term grounded theory in their seminal book, The Discovery of Grounded Theory: Strategies for Qualitative Research, in the late 1960s[14].

Many other qualitative researchers have since adopted and written about grounded theory. Grounded theory has become a popular approach that has been adopted by several disciplines, including public health, business, and criminology, to name a few. Consider the purpose of your research when deciding whether or not to use grounded theory. One of the primary benefits of grounded theory is the ability to "generate theory that will be relevant to [scientists'] research" [14], as opposed to verifying theory, which is used when following the traditional scientific method, which is deductive. Grounded theory is an excellent approach to gathering information during the discovery phase. It is more appropriate for researchers whose goal is to generate knowledge, themes, and patterns rather than to prove the theory.

The central premise of grounded theory is that theory emerges from data analysis. Rather than the researcher dictating which themes and ideas will be investigated, the data will dictate what is relevant and important to investigate further. "Grounded Theory is based on systematically generating theory from data derived systematically from social research" [14]. As a result, the grounded theory approach considers research methods a component of the theory-generation process. The process is iterative; the researcher constantly analyses and looks for themes and comments. It is a very hands-on approach to data sorting.

The heart of the grounded theory is the analysis and search for patterns in data. The researcher attempts theoretical saturation in the study[15]. Theoretical saturation means that no new themes, concepts, categories, or relationships emerge from the data, which can only be achieved after the researcher has gone through the data several times, identifying themes and looking for data to support the themes. Bernard summarizes how grounded theory can be achieved through the following steps:

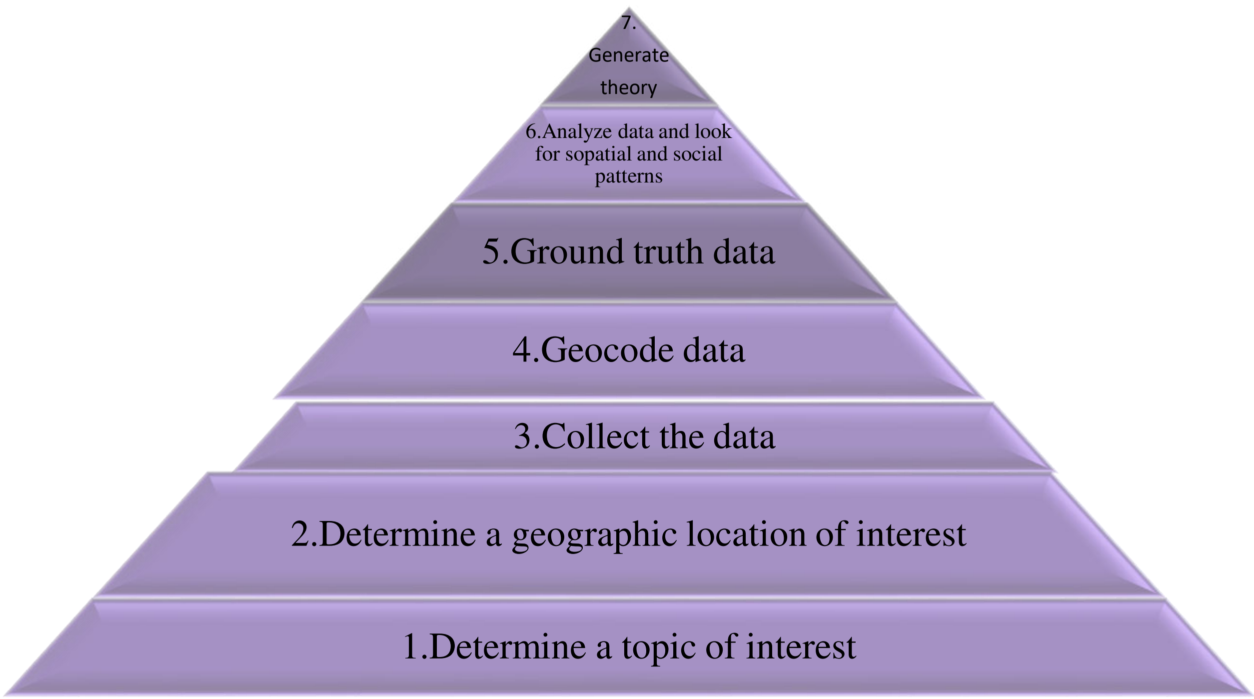
1. Begin with data (e.g., interviews, transcripts, or newspaper articles).
2. Look for possible themes in the data.
3. As categories emerge, pull data together.
4. Consider the connections between categories.
5. Create theoretical models based on the connections.
6. Use examples to present the results[16].

Following these steps, you begin with whatever data or information you want to analyze. This information will almost certainly be qualitative. Identifying potential themes in your data can be done by hand or with the assistance of a qualitative data analysis programme.

Certain words or phrases will emerge consistently as you sift through the data. The identified themes can then be used to create a coding scheme to complete the theme analysis[17]. Step 3 requires you to organize your data by grouping it or categorizing it. In essence, you look for similarities, differences, and repetitions in what has been stated. This iterative process evolves as you analyze the data using your coding method[15].

Step 4 asks you to consider the connections between the grouped categories. This is similar to creating a conceptual framework or model. This naturally leads to the next logical step: building a theoretical model based on your discovered links. This is your best model of the relationships you observed emerge between the themes you identified in the data. Finally, in step 6, you present the data using examples. These are simply quotations or snippets from the data that illustrate the themes, concepts, or relationships you are discussing. Consider exemplars to be examples (shared words, quotes, etc.) of concepts or themes that emerge from the data analysis process.

Geospatial grounded theory used in GIS: GIS has rarely been used in analyses that explicitly use grounded theory. We believe that the spatial information provided by GIS can be a significant additional component of inductive research. Visual patterns in spatial data can be a powerful indicator when exploring emergent themes derived from spatial data.
To develop theory, use existing data. When using GIS as part of this approach to social research, we have devised a series of steps that you can follow:



1. Determine a topic of interest: You should select a topic that interests you when selecting a topic. This will ensure that you enjoy the research process and approach it with vigour. When considering your topic, consider what might be a feasible area of study for you in terms of time, money, and interest. Having a lot of time, money, or resources significantly influences your research method selection; for example, you might choose detailed interviews. If you have a limited amount of time, money, or resources, you may need to rely on available data.
2. Determine a geographic location of interest: Determining the geographic location of interest entails identifying a study location related to your topic. This could be a neighborhood, a county, or something more ambiguous, such as former residents of a defunct community. There was one such community in New Mexico called Santa Rita. It was next to an open-pit mine, and as the mine expanded, the townsite became a part of the mining pit's giant hole. Many of the town's homes were relocated to nearby towns, and ex–

Santa Rita residents moved in. Today, a study of these residents' perceptions of the town will be conducted about a place that no longer exists physically, the town of Santa Rita.

Fig. 3.7 Thousands people are vulnerable for by mining in Bengal's Ranigunj[14]

Assuming you can locate former residents of this town, you could conduct interviews with them to learn about their impressions of the town. You should also take note of where these people are now living. Why? Because the geographic locations of former Ranigunj residents may be a factor that corresponds to their perceptions of the former town. For example, do residents who live within five to ten miles of the old mining pit (Ranigunj townsite) have different community perceptions than those who moved further away from the town? Or, regardless of current geographic location, do all residents have the same perceptions of the city? We want to make sure that the physical areas of a place can play an essential role in the analytical process when using grounded theory.

3. Collect the data: Even when using a grounded theory approach, you can collect information about the spatial surroundings while collecting data. Why do we believe this is a good idea? Our motivation for gathering both types of data stems from a philosophical belief that the social and physical environments interact and influence one another. The extent to which a researcher uses a dual data collection process is determined solely by the researcher and their preferences.

Using a grounded theory approach makes sense to collect information on the geographic location and natural environment related to your data. Why? Incorporating this type of information could significantly improve the emergence of themes, ideas, and relationships in your model. Your theoretical model may include previously unconsidered physical, social, and environmental features. This is an area were grounded theory and GIS work well together. Grounded theory is adaptable enough to include and identify various data types, including geographic information.

4. Geocode the data: When you spatially code data, you assign a code that reflects the geographic location of your data. Assume you want to examine how different newspapers cover the issue of immigration. You decide to analyze newspaper articles from various locations across the country for your content analysis. As part of your grounded theory analysis, you could code the site of each newspaper and note other characteristics about the community in which it is published to see what kinds of patterns emerge in your data analysis. This would allow you to determine whether the physical environment and population are related to perceptions of immigrants. If you fail to collect this information and treat all newspapers the same, you may be missing a critical explanatory element for your theoretical model. In conducting your research, it would be interesting to see if there were any differences in attitudes toward immigration between the coverage of these issues in different newspapers. A content analysis of the data mentioned above would reveal themes and patterns that could be crafted into a theoretical model.

5. Analyze the data and look for spatial and social patterns: Searching for patterns in your data is essential for the grounded theory approach. If you want to incorporate a GIS into your information-gathering process, you should connect each piece of data or information to its geographic location. Assume you have a collection of historical diaries from the 1940s. As a researcher, you might be curious about how World War II influenced people from that era.

You could use grounded theory to analyze the diaries while also creating a coding system that notes the geographic locations where the diaries were recorded.

Individuals living in different parts of the United States, for example, may have had very different experiences during the war, depending on various factors. Were there military bases nearby, for example? Did the authors of the diaries live in areas populated by specific ethnic groups from parts of the world viewed positively or negatively as a result of the war?

Keeping track of geographic information as you conduct your qualitative data analysis may reveal geographic patterns in the data indicating that location influences the attitudes expressed in diaries. Certain geographic areas may have been harder hit by rationing, more local men and women who served in the military, and so on. None of this is evident at the start of grounded theory analysis.

However, if you keep track of where the diaries were recorded geographically, your analysis could yield exciting results.

The logical question is, "How do you know when you've sufficiently analyzed the data?" provided a concise summary of the grounded theory analysis process[15]. He stated that researchers should stop their research when they reach theoretical saturation, identify a core category or main storyline, integrate the analysis around the main storyline, and then use the coded information to modify the results, terminating the process when a useful theoretical model emerges[15].

6. Generate theory: The most creative aspect of the grounded theory approach is the generation of hypotheses. At this point, you get to create a theoretical model that reflects the patterns in your data. As mentioned in the previous step, the geography—or, more specifically, the spatial location—associated with data may play a significant role in the theoretical model you develop. The variable geography could play an essential role in the analysis in any of the examples provided in this section. When building your model, indicate whether the physical, social, or environmental context influenced the grounded theory generated during the research process. Figure3.8 shows how geography can influence people's perceptions of World War II, evidenced by their diaries.

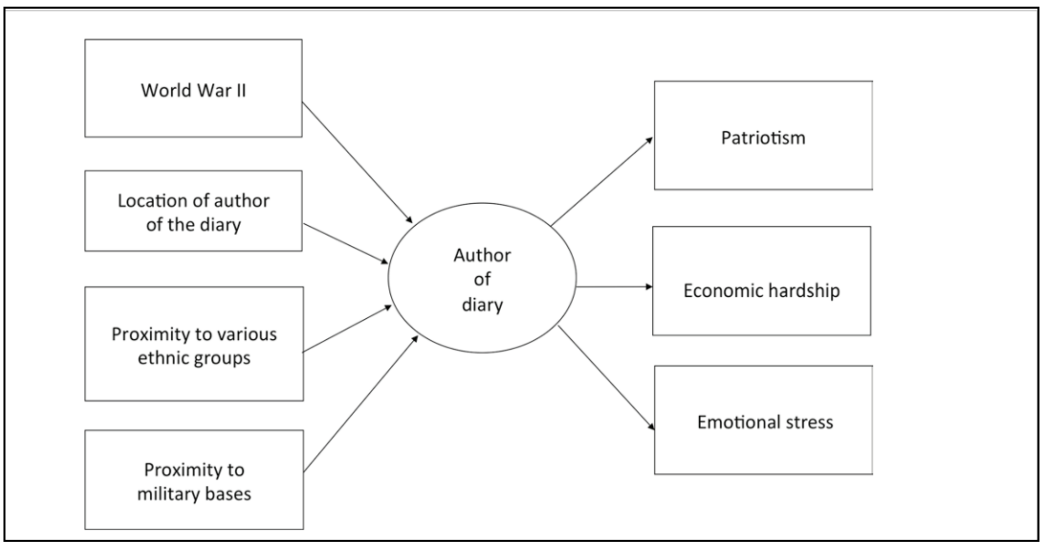


Fig.3.8 A variety of variables, including environmental, geographic, and social, are believed to affect the authors of the diaries assembled for an analysis using a grounded theory approach. In some combination, these might influence the themes that emerge from the diaries and help to inform the eventual theory suggested by this research.

The following emergent themes emerge from a grounded theory analysis: economic hardship, emotional stress, and patriotism. Perhaps those in the heart of the country were less worried than those on the coasts, who feared an attack by German submarines or Japanese kamikaze planes. Those who lived near military bases may have felt more stressed because many of their friends and loved ones were directly involved in the war effort.

Areas of the country with high concentrations of ethnic groups with ties to the Allies may have experienced more significant hardship or stress. From a historical standpoint, this figure depicts grounded theory in action.

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UNIT 4 - RESEARCH DESIGN AND SPATIAL ENQUIRY

Research Ethics and GIS: The principles and practices that guide how people conduct research are referred to as research ethics. Topics range from how a researcher recruits project participants to how data is collected, stored, analyzed, and ultimately communicated and shared. For example, will you share your research data with whom and at what level of detail?

Will your findings be included in your research? Research ethics encompasses a wide range of issues. A spatially based study should consider several additional factors regarding the scale of analysis and detail of location-based data collected and reported.

Every time you conduct research, you should think about research ethics, especially involving potentially sensitive or personal information. Failure to consider research ethics may endanger people. Documented procedures or professional practices may be available to help guide your work in some research contexts. Institutional review boards, ethics panel's, or research sponsor requirements will frequently provide detailed guidance and review of a research plan. However, formal ethics protocols may not be in place in some contexts, and even if they are, they may not address your specific research plan or its potential pitfalls. Although anyone can conduct research, not everyone conducts research in an ethically correct manner, and powerful software and data collection tools in a spatial context may necessitate additional ethical considerations. Failure to incorporate research ethics may call into question the motivations of your research project and the findings of your work.

Many social science studies include personal information, which must be treated with care and confidentiality. This is especially important when storing data in a GIS because the data is linked to a specific location. Consider how the data might affect particular groups or individuals about the issue or topic under study or how details about the areas of sensitive information on environmental or built infrastructure might have a negative impact on those resources. For example, explicitly reporting the locations of a specific minority population could provide information to those who may wish to target or oppress that population. Similarly, while writing about the site of an endangered species of plant or animal may help protect the resource, it may also provide poachers with the information they need to collect them for personal gain.

In traditional data collection, it is relatively simple to decouple personal data from an individual respondent by assigning a random ID code to the responses. Simply removing identifying information like names and addresses can help protect your privacy. However, when these same data are linked to a map, the map can be used to obtain a respondent's address or other locational information. As a result, data scale or generalization of locations is frequently used to obscure such details. For example, results could be mapped by city or postal code rather than mapping results at a specific street address or neighborhood scale.

The foundation of research is collecting and analyzing data to identify patterns. It is critical to think carefully about how you will collect and analyze data as part of this process. Many research studies have the potential to produce positive results. Still, an ethical researcher will also consider potentially unintended, adverse outcomes and strive to ensure that work is done with ethics and professionalism in mind.

Social implications: Essentially, all research has the potential for direct or indirect social implications arising from work itself or the study's findings. The term "social implications of research" refers to research's impact on various societal aspects. In other words, what does or could the research mean for society?

Whether it is a health study or research on specific natural resources, research is usually linked to a societal question or interest, giving the work social relevance. Because it can be used to document and highlight where social inequalities occur, spatially based research raises additional ethical concerns. Furthermore, mapping the location of specific resources (human, capital, or natural) and who owns these resources is naturally vital to people. This information can be exploited in ways that the researcher may not have intended. For example, discovering a valuable natural resource on land occupied by a group with little political clout may result in their displacement by individuals with financial or political influence. By bringing people and resources together, geographically based spatial research opens up new avenues for discussion about meeting society's needs. This theme permeates many different types of research, spanning disciplines as diverse as business, marketing, health, natural resources, and social services.

Cultural implications: The term cultural implications of research refer to how a study can affect a specific culture. Cultural research might involve understanding the boundaries and locations of sites important to a particular group of people, such as a tribe in the Amazon forest. This tribe claims to have been conducting sacred rituals and ceremonies in some forest regions for many years. You can determine where tribal boundaries exist by asking the right questions using a survey or public participation GIS (PPGIS). We present methods for conducting spatial surveys and explain how to use PPGIS. The researchers will be able to interview tribe members due to these processes. Ethical considerations come into play when deciding which details to include and which to leave out or obscure in the final report. For example, you would not want a map showing the exact locations of tribal sacred sites, burial grounds, and exceptional hunting grounds in a final report distributed to other researchers or the general public. If such a report became public, poachers, grave robbers, and thieves interested in stealing tribal artefacts could gain knowledge of these locations through your map and thus pillage the resources. This is an example of failing to consider sound spatial research ethics—you were unable to account for and protect the privacy of information about sacred and essential sites to these forest dwellers, which should not be shared publicly. Sharing information that should have remained private may not constitute a violation of the law, but it does violate the ethical boundaries of what is considered appropriate. By making public something that was supposed to be kept private—only known to tribe members—you jeopardize an essential aspect of the culture. It would help if you never did this because it can harm the people who took part in your study and shared information with you.

Political implications: Data by themselves are not political. Individuals' or groups' use of data, on the other hand, can be political. The term political implications of research refer to the research's potential political effects or impacts. People or groups will sometimes reject data that presents facts simply because it does not support their point of view. This is a typical example of when communities are assumed to have specific political orientations. Various country regions have long been referred to as red states (Republican) or blue states (Democratic). This could give the impression that everyone in California is a liberal and everyone in Texas is a conservative. While these generalizations relate to which party these states voted for in recent elections, assuming only Democrats live in California and only Republicans live in Texas is a gross oversimplification. The reality is that people with a wide range of political views can be found in every state, and delving into the specifics of the data at a local level would help to clarify this fact.

Nonetheless, this is an intriguing example of the political aspect of data. Even when data speak the truth about a situation, that truth may be challenged or acted on based on people's beliefs rather than what the data shows.

This certainly plays out in national politics, as presidential candidates choose to concede some states while focusing their campaigns on areas where demographics are perceived to be more politically diverse.

Another factor to consider when it comes to the political implications of data is the level at which politically charged information is gathered. Incorporating a geographic variable that relates individuals' responses to a specific geographic area can pose difficulties. Individuals may be less willing to participate in a survey or other data collection effort if they believe their privacy will be jeopardized. In other words, if a person shares detailed, personal data with you, such as income level, the person may be concerned that if these data were to be shared publicly, the person would suffer a negative impact.

If community members learn about a person's opinions, there is a chance that they will marginalize them. For example, suppose you were researching people's views on gun control. In that case, you could use GIS to link responses to specific houses or neighbourhoods, allowing you to determine which neighbors support gun control and which do not.

Because of the emotional nature of this subject, doing so may result in unexpected outcomes or conflict between neighbours. To protect individual respondents' privacy, it would be preferable to mask responses at the household level. This can be accomplished by visualizing the data at a sufficient level of generalization to conceal individuals, such as at the ZIP Code, county, or state level.

A consideration for political issues is that making this information public may have ramifications for the people linked to it. This is appropriate or required by law in some cases. For example, the Federal Election Commission reports campaign contributions by name, occupation, and ZIP Code, making it easy to determine how much an individual has contributed to a candidate's campaign.

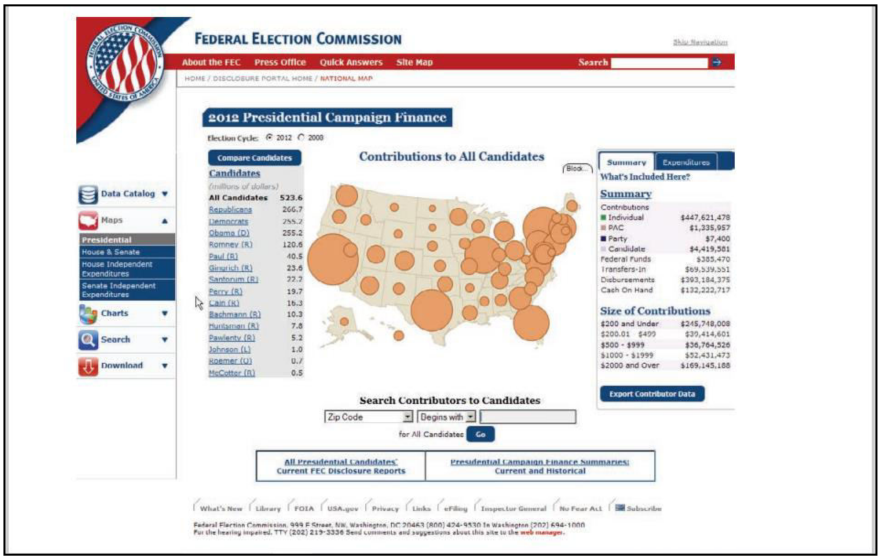

Fig.4.1 A web-based map of campaign contributions searchable by city, ZIP Code, or name[1]

Similarly, specific geographic data related to criminal behaviour may be made available through public websites; for example, data on sex offenders is available on Megan's Law websites in many states.

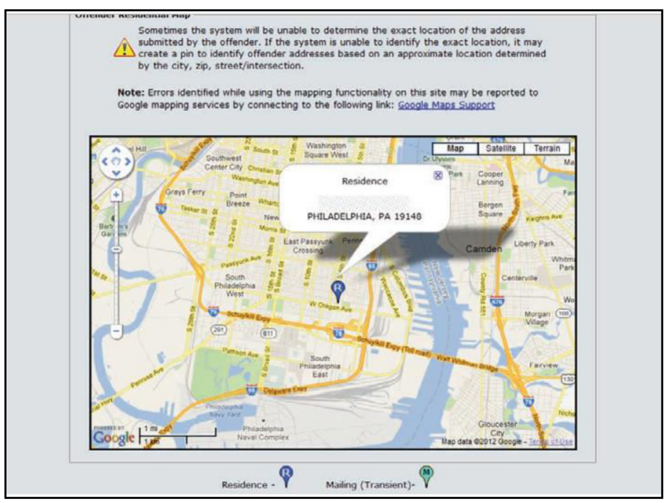

Fig.4.2 An example of a Megan's Law offender map showing the specific street address of a selected individual (hidden here). Such systems allow searches for offenders within a distance of a particular lesson or other features (e.g., a school, a park, or at a certain distance from a given street address)[2]

The US Census collects geographic information alongside all of a person's personal information, but it does not publicly display this information; instead, it aggregates the data.

However, it is worth noting that after 72 years, these data connecting people and geography are now publicly available. In the case of the US Census, the underlying assumption is that after seventy-two years, respondents are no longer alive.

Errors Caused by Analysis: Some errors may creep into your results during your data analysis. The term "errors caused by analysis" refers to errors arising from the analysis process. Errors can be caused by various issues, from significant blunders in data entry and processing to minor mistakes that go unobserved. The significant errors are usually obvious and, in most cases, more accessible to identify and correct.

These could result from a faulty processing step or the inadvertent use of the incorrect data file. Such errors may result in empty output files or inaccurate results if the output is generated. For example, an intersection operation using data from two different counties would produce a blank or erroneous work because counties are not expected to share the same geographic space by definition. We will concentrate on more subtle errors in the following sections, such as those caused by data sources.

Existing data sources: When working with existing secondary data sources, you should consider several factors such as data format, quality, and utility. The term existing data source refers to a source of data that has already been collected and lives before the start of the research process. It is critical to review the metadata or other related data documentation for existing sources, whether the data is spatial or tabular. Is the information you're working with from the original, raw dataset, or has it been summarized and aggregated somehow? Data obtained from government sources, such as the decennial census, is an example of aggregated data. The census data is aggregated to enumeration areas, representing groups of people. Other data sources may provide data for similar geographies, but data attributes are developed from sampled data. Sampled data can be generated in various ways, depending on the sampling frame, sample draw, number of samples, etc. Both complete census data and sampled data are valid.

As a researcher, you must exercise caution in selecting and comprehending the data sources you use in your research. Data that includes detailed metadata will better understand the dataset's nature and intended purpose. Then, based on your research objectives, you can decide whether and how to incorporate these data into your work and how doing so will affect the interpretation of your results. Of course, some of the information you find may not be well documented. Metadata could be missing, incomplete, or presented in an unusual format. Although metadata standards have evolved and formalized over time, if you are working with historical data or data generated without these standards in mind, you may need to dig deeper to find this information. Reviewing the methods section of a final report associated with such data, for example, may shed light on the sample design and data processing that resulted in the resulting dataset you are considering. In other cases, you may need to look through agency documentation to find the protocols and standards used for mapping or data collection. It's even possible that you'll need to track down the person in charge of the data in question and ask them directly about the study.

Of course, if your efforts to obtain documentation for a secondary dataset fail, you can still use the data in your analysis; however, failure to secure the necessary information to validate the dataset should raise a red flag, prompting you to pause and consider whether using the data anyway is your best option. Could you find a different data source? Is it possible to collect or create your unique data? Although we cannot go back in time to retrieve historical data, some workarounds are available. Incomplete maps of historical land cover and land use, for example, could be supplemented with new data derived from aerial photography of the area in the past. Other data types, such as surveyor's notebooks (which frequently predate aerial imagery) or oral histories passed down through generations of locals, may also be helpful. Of course, these approaches are not a perfect solution and may necessitate a significant investment of time and resources, so using an alternative to an imperfect or poorly documented dataset has its own set of issues.

Even if your data is well documented and appears to meet your research objectives perfectly, it will not be perfect. Whether created by us or obtained from other sources, all datasets contain some error level. Despite careful researchers' efforts to eliminate or reduce errors, attributes may occasionally be miscoded or calculated incorrectly. To that end, it is reasonable to consider the data's source. Do they come from a reliable and credible source? Have other experts in the field reviewed the data? Specific data sources (government agencies, universities, or other research organizations) are accepted and authoritative in many areas of study. The fact that the data came from such sources is a fairly good indication that it will meet the needs of your study. Data from interest groups or individuals who are not affiliated with a known, reputable organization, on the other hand, may require additional scrutiny to ensure that they are not biased to support a particular perspective or agenda. Of course, there is no guarantee that data from a specific organization is more or less trustworthy than data from other sources. Finally, it is up to you, the researcher, to exercise caution when selecting data and to determine its suitability for a given purpose.

Variations in data accuracy, scale, and temporal change: The term accuracy issues refers to the project's results' accuracy. The mapping scale, projection, coordinates, and selected datums can all contribute to errors in the mapping process. These issues can arise at various stages of the data development workflow, beginning with the original fieldwork or image interpretation from which the maps are created and progressing through multiple sets of data entry and processing in developing a GIS data file. As described in the previous section, reviewing the metadata of a given dataset to understand how the spatial data were acquired, prepared, and processed can provide valuable information that will assist you in determining the dataset's suitability. Although the integrity of each data layer is critical, it is not the only factor to consider. We may use multiple data layers to compare, combine, and query in typical GIS analysis.

When data is combined in GIS, it is easy to assume that the observed differences are fundamental (Figure 4.3). Although ArcGIS software can assist us by aligning datasets to the same coordinates, projection, datum, and scale, this does not necessarily imply that the underlying data was initially mapped. If you want to measure differences of a few metres, you should not overlay a US Geological Survey quadrangle created at 1:24,000 scale on a local city map at 1:1,000 scale. The quadrangle is not accurate enough to perform an analysis at that scale, but we have seen many inexperienced GIS users unknowingly attempt to go down that path. Differences in map layers, which are development artefacts, can also be caused by differences in or changes to map projections, coordinate systems, and datums. Cartographic alterations, such as the displacement or offsetting of some features to facilitate map reading on the paper medium, may also be reflected in map data created from digitized paper maps. While such cartographic conventions are appropriate for printed maps, their translation into an interactive and dynamic GIS realm means some features may be misplaced.

Another type of error might occur during the data processing activities performed by your GIS programme. For instance, there may be computational discrepancies between how an algorithm is implemented in the programme you are using or in the software used by the creator of a dataset that affects the accuracy of your results. Most of the computational differences arise from rounding or other tolerance settings in the GIS software. Understanding the software utilized and the tolerance settings or algorithms employed will assist you in assessing the accuracy of the data used in your study and the interpretation of the results obtained.

It's worth noting that, while GIS is based on computer analysis, the processing methods and algorithms used in these programmes are dependent on a range of assumptions. Human errors that may impair data collection and quality persist until data is fed into a computer. Take caution not to over-rely on the computer. Be logical in your conclusions and transparent about your assumptions and potential inaccuracy when reporting your findings (Figure4.3).

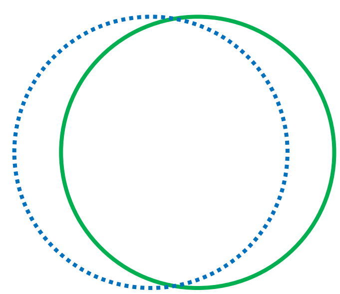

Fig.4.3 Consider what appears as a visually small error in the alignment of the two circles in the figure. If these circles represent the overlap between two variables in your study, it might suggest that they are highly correlated. However, is this correlation statistically significant

What would you do if you were performing a study that required a correlation of 95 per cent and the computer reported several 94.3 per cent? What if the connection was 95.2 per cent? These disparities, mainly when they are slight, could very well be the result of mapping or other stages of the data collection process. It may be unethical to cancel a new project or programme designed to aid a community if it falls just short of a predetermined (and possibly arbitrary) cutoff value, mainly if the shortfall is just as likely an artefact of the analysis process.

More subtle inaccuracies may be inconsequential because social science research rarely requires centimetre-level precision or even a few metres. The critical point is that while ArcGIS can provide measurable results to several decimal places, you should most likely not.

Errors in human inquiry

Social research is not a trivial endeavour. There are various considerations in the early phases of any social science research project's design. The term "human inquiry errors" refers to various human-induced errors that might arise during the research process. **Earl Babbie** highlights some typical problems in social research that should be addressed in his book The Practice of Social Research. (1) erroneous observation, (2) exaggeration, (3) selective observation, and (4) irrational reasoning. These hazards are avoidable with some forethought[3].

Inaccurate observations: To avoid making erroneous observations, it is critical to have a well-defined data gathering strategy. Most importantly, you should always capture data as they are noticed rather than relying on your memory to recall what was observed accurately. It is critical to have data-gathering forms, tape recording devices, and explicit descriptions of pertinent criteria and terminology. If you intend to gather data with more than one person, it is critical that everyone knows and applies the same concepts when making observations. Training your data collection personnel to record the same information in practice is beneficial if your study permits it. Allow them to observe in the same location for numerous data collecting runs to guarantee that all observers obtain similar results. Once everyone has been trained to notice the same things, the likelihood of individual results from numerous observers being consistent across your study increases. Approaching a study with a specified plan for data collection increases the possibility of doing reliable observation.

Overgeneralization: Overgeneralization is another typical research error. It occurs when you, as a researcher, draw conclusions that are not supported by your research findings. This error is easy to make since it results from the constraints (time, money, or other resources) inherent in most investigations. Two types of overgeneralizations can occur with study data. It can happen when your sample size is insufficient or acquired using an ineffective sampling strategy, resulting in an inaccurate representation of the intended study population. Second, overgeneralization occurs when the findings of one study are incorrectly applied to contexts in which they do not apply. If you see that multiple house in your neighborhood come up for sale in the same month, you might conclude that the community is declining and everyone is fleeing. A further exaggeration would be to claim that the entire city is deteriorating without examining the situation of adjacent areas. While this notion is entirely feasible to be correct, it is merely one possible explanation. You need to gather further data to ascertain the true causes behind people leaving your community.

Selective observation: Following overgeneralization, there is a natural tendency to believe what we observe. Particular comments could be defined as continuing an observation pattern that is likely to corroborate earlier findings, limiting your ability to observe objectively. In other words, we see what we expect to see and overlook what does not conform to our preconceived notions. Allowing preconceived assumptions to impact data gathering can be a self-fulfilling prophesy and is an easy trap for any researcher seeking validation for a theory or idea.

It is critical to plan your research to avoid this trap, outlining the quantity and type of observations collected. For instance, to ascertain why people choose to remain in or leave particular communities, you may survey a random sample of houses in each neighbourhood throughout the city, rather than only those whose homes are for sale in your area. One strategy is to stratify your sample design according to socio-demographic or physiographic factors. Alternatively, you may want to sample the population randomly or methodically. In any case, having a strategy in place in advance is the most effective method to prevent the problem of selective observation.

Illogical reasoning: Finally, inconsistent reasoning is another potential mistake to avoid when conducting sound scientific research. When conducting research, mainly when supported by computer analysis, it is critical to analyze the reasoning behind the data and analytic outcomes. If the findings of a study appear weird to you, they probably are. The following section discusses the concept of ecological fallacy, which serves as a formal definition of this issue. However, in basic terms, you should always evaluate the logic of your actions rather than racing ahead blindly. Logic systems can aid you in this attempt. For instance, a simple flowchart might serve as a starting point for developing your study and a method for delving further into the logic of GIS analysis.

Ecological fallacy

Ecological fallacy is a critical notion that every researcher should understand, even more so when working with GIS. An ecological fallacy is merely an erroneous causal connection that is statistically supported by the data, often known as a false association.

It is too simple for a researcher to draw erroneous causal connections between unrelated occurrences of variables. This is especially true when using a computer to analyze since the researcher might quickly lose sight of what the study variables represent while performing statistical analysis on enormous datasets. This is especially true when statistics take precedence over the meaning of the underlying facts.

For instance, we could plot the locations of bars on a map with an educational achievement plot. If there appears to be a correlation between the number of bars and educational attainment, one might conclude incorrectly that increased availability of alcohol makes individuals smarter. Indeed, a GIS-based study of the spatial correlations between these two datasets may reveal a highly significant association, regardless of whether it is causal. Of course, we could more accurately assert that practically any town with a university is likely to have a sizable number of bars, perhaps an abnormally high amount.

Consider the following somewhat less ludicrous example: Assume you study in an area with many black residents. Additionally, this neighborhood may have a high crime rate. They assume that the region's high crime rate results from its significant black population would be an ecological fallacy. The mere presence of two variables in the same geographic area does not imply that they are linked. The ecological fallacy is a straightforward trap to fall into, especially when combined with the previous four mistakes of human inquiry.

The likelihood of a spurious association grows as datasets grow more significant, more complex, and more variables are included in the analysis. By using geographical data from GIS, we run the risk of committing the ecological fallacy. It is natural to presume that two variables that occur concurrently in geographic space are connected somehow. Even worse is assuming causality. Causality is another difficult-to-prove aspect of analysis that should be handled cautiously to avoid producing erroneous results. Correlation and causality may exist. However, it is critical to analyze the study's reasoning and design before leaping to such conclusions.

Ethics and data collection

Fortunately, a researcher can utilize various straightforward strategies at different stages of the GIS process to decouple data from respondents' accurate locations while retaining the necessary spatial linkages for data analysis. As with any study, including privacy concerns, it is critical to maintain data security during the study's duration and to remove any identifiable information as quickly as feasible.

Most research institutes, and occasionally even businesses, have research review boards from which researchers must receive approval before being granted permission to collect data. The purpose of such entities is to safeguard the research subject's rights. Suppose a researcher wishes to collect data in a manner that does not ensure anonymity (e.g., through a random survey). In that case, the researcher must typically provide the research subject with an informed consent form that explains the project's purpose and, most importantly, informs the issue of their rights as a research subject.

When collecting spatial data, it's critical to examine the level of information required to address your study issue. When considering research ethics, one crucial issue is privacy: when collecting data, evaluate the amount of depth in which you wish to collect data for your project. Naturally, the answer to this question will be partially dictated by the research question. Is it necessary to know the location of each respondent's residence, or will the neighborhood, ZIP Code, or simply the city in which a respondent resides suffice? The level of personal detail that should be maintained during data collection should be evaluated against the ethical use of GIS data to respect individual respondents' privacy. Often, the level of detail with which data are collected differs from the reported level.

Privacy

The most frequently raised concern in research involving humans is the appropriate amount and degree of privacy and anonymity. Are you going to aggregate your data (as covered later in this chapter), or will you present your data to enable people to identify "whose" data they are looking at? These two concerns can be addressed most effectively by emphasizing two critical concepts: anonymity and secrecy.

Anonymity

Anonymity refers to the fact that when conducting research, you do not ask for a person's name or any other identifying characteristics that may be used to determine who they are. You can maintain your anonymity by opting out of collecting such personally identifiable information. Numerous businesses and colleges that do research prefer to perform it anonymously to avoid sharing personal information about individuals. When you do anonymous research, you protect your study's research subjects. For instance, a survey is said to have been conducted anonymously if no personally identifying information is obtained throughout the study.

Confidentiality

Confidentiality refers to the safeguarding of personal information. When collecting data from which individuals may be identified based on specific details contained in the data, it is critical to safeguard that information. Confidentiality does not preclude you from collecting and analyzing detailed data from your study subjects; it simply means that you will take appropriate measures to safeguard the raw data and will not share them with the general public. Individual responses are typically stored in a secure environment, such as a secure research lab, locked filing cabinet, or password-protected computer. Individual responses should be masked or aggregated when results are reported to protect the identities of those who shared their information with you.

After a study involving sensitive data, it may be appropriate to destroy the raw data and retain only the final, aggregated results. As a researcher, you should know your organization's research protocols and develop a plan for archiving data.

Data aggregation

Data aggregation is one possible solution for addressing some of the privacy concerns that inevitably arise when mapping social variables. The researcher simply selects a more general spatial level to view the data during data aggregation. Although the researcher may be able to link individual responses to specific households, the researcher may choose to analyze the data at the neighbourhood or community level by aggregating data. This would ensure the ethical confidentiality of responses about specific individuals.

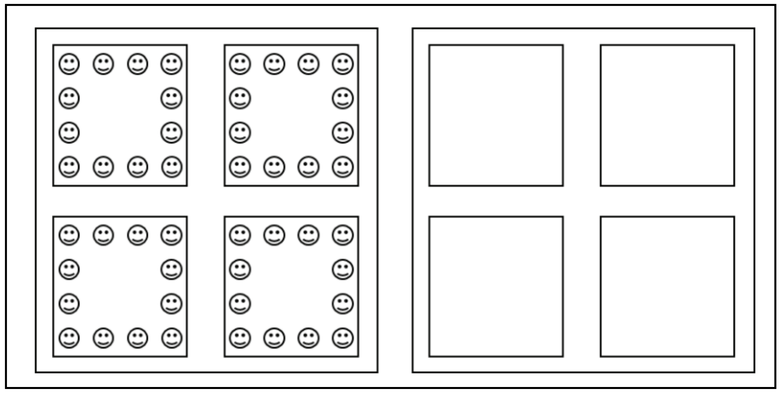

Fig.4.4 Data may be collected by individual households, as shown on the left. Although it is possible, and perhaps necessary, to retain the household-level information, many studies do not require this detail. If not, it might be preferable to aggregate data into larger units of analysis. The map on the right would be an example of aggregating data to each block or neighborhood. Other aggregation units might also be used, for example, street, census block, ZIP Code, telephone calling prefix, or city or county.

Other, more inventive solutions to the privacy issue may be possible, depending on the study's specific requirements. For instance, if you need to maintain individual responses, you can map the data to a fictitious coordinate system, obviating the need to store the data's actual geographic location on the ground in the GIS. This is accomplished by mapping locations about a fictitious origin located within or near the study area. Using a false basis, spatial information such as distances and directions can be maintained without producing a map that could be used to navigate back to the home of a specific respondent.

For instance, an actual geographic location in UTM coordinates could be described as (479688, 4600488). The northern hemisphere's UTM coordinates are derived from an origin west of the UTM zone (for the x values) and at the equator (for the y values), both in meters. Simply change the coordinate values by a specified amount. In other words, by merely adding or subtracting a fixed value from or to all of the study's x,y geographic coordinates, the actual locations are obscured, but the spatial positions are preserved. This type of adjustment can be made in bulk for an entire dataset in your GIS software by specifying the values to be applied using the tools designed for data reprojection.

Masking

Another consideration when masking spatial data is that even if values are adjusted to obscure mapped coordinates, care must be taken with the information on printed maps associated with your study. For instance, incorporating standard cultural features such as roads and political boundaries and natural elements such as rivers or lakes may provide an informed viewer with sufficient information to identify the study's location (Figure4.5). For studies requiring confidentiality, you'll want to use map figures that reveal as little information as possible.

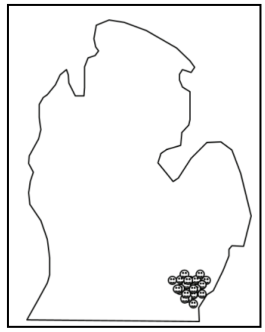

Figure4. 5 In this figure, without telling the reader anything about the location of the study, most people with a general knowledge of geography would find it simple to determine several things about the location of this study. Ask yourself the following: Can you decide which country this study was completed in? What about the part of the country? Can you make an educated guess about the city that was the focus? Odds are you could answer most or all of these questions correctly given a simplistic map that only shows an outline of the major region where the study occurred

These data could easily be masked in the example in Figure4.5 by omitting the outline of Michigan's Lower Peninsula. In that case, it would be difficult to determine the location of the study. Even omitting basic geographic features and details can help ensure the confidentiality of your research.

Ethics and data sharing

The term "data sharing" refers to disclosing data gathered during a research project. The issue of data sharing is critical and should be addressed at the outset of any research project. Why? Because you want to be able to explain to participants in your study how their data will be used, with whom they will be shared, and how their confidentiality will be protected. Your responses to these questions may influence whether or not participants wish to participate in your study.

Often, spatial data projects use existing data, or what we refer to as secondary data. However, organizations and government agencies are not always as forthcoming and willing to share this information. As a result, it becomes critical to negotiate with the owners of such information to obtain permission to use it. This may include a commitment to share your data or findings with secondary data holders following the conclusion of your research. Apart from sharing the entire dataset, another option is to share the data's output, such as a map PDF. Data sharing is frequently a component of research projects. For instance, someone may share information during your research that you analyze and use to create a report that you will share with other researchers, your funder, or even the general public or media. Many research projects use the Internet to distribute data files, reports, and additional project information, emphasizing the importance of data management and research results.

Ethics and data storage

If you have digital data, it must be stored on a computer with specific safeguards to ensure the data's security. The term "data storage" refers to the location and method of storing data. As previously stated in this chapter, any research project may contain data or information that, if made public, could have a negative impact on individuals. Data storage considerations may include the location of digital files and who has access to them. There may be instances where confidential data is accessed or left exposed to the outside in networked computer environments. Take care to secure computers that contain sensitive data with passwords and access controls that are sufficient to maintain data confidentiality. It may be preferable to store sensitive data on computers isolated from public computer networks or in secured facilities. Other data security issues may arise due to a lack of procedures for properly controlling data access and copying, such as data being copied from secure computers to a laptop or external storage device by a well-intentioned individual attempting to complete additional work at home. A misplaced laptop or USB drive can thwart even the most meticulous data security plans.

When a research project comes to an end, you should consider how to delete your digital data properly. Depending on your research protocols, it may be necessary to retain a copy of your raw data for a specified period. If this is the case, data should be copied to removable media and secured. It is critical to understand that simply deleting data from your hard drive does not guarantee the data. Even casual computer users are aware that deleted data can frequently be recovered from the trash can on their computer. While emptying your computer's trash provides a slight boost in security, an experienced user can still retrieve deleted data from the system. To delete data in a truly secure manner, you should use software designed specifically for this purpose, especially if your data is sensitive.

There are several options for securely deleting data in the Microsoft Windows environment, where the majority of ArcGIS users work, including SDelete, which is available from the Microsoft Technet website [4].If you work on a different computing platform, you should look for a similar tool. Consider that data may be stored in multiple locations. For instance, if field computers were used to collect data or project staff copied data to removable media, these should also be tracked appropriately and deleted. As a conscientious researcher, you should identify any working files or data backups that may need to be deleted (including off-site backups). Additionally, it is critical to check the temporary file locations specified in ArcGIS configuration or any other analytical software used to enter and process the data. It is prudent to retain copies of the log files generated by SDelete or whatever tool you use as evidence that your research protocols deleted all data.

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UNIT 5 - METHODS OF DATA COLLECTION AND MANAGEMENT

1.1 Different data types: Matching geoinformatics and variables

Data collection and analysis are part of the research. Once the topic has been defined and the study approach developed, it is time to gather in situ and remotely sensed data. To be helpful, data must be collected correctly. Every problem has unique data requirements, regardless of logic or study kind. This chapter will examine data, collection/selection procedures, and related topics. It will first cover the criteria influencing the selection of remote sensing data for various applications before moving on to ground truth and other data.

TYPES OF DATA COLLECTION

IN-SITU DATA COLLECTION

REMOTELY SENSED DATA

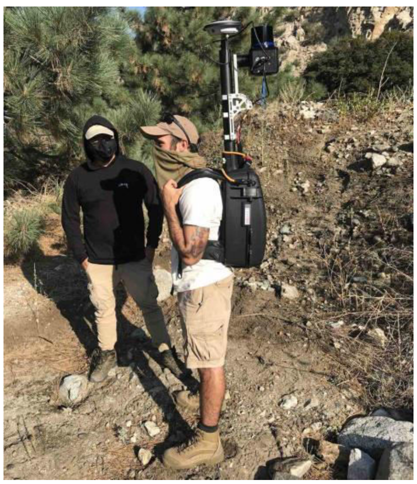

Fig5.1 IN-SITU DATA COLLECTION [1]

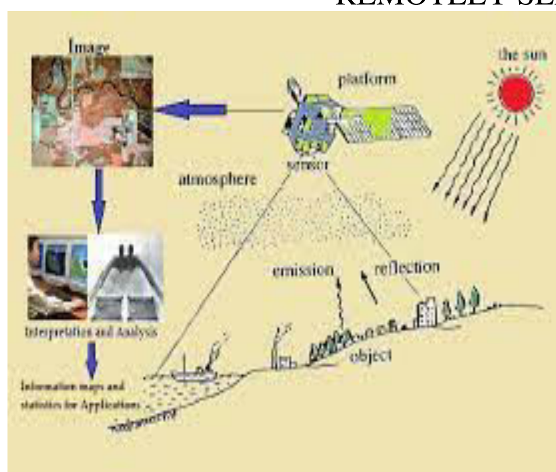

Fig5.2 REMOTELY SENSED DATA [2]

Data for Remote Sensing Research: Before starting a data collection project, a researcher should determine what information is required. While there may be scenarios in which only in situ data or only remotely sensed data is needed, many situations will necessitate collecting both forms of data by the researcher [1]. Aside from in situ data, remote sensing research necessitates ancillary data, such as census data, topographical maps, and data from existing geographic information systems (GIS). Primary and secondary data are required for all scientific investigations. The investigator who is performing the research collects primary data. Secondary data is information that has been gathered by someone other than the researcher. It is critical to understand that the researcher or team does not often collect remote sensing data. Rather than that, the researcher cherry-picks relevant data from available sensors. These data are gathered by the entities responsible for maintaining and operating remote sensing sensors. However, it is primarily the researcher's responsibility to acquire ground truth. Additional data are secondary—they are acquired by individuals or organizations other than the researcher or their team. However, primary data in remote sensing studies are remote sensing images, even if the researcher does not acquire them. Remote sensing data are critical since they serve as the foundation for such analyses. Secondary data include in situ and other ancillary data, enhancing the primary research. Secondary data sources for remote sensing research include ground truth, topographical and other traditional maps, GIS data layers, digital elevation models, censuses, surveys, organizational records, and data acquired as part of further quantitative or qualitative research.

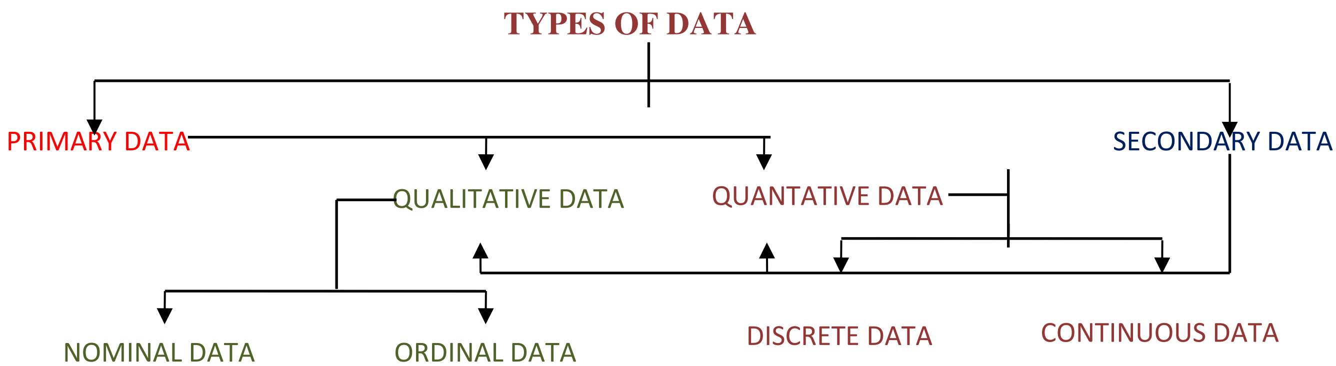

Fig5.3 TYPES OF DATA

In Situ Data: In situ data collection may take the form of field sampling, laboratory samples, or a combination of the two. In situ data are frequently utilized to offer a reference point for calibrating remote sensing imageries and/or validating remote sensing imagery retrievals. Ground truth is a jargon phrase used in remote sensing to refer to observations made at or near the surface. Its most basic definition refers to 'what is actually on the ground that needs to be associated with the relevant features in the distant sensing image'. Scientific statements must be based on observable evidence; this evidence serves as ground truth in many circumstances. Ground truth is critical for associating image data with actual features and materials on the ground.

Fig.5.4 KINDS OF IN-SITU DATA COLLECTION

Many different types of data can be collected, but it's best to learn about them in physical and natural science classes relevant to your field of study. It also collects the geographic coordinates of the ground resolution cell. It compares them to the coordinates of the pixel being studied to determine and analyze the location errors and how they might affect a study. Because they are easy to use and more affordable, global positioning system (GPS) receivers are the best to get information about where you are. Use a GPS receiver to get longitude, latitude quickly, and altitude coordinates to identify and find individual samples concerning remotely sensed data. This way, you can quickly identify and locate each sample in the data.

Remotely Sensed Data: It's important to remember that the format and quality of remote sensing data might vary significantly. These changes depend on the sensor's resolutions (radiometric, spatial, spectral, and temporal), which are all different [3]. Sensors are also distinct in terms of the areas of the electromagnetic spectrum that they can detect. Depending on their design, various remote sensing equipment record data from different segments or bands of the electromagnetic spectrum. It is critical in any investigation to determine the appropriate spatial, spectral, radiometric, and temporal resolutions before beginning. Furthermore, determine whether optical, thermal, or microwave data is required for the investigation. Integrating several data sources is common in remote sensing research; for example, the integration of microwave and optical imageries is expected in this field.

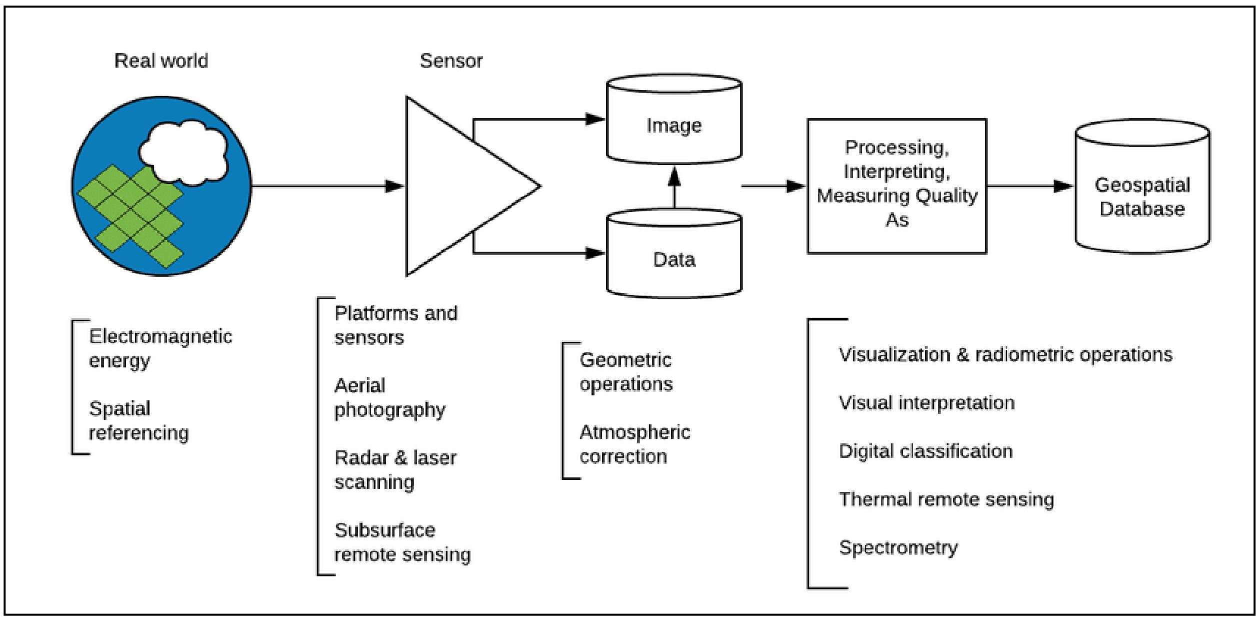

Fig.5.5 DATA ACQUISITION PROCESS FOR SATELLITE IMAGE [4]

Other Ancillary Data: In situ data are one sort of supplementary data used in the processing of remote sensing data. Numerous more data types must be used in conjunction with remote sensing data. Ancillary data is not directly related to the primary subject and is not derived from remote sensing. These are data from non-remote sensing sources that are utilized to aid in analysis or to supply metadata. Associated data are frequently extremely diversified and may contain maps, vegetation phenologies, and various other general information types regarding human activities. Ancillary data sources may include (but are not limited to) the following: existing maps (analogue/digital), reports and publications, field surveys or GPS, and current GIS data layers.

Study area and sample unit boundaries: Before analyzing data and prioritizing sites for protection, the project team had to choose and formalize the study area's geographic borders. Three factors drove this process.

1. **Limiting the size –** Due to the vast physical extent of the entire River watershed or any geographical area, the team was compelled by several compelling reasons to develop a more focused study region within the larger area.
2. **Selecting a general location –** Once the decision was taken to limit the size of the study area, the project team had to define the general location of the study region. What should the project's primary focus be, and how should the team make that decision
3. **Delineating specific boundaries** –After establishing a general location for the study area, the team needed to establish the study area's precise geographic borders [5].

Sampling is measuring a small quantity of something and then generalizing about the entire item. Sampling is the process of selecting a subset of individuals from a population to estimate the characteristics of the whole population. Sampling enables the examination of a vast and heterogeneous population. Researchers rarely conduct population surveys because the study region may be too huge or the population to be investigated is limitless. Sampling enables this type of study since it allows for the inclusion of only a tiny percentage of the phenomena in the study, allowing the researcher to reach all through this small piece.

The three primary advantages of sampling are that it is less expensive, data gathering is faster, and because the data set is more minor, homogeneity and data accuracy and quality can be improved.

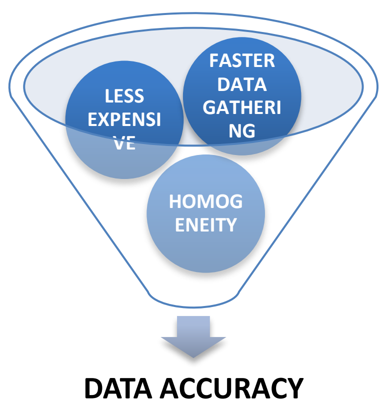

Fig.5.6 ADVANTAGES OF SAMPLE

A sample design is a predetermined strategy for selecting a representative sample from a specific population. It refers to the method or procedure used by the researcher to pick things for the sample [6].

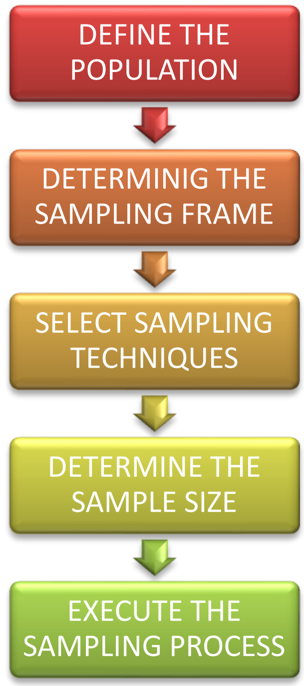

Fig.5.7 THE PROCESS OF SAMPLING DESIGN

A sampling frame is a list or device that delimits, identifies, and access specific population items. A probability technique is used to choose sample elements from the structure.

Frame Units: Examples	
Area units	**Non-area units**
Administrative Subdivisions	Housing Units
Census Enumeration Areas	Households
Areas Delineated on Maps	Persons
Agricultural Holding	Enterprises

Importance:

1. It was related to the survey's cost: the availability of a sampling frame that is optimal among various sample designs.
2. Affects data quality: 'defective' sampling frames result in non-sampling mistakes.

Evaluating data sources: It is critical to evaluate each source as you review it to establish the quality of the information. Standard evaluation criteria are the goal and intended audience, authority and credibility, correctness and reliability, currency and timeliness, and neutrality or bias. Each of these characteristics will be discussed in further detail further down.

Methodologies for gathering data for an evaluation: For many years, scientific approaches dominated the appraisal profession. These strategies establish cause-effect linkages through systematic data gathering procedures, provide generalizable outcomes, and give quantifiable data. Over the last decade, alternative strategies for understanding complicated social contexts have gained traction. Methods such as observation and open-ended interviews strive to delve deeply into events. As a result, we now have a variety of strategies to pick from, all of which are considered credible within the profession.

Due to the diversity of evaluation approaches, there is no unified list or classification of data collection methods. The following is a list of the most frequently used methods for evaluating Extension programmes, several of which double as social science research procedures (survey, case study). Some are geared toward quantitative (numerical) data collection, while others are qualitative (narrative) data collection. Some may be more suited to particular audiences or resource constraints.

- Survey: collecting standardized data via structured questionnaires to obtain quantitative data. Surveys can be shipped (surface and electronic), completed on-site, or administered face-to-face, telephone, or electronic interviews. While sample surveys employ probability sampling, informal surveys do not.
- A case study is a detailed assessment of a specific situation—a programme, a group of participants, a single individual, a venue, or a place. Case studies rely on various sources and approaches to the complete picture possible.
- Interviews: data gathered through speaking with and listening to individuals. Discussions range from highly structured (as in a survey) to free-flowing and conversational.
- Observation is gathering data by "looking" and "listening." Structured and unstructured observations are also possible.
- Group assessment: The use of group methods such as a nominal group methodology, focus groups, Delphi, brainstorming, and community forums to collect evaluation information is known as group assessment.
- Expert or peer review: examination by a review committee, an expert panel, or peer review.
- Portfolio review: a collection of materials, such as work samples, that demonstrates the depth and scope of the programme or activity under evaluation.
- Testimonial: a statement made by a person that expresses personal feelings and reactions.
- Test: use of pre-existing standards to measure knowledge, competence, or performance, such as a pen-and-pencil or skills test.
- Photograph, slide, and video: photography is used to capture visual images.
- Diary and journal: long-term records of occurrences that convey the writer's or recorder's point of view.
- Log: Chronological entries are often brief and factual.
- Document analysis: analyzing and summarising printed material and existing information through content analysis and other approaches [7].

Obtaining GIS data from the Internet and offline sources: Data collecting and preparation take significant time and effort in GIS-based research. The data may originate from various current sources or a new collection. The extensive usage of GIS has resulted in increasing digital data sources. As a result, many research efforts use a significant quantity of existing secondary data. GIS layers or tabular data may depict demographic, health, economic, or environmental information. Data sources include municipal, regional, state-wide, national, and worldwide governments; nonprofits; and commercial groups. This chapter will teach you to discover, appraise, and obtain existing or secondary data pertinent to your project.

Online data acquisition of GIS information is now easily accessible via the Internet. Millions of websites come up when you type in "GIS data" in the search bar of your web browser. The problem of getting data online isn't so much a matter of finding data as it is a matter of finding the correct data for your project. Consider the following when searching for information on the Internet.

Perhaps the most critical factor to examine is the source or provider of data. With thousands of providers available online, it's not uncommon to come across various copies of a dataset that appears to fit your requirements. In broad strokes, data will be made available from four distinct categories of providers: (1) government agencies, (2) universities and research groups, (3) nonprofit organizations, and (4) commercial businesses. What is less obvious is that many of these disparate data sources are based on the same, original government data [8].

GIS data for global datasets	
Name	**Description**
Natural Earth	Public domain vector and raster dataset. They are supported by the NACIS.
Global Map	Provides consistent coverage of all the Earth's land cover area. Includes different thematic maps such as transportation, elevation, drainage, vegetation, administrative boundaries, land cover, population centres, and land use. Registration required.
UNEP Environmental Data Explorer	Includes global forest cover, global potential evapotranspiration, global average monthly temperatures, dams, watershed boundaries, etc. Use the advanced search to select geospatial data sets. It is provided by the United Nations Environment Programme.
GSHHG	Global Self-consistent, Hierarchical, High-resolution Shoreline Database: high quality and consistent data.
ASTER GDEM	30m resolution global elevation data derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer satellite images.
OpenTopography	OpenTopography facilitates community access to high-resolution, Earth science-oriented, topography data and related tools and resources. Find high-resolution, Earth science-based topography data and associated tools and resources.

	Available as dense point clouds and DEMs.
NCAR GIS Climate Change Scenarios	Includes data used by the IPCC in their reports and operated by the National Center for Atmospheric Research. Registration required.
IRI/LDEO Climate Data Library	Collection of more than 300 datasets from various climate models and datasets. It was operated by The Earth Institute and Lamont–Doherty Earth Observatory.
Global Climate Monitor	Climate web viewers containing accessible climatic information from 1901 can be downloaded in various GIS formats.
HydroSHEDS	Global hydrological data based on the SRTM elevation data. Includes river networks, watershed boundaries, drainage directions, and flow accumulations.
USGS Land Cover Institute	Set of links from the USGS for numerous land cover datasets. Although primarily US data, there is data for other continents further down the list.
Atlas of the Biosphere: Mapping the Biosphere	Raster maps of environmental variables, including soil pH, potential evapotranspiration, average snow depth, etc.
Global 200	Vector data from WWF of "a set of the Earth's terrestrial, freshwater, and marine ecoregions that harbour exceptional biodiversity and represent its ecosystems."
Global Lakes and Wetlands Database	Vector data was created from multiple sources by the WWF and Center for Environmental Systems Research, the University of Kassel, outlining global wetlands, swamps, bogs, reservoirs, etc.
Conservation GIS Data	Data from The Nature Conservancy and associated organizations, including TNC Lands & Waters (properties/preserves, easements and leases), Eco-regional Portfolio, Terrestrial Ecoregions of the World, Freshwater Ecoregions of the World, and Marine Ecoregions of the World.
The Biodiversity Hotspots	Data from Conservation International on world areas with especially high endemism and high numbers of threatened species.
Pilot Analysis of Global Ecosystems: Forest Ecosystems	Data from the World Resources Institute include percentage tree cover, population density and tree cover, the share of wood in fuel consumption, etc.
SoilGrids1km - soil property and class maps	SoilGrids1km is a collection of updatable soil property and class maps at a resolution of 1 km produced using state-of-the-art model-based statistical methods. Presents estimates (means and 90% confidence intervals) for pH, texture (sa, si, cl), organic carbon and more for six depth layers up to 2 m depth.
Harmonized World Soil Database	Combines regional and national soil databases and maps under the Land Use Change programme of the Food and Agriculture Organization of the United Nations. Includes pH, depth, and texture parameters—30 arc-second resolution.
Datasets from the United Nations Environment	Includes global ecoregions, wetlands, distribution of coral reefs, mangroves, and more.

Programme	
Mineral Resource Data System	A collection of reports from the USGS describing metallic and nonmetallic mineral resources throughout the world. Include names, location, commodity, description, geologic characteristics, production, reserves, etc.
World Bank Geodata	There is a wide range of World Bank datasets: schooling and financial data, etc.
Global Administrative Areas	Administrative areas in this database are countries and lower-level subdivisions such as provinces, departments, bibhag, Bundesland, Daerah istimewa, fivondronana, krong, landsvæðun, opština, sous-préfectures, counties, and thana.
Crop Calendar Dataset	Raster data on planting dates and harvesting dates worldwide for 19 crops. Available at 5 minute and 0.5 degree resolutions.
Global Agriculture Lands	Raster dataset from NASA's Socioeconomic Data and Applications Center representing global extent and intensity of use of agricultural lands in 2000. Satellite data from MODIS and SPOT (satellite) image vegetation sensors were combined with agricultural inventory data.
Global Irrigated Area Map (GIAM)	Vector mapping by the International Water Management Institute of global irrigated and rainfed cropland.
Past and Present Agricultural Land Use	Multiple datasets show agricultural land use dating from 1700 to 2007 for 175 crops.
Historic Croplands Dataset, 1700-1992	Documents historical changes in global land cover: croplands from 1700 to 1992.
Global Reservoir and Dam (GRanD) Database	Vector dataset from NASA's Socioeconomic Data and Applications Center on all reservoirs with a storage capacity >0.1 cubic km.
Armed Conflict Location and Event Dataset	Contains all reported conflict events in 50 countries in the developing world, from 1997 to the present.
Gridded Population of the World (GPW)	Dataset from NASA's Socioeconomic Data and Applications Center includes raw population, population density, historical, current and predicted.
Global Rural-Urban Mapping Project (GRUMP)	Dataset from NASA's Socioeconomic Data and Applications Center (based on the above data, but includes information on rural and urban population balances).
Global Roads Open Access Data Set (gROADS)	Well documented global dataset from NASA's Socioeconomic Data and Applications Center of roads between settlements using a consistent data model (UNSDI-T v.2), which is, to the extent possible, topologically integrated and accurate to approximately 50m. Only roads between settlements are included, not residential streets, and the dataset is suitable for mapping at the 1:250,000 level.
OpenStreetMap	Crowdsourced data for the whole world, including most things you'd find on a standard local paper map: points of interest, buildings, roads and road names, ferry routes etc.

World Port Index	Contains the location and physical characteristics of, and the facilities and services offered by major ports and terminals worldwide, from the United States National Geospatial-Intelligence Agency.
OpenFlights Airport, Airline and Route Data	Includes all known airports and a large number of routes between airports (not provided in GIS data formats, but can easily be converted from CSV).
GeoHive	Population and county statistics (not provided in GIS data formats, but can easily be converted from CSV).
Viewfinderpanoramas Digital Elevation Model (DEM) repository	Global digital elevation model data was maintained by Jonathan de Ferranti. Significant coverage areas include Asia, North America, South America, Alps, North, Other Europe, Africa, Antarctica, others.
CHELSA Climatologies at high resolution for the Earth's land surface areas	Global climatologies at 30 arcsec (~1 km) resolution for land surface temperature and precipitation.[8] Accessible under the creative commons CC BY license. Files in GeoTIFF format
Orrbodies	Includes geology, topography and mineral occurrence data for several countries and globally. Files are mainly in MapInfo format. Both free and commercial datasets are available.
Nextag Global Energy GIS Data	Covers more than two million miles (3.2 Million Km) of oil and gas pipelines and thousands of energy facilities, such as refineries, LNG terminals, gas processing plants, terminals, etc.
International Peace Information Service (IPIS) Open Data	Datasets originate from the International Peace Information Service (IPIS) 's data collection campaigns and research in sub-Saharan Africa with a thematic focus on natural resources, conflict motives of armed actors, business and human rights, and international arms transfers.
The OCC Environmental Data Commons	Repository environmental public data sets of scientific interest hosted as part of the Open Science Data Cloud Ecosystem.
Open Aerial Map	OpenAerialMap (OAM) is a set of tools for searching, sharing, and using openly licensed satellite and unmanned aerial vehicle (UAV) imagery.
Open Land Map	World's environmental data representing land mask (land cover, vegetation, soil, climate, terrain data and similar)
IPUMS International	Harmonized International Census Data for Social Science and Health Research

Fig.5.8 Freely available GIS data sources[9]

Naturally, it is possible that the data you require may not be available on the Internet or that the information you do locate online will be insufficiently documented or from an unknown source, making you uncomfortable using the data in your study. It is critical to remember that just because data is accessible via the Internet does not guarantee excellent quality. Often, you will discover that searching for data elsewhere or developing new information is preferable.

Database concepts and GIS: Spatial databases serve as the basis for accessing, storing, and managing your empire of spatial data.
A database is a collection of related information that enables data to be entered, stored, input, output, and organized. A database management system (DBMS) is a software application that bridges users and their databases.

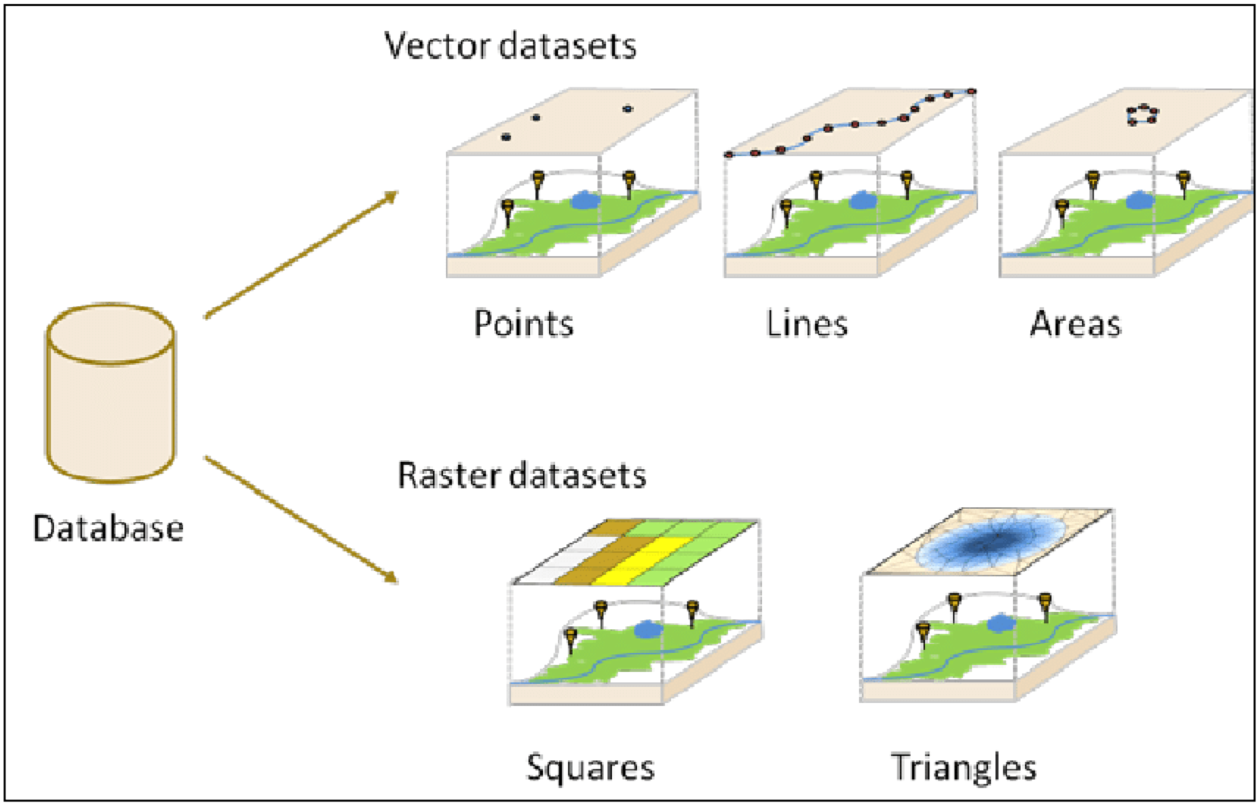

Fig.5.9 TYPE OF GIS DATABASE[10]

A spatial database contains information about its location. It has geometry in the form of points, lines, and polygons. GIS incorporates spatial data from various sources and a variety of different persons. Databases establish a connection between users and the GIS database.
Two approaches to using a database management system (DBMS) within a geographic information system (GIS)-
1. Complete DBMS solution Because all data is accessed via the DBMS, it must adhere to the DBMS designer's assumptions.
2. Aqueous solution
Specific data (often attribute tables and relationships) are accessed via the database management system (DBMS), whereas others (typically locational data) are accessed directly since they do not match the DBMS model.
Typically, GIS interfaces allow two distinct types of interaction mechanisms, which are explained in this section:

- languages of the textual query
- manipulating geographical features interactively

I. **Textual queries: extended SQL:** Numerous additions to SQL have been proposed to transform it into a spatial language [11]. Discusses the inadequacy of this technique. The following deficiencies are highlighted:

- integrating spatial ideas of graphic specification and display into a SQL (at the table) architecture;
- the relational model's inability to provide qualitative responses, knowledge, and metadata inquiries.

II. **Other textual query mechanisms:** Numerous alternative (textual) query strategies are described in the geographic information system literature [12]. QPF is described in the query language section. This language is utilized in a vector-based geographic information system that uses the AI concept of frames to assist users with their inquiries. An inquiry may be expressed through the use of forms (visualization of frames) or the use of menus. In cartography applications, expand the O2 object-oriented language with geometric and topological operators for a vector model [13]. Use a collection of knowledge-based tools to conduct area classification queries[14].

III. **Visual languages:** A query language for visual GIS must permit the selection of things based on their spatial location and reference to objects within a drawing, allowing users to modify representations of geographic phenomena directly. While some systems now allow users to visually specify fuzzy spatial concepts (for example, nearness), visual querying capabilities remain limited.

One critical issue in gis that these languages do not currently support is that qualitative analysis in planning is frequently reliant on visually comparing intermediate query results. As a result, visual inquiries must allow all users to edit alternatives interactively, placing results in their proper graphical context [15]. When a graphical query is a specific city, it is pointless to display a point labelled with the city's name on the screen. Instead, the output must include enough contextual (spatial) information to interpret the answer effectively.

IV. **Image databases:** Many gis applications need image retrieval. The user usually preprocesses photos using a value partitioning approach (e.g., pixel classification strategies). The query then retrieves photos depending on the classification. Because most gis interprets photos as text fields, there is no way to perform content-based image retrieval (as defined in). The use of picture databases for content queries is emphasized. The correctness of the picture saved (due to faults during the image entering and analysis process) affects the query results[16].

Querying image databases must also consider the spatial aspect of picture data. Discusses picture tagging for spatial querying. A 90' curve on a river is difficult to find in most image databases. The benefits and downsides of various image searching methods are examined[17].

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UNIT 6 - PROCESSING AND ANALYSIS OF DATA

Communicating results and visualizing spatial information: This chapter will introduce crucial aspects of presenting your study findings. A project's success depends on the practical and proper transmission of your message to the target audience. Of course, while using ArcGIS, a map is an essential tool. This chapter will learn about great ArcGIS visualizations and effective spatial communication tactics. You will learn to create a data presentation that effectively uses ArcGIS cartographic visualization tools.

You will also learn how to utilize GIS to convey significant research findings to a wide range of people.

Learning objectives:

- Gain an understanding of the keys to effectively presenting results.
- Acquire a working knowledge of spatial visualization and how to implement it.
- Acquire the ability to select the most appropriate mode of communication Recognize the standards for producing a final result.

The essentials of good communication: You've heard the adage "a picture is worth a thousand words," which is true in maps' realm. Perhaps the most visible result of a GIS is the map, a graphic representation with a long history in various civilizations. Open any atlas, and you'll find maps that convey information about demographics, economics, cultures, languages, history, politics, and many other topics about the world's cultural, physical, and natural geography. The GIS is a tool that incorporates the majority, if not all, of the software tools required for data gathering, organization, storage, analysis, and output. Before delving into the specifics of expressing your findings, we'd like to highlight several factors to consider when building an effective communication strategy.

Audience: While some study is done purely for curiosity, most research has a purpose. "My goal is to scientifically examine something and share my findings to my academic peers," you may be thinking as you read this. But consider the context. Where will your talk be held? Will you deliver this in a conference with maps shown on a screen, or will your data be put in a paper or report? Is it possible to create animated or interactive online visualizations of your data? Does it bring value to your audience or complicate things? We'll go back to the question: What do you intend to achieve with this presentation? Aiming for a journal publication? Do you wish to spark fresh ideas and discussions? Want to take this presentation somewhere?

Who are your peers, even if they are your peers? Are they familiar with map-based data analysis and visualization? Your audience may have attended GIS classes in school or maybe worked with GIS at some point. If so, your audience may have a rudimentary comprehension of your study techniques and outputs. In other circumstances, your audience may not have considered reading a map since high school geography (or trying to navigate on vacation). While your peers may understand your discipline or profession's fundamentals, they may not understand how to apply GIS to these concerns.

Outside of academia, your audience may be significantly more diversified. You may be researching to improve an organization's services, better understand the underlying causes of a significant social issue in a community, or allocate scarce resources more efficiently. In each of these instances, an individual or group will need to evaluate and comprehend your findings and recommendations, whether that individual or group is an organization's executive director or board of directors, the city council or school board, or the general public.

For instance, you may be an employee of a corporation or government agency that has gathered spatial data on a subject and wishes to communicate it with your colleagues to make sense to them. Perhaps you could create a visual presentation to accompany your oral presentation. That is an effective method of introducing new information to an audience, significantly if the material is modified. Your presentation location may be more internal to your organization or agency. Depending on your stage in the data collection process, you may wish to create a brief write-up or report that includes your maps in this case.

As you are undoubtedly aware, each of these groups will have a varying degree of familiarity with GIS, maps, and the specifics of the subject or topic under research. When creating outputs and data visualizations, keeping this varied amount of information in mind is critical. For instance, a policymaker audience will be interested in how your findings may be converted into a regulatory or legal framework. A nonprofit's director may be more concerned with the cost and effectiveness of service delivery to the organization's clients. If you distribute information to the general public, examine whether a printed brochure or a website is the most effective distribution method. Given that none of these audiences is likely to be ArcGIS specialists, it is unlikely that you can hand them your data and project files and expect them to draw their conclusions. Rather than that, you must deliver the material in a manner and with a level of detail that is appropriate for your intended audience.

Purpose: When preparing to convey your findings, your objectives are first to examine. Are you considering presenting your work at a scholarly conference? Are you attempting to elicit action from your audience through the presentation of your findings? Are you aiming to increase your organization's funding? As part of your funder's mandate, are you merely disseminating your project's findings to the public? Is disclosing your findings solely to inform or educate the broader public? As the researcher, you must examine the objective of your communication and create products that are successful communicators before presenting, sharing, or disseminating your findings.

Typically, you will import a sizable dataset comprising several thematic layers, data tables, and variables when undertaking GIS analysis. Not everything you investigate or incorporate in your study will be equally significant.

As a result, you must eliminate extra elements and deliver essential, direct messages. This entails restricting the amount of information contained in each map in the case of map output. Similarly, while a lengthy and detailed report detailing your data sources, methods, analysis, and findings may be necessary for some audiences, a concise executive summary or fact sheet distilling key findings into a few pages, accompanied by charts, graphs, photos, and maps, is much more likely to be read and thus effectively communicate your message.

Information: Keeping your tale basic while presenting the data is critical. If feasible, confine each map to one core message, and make that message clear to the reader by using appropriate colours, symbols, and labels when constructing the map. Because GIS allows you to incorporate so much data into your work, there is a propensity to try to include it all. This, however, might result in information overload—a map with so many colours and symbols that it becomes a jumbled mess.

For an effective map visualization, you will require at least two components. To begin, you'll need a base map to offer context. Base maps should have a few significant elements familiar to and orient the reader, such as main roads, rivers, or boundaries. However, because these layers aren't always necessary to convey the message, you could wish to deemphasize them in the visual hierarchy by using subdued colours that fade into the background. Second, you should have map data that depicts your main message. Brighter colours and clear labels or legends should be used to express this information. Limiting the number of categories within a map is also important; for example, it may be preferable to create a map that communicates a limited number of data categories (Figure 6.1) rather than one that attempts to differentiate numerous types that become difficult for the reader's eye to distinguish.

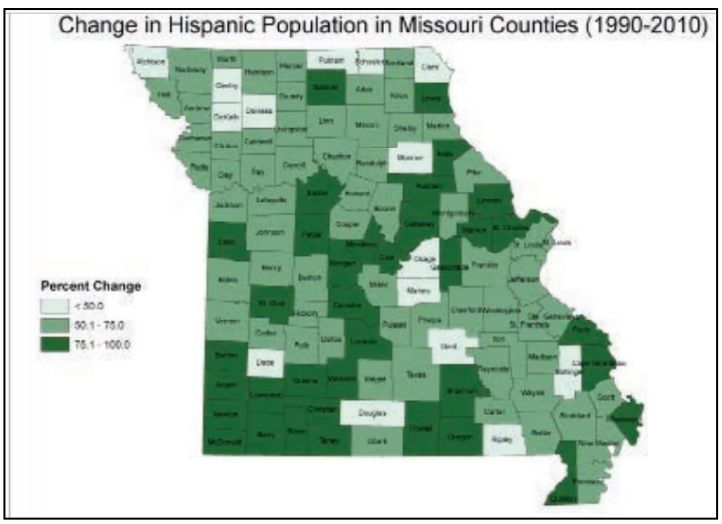

Figure. 6.1 A map with only three categories is more accessible for a reader to decipher, making patterns in the data more apparent. In this map, a more significant percentage change in the Hispanic population during the study period is easy to identify across the state[1].

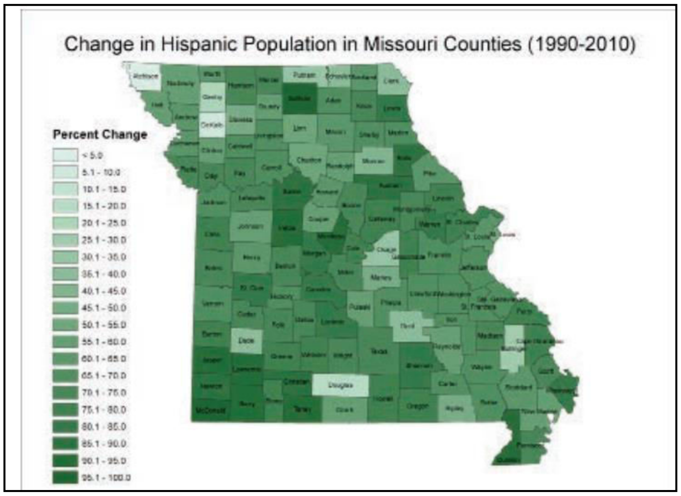

Figure 6. 2 The same data presented in Figure 6.1 uses twenty categories. Although the map now provides more detailed information regarding the percentage change in the Hispanic population, it is difficult for a reader to decipher. Patterns in the data are less apparent than they are in Figure 6.1. An identical colour gradient was used for both maps[2].

You don't want to include too much information in your visualization. Still, you also want to make sure the spatial visualization resonates and makes sense to those who see it. The continents shown in Figure 6.2 are offered more abstractly overlaid with data showing populations at risk of earthquakes. It may not be what you thought an earthquake risk map should look like. Once you've taken a few minutes to figure out what the patterns of colour mean, the visualization is very effective.

This map is focused on one thing and doesn't have a lot of extra information that clogs up or complicates the visualization. The map shows a lot of blue, which means there aren't many risks there. This is because trouble happens when there are both people and earthquakes. So, there aren't many people except for a few islands for a lot of the water world, and the risk is low. But these low-risk areas cover a lot of land on the continents where there aren't many people or many earthquakes. Whenever these two datasets line up with each other, red is used to show where they do. If you want people to pay attention, red is a good colour. Most people think red is a warning or a sign of danger. This eye-catching picture shows the coastal areas of the Pacific ring of fire and other parts of the world that a big earthquake could hit. This map is interesting because it doesn't show the actual shape of the continents. Instead, it shows how much risk there is. Information about the different continents is a background, but it isn't overpowering.

People often use "information" instead of "data" to describe things. When a map communicates well, it clearly shows data to the people who see it. You should be able to get your point across by making clear and simple images that don't have a lot of extra information. It doesn't matter if you use a traditional map like Figure 6.1 or a stylized map like Figure.3 to share or convey your data. You could also use an infographic, a visual representation of your data but not in map form (Figure 6.4). If you try to put too much information into one map or graphic, you will complicate things. It's better to keep things simple.

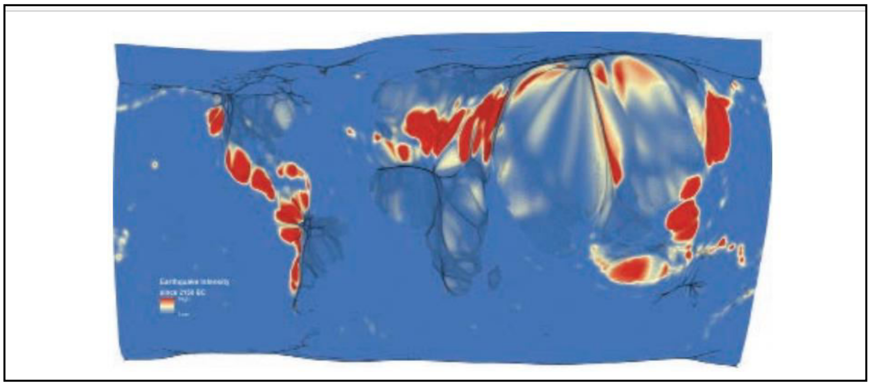

Figure 6.3 People at risk: Humanity and global earthquake intensity. Data from National Oceanic and Atmospheric Administration National Geophysical Data Center, Socioeconomic Data and Applications Center (SEDAC), Columbia University[3].

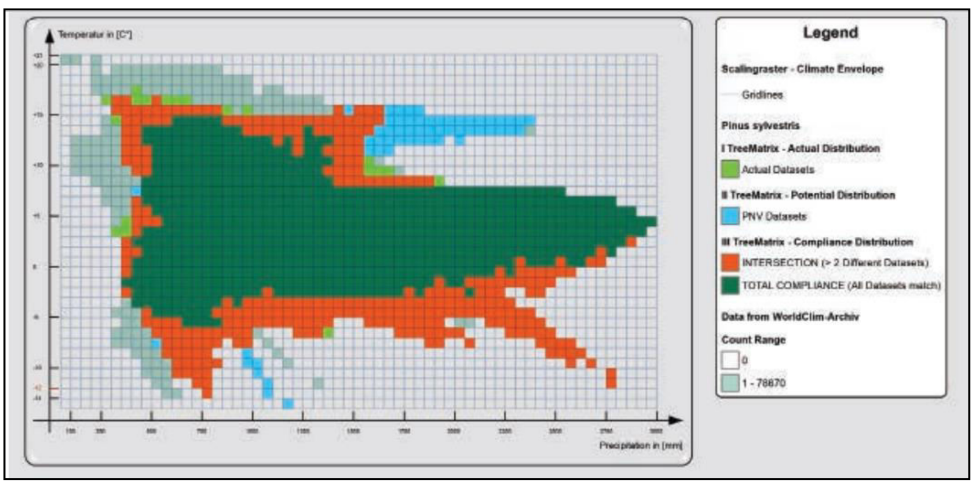

Figure 6.4 An infographic shows a graphical relationship between data in a nonmap format. The relationship between tree species and climate change factors (temperature and precipitation) in this case. While these concepts connect to geography, we expect certain types of trees to grow in specific locations; as the climate changes, the areas of particular habitat zones may also shift. Data from Natural Earth Data, Germany; European Environmental Agency; AFE Data: Botanical Museum of Helsinki; ISPRA Data: Bavarian regional office for forest and forest management ICP Forest Level 1, Italy; Meusel Data: Bavarian regional office[4].

Interest in the topic: Your presentation of data should make people interested in the subject. It is likely that when an organization or group asks you to do a spatial study, you will be interested. However, a fun map visualization can help you interestingly show essential findings. When you look at a map, you might see patterns. These patterns can help you tell the storey in the data and get the people who will use this information to think about it.

When your audience is more ambiguous, and engaging map can help pique their interest in the subject. Suppose you understand your audience, which could include members of the general public or recipients of a service your organization provides. In that case, you may be able to capitalize on the current interest. However, you cannot assume that everyone has the same expertise or understanding regarding the subject at hand. Establishing interest entails creating some hook or opening for the map viewer or consumer. This hook could be based on how the information is presented or on the level of curiosity generated by a unique and creative map presentation.

Map context

When we talk about map context, we mean the spatial storyline you wish to communicate. Maps have long told stories. Early maps often represented ocean perils (sea monsters, sirens, a tumbling waterfall off the earth's edge, etc.). The threats shown in these maps were real, and the symbols utilized by the mapmakers set the context of danger and uncertainty in particular uncharted regions. Story maps have entered a new world with the advent of interactive maps online. An interactive map is a computer-generated map that allows users to interact with it. The Esri story maps website has many outstanding examples[5].

Each map or visualization has a contextual history of meta-information associated with it. Your audience's spatial geographic literacy should determine the amount of content you provide. Geographic literacy relates to an audience's familiarity with the geography depicted in your visualization. Additionally, keep in mind that a person may be familiar with geography but not with the spatial representation of data; it may take some time for certain people to adjust to your depiction. This demonstrates the importance of having basic and straightforward visualizations. If you simultaneously overload a map with too much information, you risk losing the message or the map consumer.

Today, most individuals have limitless access to web-based information, including data presented as maps or geographically referenced data, infographics, and other formats. To communicate effectively in today's media- and image-driven culture, you must be innovative, analytical, and targeted in your approach. The next part discusses some additional considerations that can assist you in adequately communicating your results and the critical information included within them.

Culture and map visualization

Each group or community will have characteristics of communication and culture unique to it. When creating a map, it is critical to keep its culture in mind. On the other hand, if you're building a map to give to individuals from numerous cultures, you'll want to incorporate symbols and visual artefacts that people from diverse backgrounds can relate to.

Figure 6.5 illustrates how to show information on a map for visitors unfamiliar with Luxor and interested in seeing various places. The map introduces the visitor to the city's topography by highlighting some of the city's significant physical features, such as the Nile River's bank and the locations of major thoroughfares. To improve user comprehension, streets are labelled in both English and Arabic. Additionally, the map makers considered their audience when creating this map. As you can see on the map, they've made effective use of international symbols for meals (the knife and fork) and toilets (another feature that travellers value). The map is pretty straightforward and does not contain much information beyond the types of sites and services that would interest a visitor and a road basis in assisting the reader in orienting themselves. If you understand what is essential to your audience, you can communicate it clearly and succinctly.

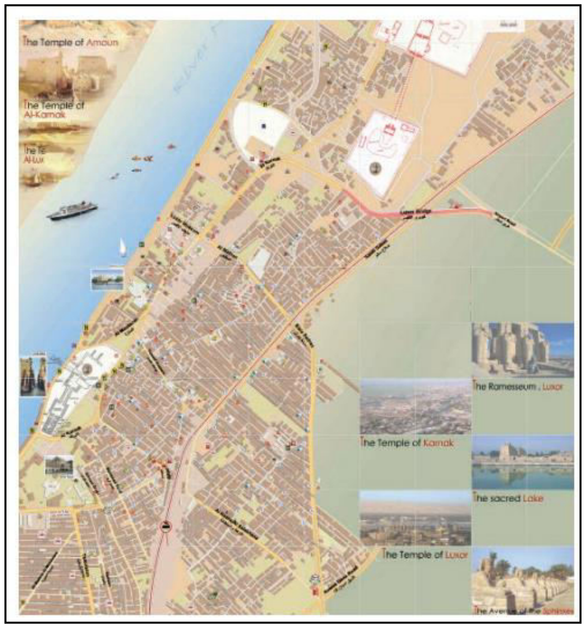

Figure 6.5 A tourist map of Luxor, Egypt. Graphics such as a cruise ship orient tourists to one of the primary means of entering the city. Photographs highlight some of the key attractions, and well-understood symbols for food, restrooms, and other services provide additional visual information to the reader. Data from Esri Northeast Africa Data Center/Cartography Department. From Esri Map Book, vol. 26 (Redlands, CA: Esri Press, 2013), 11[6].

GIS output

A clear understanding of the expected outcomes from a GIS study can help influence the data collecting and analytical techniques implemented early in the process. The following sections describe two major categories of data visualization: the graphic output of the GIS, which is typically a map, and the statistical work of the GIS, which may take the form of statistics, graphs, or mathematical models. Finally, we'll explore exporting your GIS analysis results to other apps to aid in the analysis and convey the final results.

DATA VISUALIZATION

Historically, printed maps were the most popular graphic output from GIS—that is, maps designed to illustrate the relationship between and distribution of a small number of variables for a specific geographic extent (research area) to a particular period. While becoming more creative with cartographic design may have effectively demonstrated change over time or a more significant number of factors in combination, doing so frequently resulted in a map that was difficult to grasp without considerable effort on the reader's behalf. Alternatively, as Figure 6.6, sets of maps can transmit numerous variables simultaneously. While these individual maps are undoubtedly easier to comprehend, mentally synthesizing the concepts included in these various maps to properly understand the storey they convey may prove challenging for the reader.

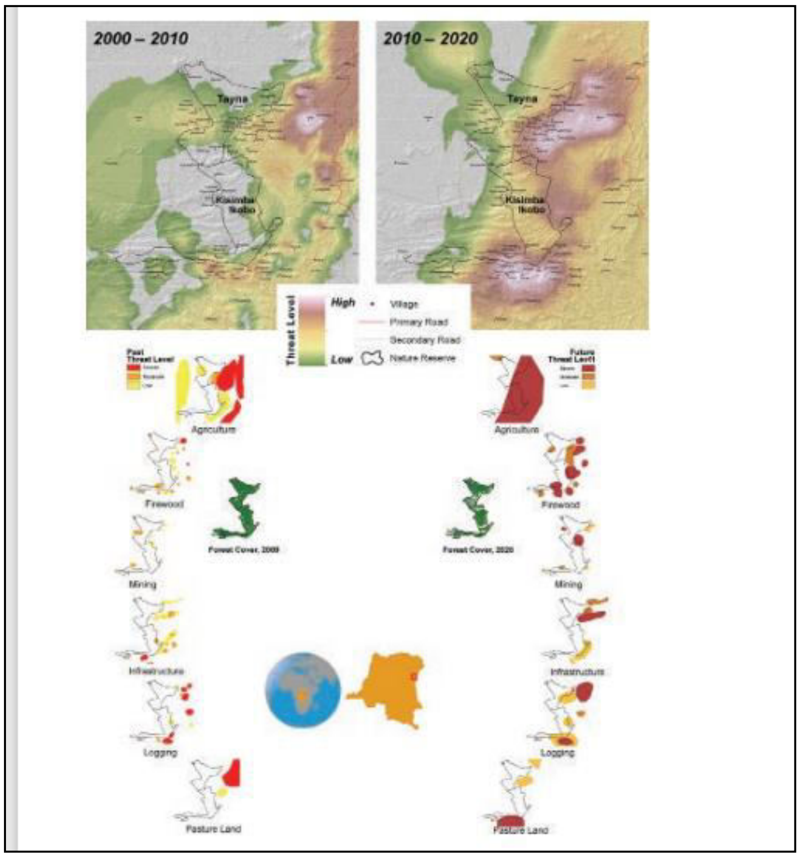

Figure 6.6 Drivers and agents of deforestation in Tanya and Kisimba-Ikobo Reserves, Democratic Republic of Congo. Data from World Resources Institute, Ministry of Environment, Conservation, and Tourism of the Democratic Republic of Congo[7].

The ongoing issue for a researcher or policymaker is to deliver the desired information without going overboard and providing too many details that obscure the underlying topic or factors being conveyed. When communicating a large amount of information gleaned from an analysis, using a series of maps may be beneficial. Alternatively, if animated maps are acceptable for your audience and purpose, you may consider them. While animation needs your audience access to digital technology and maybe Internet connectivity, animated or interactive maps enable the transfer of additional information by transforming the map. This is especially advantageous when communicating a change over time.

Figure 6.6 illustrates a change map with numerous variables. This map series is an excellent representation of change through time. The vast maps at the top depict the real threat to the reserves in the present and future for two distinct decades. These maps incorporate pertinent base data, such as the positions of villages and roads in the reserve's vicinity.

However, because risks originate from many sources, the map designers provide further data by depicting these individual elements as simple symbolic drawings beneath the primary maps, orienting the viewer to comprehensive information about resource use via the reserve's outline forms. This map series informs the viewer about both previous and future resource-related dangers to the funds and the threat's relative severity. As a result, we have the opportunity to envision and comprehend two different depictions of change in this example. This enables effective communication of both the critical message and supporting elements necessary for expressing the whole storey of the data.

Naturally, working in an interactive environment opens up many chances to enrich the storey your maps convey. For instance, the user may be given the option of viewing only particular data layers or focusing on a specific geographic location.

Due to the reader's influence over the map, new detail may be made available as the viewer zooms in or toggles between different themes. Supporting material in images, charts, or text can be linked to the map without clogging the visual interface. Interactivity, however, does not absolve the creator of a map of the responsibility to make the information understandable. As with a printed map, you do not want to include everything on the map simultaneously. Examining the initial view and how various data will be represented to keep your maps readable is critical. For instance, do you wish to hide specific data (for example, local roads) until the spectator zooms in? How will you ensure that the map viewer does not lose out on critical information that is not visible in the initial view or becomes confused while attempting to simultaneously switch on all accessible information?

While interactive maps can give valuable features, they can overwhelm or confound the audience if not used properly. At their best, interactive maps will behave similarly to static maps, showing critical information plainly and uncluttered. At worst, these may resemble an online version of GIS, delivering so much data and capability that the user needs be a GIS expert to engage with the data correctly. Numerous websites are now available to explore geographic information systems (GIS) data interactively. National atlases for several countries are now available online rather than in print. For instance, the National Atlas of the United States [8] makes static and animated maps and the underlying map data available for download and use with your GIS software (Figure 6.7). Other comparable services are provided by the Atlas of Canada [9] and the Atlas of Sweden [10].

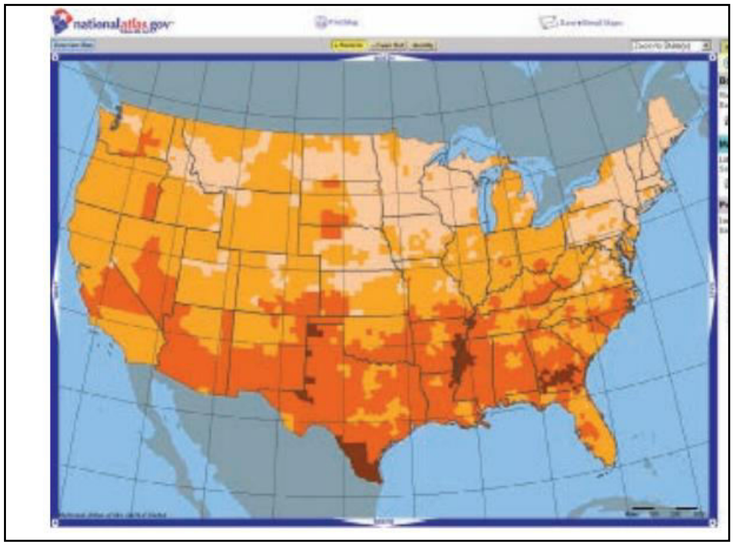

Figure 6.7 A screenshot from the National Atlas of the United States of America website [8].The site enables visitors to browse data for the entire United States or any section in various categories. The graph depicts the number of live births per 1,000 women aged ten to nineteen. Each dataset is associated with the agency that created it, the Centers for Disease Control and Prevention [11].Whether built on a personal computer using proprietary GIS software and data or via publicly accessible websites, interactive maps enable users to examine data variations and combinations far more efficiently than static maps on paper or scanned computer graphics. The authors built the map using an open-source dataset. The National Atlas of the United States of America provided the data[8].

If the results of your study will be shared via video on a computer, video on a website, or even classic video, the animation is an effective technique. A frequent example of this video map is the animated radar maps on your local news show's nightly weather report. Time-maps with animation is enabled by default in the current version of ArcGIS. This is beneficial for visualizing change over time within the software. A time slider tool in the interface can navigate sequentially through the data; this presupposes that the data with which you are working include a date field as one of the layer's attributes.

Additionally, time-enabled maps can be exported as separate files. The avi file format is compatible with widely accessible Windows media players, allowing you to share your animations with individuals who do not have access to ArcGIS software. Using third-party extensions to ArcGIS or other video editing applications, you may create more complicated animations.

Three-dimensional visualization is another effective method of conveying information. The GIS may generate accurate perspective views of the terrain from any location. Numerous tools for producing these perspective views are included in ArcGIS extensions, such as 3D Analyst. While attempting to communicate a proposed project or conclusion, a visual representation of how things will look after completion can make all the difference during a community meeting (Figure 6.8). For instance, how will constructing a new structure on an empty lot influence the neighbourhood's appearance? How will it affect the city's skyline?

Figure 6.8 A perspective view for a community development scenario. This image was derived from actual data of roads, buildings, and an available parcel in ArcGIS. A proposed community park was incorporated into the plan and visualized using the CommunityViz extension to ArcGIS[12].

Even more dramatic 3D graphics can be animated to create a flythrough of the terrain, presenting a variety of realistic viewpoints and perspectives in the format of an animated movie.

A flythrough enables the user to wander interactively across a three-dimensional scene, simulating how things would seem if a human walked, drove, or flew through it. This is often referred to as virtual reality. With the necessary tools, data, and effort, such animations may be made to appear as realistic as desired, even including authentic images of the surrounding surroundings.

Statistical output

The nongraphic outputs, or statistics, may not be as apparent to a person who isn't used to GIS as they should be. Many people who take an introduction to GIS class are surprised to learn that some of the first GIS systems were made before computers could show graphics. The first GIS systems didn't even make maps the way you think of them today, and the computers that did the analysis usually didn't have a screen that could show the data in a way that looked like a map. Today, this is a little surprising because of how vital maps have become in communication and making decisions, so this is a little surprising.

GIS has a lot of value because of its statistical or numerical output with its nongraphical roots.

For example, suppose you were using a GIS to make a list of people who need to be told about a construction project in the community. In that case, the analytical process might be to create a buffer of a certain distance around the task to find the owners of the parcels that need to be told. Analysis: The goal may be to determine how many properties or people are affected and to make mailing labels for the notice sent out. In this case, a map isn't necessary. Some statistics and a list of addresses are what they want instead. As we talked about in the book, one of the great things about using GIS is that you can measure your data or information.

It's like this; If you look at Figure 6.9, you can see how data for emergency medical calls in Baltimore, Maryland, is shown in a map and statistics. Over 150,000 calls are made to the Baltimore City Fire Department each year. Emergency response planners can better predict where, when, and what resources may be needed in different parts of the city by looking at which stations respond to calls at other times of day and types of calls. The figure also shows how far the response came from, which helps us understand its meaning.

The value of this picture is that it shows these data on top of the city's geography. An excellent way to show statistics is to show them clearly and simply so that it doesn't overwhelm the reader with too many extraneous details.

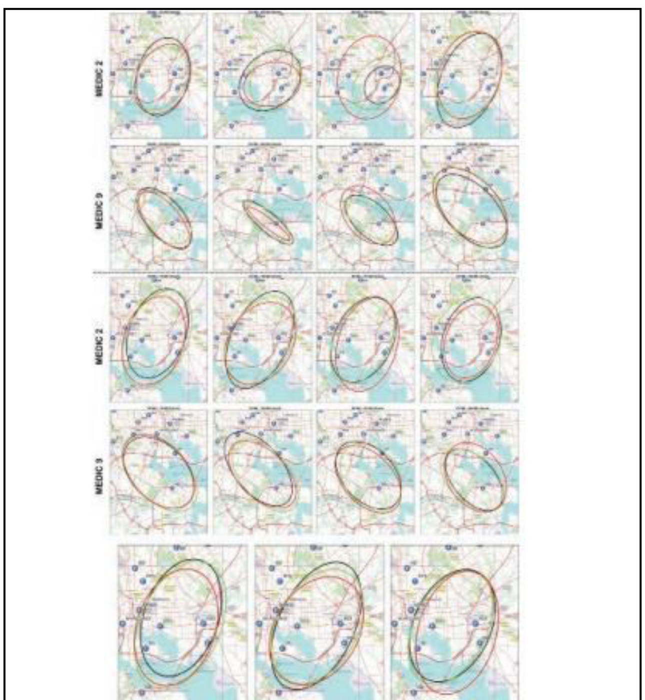

Figure 6.9 The maps show emergency calls divided into various types of calls such as "shootings, cuttings and cardiac arrests to show where most of the city's calls occur. The calls have also been grouped by hour of the day to see how far units are responding to their station[13].

In many cases, the benefit of the map or visualization may exceed numerical data requirements. This is particularly true in decision-making applications where percentages, risks, and probabilities, or dollars and cents, provide the researcher with more convincing facts. As previously stated, ArcGIS contains several tools for performing statistical analysis on your data. Additionally, it includes several tools for summarising data and results using standard descriptive statistics and charts and graphs showing the results, similar to what would be found in a conventional statistical analysis software package. GIS's primary strength is its capacity to perform spatial operations on the data in these analytical circumstances.

Whether you develop your research entirely within ArcGIS or use external tools for pieces of it, integrating the data into a specific visualization creates a convincing presentation of your findings.

Exporting data to other applications

When the GIS programme does not include the more sophisticated statistical analysis capabilities you require, the database of spatial and non-spatial data contained inside the GIS can easily be queried for the required variables and exported to a statistical software application of your choice. To assist this procedure, facilities for direct data transfer between the GIS and your favourite statistical software may be offered.

As with data tables, the GIS can examine spatial relationships and generate new information tables for export to other software packages. Consider the following scenario: you have a GIS database of public health information for the entire United States but conduct research on a single location. You might utilize ArcGIS's spatial analysis capabilities to choose records linked with the region in question and generate a new, smaller database table containing the information you need for your study. Thus, you can utilize the GIS to select and extract data for statistical tests or other analytical operations.

Of course, you may object, "I could do that in a database by searching for the state or county names I require; why utilize the GIS?" This is an excellent point. If the database provided that information, no GIS would be required. What if your research region included all residences within one mile of an industrial facility registered with the Environmental Protection Agency to release recognized toxins? Alternatively, suppose you're researching West Nile virus transmission. In that case, you may choose to locate all residential locations within two kilometres of lakes and ponds (bodies of water where mosquitoes could breed).

While this type of spatial analysis is impossible with a regular database query, it can easily be achieved with a GIS.

Selecting the mode of communication

After completing a research study or collecting and analyzing data, you will naturally want to communicate your findings. Specific individuals may be inclined to take a one-size-fits-all strategy. We strongly advise against this, however. Your objectives and audience should determine the optimal communication medium. Earlier in the chapter, we stressed the

necessity of defining your goals for conveying your findings and the target or audiences you aim to reach with your final output. Often, a multipronged approach will be necessary.
Of course, developing communication goods requires time and effort (not to mention money and cents), so it's critical to weigh the advantages of each. Is it necessary for your findings to be accessible to a broad audience or a small group, or an individual? Will your data presentation be accompanied by other resources (a written report, executive summary, or even an oral presentation), or must it stand alone? Is the project intended to last an extended period, or is it a one-off analysis that will not be revisited?

Reports

If you are a part of a more formal data-sharing arrangement, you may wish to consider producing a report. Numerous organizations may require a comprehensive description of the data, methods, and findings that may be referred to and stored for future reference. The spatial representation of your data can be included in the report as figures or appendices, and an executive summary may be provided to highlight the study's key conclusions or recommendations. Naturally, words are simple to publish online, particularly if your business already has a website. Posting a report or the connected static maps does not require additional software or knowledge.

Pamphlet

A pamphlet is an excellent medium for communicating with a group of people who lack access to technology or with a population that has trouble using technology. Pamphlets are also a perfect way to promote other modes of communication that you may have accessible. For instance, a leaflet summarising key findings and maps might be placed in your office lobby to pique the public's curiosity and direct them to your website for additional information or interactivity. Pamphlets can also function as a complete product for groups unlikely to read lengthy reports or lack access to computers. This may include some minority, elderly, or economically disadvantaged people whose access to computers is limited to those located in public libraries or community centres.

Poster

A poster is an excellent way to convey a large amount of information, and it can serve as a permanent representation of that information. Posters are frequently used in workplaces to communicate information that an employer or organization wishes to impart in a more self-paced manner, either internally or inform office visitors. Posters are an excellent way to integrate spatial data/maps into a more oversized format, allowing for extra detail on your maps and written text to explain and highlight the various maps or visualizations. Posters are also popular in educational and professional contexts, such as schools, community centres, government buildings, and academic and professional conferences. While a poster, like a booklet, is pretty limited in detail, it can also be used to promote further resources accessible online or in a published report. Posters can work well with pamphlets; a poster can pique viewers' attention and prompt them to pick up a leaflet for future reference.

Oral or slide presentations

In some instances, you will have the opportunity to address your audience with your study and findings directly. In this situation, you benefit from sharing your passion for the work and the chance to respond to audience questions and provide further insight. Oral presentations supplemented by a slide presentation offer an additional opportunity to employ technology. With your laptop in hand, you can incorporate animated maps, a flythrough of the data, or just the ability to zoom in on a specific region of interest to assist the audience in comprehending the material more thoroughly. A presenting risk relates to the idea expressed at the beginning of this chapter: be concise and avoid clogging your message with unnecessary information. Live presentations carry the risk of overloading the audience with too much information in a short period or overpowering them with too many animations and fly-throughs, thereby losing the message. As is customary, keep things basic. Additionally, because your presentation is temporary, it can be beneficial to provide the audience with items to take home, such as printed copies of critical maps and results or possibly a pamphlet or executive summary. Expect your audience to hear, see, and absorb all you say during the brief time that the map is displayed on the screen.

Preparing the final product

While you're working on your final visualization output, keep in mind the different pieces of guidance we've provided throughout this chapter. To summarise, the following are some points to consider:

- the project's objective;
- the project's geography;
- the project's audience;
- the project's resources; and the project's timeliness.

Goal

Make sure that your purpose is evident to you and your project team and communicated in an understandable way to others. When creating goods to share with others, this entails going over the results of your study to highlight the most critical data or information for spatial visualization.

Geography

How significant is geography in your map? Geographic elements were used in the background of some of the spatial visualizations depicted here to establish context, but they were not oppressive. Generally, you'll need some geographic context to ground your data, but how you display that context is entirely up to you and your project's objectives. At the same time, a geographic component is necessary to anchor your data; how you show that context is entirely up to you and your project's objectives.

Audience

Always keep your audience in mind. Consider the forms of information your audience is used to seeing, the amount and complexity of the material, the type of information you are providing, and multiple tactics such as visuals, charts, statistics, and text. Is your audience familiar with the geography you're presenting? Are the members in your audience literate or illiterate? What is your audience's primary language? What are some of your audience's cultural practises? For instance, are they accustomed to visualizing and discussing information? How much time is required of the audience to engage with the material? Is a one-page summary more appropriate than a comprehensive report?

Resources

What resources are available to you to showcase your final product? If you have limited resources, we recommend creating something digitally rather than physically wherever possible.

Consider whether your audience has the necessary technology for obtaining and interacting with digital products. It can be quite costly to print your maps in colour, especially if you require many copies or output in a larger format. If your project is ongoing, you may prefer digital representations that may be adjusted and amended over time, whereas printing your final deliverables may be justified.

Temporality

What stage of the process are you at to generate final results? Is your map used during the exploratory phase of the project or at the conclusion (as a sort of the last report)? Are you creating data that must be displayed in a static format, or can they be presented more fluidly? Typically, during the early stages of a project, maps and data are still being developed and will be more fluid than they will be toward the finish when consumers demand a more definitive portrayal of the facts and information.

Once these questions have been addressed, you should be prepared to create your final visualization. Once again, you have control over how information is presented. You can either emphasize geography or reduce it in favour of data.

Conclusion

As stated previously in the chapter, GIS is a data and information integrator. One of the GIS's main advantages is its geographical analysis and exploration. Basemaps at any geographic size can be linked to data at any scale and often at many scales. Data from a countywide study, for example, could be aggregated to a regional or statewide level later on. Statistics' spatial patterns and distributions can assist explain otherwise invisible relationships.

We can use GIS to combine and query current data, but we can also create and store new data. GIS is a powerful analytical tool when used together.

Finally, GIS provides visual and numerical output options. This chapter has provided numerous instances. Exported data are utilized for additional analysis in statistical software or discipline-specific modelling and may include final deliverables like maps, tables, and graphs. External packages can then feed their results back into ArcGIS as new datasets for use in further analysis and mapping. Don't try to impress the audience with excellent technology or data-loaded maps rendered in forty-seven hues of chartreuse with twelve distinct fonts merely to impress them [14].

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UNIT 7 - INTERPRETATION AND REPORT WRITING

Afterward, the researcher must draw conclusions, which leads to writing the report. Because if this isn't done carefully, erroneous conclusions could be derived, and the whole point of research could be lost. Interpretation is the only way for a researcher to learn about the relationships and processes that underlie his findings. When a researcher tests and confirms his or her hypotheses over and over again, he or she may make generalizations. In other words, if the researcher doesn't have an idea, he will try to use a theory to explain what he found. This may sometimes lead to new questions that require more research. All of this analytical information and the conclusions that come from it can be shared with the people who use research findings, which could be an individual, a group of people, or a public/private organization.

MEANING OF INTERPRETATION

The term "interpretation" refers to the process of reaching a conclusion regarding the data discovered during an analytical or experimental inquiry. Because it is what the public desires. Performance is divided into two distinct components:

(i) The effort to sustain research by linking the findings of one study to those of another; and the production of some explanations.

(ii) Interpretation involves a method known as "partially overlapped analysis." This indicates that interpretation is concerned with the links between the acquired data. Additionally to the data from this study, interpretation considers findings from other studies, theories, and hypotheses." [1]

Thus, Interpretation serves as a tool for better understanding the factors that explain what the researcher observed during the study and providing a theoretical framework that can guide future research.

WHY INTERPRETATION?

(i) When the researcher interprets his findings, he or she can see the abstract principle at work in the background. In this way, he can connect his findings to those of other studies that use the same abstract principle and make predictions about the real world of events. Following questions can be used to check these predictions. This way, the experiment can stay the same.

(ii) Interpretation results in the development of explanatory concepts that guide future research studies; it opens up new avenues of intellectual adventure and stimulates the pursuit of knowledge.

(iii) Only through interpretation can a researcher better understand why his findings are what they are and how to communicate the true significance of his research findings to other people, which is why interpretation is so important.

(iv) Because the Interpretation of experimental research findings frequently results in hypotheses for experimental research, Interpretation is a necessary component of the transition from exploratory to experimental research. Because an exploratory study begins without a hypothesis, its findings must be interpreted post factum, which is technically referred to as 'post factum' interpretation.

TECHNIQUE OF INTERPRETATION

Interpretation is not a simple task; it requires considerable skill and dexterity on the researcher's part. Interpretation is an acquired skill that requires practice and experience. At times, the researcher may seek assistance from experts to complete the task of Interpretation. Frequently, the technique of Interpretation entails the following steps:

(i) The researcher must provide reasonable explanations for the relationships he discovers, interpret the relationship lines in terms of the underlying processes, and attempt to uncover the thread of consistency that runs beneath the surface layer of his diverse research findings. Indeed, this is the technique by which generalization and concept formulation should be accomplished.

(ii) Extraneous data must be considered when interpreting the study's final results, as they may prove to be critical in comprehending the issue at hand.

(iii) It is prudent to consult someone with insight into the study who is candid and will not hesitate to point out omissions and errors in logical argumentation before embarking on the final Interpretation. This consultation will result in accurate Interpretation, thereby increasing the utility of research findings.

(iv) To avoid making incorrect generalizations, the researcher must complete the task of Interpretation only after considering all relevant factors affecting the problem. He must take his time interpreting results, as frequently, conclusions that appear to be correct at the outset may not be accurate.

PRECAUTIONS IN INTERPRETATION

One should never forget that even if data are collected and analyzed correctly, incorrect Interpretation will result in inaccurate conclusions. Therefore, the task of Interpretation must be carried out with patience, objectivity, and a sense of proportion.

For proper Interpretation, the researcher must consider the following points: At the outset, the researcher must invariably satisfy himself that (a) the data are appropriate, trustworthy, and adequate for drawing inferences; (b) the data exhibit good homogeneity, and (c) proper statistical analysis was performed.

(ii) The researcher must exercise caution in interpreting results to avoid errors. Errors can occur due to incorrect generalization and misinterpretation of statistical measures, such as extrapolating findings beyond the range of observations, confusing correlation with causation, etc. Another significant pitfall is the tendency to assert the existence of specific relationships solely based on confirmation of particular hypotheses. Indeed, positive test results accepting the hypothesis must be interpreted as "concordant" rather than "confirming the hypothesis's validity." The researcher must be vigilant about these factors to avoid making erroneous generalizations. He should be well-equipped with and knowledgeable about the proper application of statistical measures for drawing inferences about his study.

(iii) He must never forget that Interpretation is inextricably linked to analysis and cannot be disentangled. As such, he must treat Interpretation as a distinct aspect of research and take all the usual precautions associated with the analysis process, namely, precautions regarding the reliability of data, computational checks, validation, and comparison of results.

(iv) He must never lose sight of the fact that his job is to make sensitive observations about significant occurrences and identify and disengage factors that are initially invisible to the naked eye. This will enable him to carry out his interpretation duties properly. Broad generalization should be avoided because most research is not amenable to it. After all, the coverage may be limited to a particular period, geographic region, or circumstances. Such constraints, if any, must invariably be specified, and the resulting results must always fall within their bounds.

(v) The researcher must keep in mind that "ideally, there should be continuous interaction between the initial hypothesis, empirical observation, and theoretical conceptions throughout a research study." Opportunities for originality and creativity exist precisely in this interaction zone between theoretical orientation and empirical observation."[2]While engaged in Interpretation, he must pay special attention to this aspect.

SIGNIFICANCE OF REPORT WRITING

The research report is a critical component of the research study because the task of conducting the research is not complete until the information is presented and written. Indeed, even the most brilliant hypothesis, the most meticulously designed and driven research study, and the most striking generalizations and findings are worthless unless communicated effectively to others.

The purpose of research is defeated unless and until the findings are disseminated. Inevitably, research findings must be incorporated into the general body of knowledge. All of this demonstrates the critical nature of writing a research report. Some individuals do not view report writing as a necessary component of the research process. However, most researchers believe that presenting research findings or writing a report should be considered an integral part of the research project. Report writing is the final stage of a research study and requires skills distinct from those needed during the earlier stages of research. This task should be carried out with extreme caution by the researcher; he may seek assistance and guidance from experts.

DIFFERENT STEPS IN WRITING A REPORT

Research reports are the result of meticulous, painstaking inductive work. The typical steps in writing a report are as follows: (a) logical analysis of the subject matter; (b) final outline preparation; (c) rough draft preparation; (d) rewriting and polishing; (c) final bibliography preparation; and (f) final draft writing. However, each step is self-explanatory; a brief mention of each will aid incomprehension.

The first step is a logical analysis of the subject matter, which is primarily concerned with the development of the subject. There are two methods for developing a topic: logically or chronologically. Logical development is accomplished by using mental connections and associations between one thing and another. Often, analytical treatment entails progressing from the simplest possible structure to the most complex. Chronological development is based on a relationship or sequence of events in time or space. Generally, instructions for doing or making something follow a chronological order.

Final outline preparation: This is the subsequent step in writing the research report. "Outlines provide the framework for lengthy written works. They aid in the logical organization of the material and serve as a reminder of the report's key points."[3]. Following the logical analysis of the subject and creating the final outline, the rough draft is prepared. This is a critical step because the researcher is now sitting down to write down what he has done in the context of his research study. He will detail the procedure he used to collect the data for his research, the various constraints he encountered, the analytical technique he used, the broad conclusions and generalizations he reached, and the multiple recommendations he wishes to make regarding the subject at hand.

Rewriting and polishing the rough draft is the most time-consuming step in all formal writing. Typically, this step takes longer than writing the rough draft. Careful revision separates a mediocre piece of writing from a good one. While rewriting and polishing the report, one should look for inconsistencies in its logical development or presentation. Additionally, the researcher should "determine whether the material, as presented, possesses unity and cohesion; does the report stand upright and firm, exhibiting a distinct pattern, similar to a marble arch?" Or does it have the appearance of an old wall made of mouldering cement and loose brick?" [4]

Additionally, the researcher should pay close attention to whether or not he was consistent in his rough draft. He should double-check his writing mechanics—grammar, spelling, and usage.

Compilation of the concluding bibliography:

Following that is the task of compiling the final bibliography. The bibliography, typically included with the research report, is a list of books that are somehow related to the research conducted. It should consist of all sources consulted by the researcher. The bibliography should be alphabetical and divided into two sections; the first section should include the titles of books and pamphlets, while the second section should include the titles of magazine and newspaper articles. In general, this bibliography format is considered convenient and satisfactory from the reader's perspective, though it is not the only format. The bibliography entries should be made in the following order:

The following order may be used for books and pamphlets:

1. Author's name, last name, first.

2. Title, italicized.
3. Publisher, location, and date of publication.
4. The number of volumes.

For magazines and newspapers, the order may be as under:

1. Author's name, last name, first.
2. The article's title is enclosed in quotation marks.
3. The title of the periodical is italicized to indicate italics.
4. The volume or the combination of volume and number.
5. The publication date.
6. Page numbering.

While the preceding examples serve as samples for bibliography entries and may be used, it is essential to remember that they are not the only acceptable formats. The only thing that matters is that choosing the method must be consistent.

The final step is to write the final draft. The last draft should be written concisely and objective, using straightforward language and avoiding ambiguous expressions such as "it appears," "there may be," and similar ones. The researcher must avoid abstract terminology and technical jargon when writing the final draft. Illustrations and examples from everyday life must be included in the final draft because they are the most effective means of communicating research findings to others. A research report should not be boring; it should enthuse readers, maintain their interest, and demonstrate originality. It must be borne in mind that each report should attempt to resolve a philosophical problem, contribute to the resolution of a problem, and contribute to the researcher's and reader's knowledge.

LAYOUT OF THE RESEARCH REPORT

Any reader of the research report must be informed sufficiently about the study to place it in a broader scientific context, evaluate the adequacy of its methods, and thus form an opinion about how seriously the findings should be taken. This goal necessitates a well-structured report. The report's layout indicates what the research report should contain. A thorough layout of the research report should include the following:

(A) preliminary pages;

(B) the main text; and

(C) the conclusion.

Let us deal with them one by one.

(A) Introductory Pages

The report's title and date should appear on the first page, followed by acknowledgements in a 'Preface' or 'Foreword'. Following that, a table of contents should be included, followed by a list of tables and illustrations. The decision-maker or anyone interested in reading the report can quickly locate the required information.

(B) Main Text

The main text contains an outline of the research report and all of the details. The study's title is repeated at the top of the first page of the main text, followed by the other information on consecutively numbered pages beginning with the second page. Each of the report's significant sections should start on a new page. The report's main text should include the following areas:

(i) Introduction;
(ii) Findings and recommendations;
(iii) Results;
(iv) Implications drawn from the results; and
(v) Summary.

(i) Introduction: The Introduction aims to acquaint the reader with the research project. It should contain a clear statement of the research objectives, i.e., sufficient background information should be provided to explain to the reader why the problem was deemed worthy of investigation. A summary of other pertinent research may also be included to help contextualize the current study. The study's hypotheses, if any, and definitions of the central concepts used in the study should be stated explicitly in the report's Introduction.

The methodology used to conduct the study must be explained in detail. The scientific reader would like to learn more about such a thing: How was the study conducted? What was its fundamental design? If the study was experimental, what manipulations were used in the experiment? What specific questions were asked if data were gathered via questionnaires or interviews (typically, the questionnaire or interview schedule is included as an appendix)? If measurements were made through observation, how were the observers instructed? The reader should be informed about the sample used in the study: Who were the subjects? How many people were present?

How were they chosen? These questions are critical for estimating the findings' probable limits of generalizability. Additionally, the statistical analysis used must be stated plainly. Additionally, the study's scope and boundary lines should be defined. Further, the various constraints under which the research project was completed must be described.

(ii) Conclusions and recommendations: Following the Introduction, the research report must include a conclusion and recommendations section written in plain language that all parties easily understand. If the findings are lengthy, they should be summarized at this point.

(iii) Results: The next step in writing the report's main text is to present the study's findings in detail, including supporting data in tables and charts and validation of the findings. This section generally comprises the report's main body, which may span several chapters. The report's results section should include statistical summaries and data reductions rather than the raw data. All findings should be presented logically and divided into easily identifiable sections. All pertinent findings must be included in the report. However, the fundamental question is how one determines what is relevant. Quite frequently, guidance comes primarily from the research problem and, if any, hypotheses addressed in the study. However, the researcher must ultimately rely on their judgement when formulating the report's outline.

"However, it is still necessary for him to state plainly the problem he was addressing, the procedure he used to address the problem, the conclusions he reached, and the basis."[5]

(iv) Implications of the findings: Near the conclusion of the main text, the researcher should restate the findings clearly and precisely. He should also discuss the implications of the study's findings, as the average reader is interested in the implications for understanding human behaviour. As stated below, such implications may take three forms:

(a) A statement of the conclusions drawn from this study that are likely to apply in similar circumstances.

(b) The current study's limitations may limit the scope of legitimate generalizations based on the study's inferences.

(c) The pertinent questions that remain unanswered or that the study raises and suggestions for the type of research that would provide answers.

It is considered best practice to conclude the report with a brief conclusion summarizing and recapitulating the study's significant points. The study's decision should be related to the introductory section's hypotheses. Simultaneously, a forecast of the subject's probable future and an indication of the type of research that needs to be conducted in that particular field are both valuable and desirable.

(v) Summary: It has become customary to conclude the research report with a summary reiterating the research problem, methodology, major findings, and significant conclusions drawn from the research results.

(C) Final Point

Appendices should be included after the report for all technical data, such as questionnaires, sample data, mathematical derivations, etc. Additionally, a bibliography of the sources consulted should be included. After the report, an index (an alphabetical listing of names, places, and topics, along with the page numbers in the book or report on which they are mentioned or discussed) should invariably be included. The index's value stems from the fact that it serves as a guide for the reader regarding the report's contents.

MECHANICS OF WRITING A RESEARCH REPORT

There are very specific and established rules that must be followed when preparing the research report or paper. Once the techniques have been determined, they must be strictly followed, with no deviations permitted. The format criteria should be established as soon as the research materials for the paper are gathered. Concerning the mechanics of writing a report, the following points are worth noting:

1. Manuscript size and physical design: The manuscript should be typed on unruled paper measuring $8^{1/2}$ x 11 inches. If it is to be written by hand, it should be written in black or blue-black ink. Allow at least one and one-half inches on the left and at least half an inch on the right side of the paper. Additionally, there should be one-inch top and bottom margins. The paper should be well-structured and readable. If the manuscript is typed, all text should be double-spaced on one side of the page except for the lengthy quotations.

2. Procedure: The steps involved in writing the report should be followed precisely (all of these steps have been discussed previously in this chapter).
3. Layout: Considering the objective and nature of the problem, the report's layout should be considered and decided upon (the layout of the research report and various types of reports were discussed previously in this chapter and should be used as a guide for report-writing in the case of a specific problem).
4. Quotations should be enclosed in quotation marks and double spaced, as they form an integral part of the text. However, if a quotation is longer than four or five typewritten lines, it should be single-spaced and indented at least a half-inch to the right of the standard text margin.
5. Notes on the footnotes: Regarding footnotes, the following points should be considered:
(a) Footnotes serve two purposes: they identify the sources of quotations in the report and the notice of materials that are not directly related to the body of the research text but are still helpful as supplements. In other words, footnotes are used to cross-references, cite authorities and sources, acknowledge sources, and elucidate or explain a point of view. Remember that the footnote is neither an end nor a means of displaying scholarship. The modern trend is to use footnotes sparingly when the scholarship is not required to be displayed.
(b) Footnotes are positioned at the bottom of the page immediately following the end of the reference or quotation they identify or supplement. Footnotes are typically separated from the textual material by a half-inch space and a one-and-a-half-inch long line.
(c) Footnotes should be consecutively numbered, typically beginning with 1 in each chapter. The number should be slightly above the line, for example, after a quotation. Again, the footnote number should be indented and typed slightly above the line at the bottom of the page. Thus, consecutive numbers must be used to link the reference in the text to the note at the bottom of the page, except in the case of statistical tables and other numerical material, where symbols such as the asterisk (*) or a similar character may be used to avoid confusion.
(d) Although separated by double space, footnotes are always typed in a single room.
6. Style of documentation: In terms of documentation, the first footnote reference to any given work should be exhaustive, providing all pertinent information about the edition used. Such Documentary footnotes generally follow a chronological order. The standard order can be summarised as follows:
(i) With regards to the reference in a single volume
1. The author's name in standard order (rather than beginning with the surname as in a bibliography), followed by a comma;
2. The title of the work, italicized;
3. The location and date of publication;
4. Pagination references (The page number).

For instance, John Gassner, Masters of the Drama, Dover Publications, Inc., New York, 1954, p. 315.

(ii) With regards to multivolume reference works

1. The author's name in the conventional order;
2. The work's title, italicized to indicate italics;
3. Publication location and date;
4. Volume number;
5. Pagination references (The page number).

(iii) With regards to alphabetically arranged works

No pagination reference is typically required for alphabetical works, such as encyclopaedias and dictionaries. In these instances, the order is as follows:

Example 1 "Salamanca," 14th Edition of the Encyclopaedia Britannica.

Example 2 "Mary Wollstonecraft Godwin," National Biography Dictionary.

However, a volume and pagination reference may be necessary if a detailed reference to a lengthy encyclopaedia article is required.

(iv) About periodicals

1. Author's name in regular order;
2. Article title in quotation marks;
3. Periodical title in italics;
4. Volume number;
5. Date of publication;
6. Pagination.

(v) Concerning anthologies and collections

Not only must quotations from anthologies or collections of literary works be acknowledged by the author, but also by the collector's name.

(vi) Concerning second-hand quotations

In these instances, the documentation should be handled in the following manner:

1. Author and title of the original work;
2. "quoted or cited in,";
3. Second author and work.

For instance, J.F. Jones, Life in Polynesia, p. 16, as cited in R.B. Abel's History of the Pacific Ocean area, p. 191.

(vii) A case involving multiple authors

Suppose there are more than two authors or editors. Only the first author's or editor's name is given in the documentation, and multiple authorship is indicated by "et al." or "and others."

Subsequent references to the same work do not need to be as specific as those mentioned previously. If the same result is cited again without any intervening work, the citation may begin with ibid, followed by a comma and the page number. A single page should be abbreviated as p., while multiple pages should be abbreviated as pp. When several carriers are referred to consecutively, it is customary to use the page number, for example, pp. 190ff, which refers to page 190 and the subsequent pages, but only for page 190 and the subsequent page '190f'. Roman numerals are frequently used to denote the volume number of a book. Op. cit. (opera citato, in the cited work) and Loc. cit. (loco citato, in the mentioned location) are two extremely convenient footnote abbreviations. After the author's name, op. cit. or loc. Cit. Indicates that the reference is to work by the author that has been extensively cited in an earlier footnote but is obscured by other references.

7. Footnote punctuation and abbreviations: The author's name is listed first in the footnote, following the number in the standard signature order. Following this is a comma. The title of the book is given following the comma: the article (such as "A", "An", "The", etc.) is omitted, and only the first word, proper nouns, and adjectives are capitalized. A comma is placed after the title.

The following section contains information about the edition. Following this entry is a comma. The place of publication is then specified; it may be abbreviated if the location is well-known, such as Lond. for London, N.Y. for New York, or N.D. for New Delhi. Following this entry is a comma. The publisher's name is then mentioned, and this entry is closed with a comma. It is followed by the publication date if one is specified on the title page. If the date appears in the copyright notice on the reverse side of the title page or elsewhere in the volume, omit the comma and include the date in square brackets [c 1978], [1978]. A comma is placed after the entry. Then, if both volume and page references are provided, they are separated by a comma. A period marks the conclusion of the documentary reference in its entirety. However, one should keep in mind that the documentation for acknowledgements in magazine articles and periodical literature takes a different form, as previously stated when explaining the bibliography entries.

Certain abbreviations in English and Latin are frequently used in bibliographies and footnotes to avoid tedious repetition. The following is a partial list of the most commonly used abbreviations in report writing.

8. Appropriate use of statistics, charts, and graphs in research reports is frequently regarded as a virtue. It significantly contributes to clarifying and simplifying the material and research results. One may recall that a good photograph is often worth more than a thousand words. Typically, statistics are presented as tables, charts, bar and line graphs, and pictograms. This type of presentation should be self-explanatory and self-contained. It should be appropriate and pertinent to the issue at hand. Finally, the display of statistical data should be neat and appealing.

9. The final draft: Before writing the final draft, it is critical to revise and rewrite the report's rough draft. To this end, the researcher should ask himself the following questions: Are the sentences in the report clear? They are grammatically correct, aren't they? Do they convey the intended message'? Do the report's various points make logical sense? "It is extremely beneficial to have at least one colleague read the report before the final revision. Sentences that seem self-evident to the writer may be quite perplexing to others; a self-evident connection may strike others as a non-sequitur. By pointing out passages that appear unclear

or illogical and possibly suggest ways to resolve the difficulties, a friendly critic can be an invaluable ally in achieving the goal of adequate communication." [5]

10. Bibliography: As discussed previously, a bibliography should be prepared and annexed to the research report.

11. Index preparation: After the report, an index should always be included; its value lies in the fact that it serves as a good guide for the reader. The index may be prepared as a subject or author index. The former includes the names of the subject areas or concepts and the number of pages on which they appear or are discussed in the report, whereas the latter consists of the same information for the authors' names. Always arrange the index alphabetically. Some people prefer to create a single index that contains all of the authors' names, subject topics, and concepts.

PRECAUTIONS FOR RESEARCH REPORT WRITING

A research report serves as a vehicle for communicating research findings to the report's readers. A good research report accomplishes this objective effectively and efficiently. As such, it must be prepared with the following considerations:

1. When determining the report's length (as research reports vary significantly in size), it is essential to keep in mind that it should be lengthy enough to cover the subject thoroughly but concise enough to maintain interest. Indeed, report writing should not be used to acquire ever-increasing knowledge about ever-increasing amounts of information.
2. A research report should not be dull, if possible; it should maintain the reader's interest.
3. Avoid abstract terminology and technical jargon in research reports. The report should be able to communicate the subject in the most straightforward possible manner. The report should be written objectively and plainly, avoiding expressions such as "it appears," "there may be," and the like.
4. Because readers frequently want quick access to the report's key findings, the information must make them readily available. Charts, graphs, and statistical tables may illustrate the different results in the main report and a summary of the significant conclusions.
5. The report's layout should be well-considered, appropriate, and consistent with the research problem's objective.
6. Reports must be free of grammatical errors. They must adhere strictly to report-writing techniques such as quotations, footnotes, documentation, proper punctuation, and the use of abbreviations in footnotes and the like.
7. The report should include a logical analysis of the subject. It must reflect a structure that integrates the various pieces of study about the research problem.
8. A research report must demonstrate originality and always attempt to resolve a philosophical problem. It must contribute to resolving an issue and the accumulation of knowledge.

9. Toward the conclusion, the report should also discuss the policy implications of the issue. It is generally considered desirable if the report forecasts the subject's probable future and indicates the types of research that remain to be conducted in that field.
10. Appendices should be included for all technical data contained in the report.
11. A bibliography of sources consulted is a required component of any excellent report and must be included.
12. An index is also considered an integral part of a well-written report and must be prepared and included at the conclusion.
13. Whether typed or printed, the report must be visually appealing, neat, and clean.
14. Calculated confidence limits must be included as the various constraints encountered during the research study's conduct.
15. The study's objective, the nature of the problem, the methods used, and the analysis techniques must be clearly stated in the report's Introduction.

CONCLUSION:

Regardless of what has been stated previously, one should never forget that report writing is an art that is best learned through practice and experience rather than through indoctrination.

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UNIT 8 - FUTURE DIRECTIONS FOR GEOSPATIAL USE

You will learn about the directions, trends, and emerging applications of spatial technology in this chapter. Although it is difficult to predict the future with certainty, mainly as it may revolve around computing technology, several trends that incorporate spatial information in novel ways are already emerging. A few years ago, phones with the Global Positioning System (GPS) were rare. Now, they're all over the place. We are now seeing wearable computers in glasses and "smart clothes" that have location intelligence and sensors that can track things like the wearer's heart rate. Almost everything in the world now "connects." This is called the Internet of Things.

Imagine the future

Over the years, the world of GIS has changed a lot, going from workstations in the backroom to desktop computers to the Internet, cloud, and mobile devices in the last few decades. A few decades ago, GIS analysts needed to spend thousands of dollars on hardware and learn how to work with command-line interfaces to analyze data. Today, field staff can get the same analysis in real-time with the swipe of a finger or the command of their voice. These, and probably other technologies that aren't even thought of yet, will keep being combined to make spatial analysis, thinking, and understanding even more useful. We don't want to talk about or solve any of these issues here. Instead, we talk about how these and other new technologies might be used to collect and analyze spatial data in new and interesting ways, which would broaden the toolbox of any researcher, scientist, or practitioner. Each year, GIS becomes more and more popular as a research tool. It is used in new and different ways by people in many different fields. Many of the ideas in this book are now available to almost everyone thanks to digital maps that can be used online and on mobile devices like smartphones, tablets, cameras, and cars. Most often, these apps help people find a store, train station, or another place of interest. These same applications already connect to a lot of other quantitative and qualitative data sources. There are Italian restaurants near us, so we could ask a smartphone to show us where they are. The map would show us the restaurants that had the best reviews, a phone number to call to make a reservation, directions (with traffic information), and business hours. We'd also be able to see the restaurant's website, which would show us its menus and prices, as well as images. This information is very important to an author who is hungry or a traveler who is in a new place. It is also a rich, easy-to-use, and up-to-date digital resource for researchers who are looking for spatial data. These data aren't connected to our desktop version of ArcGIS. It's not hard to get them into a geodatabase to use in the analysis, though, so they can be used. The point is that even though you can get a lot of geographic information about any business by going online, it takes GIS to be able to use that information to make sense of it. With the other data sources that this text talks about, there is a lot of room to use these data for project planning, secondary data collection (e.g., a virtual site visit), or primary data collection by giving study participants a mobile app that collects the data they want at certain times or places during the day. Because so much information about where people live is available on social media, there is another new way to get data about specific behaviors or events. When we say that, what do we mean? This kind of information can be found on social media. People also use data from social media platforms like Twitter and Foursquare to map social trends in space and time. If you want to map events like earthquakes and severe weather, you can use live streaming social media feeds to add information to your ArcGIS maps. There are already many examples of this, like this one from Twitter: https://develop.twitter.com/case studies. To tell a story or make a complete picture with maps, it is important to combine different types of data. Other applications are coming up because sensor networks are getting better and the Internet of Things is becoming more common (a world in which almost everything from your home appliances to your door locks and even your clothing is connected to the Internet). Operations can be started or stopped based on where they are by using the ArcGIS Tracking Analyst extension and spatial data from a GPS-enabled car or mobile device. As an example, someone who is getting ready to pick up a package could be alerted when a vehicle enters a certain area or nears a delivery location. This is called geofencing, and both of these examples are examples of how this works. It's called geofencing when you set up a set of boundaries (fences) that are used to filter analytical operations or send alerts based on certain attributes or spatial locations. Smart homes can lock doors, change the temperature and turn off appliances if you leave a certain distance from home. As you pull into the airport parking lot for a well-earned vacation, you won't have to wonder if you forgot to turn off the stove. Based on your distance from home and the traffic conditions at the end of the workday, your dinner may already be ready to go when you get home from work. In the future, researchers will think about how they can use these devices and tools to do things like collect data, edit it, and analyze it in the field. In the past, many GIS features were only available on a computer. Now, tools like ArcGIS Online make many of those features available online. These new tools make it easier for people who are creative to look at and use GIS in new and different ways.

As we have talked about in this text, one of the main benefits of using a geospatial perspective is that it gives you a broad view of a wide range of research topics. GIS can merge data from different sources to show a single picture. New perspectives broaden and deepen your study of what you're interested in. As emerging technologies and data sources become available to researchers, new ways to improve your research of almost any subject and, perhaps more important, open up new possibilities. In the past, who would have thought that it would be possible to map the thoughts of many people based on their tweets? Before 2006, a tweet was just the sound made by a bird, and wildlife biologists were mostly interested in mapping them, so this isn't a big surprise. Today, if you search for "Twitter Map" on Google, you'll see a lot of examples of how data from tweets have been used to make maps about a lot of different things.

As the world becomes more aware of where things are, the need for spatial analysis skills will almost certainly keep growing. It is now possible to make a wide range of map types, and more and more people are asking spatial questions and making maps. The problem is that they don't always call these maps, and a lot of the press now prefers infographics. Infographics are data visualizations that often use a map-like perspective to show the data.

Figure 8.1 Infographic [1]

Figure 8.2 illustrates an infographic in a more modern and map-like format. The general appearance, geographic location, and connectivity of the United States are retained in this example, while colour and size are used to communicate which candidate received electoral votes.

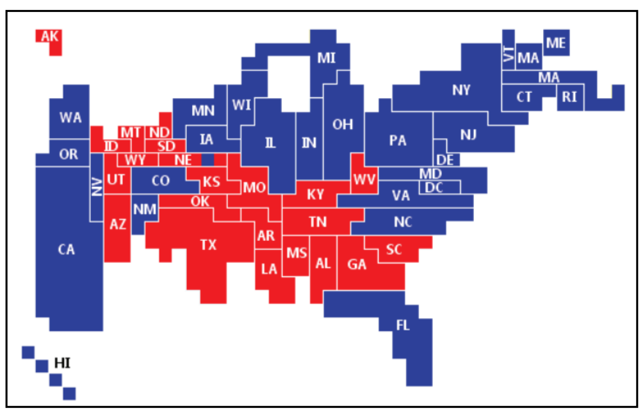

Figure 8.2 Map of the 2008 electoral college. Votes for Obama–Biden is shown in blue squares on the map above. McCain–Palin votes are shown in red squares, and they are shown on the map This map is correct in terms of geography. They don't touch the ground when they are in real life. [2].

Geospatial agility

Many researchers and scientists are drawn to GIS because of its extra analytical and visualization abilities. It allows the researcher to move around the world.

Having a lot of agility means that you can move quickly and easily. Geospatial skills are about being able to understand spatial concepts and patterns in your data quickly and easily, and then quickly and easily move through them. You have an advantage when you mix breadth and focus.

Animals must quickly figure out their surroundings and the speed of their prey to stay alive, so they must learn quickly about both. In this case, the big picture of the meadow and just one field mouse are very important for a bird-of-prey to hunt well. Step by step, the hunter makes his choice and kills the hawk. If possible, he then tweets about it.

When thinking about, collecting, analyzing, and communicating research findings, map-based data visualization is often the best way to tell the story without confusing statistical results and the complexity of the research. When you do research with people who make decisions in mind, a simple and effective way to show your data can help you turn it into action and make a difference. This is an important part of geospatial agility. Whether you're a corporate partner, a nonprofit, a school board, or an elected official, you make decisions or put in place rules. As scientists who study both the natural and social sciences, we believe that research and investigation can change the world. As a result, we've always looked for tools that help us improve our analytical skills and understanding.

A big benefit for a researcher is that he or she can look at both macro and micro perspectives at the same time in the same place. Users can zoom out to see data, analyze at different levels, and see patterns and trends across large areas or landscapes when they use GIS. In addition, you can zoom in to look at the data and drill down into the specifics. People can work with data in both directions with a GIS, combining the most relevant data sources at each step. As a result, when looking at a subject from different angles and different scales, taking a spatial perspective is important to research success.

Image versus data

Researchers need to make a big difference between being able to see images in space and having access to "data." Because this is important.

Why should we care? A lot of people who use GIS applications every day just want to know where something is and how to get there. Most people may use spatial mapping for this, but it could be one of the most common ways people use it. Consumer applications of spatial analysis don't need you to get the data or figure out how to use it. The tools you need are built into the device or can be accessed through wireless communication to the cloud. An online search on a phone or computer, or using the GPS in one's car, will do. It's important to point out that being able to see information or data isn't the same as having spatial data that a researcher can use for his or her work. Also, we want to point out that information on the Internet can be wrong at times.

For example, when we first moved into our new home in a new housing subdivision, the online map provider displayed an incorrect configuration of our street. As a result, no one could find us for the first six months we lived here, from the newspaper delivery person to the pizza delivery truck. As if fictitious data had supplanted our "true" location. Since no one could locate us virtually, it was as if we didn't exist.

As a researcher, student, practitioner, or policymaker, you will encounter numerous analytically demanding questions. You'll want to be able to do more than simply view data that was provided to you by someone else in the limited ways they offered it. You'll want to be able to create, analyze, and manipulate data using your GIS software in those instances. Fortunately, many commonly used datasets (streets, boundaries, census data, crime data, and various other data types) are readily available in GIS-compatible formats such as shapefiles, geodatabases, raster grids, or images. Throughout this book, we have discussed numerous methods for locating and analyzing spatial data for research and application purposes. However, it's important to keep an eye out for new and interesting ways to find and get data that could be useful in your work. Keep an eye out for new sources of data, including social networks, new consumer devices and technologies, and sensor networks run by government agencies (weather, traffic, pollution, and others).

Numerous of the most innovative and enlightening spatial analyses results from someone exercising their creativity. While many time-tested investigations remain valuable, particularly in production environments, research is a different animal than occasionally wishes to tweet. Consider how you can leverage those sources or create new, primary data in novel ways. Currently, over 140 million people in the United States (45 per cent of the population) own a smartphone. This opens up enormous opportunities for data collection, including locations, photographs, and much more. As mentioned previously, many of these individuals volunteer valuable data through their social media postings. Some of these data are subsequently made available through other channels (mobile companies undoubtedly obtain helpful information about their customers, and law enforcement can subpoena data, for example).

A smart researcher, on the other hand, might look for people to study and get them to sign up. Consider giving study participants a smartphone app, making them wear a small GPS receiver on their dog's collar for a month, or putting environmental sensors on their windowsills to make a dense network of data loggers. With widespread cell coverage, public Wi-Fi, and home networks, you have more options for collecting spatial data than you did in the past. Deployment to the field may take little to no time for you, and you may be able to start collecting data right away (or your staff). As the costs of hardware and software keep going down, more and more opportunities become available. Citizen science groups are forming and developing new tools for collecting data regularly, and they may already have the tool you need. Many of these options won't work for every study, but you should think about them and come up with new ideas.

A rebirth of spatial awareness

Over the last decade, enough adventurous students and faculty have begun to investigate GIS as a means of expanding their disciplinary toolboxes that applications in these disciplines have started to emerge. Though not yet widespread, GIS is increasingly being integrated into curricula on some campuses, including those for K–12 education. Maps are more accessible to the public than at any other point in history. It doesn't matter if you use GPS in your car or your smartphone to find a place to eat, or you use simple spatial queries to find a place to eat. This growth of spatial thinking, and thus of GIS, into new areas and applications are almost certain to keep going as people find new ways to use the technology to solve their problems. A new generation of spatial thinkers is being raised, and they will grow up and keep incorporating a geospatial mindset and a socio-spatial point of view into their work and lives.

Nonetheless, if you are a social scientist just beginning to use GIS, you are most likely still among the early adopters. The good news is that as you incorporate GIS into your work, you will become a source of suggestions and creative ideas for others. This is true even if you have only a passing familiarity with GIS, as it is still a relatively new field. As professors, we share this adage with our college classes to demonstrate that, even if they are not "GIS experts," their skills and ability to think spatially will be in demand. This has invariably proven to be true.

Although many local and regional governments have adopted GIS, nonprofit organizations, and schools, you may still be the first to implement GIS in your organization. While this is an exciting opportunity, it can make it more challenging to develop a sense of community among colleagues. If you work for a government agency, we recommend finding out who else uses GIS in your organization. Colleagues down the hall in a department devoted to infrastructure, parks, or other natural resources may be the source. If you work in academia, you may come across individuals who use GIS in various departments. Naturally, inquire about the geography department's use of GIS. Some specific individuals are highly knowledgeable about the types of analysis you are interested in.

In addition, traditional natural resource departments should be looked at, where GIS has been used for a long time. It's not the only field where GIS experts might work. GIS is used by a lot of energy and telecommunications companies, logistics and shipping companies, engineering and environmental consulting firms, and non-governmental organizations in the private sector. There is a local GIS user group, regional or state GIS meetings, and national and international forums like the Esri International Users Conference and conferences for different fields. [3].

Furthermore, being a trying cut user of any new technology might make you think outside the box about how you use these tools. GIS studies of wildlife habitats may not be easy to translate into a situation where you need to do social science analysis. Try to think outside the box. In the wild, of course, the reasons why an animal lives where it does might be very similar to how humans choose and develop their neighborhoods. It's not just humans who have needs they are trying to meet. Animals and humans both need to be close to resources like food, water, and safe places to live that aren't too noisy or crowded. The point is that the same tool can be used in many different fields.

GIS is an art form

It's a mix of art and science to use GIS as an analytical tool. The trick is to figure out how to do your analysis in the GIS in a way that makes sense. As you can see, the science of the GIS is in how it is processed, how it is used, and how it is used statistically. As we said at the beginning of this book, GIS is a technology that allows data from different sources and different fields to be combined. Being creative when using these tools is an important part of successful GIS analysis, especially when using them in new ways, which is often the case when doing research. Because once you have a reliable process that can be automated and even run by itself, you'll want to keep using it for future work.

GIS has been around for more than 50 years, but it is becoming more and more popular in the social sciences as a way to help people learn about the world. As far as I know, most social science researchers have only recently started to look back at their roots in the places where they work. If you look back at the history of your field of study in the social sciences, you'll find that maps were an important part of the analysis procedure at some point. Many social science fields have broken away from these roots over time, looking for new and different ways to do things. Even academic geographers mostly didn't pay attention to GIS when it was in its early stages. GIS, on the other hand, grew in popularity in other fields, mostly in the natural resource sciences, over the intervening years, but social scientists didn't notice.

However, as GIS software has become more accessible and easier to use, it has become more familiar, accessible, and easier to use than at any point in its development. This is mostly due to the advent of the graphical interface with ArcView in the early 1990s, and it has continued with the introduction of ArcGIS for Desktop, ArcGIS Online, and ArcGIS for Mobile. This is good news for social scientists: They're rethinking the value of a spatial perspective and trying out GIS apps in their fields. What was once out of date has been brought back in. The use of GIS could help many government agencies, private businesses, community groups, and non-governmental organizations. GIS gives a more complete picture of a subject than other methods, as this book has shown. As a bonus, because it is visual, it helps make scientific data easier to read and understand.

Of course, GIS is not a perfect technology. Most importantly, one cannot develop technology without considering the people who will use it (the human side of GIS).

GIS as change technology

Numerous scientists are concerned with concepts of change over time. Data from two or more points in time are required to assess change. You would start with what is referred to as the initial set of data, or baseline data, and then create or discover data for subsequent points in time. Because taking action or developing a policy is frequently a direct response to a particular state of affairs, we refer to GIS as change technology. Using ArcGIS software, it is possible to visualize and chart these states of affairs.

The social scientist is frequently interested in the changes that affect our society and may pose the following questions: What social changes are currently affecting society? Which society does one inhabit? What political and environmental changes are currently affecting the community? Is there an occurrence of inequality? Social scientists attempt to categorize various forms of inequality, such as ageism, sexism, and racism.

Essentially, any of these questions would benefit from taking the spatial context into account. For instance, where do various forms of inequality occur? Who is disproportionately impacted by these forms of inequality? Due to the dwindling environmental and social resources that sustain certain societies and social structures worldwide, questions of geographic location and inequality are gaining prominence. Environmental justice is one academic field of study that addresses such issues. This field places equal emphasis on the interconnected nature of the social and physical environments. It is not coincidental that poorer people and people of colour frequently live in substandard physical environments, both health and safety. Another area of social science that can benefit significantly from geospatial technology is the study of social inequality. As information sharing continues, where these various types of inequality occur geographically will become increasingly relevant. By identifying inequality hotspots, we may be able to forecast areas ripe for political unrest and the demand for specific types of resources.

Identifying social inequality

Social inequality can exist at any level, whether within an organization, a community, a neighborhood, a state, or a country. Today's world widens the divide between the haves and have-nots, the rich and the poor. GIS is a critical tool for documenting and analyzing where, to what extent, and types of social inequality exist in various locations. More importantly, to truly assess social inequality, you must have baseline data that document a situation as it exists today and over time. This enables the researcher to create maps that visually depict changes (both positive and negative) as they occur across a geographic region. Consider the following scenario: suppose a group of people lived in a polluted environment gradually being cleaned up. On a map, one could track the progress of this environmental cleanup. They could also track people's movement away from polluted areas and presumably healthier and safer areas. All of this is mappable, trackable, and analyzable in ArcGIS. Figure 8.3 depicts a polluted environment in the Yamuna River during Chhath puja.

Figure 8.3 Toxic Yamuna River [4]

Additionally, by delving into the social structures of places where inequality exists, we can better understand the causes and possible solutions. This is critical information because it enables a more rapid response to various social, economic, medical, environmental, and political issues that arise globally.

Solutions that use GIS analysis can be thought about from a geographic point of view. To figure out where safe drinking water is available, you can use a computer programme called GIS to look at the distance between water sources in an area where people get sick from drinking water. Dr John Snow's famous analysis of drinking water in the 1800s found the contaminated pump that caused cholera. A modern study in ArcGIS could look for ways to solve and improve the same problem in a developing country. The community might be able to solve the problem by drilling a new well for drinking water in a place that is convenient for them. Analysis as to where people get their water and the location of a new well could both benefit from a GIS tool, like this one. Identifying the factors or variables that are causing the problem and coming up with a good solution would be material and tangible examples of social change in action.

Trying to find ways to improve society, the world, existing problems, injustices, and inequalities in an organization, community, or organization is what finding solutions to social inequality is all about. Each of these goals can be helped by GIS software, especially ArcGIS. The applied or practical view of social change encourages people to figure out what steps they need to take to right wrongs and figure out how to solve a specific social problem. It can be used to make things more equal for groups that have had unfair treatment in the past.

The role of geospatial crowdsourcing

As more people around the world get cell phones, their ability to get and share information about places and times has grown rapidly. Everyone can be a source of data because they already have information and can now share it with others through social media and the web. This is called geospatial crowdsourcing. This is because cell phones have become more common in a lot of places. Indeed, it is common to see people with cell phones in many rural areas of developing countries, even in places where there are no landlines. The ability to map and share this kind of data has grown a lot. Increased access to information has made people more reliant on and able to use spatial technology through their phones when they respond to emergencies or organize for social change. Cell phones have GPS, which allows people to be on the ground reporters and spread important information. When there have been natural disasters (like a hurricane or tornado) or man-made disasters (like a flood or earthquake), this has been the case, too (a significant oil spill). Figure 8. 4 shows the seismic zones in India, which help us figure out which parts of the quake were important.

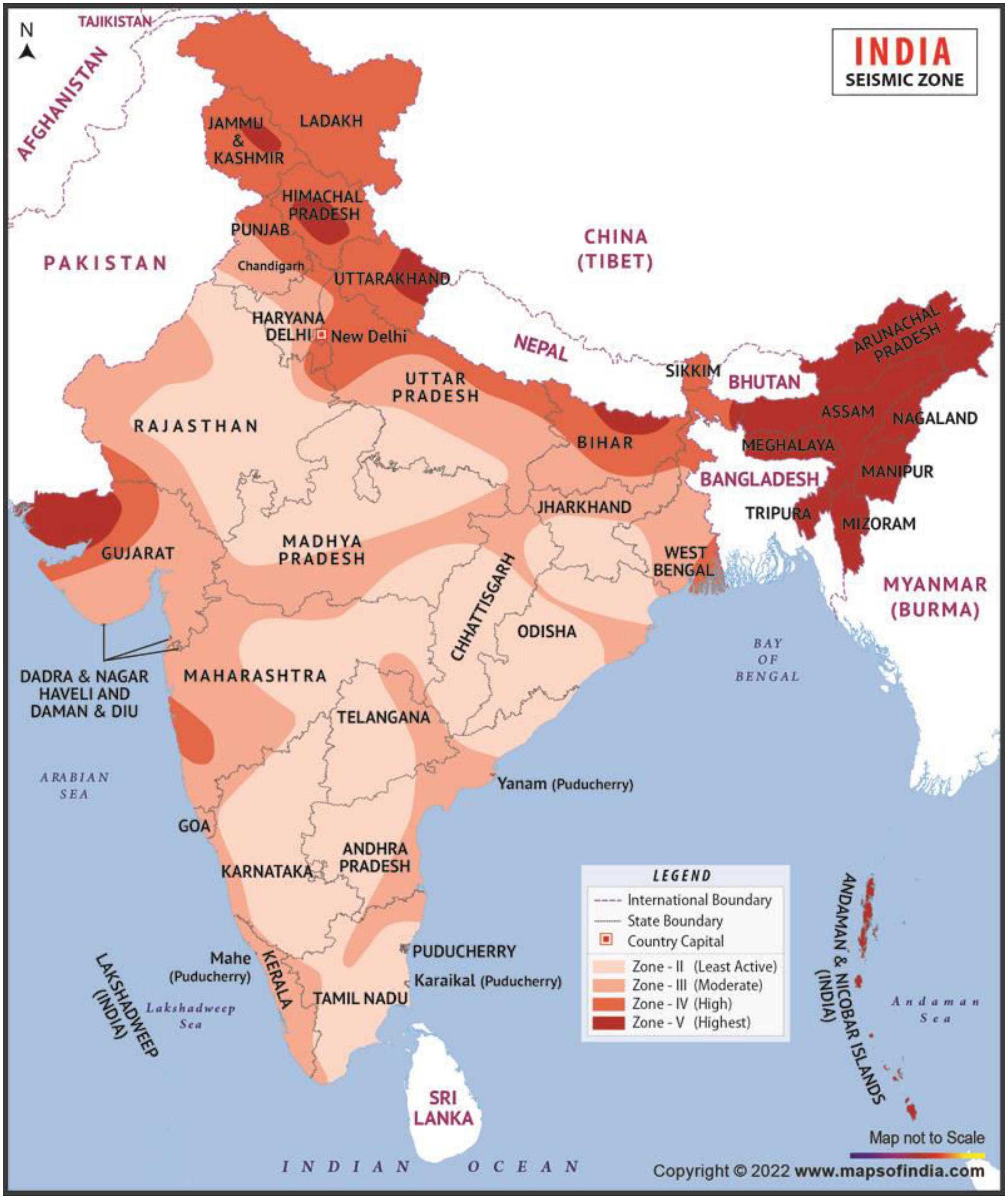

Figure 8.4 Seismic zoning map of India [5]

New directions for GIS-based research

As GIS permeates our societal consciousness, space will inevitably remain central to all disciplines and sciences. The general public now demands that information be conveyed and shared spatially, as spatial thinking has become a norm in many societies. Indeed, many people anticipate it.

Spatial data and smartphones

GIS has become a big part of many people's lives thanks to their smartphones and the many websites on the Internet that use maps and mapping technology. In addition, spatial perspectives are often shown in the news, both in hard copy through newspapers and magazines, and on TV through 3D maps and fly-through visualizations. There are already many elementary and middle school schools around the world that teach GIS software and other digital mapping tools, such as GPS.

We think it's important to stress how important it is to make your data spatial. You can quickly make a map with many tools. However, few of these tools allow for long-term access to the data behind that map, nor do they allow for long-term analysis or access to the data behind that map. In your job as a researcher or policymaker, you want to make sure that you can get your hands on the data and that the maps you make will last. This is possible because of the ArcGIS technology that can be used. This technology can be used in a lot of different ways (see Figure 8.5, which illustrates an ArcGIS mobile map).

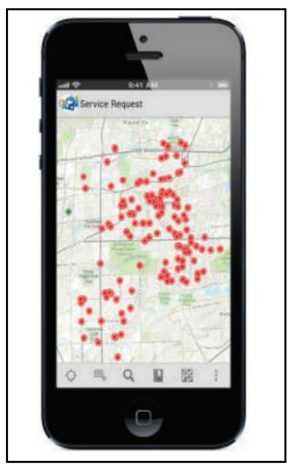

Figure 8.5 An example of an ArcGIS mobile map deployable to the field on a smartphone. Esri.

With such widespread exposure to these tools and their numerous applications for comprehending the world around us, it would be naive to assume anything other than increasing public demand for spatial data and analysis.

Visualization and GIS

GIS is used to make, analyze, manipulate, and visualize data about places. GIS lets people see how social and physical characteristics change over time. As a result, this could help us look at how physical environments, human settlement patterns, disease spread, and resource access have changed over time. From a research point of view, the value of GIS comes from its ability to combine different types of data, such as community histories, sociodemographic features, and community needs assessments, together. From a natural science or medical science point of view, there are almost no limits to what can happen. The health and medical fields have become more and more dependent on spatial technology for their daily work and research. As the first field to use GIS, we can also expect that the natural sciences will play a big role in the development and use of GIS technology in the future. As businesses and corporations keep using spatial technology to run their businesses and plan new ones, we'll see more businesses and corporations using GIS.

GIS makes it possible to combine information from different sources into a picture of the troubles facing a specific area or a group of areas. We hope you now understand how important it is in natural science, medicine, social science, the arts and humanities, and any other field. GIS helps the user understand recent and long-term trends as well as changes in the environment and social worlds.

Numerous tools enable the researcher, city planner, or community developer to simulate various future development scenarios based on population growth and available resources. Community Viz (http://placeways.com/communityviz/), which works in conjunction with ArcGIS to provide powerful dynamic models, is one such example that supports both dynamic modelling and 3D visualization of the results. By inputting various parameters into the programme, the individual can model and visualize how things would appear in the future under a specified set of conditions (see Figure 8.6).

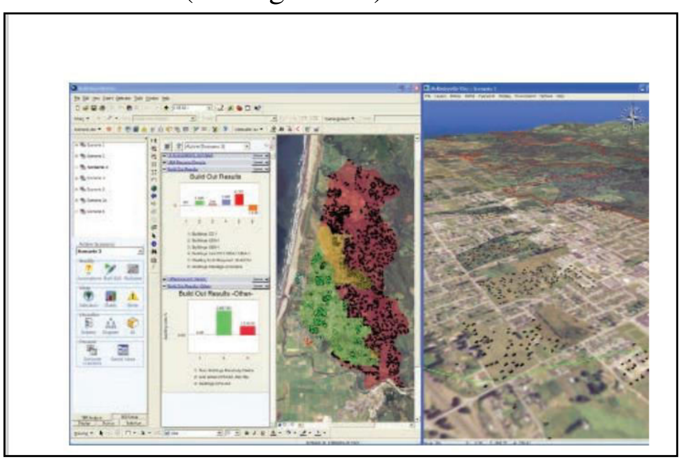

Figure 8.6 Using the CommunityViz extension to ArcGIS, these visualisations were made for a city planning process that looked at different scenarios for infrastructure capacity or expansion, housing density, and protected areas. Michael Gough took this picture for Humboldt State University and got money from the North Coast Environmental Center in Arcata, CA.

As an example, think about a town that recently got a grant for economic development to improve its downtown. This revitalization will include the construction of new buildings that will match the Victorian-style design of the downtown and the addition of a new bridge. To build the bridge at least a year will pass. During this time, some roads will be closed, and traffic patterns will change for some new buildings in the downtown area. How and where these buildings will be built, how high they will be, how much parking they will need, and so on can be seen using GIS.

As computers become more powerful and affordable, photo-realistic 3D visualization and simulation models of various options will become more accessible and user-friendly. We are likely to have ready access to augmented realities within the next few years, in which scenarios like this will be presented in real-time and space via overlaid data on a smartphone image of one's surroundings or projected images via wearable devices such as virtual reality goggles.

Faster response time

Improve your analysis and save time by using a GIS to collect data about a community and then putting it into a database right away. Much of this information may have already been out there in a spread-out way. Each agency may have information about its problems and needs, but it may not know about the data held by other agencies and organizations. The same information could have been stored on different maps or in filing cabinets, but it didn't have to be. Such data would be used very rarely in the analysis of social issues or planning processes. When you use a GIS to combine these different types of data into one format, you make it easier for people to share and consolidate their work, which leads to better overall data. Having more detailed information about the community can be very helpful when you're planning. However, just because data can be found online doesn't mean that people or organizations will freely share it. Agency preparation and response to Hurricane Katrina didn't go well because there wasn't enough communication and data sharing between different types of agencies that needed to talk to each other before, during, and after the storm hit in August 2005. In an emergency, quick decisions need to be made with the right information. If you don't have enough information, bad or ineffective decisions could happen.

That major data sharing snafu underscored the importance of different agencies with varying governmental affiliations (federal, state, regional, and local) communicating quickly and efficiently, particularly during times of crisis. The cost of being unable to communicate and share data rapidly is simply too high.

Parting thoughts

This book has led the reader through the most important issues that GIS users, especially ArcGIS users, are facing right now. In addition, we have given you some background info on GIS, how to choose topics that are good for ArcGIS technology, how to collect data, and how to measure, prepare, and analyze it. A spatial perspective can help you do your job better, and we hope this book will help you see how this can be done with the help of ArcGIS tools.

If we have made you want to try to use GIS methods to solve your problems, we have met our main goal. People have a hard time adopting new technology because they don't dare to take the first step and try it out. As with any new project, the more time you spend on it, the easier it will become. Begin with something simple and work your way up to something complex. As the proverb goes, one must first learn to walk before one can run.

Geographic information systems are useful tools that can be used by researchers, scientists, and people in a wide range of fields. As these technologies get better and more common in our society, the chances to use GIS in new and creative ways will grow. With more spatial technologies being used, the need for good analysts who know how to use GIS will only get bigger. By mastering ArcGIS, you will be able to examine and comprehend a wide variety of problems or issues through a geospatial lens; in other words, you will increase your geospatial agility.

Whether it's physical, natural, social, or conceptual, almost every piece of data has a geographic component that can help us understand different topics and make better policy decisions. This book is meant to help people like you get started with new and may be unfamiliar technology. A second goal is to help you understand how this technology could help you with data collection, analysis, and decision-making in the social sciences. GIS can help researchers, policymakers, practitioners, and scientists all over the world meet the needs of a wide range of people. It allows researchers and policymakers to think about important factors in the context of their decisions. Please help your fellow geospatial scientists, researchers, and practitioners move forward in this direction. This is both the history and future of this field.

As we said at the start of this text, spatial analysis techniques can be used to solve a wide range of problems, even ones that haven't been thought of before. These tools can be used in many ways in a geospatial context, and the useful information and analysis results they can provide are only limited by the imagination of the people who use them. We hope that some of the ideas in this text will help you think outside the box when you use GIS in your work and share your experiences with others.

Suggestions for student research projects

Any set of variables with a specific location is a good choice for a GIS-based study. As a starting point, we give you some ideas for a GIS-based social science research project in a field of your choice. The following are some possible GIS-based investigations that could be done. (For each subject, talk about how to get important information about it in small groups.)

1. Environmental justice: Poor and minority communities are more likely to live near hazardous waste sites. (A question of geographical proximity)
2. Health: Cities with more international airline connections have a higher risk of contracting contagious diseases. (A question about network proximity)
3. Crime: Areas with a high concentration of teenagers have a higher crime rate.
(An issue of spatial correspondence–containment)
4. Anthropology: Rural indigenous communities located further from cities maintain a higher level of cultural preservation than those located closer to cities.
(A question of proximity)

5. Political science: Communities closer to international borders are more likely to support free trade agreements such as the North American Free Trade Agreement (NAFTA). (A question of geographical proximity)
6. Sociology: Communities with a high concentration of community service organizations have more robust social networks. (An issue of spatial correspondence–containment)
7. Wildlife science: Encroaching development has a more significant impact on the home ranges of various wildlife species in suburban areas than in rural areas. (A question of geographic proximity, including buffer zones).

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UNIT 9 - WRITING RESEARCH REPORT

Research Report: A research report is a well-written document that summarizes a systematic investigation's findings. It is an important document that provides an objective and precise assessment of the research process. A research report is essentially a summary of the research process that highlights key results, recommendations, and other facts. Reading a well-written research paper should supply you with all the information you need.

A research paper mimics a formal report in style, organization, and methodology. It differs from a formal report in a few ways. The main characteristics of a research paper are listed below.

- A research paper is the most common type of expository writing. It can be written about any topic or issue, including scientific, technological, social, cultural, and so on, as long as the treatment is scholarly.
- It is highly stylistic, with a high concentration of literary skills such as definition, classification, interpretation, abstraction, and description.
- It is objective, with accurate, concise, direct, and unambiguous information presentation.
- Most research papers include graphic aids as well as scientific, technical, or specialized jargon.
- Every research paper is a coherent composition resulting from the investigation of a certain subject, the gathering of relevant material, and the organization and analysis of the same.
- A research paper is a prose composition that has been documented. All relevant analyses must be backed up by sufficient evidence. In summary, all research articles require documentation.

Types of Report: The following are examples of common report types:

1. **Informative or instructive**

- provide information.
- The details of events, activities, or conditions are visible to the reader.
- There are no scenario analyses, conclusions, or recommendations.

2. Problem-solving written analytically

- Information is scrutinized.
- Conclusions are reached, and suggestions are presented.

Persuasive

- An extension of analytical reports, with the primary goal of selling an idea, service, or product.
- The most common type is proposals.

Reports typically target a broader audience, serve many purposes, and provide more thorough information.

Other types of reports include:

- **Incident Report**: A report that details how near you are to completing a project.
- **Accident Report**: A report that details how many goods or services were sold and why any deviations from the plan occurred.
- **Sales Report:** A report on what has occurred in a specific location and how close your company is to completing construction.
- **A progress report** it is an academic document that describes how and why something has evolved.
- **A feasibility study**/report is a document that describes what transpired.
- **Recommendation Report**: A report on the feasibility of a plan.
- **Site**: A report on what your company should be doing.
- **A case study** is a report that details how someone was injured or something was harmed.
- **Periodic Operating Reports:** To track and oversee manufacturing, sales, shipping, and customer service, among other things.
- **Situational Reports** are used to report one-time events like vacations, conferences, and seminars.
- **Investigative/Informative**: To look into problems and provide information - with little analysis.
- **Compliance report:** Government agencies and laws require compliance.
- **Justification/Recommendation**: To provide management with recommendations and to serve as instruments for solving problems and making decisions.
- Research Studies: Interpreting an issue, formulating hypotheses, gathering data, analyzing data, and making conclusions are all examples of scientific studies.

Formats of A Research Report: A research report is a written record of the study's research activities and findings. It, allows the reader/audience to reconstruct events without distortion. The research report begins with an introduction, followed by a description of the research conducted, and finally, conclusion and suggestions for further research.

For the presentation of a research report, there are numerous styles. These instructions instruct the researcher on the exact style and format standards to be followed when preparing a research report. Some universities, institutes, or departments of education establish rules for how theses, dissertations, and research articles should be formatted. However, all forms follow the same outline (Koul, 1986), which is divided into three sections:

i) the preliminary section,

ii) the body of the report or text, and

iii) the reference sections

Each main section consists of several sub-sections. Let us go through the general format of the research report as described by Koul (1 986).

- **Preliminary Section**

1. Title page
2. Preface, including acknowledgements (if necessary)
3. Table of contents
4. List of tables
5. List of figures, maps or illustrations (if any)

- **Body of the Report or Text**

a) Introduction

I. Statement of the problem
2. Analysis of previous research
3. Relation of present problem to theoretical position of the previous research
4. Significance of the problem
5. Delimitations of the study
6. Assumptions underlying hypotheses
7. Statement of hypotheses
8. Definition of important terms

b) Design of the study

1. Procedures employed
2. Sources of data
3. Data gathering instruments
4. Sampling and methods of gathering data

c) Analysis and Interpretation of the Data

1. Tables (if any, are usually included in the text)
3. Figures (if any, are usually included in the text)

d) Summary and conclusion

1. Brief statement of problem and procedures
2. Principal findings and conclusions with their practical implications (if any)
3. Suggestions for further research

- **Reference Section**

I. Bibliography
2. Appendix
3. Index (if any)

Every research report has seven main components, that's are title, authors and addresses, abstract, keywords, introduction, materials and methods, results, discussion, conclusions, references

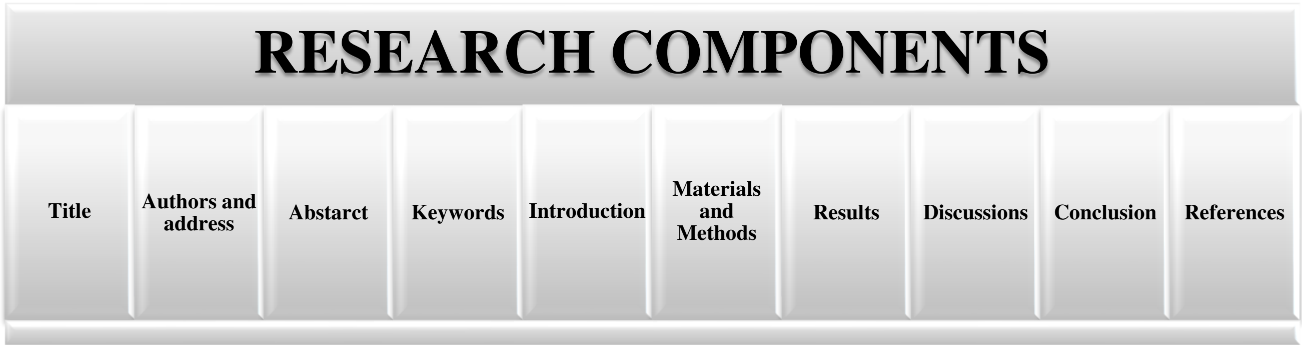

Fig.9.1 Research Components in a Research Report

Title page: A research paper's title can be defined as the fewest feasible words that adequately summarize the paper's contents. It should be thoroughly researched and provide a clear and comprehensive picture of what is to come. When writing a paper's title, the author should keep in mind that the title will entice someone to read the entire document. As a result, every word in the title should be carefully chosen, and their relationship to one another must be properly regulated. It's important to remember that indexing and abstracting services rely substantially on the title's accuracy. Furthermore, a paper with an incorrect title may be essentially lost and never reach its intended audience.

Authors and Addresses: A full name and address should be deemed mandatory unless the author of a research paper desires to remain anonymous. In all of their writings, the author's names should be spelt and given in the same way. When information is gathered, deviation from this leads to confusion. Only individuals who actively contributed to the overall design and execution of the experiments should be listed as authors. In addition, the authors should be named in order of importance to the experiments, with the first author recognized as the senior author and major progenitor of the work being reported. The function of an address is to identify the author and to provide the author's mailing address. If various authors of the same work have distinct addresses, the names and addresses of each author should be listed separately.

Abstract: The abstract of a research study has taken on new significance as secondary services, particularly abstracting publications, have grown in importance. It serves two purposes:

(1) to enable readers to quickly and accurately identify the basic content of a document to determine its relevance to their interests and, as a result, whether they need to read the document in its entirety, and (2) to satisfy the requirements of abstracting journals. Abstracts are divided into two categories: informative and indicative. A research paper should typically include an informative abstract that includes information about the study's objective, newly discovered facts, experiment or argument conclusions, and, if possible, the important components of any novel theory, treatment, apparatus, procedure, etc. Because the abstract eliminates the need to read the entire manuscript, it should be self-contained in terms of new information. The indicative abstract is another prevalent sort of abstract (descriptive abstract).

This is better suited to extensive, descriptive pieces or reviews. A suggestive abstract summarizes the contents of the study and the scope of the research without revealing the findings or conclusions.

(1) should be as concise as possible and should not exceed 3% of the total length of the paper; (2) self-contained; (3) does not contain any bibliography, figure, or table references; (4) does not contain any obscure abbreviations and acronyms; (5) generally written after the paper is prepared (Raman and Sharma 2004).

The following are the steps involved in writing an abstract: (1) read the study's introduction paragraph to determine the goal; (2) skim the summary and conclusions at the end to note the study's main findings; (3) skim the text for information on the methodology used, fresh data, and any other important details; (4) Create a rough draught by putting the following components in the following order: objective, new approach or equipment used, fundamental data, and significant conclusions and/or correlations derived; (5) revise and cut it to the desired size.

Keywords: An index item that identifies a specific research publication is known as a keyword. The terms will be used by most electronic search engines, databases, and journal websites to determine whether or not to display your paper to interested viewers. Keywords are used to classify publications in journals, search engines, and indexing and abstracting services.

As a result, a precise list of keywords will ensure proper indexing and will aid in the promotion of one's research to interested parties. As a result, the odds of one's paper getting referenced will increase.

Here's how to choose the best keywords for a research paper:

(1) thoroughly read the paper and make a list of the terms/phrases that appear several times throughout the text;
(2) double-check that this list covers all of the primary key terms/phrases as well as a few additional key phrases;
(3) contain term/term variants (e.g., spatial metric and landscape metric), methods, and so on;
(4) include term abbreviations (e.g., GIS, GPS);
(5) now, check a common vocabulary/term list or indexing standard in the chosen discipline (e.g., GeoRef, Scopus, etc.) to make sure the terms used match those in these resources.
(6) finally, before submitting the article, run the keywords via a search engine to see if the results match the paper's topic. This will assist an author in determining whether the keywords are relevant to the paper's topic.

Introduction: The goal of an introduction is to provide enough background information for the reader to understand and assess the study's findings. As a result, it may be required to refer to previous work only when it is directly relevant to the aforementioned goal. It's sometimes required to include a summary of the author's previous attempts to tackle the problem, as well as citations to relevant literature. Attempting a comprehensive historical examination of prior work, on the other hand, is pointless. Rather than listing a large number of references, it is often possible to cite a single reference to a recent key review paper; all of them may have been mentioned in the review article.

The following are some guidelines for a good introduction: (1) it should present the nature and scope of the problem under investigation as clearly as possible; (2) it should review relevant literature to orient the reader; (3) it should state the method of investigation and, if necessary, the reasons for choosing that method; and (4) it should state the research objectives.

Materials and Methods: The major goal of this part is to discuss (and defend if necessary) the results, experimental design, experimental procedure, or theoretical derivation, and then provide enough details for a competent worker to reproduce the experiments. It is sufficient to cite the appropriate literature reference where the description is available if a well-known technique or approach is applied. However, there are times when it is necessary to deviate from this guideline, such as when the source is obscure.

When a technique or approach is adopted that differs from a prior technique or approach, a clear description of the alteration is all that is required. Specifications for materials and input data must be provided. Experiments must be explained in sufficient detail, as must the ranges covered, the new equipment employed, and so on. In addition to technical specifications, the reasoning for preferring them must be provided. There may be numerous subheadings in this section.

Results: This section constitutes the heart of the work – the conclusion. There are three ways to present the results: (1) as text, (2) as a table, and (3) as an example. A certain set of results should only be provided in one of these formats. Duplicate efforts should be avoided whenever possible. In this regard, one should avoid the two extremes when picking data for inclusion in a publication. One extreme is the inclination to transfer nearly all data from the laboratory notebook to paper. On the opposite end of the spectrum is the circumstance in which there is so little data that the reader cannot comprehend the conclusions' reasoning. The optimal course of action is to provide the crucial information that forms the basis for the study's major conclusions.

In the text, simple and descriptive information should be provided. Only those data that merit emphasis should be presented in tabular or graphical format.

The information presented in tables and figures should complement, not duplicate, the text. Regarding the choice between tabular and illustrative forms of presentation, the general criterion is that tabular presentation is preferred for values that are given for their data value (need for a high degree of exactness). When highlighting trends, favour pictorial representations. The complexity of tables should not be increased by providing too many items and too much information about them. Complex data should be separated and presented in two or more tables, rather than in a single unwieldy table. For large tables that cannot be reduced or divided, the technique of printing on a larger page and then folding it should be avoided. Due to the paper's age and regular use at the library, the fold is likely to crack after several years. The table must therefore be built on many pages. The tide and column titles must be repeated on successive pages. In the case of an illustrated form, one must note that each figure increases the production cost. Therefore, only necessary figures should be presented. Cost and space savings can be achieved in several methods, including (1) integrating numerous simple graphs into a composite representation, especially where either both or only one of the characteristics is shared, and (2) applying sensible scale adjustments to reduce the size of the graphics. To conserve space, every attempt should be made to include as many examples as possible.

Discussion: This section's primary functions are to interpret results and to emphasize the major characteristics of the research outcome and their likely explanations. It should also include a discussion of the limits of the results/methods and error sources. Avoid the tendency to repeat data descriptions inside this section. Additionally, the strengths of the approaches and outcomes should be emphasized.

Conclusions: We must now summarize our findings. One must be careful not to repeat the same words that have already been used, but we must, in a way, reiterate what has already been saying. An academic reader will anticipate a summary of our findings and a brief statement of our main points in the conclusion. In instances where the study has yielded definitive results, it is preferable to present the conclusions as a series of numbered points. But if the conclusion is merely a summary, the author misses an opportunity to demonstrate the originality and significance of the work. The best conclusions summarize, but they also go at least one step further, elaborating, for instance, on the work's broader implications. One of the most important functions of conclusions is to provide recommendations based on the study's findings. However, avoid introducing completely new concepts and evidence in the conclusion. The conclusion is not the place to introduce a new argument; rather, it is the place to conclude the previous one.

References: Citing references to the work of prior academics allows the reader to access the source. Therefore, unless full bibliographic information is included in the references, the readers will have great trouble discovering the sources. Only references that were consulted should be cited. It is inappropriate to cite references from secondary sources.
Unpublished articles and personal communications should not be included in the reference list but should be cited in the text. There exist multiple styles for referring.

Common Sections of A Research Report:

Title: Be specific. Specify the what, when, and where. Give a concise summary of the paper's findings in the main title and a subheading.

Acknowledgements: Acknowledgments are used to highlight the foundation of a study, support, assessment of a previous draught of the paper, and assist with performing research and preparing or typing a document. Figure 9.2 depicts a sample acknowledgements page.

Acknowledgements

This research was funded by the …………….. grant numbers: ……………. We would also like to thank anonymous reviewer for their constructive comments on the paper.

Abstract: On page 2 of the research report, the abstract outlines the study in 100 to 150 words. This is a full summary of the study, the methodologies employed, the findings, and the study's conclusions. It boosts the article's or study's readership because it provides a summary of the entire study.

Abstract

Despite significant advances in the development of the ecosystem services concept across the science and policy arenas, the valuation of ecosystem services to guide sustainable development remains challenging, especially at a local scale and in data scarce regions. In this paper, we review and compare major past and current valuation approaches and discuss their key strengths and weaknesses for guiding policy decisions. To deal with the complexity of methods used in different valuation approaches, our review uses multiple entry points: data vs simulation, habitat vs system vs place-based, specific vs entire portfolio, local vs regional scale, and monetary vs non-monetary. We find that although most valuation approaches are useful to explain ecosystem services at a macro/system level, an application of locally relevant valuation approaches, which allows for a more integrated valuation relevant to decision making is still hindered by data-scarcity. The advent of spatially explicit policy support systems shows particular promise to make the best use of available data and simulations. Data collection remains crucial for the local scale and in data scarce regions. Leveraging citizen science-based data and knowledge co-generation may support the integrated valuation, while at the same time making the valuation process more inclusive, replicable and policy-oriented.

Keywords: Ecosystem services Valuation approaches Data scarce regions Integrated valuation Decision making

Introduction: In brief reports, sections might be combined.
Terms and Definitions: Define or clarify any nontraditional or simply one of several interpretations of any term or concept used in the study.
Related Literature Review: Gives the reader the context they need to comprehend the study by acknowledging prior researchers' investigations and findings, as well as the researcher's knowledge and preparation for the inquiry.
Problem Statement: This is a general introduction to the subject.
The Problem's Importance: Explain why this question is worth investigating.
What are you hoping to gain from a deeper knowledge of this question?
The Hypothesis is stated as follows: Declare the question being studied and the expected findings in a single statement (not a question). (The null hypothesis predicts no difference.)
Explain all of the assumptions that must be made for the inquiry to proceed.
Restrictions: Describe any limitations that may render the study invalid or inaccurate.

Design of the Study: Provides the reader with the essential information to precisely replicate (repeat) the study with new data, or to duplicate the results if the same raw data were available. This is written in the past tense, although it makes no mention of or includes the outcomes of the analysis.
The research design and procedures used were as follows: Explain everything that happened in detail.
Sources of Information: Give full details regarding who, what, when, where, and how the data was gathered.
Procedures for Sampling: Describe how the data was confined to the amount collected. How was a representative sample obtained if all available data was not used?

Methods and Instruments of Data Gathering: Describe the procedures for collecting the data. Include the forms or methods used to record it.
Explain the comprehensive mathematical processes utilized in analyzing the data and establishing the significance of the results using statistical treatment.
Analysis of Data: Describe the data patterns you found. When possible, use tables and figures to help understand the topic.
Summary and Conclusions: This section summarizes the previous sections, shows the hypotheses' outcomes clearly, and proposes what additional can be done.
Reiteration of the Issue: This is a quick recap of the issue.
Procedures are described as follows: This is a quick recap of key aspects of the study's design.
Important Findings: The analysis' final results are provided, the hypothesis is declared, and the choice on whether or not to reject the hypothesis is made.
explains how to get to a conclusion When it comes to scientific research, there are frequently more questions than answers. Does the work suggest any promising new directions? Is there any way that future researchers could improve the work? What are the work's practical

implications? This chapter should typically be brief—a few pages at most. It is suggested that the author's contribution be written in a separate section at the end of the chapter. This should be written in a clear, concise manner with numbered points. This section is critical in convincing the examiner that you deserve the degree.

References: It is critical to list all of the significant sources that were used, examined, or quoted in the thesis. Use any of the typical research paper forms listed under Research Papers.

Appendices: An appendix to a research report is an optional addition. If there is a lengthy piece that you believe is necessary for comprehension and replication, it should generally be included as an appendix. Complicated statistical analysis, published papers, copies of questionnaires, inventories, tabular formation, special resources, or illustrations of testing equipment are all examples of appendices that might be included at the end of a report.

End Notes: Similar to footnotes, but located at the back of each page rather than at the bottom. These would include all references for all books cited in the Review of Related Literature or any other portions of the report, as well as references for any direct or indirect quotations drawn from other sources, as well as any footnote comments. As in the text, these are listed in numerical order.

Bibliography or Literature Cited: The bibliographic reference for each of the works listed in the End Notes is found in the bibliography.

Appendix: The Appendix contains any tables, figures, forms, or other resources that are not essential to the study but must be included.

APA STYLE ESSENTIALS: All sources used should be listed alphabetically at the end (references list) and cited throughout the text. By citing in the text, the author should show the readers where they got each item of information they used. The reader can refer to the list of sources for more information using these textual citations. There are several styles for recording sources in the text and the works referenced list. However, the Modern Language Association (MLA) and the American Psychological Association (APA) are the most widely used documentation styles in books, journals, and periodicals. In most Humanities classes, students are expected to follow the MLA requirements. APA rules are frequently required of students in science and technology fields. APA is the most extensively utilized remote sensing algorithm. As a result, only the APA style will be discussed. The sources in an APA-style paper are listed alphabetically on a separate page labelled "References." It is numbered and follows the text's final page. Entries are listed in alphabetical order by author's last name; two or more works by the same author are listed in chronological order by publication date.

Repeat the author's name in each entry if there are two or more books or articles by the same author. When utilizing the examples below, pay special attention to the proposed pattern, including the spacing of periods, commas, and other punctuation marks. It's important to understand that the referencing styles of two journals using the APA format may differ slightly. As a result, reading the journal's style before writing the references is critical. The journal typesetters will usually transform a reference written in normal APA format into their style. Many books and journals, including this one, adopt a streamlined format for quick and easy referencing. If the editors agree, these simpler styles can be followed.

Type of Source	Format	Example
Book Personal author(s)	"Author, A.A. (Year of Publication). Title of work. Publisher City, State: Publisher".	Srivastava,GS.(2014). Introduction to Geoinformatics. India: McGraw Hill Education Private Limited.
Book Author(s) and editor(s)	"Author, A.A. (Year of publication). Title of book. In Editor's First Initial. Last Name (Ed.). Place of publication: Publisher.	Bhuniya, GS., Chatterjee, U., Shit, PK.(2021). Modern Cartography Series. In: Bhuniya, GS., Chatterjee, U., Kashyap, A. and Shit, PK. India: Academic Press; 2021. pp 313-335
Chapter in a Book	"Author, AA, and Author, B. B. (1995). Title of chapter or entry. In A Editor, B. Editor, and C. Editor (Eds.), Title of book (pp. xxxxxx). Location: Publisher".	Bhuniya,GS., Chatterjee, U and Shit, PK.(2021). Land reclamation, management, and planning in coastal region: a geoinformatics approach. In: Bhuniya. GS, Chatterjee. U, Kashyap. A and Shit. PK (Eds). Modern Cartography Series. pp 313-335. India: Academic Press.
e-Book	"Author, A.A. (Year of Publication). Title of work [E-Reader Version]. Retrieved from http://xxxx or doi:xxxx"	Thrupp, M. and Willmott, R.(2003) EBOOK: Educational Management in Managerialist Times.[E-Reader] Retrieve from: https://www.google.co.in/books/edition/_/-jBEBgAAQBAJ?hl=en&gbpv=1&pg=PP1&dq=ebook
Journal article	"Author, A.A. Author, B. B., and Author, C. C. (year). Title of article. Title of journal, xx, pp-pp. doi:xx.xxxxxxxxxx"	Awange, J. and Kiema, JB. (2013).Environmental Geoinformatics. Berlin, Heidelberg: Springer Berlin Heidelberg. 254-300.doi. 10:978-3.
Journal articles on the internet	"Author, A.A. Author, B. B., and Author, C. C. (year). Title of article. Title of journal, xx, pp-pp. Retrieved from (give URL of	Mondal, M. S., Garg, R. D., Pandey, V., and Kappas, M. (2021). Route alignment planning for a new highway between two cities using Geoinformatics techniques. The Egyptian Journal of Remote Sensing and Space Science, 24(3), 595-607.

	journal homepage) *No retrieval date is needed.”	
Web page	“Author, A. (Date of publication). Title of work. Retrieved month day, year, from full URL”	Elements of a research problem. (April 9th, 2016). Retrieved from http://universalteacher.com/1/elements-of-a-researchproblem
Dissertation and master thesis	“Author, A. A. (Year). Title of doctoral dissertation or master’s thesis (Unpublished doctoral dissertation or master’s thesis). Name of Institution, Location”	Jaggi, G. (2008). A study of psychosocial aspects of happiness among adolescents. [Unpublished Doctoral Dissertation]. Panjab University: Chandigarh
Newspapers and popular magazines	“Author, A.A. (Year, Month Date of Publication). Article title. Newspaper Title, pp. xx-xx”	Singh, N. (2014, April 12). Well, meaning spirit. The Tribune, p. 11.
Conference paper (Unpublished paper)	“Author of Paper, A., and Author of Paper, B. (Year, Month Date). Title of paper. In A. Editor, B. Editor, and C. Editor. Title of Published Proceedings. Paper presented at Title of Conference: Subtitle of Conference, Location (inclusive page numbers). Place of publication: Publisher”	Sharma, N. and Kaur, S. (2011, March 26). Assessment of quality of life in non-working females. Anthropological and Psychological Approaches for a healthy society. Paper presented at Special Session of the section on Anthropological and Behavioral Sciences of Indian Science Congress, Chandigarh. Chandigarh: DST-Pursue Grant.
Government agency	Author Surname, First Initial. OR Government Name. Name of Government Agency. (Year).	U. S. Food and Drug Administration/Center for Drug Evaluation and Research. (2004). Worsening depression and suicidality in patients being treated with antidepressant medications: FDA public health advisory. Washington, DC: Author.

	Title: Subtitle (Report No. xxx [if available]). Place of Publication: Publisher	

Citing and Referencing Sources: Authors cite previously published material to back up their claims. Readers may choose to consult such publications for further information or to verify the author's use of the mentioned material. Citations and references must be clear and correct to help the reader. They are also easier to utilize if the style is constant. Most journals and editors have distinct preferences for how references are cited in the text and listed at the end of articles.

Citations: In today's scientific literature, there are three basic citation methods. There may be numerous variants within these systems. Name and year (sometimes known as author-date) number, with references in alphabetical order, are the primary systems.

Name and Year: Depending on the sentence construction, both or only the date may be enclosed in parenthesis. a few examples According to a recent study, the refereeing system is effective (Lock and Smith 1986). The refereeing system, according to Lock and Smith (1986), is effective. In the years leading up to 1984, manuscripts published in the BMJ received much more citations than either of the groups of rejected papers (Lock and Smith 1986, p. 312). A lowercase letter is appended to the date if there are multiple references with the same author(s) and year of publication. Lock and Smith (1986a), Lock and Smith (1986b), and so on. All cited references are listed in their entirety at the end of the paper. They are arranged alphabetically by the author's surname. If there are multiple authors, the name of the first author in the citation determines the alphabetical order. If two or more items by the same author(s) are found, they are ordered chronologically.

Number: The second system number references the order in which they appear in the text. The names of the author(s) may also be listed in some journals. Examples Scientific publications are intended to deliver information rather than to be read. Any significant departure from the norm is likely to make it difficult for the reader to comprehend the material (2). Even if it is quoted numerous times at widely spaced points, the cited work retains its number each time it is cited throughout the text. All of the cited sources are provided in numerical order at the end of the text.

Number with Alphabetical References: The third system incorporates the benefits of both systems. Previously used systems All references are listed in alphabetical order by author first. In that order, they are numbered. These numbers are used in the text for citations.

References: At the end of the paper, each reference must be described in depth. 'Literature Cited,' 'References Cited,' or simply 'References' are common headings for the list. Any references that aren't cited should be removed.

Articles: All authors' names and initials should be included in a reference to an article (however some journals will simply identify the senior author et al if there are several authors). name of the journal title and subtitle (usually abbreviated) if pages are not numbered consecutively across a volume, volume number first and last page number year of publication months or number of issues

Peer review at work, S. Lock and J. Smith, Scholarly Publishing 17: 303-16, 1986.

Books: Names and initials of all authors, title and subtitle, number of editions, if more than one, name and initials of editor or translator, if any, and place of publication should all be included in a book reference.

If there is more than one volume, page numbers must be expressly specified.

E.M. Stainton, 1982, for example. Working as an author and an editor. University of Toronto Press, Toronto, p.l7

Proceedings: References should be included in the proceedings of symposia, conferences, and workshops.

include-

Authors' names and initials

title of the paper

the volume editors' names and initials

symposium or conference title

Date and location of the meeting

publishing location

a publisher's name

the year the book was published

a specified amount of pages

Writing in the basic sciences, R. A. Day. J.T. Scott, K.F. Heumann, and L. Langlois, eds.

E.G., eds. Worldwide scholarly communication: proceedings of a joint global conference

The International Federation of Biology Editors' Council of Biology Editors hosted a conference.

Society for Scholarly Publishing, Scientific Editors' Associations: 15-20 May 1983:

Philadelphia. Society for Scholarly Publishing, Washington, DC, 1983: 33-4.

The titles of books and periodicals are italicized in some publications. The date is written in some cases.

like in the first two examples above, just after the author(s).

If there are only two or three authors, many publications mention all of their names. If there

There are more, however, they just list the senior author et al.

Punctuation has been reduced to a bare minimum in some journals, particularly in the health sciences. They have deleted the gap between authors' names and dropped the periods following their initials inside (thus Smith, J.L. becomes Smith JL).

The first and last page numbers of articles are given in some magazines. This aids the reader's navigation.

Obtain copies from the library service. It also informs the reader of the article's length.

Proceedings: References should be included in the proceedings of symposia, conferences, and workshops. include-

- Authors' names and initials
- title of the paper
- the volume editors' names and initials
- symposium or conference title
- Date and location of the meeting
- publishing location
- a publisher's name
- the year the book was published
- a specified amount of pages

Writing in the basic sciences, R. A. Day. J.T. Scott, K.F. Heumann, and L. Langlois, eds.
E.G., eds. Worldwide scholarly communication: proceedings of a joint global conference
The International Federation of Biology Editors' Council of Biology Editors hosted a conference.
Society for Scholarly Publishing, Scientific Editors' Associations: 15-20 May 1983:
Philadelphia. Society for Scholarly Publishing, Washington, DC, 1983: 33-4.
The titles of books and periodicals are italicized in some publications. The date is written in some cases.
like in the first two examples above, just after the author(s).
If there are only two or three authors, many publications mention all of their names. There are more, however, they just list the senior author et al.Punctuation has been reduced to a bare minimum in some journals, particularly in the health sciences. They have deleted the gap between authors' names and dropped the periods following their initials inside initials (thus Smith, J.L. becomes Smith JL). The first and last page numbers of articles are given in some magazines. This aids the reader's navigation. Obtain copies from the library service. It also informs the reader of the article's length.

Footnotes: In general, footnotes (notes at the bottom of the page) should be avoided. They disrupt the reader's flow of thought and raise publishing costs. Some journals provide footnotes with references.
However, in the sciences, this practice has almost vanished, and it appears to be declining in other fields. When using notes to cite references, grouping them at the end of an article or book is usually more cost-effective than inserting them one or two at a time at the bottom of each page. Footnotes are typically used to give information that the author believes is significant but would otherwise disrupt the flow of the discussion. An editor may usually find a way to include such notes into the body of the text by using parenthesis. A statement worth

making in the text is typically worth making. A superior number (1,2), a superior letter (a.b), or a symbol (*,+) are used to denote footnotes in the text. Footnotes should be typed separately from the manuscript pages, not at the bottom. They'll probably be typeset separately from the main text, and grouping them this way allows for more efficient typesetting. They should be double-spaced to make editing and setting them easier. Footnotes can be used to provide important information such as the author's address(es) (s).

Suggestions for Writing Report: True, writing is an innate ability that we are either born with or without. It is not necessary to be born with this gift; it can be studied and mastered. When viewed in this light, every one of us must start as an apprentice, acquiring tools and techniques, training, and finally honing our skills. This part is designed to provide basic training.

Writing a thesis or even a research article appears challenging as we prepare to begin. This is because it is a "challenging task." After completing a couple of chapters, the task will appear less intimidating. Towards the end, we may even find ourselves enjoying it, based on satisfaction in the accomplishment, pleasure in the progress of our technical writing, and, of course, the excitement of nearing the end. As with many other chores, writing often appears daunting before we begin; thus, let's examine how to get started.

It is generally advisable to create an outline first, consisting of several pages with chapter headers, subheadings, figure names (to indicate which results go where), and sometimes additional notes and comments. Once a list of chapters (and a relatively exhaustive list of items to be reported or explained under each chapter name) has been compiled, we begin writing. Remember that this is an initial draught that will require further adjustments. This first draught is referred to as a sloppy first draught or even a zero draught (the draft preceding the first draught; see Becker 1986 and Bolker 1998).

The objective of our typing should not be a thesis or a research paper, but something more straightforward. Our objective is to simply compose a paragraph or section for each of our subheadings. Some of us still find it difficult to begin on page one, especially at the outset, when we frequently do not know exactly what we are going to say. Therefore, it is usually best, to begin with, a simple assignment; this helps us develop the habit of writing and provides us with the confidence to continue. It doesn't matter if it's in the middle of page eight when the paper is complete; word processing software has erased that concern. Often, the easiest section to write is the Materials and Methods section, because this is the new thing that the researcher has done—she/he is the world authority on this. It is also possible to begin the literature review in the middle. The writing should be cautious, formal, and organized logically.

Most students who are new to research believe they have little leeway when writing their papers/theses, however, this is not the case. Writing a workable outline is one of the most crucial tools for taking ownership of the story the researcher is going to tell. How do we create a chapter outline? A similar outline could consist of notes and reminders. It is not written for another person, hence it need not be formal.

In actuality, the plan for this chapter consisted of only twenty-five short words or phrases intended to remind the writer of the topics to cover and to suggest an order for those themes. Materials within the outline are elective. Beginners may develop a more comprehensive outline. Assemble all the results/figures that will be utilized and arrange them in the desired order. One might as well practice expressing it to someone else since every researcher likely conducts multiple seminars based on their findings. Once the most logical sequence has been determined, record the explanation's important terms. These important terms serve as the framework for the majority of the chapter's outline. When the outline is complete, discuss it with your supervisor or mentor. This is a crucial step: not only will she/he receive helpful recommendations, but she/he will also be notified that a regular stream of chapter drafts will place high priority demands on her/his time. After supervisors have agreed upon a logical structure, writing can commence.

Setting up a filing system is a good idea that will help you out. Open a Word document for each chapter and a separate file for the references. These files can hold both text and notes. While working on something for Chapter n, we might think, "Oh, I need to talk about this in Chapter m," so we must make a note in the file for Chapter m to remind us to do so. Or, we might come up with something interesting or important to that chapter. Keep a copy of these files, and do this at least once a day. One could also use a physical filing system, like a bunch of folders with chapter numbers on them. This will make you feel good about getting started and also help you clean up your desk.

Not only will these files have graphs of the results and pages of calculations, but they will also have old notes, references, calibration curves, suppliers' addresses, specifications, guesses, letters from colleagues, and anything else that has to do with that chapter.

When writing a thesis, you should talk to your supervisor and make a schedule with dates for the first and second drafts of each chapter. This gives the time a structure and gives short-term goals. The schedule could be made into a chart with items. If we have to write two or three pages every day, it would be very helpful. If you miss a day, try to write twice as much the next day. Even though it's hard to stick to, this method is very helpful for getting an article, thesis, or book done on time. When all else fails, writing under pressure can be just what we need. As the minutes tick away until the deadline, we may find that we have to write something. Even though this isn't the best way to write well, almost every writer has found that it works. Even if a scholar starts her or his work a long time before the deadline, there may still be a lot to write when the deadline gets close. The results of research should be published quickly in peer-reviewed journals to avoid wasting time and to prove that the researcher was the first to make the discovery. This needs to be done well before writing the thesis. These journal articles do help a lot with forming a thesis and writing it.

We should always write something when we sit down to write. So write something, even if it's just a list of notes or a few paragraphs that no one else will see. It would be nice if clear, precise writing came easily from the keyboard, but it usually doesn't. Most of us find it easier to fix what has already been written than to write something new. So write a rough draught for your purposes, and then clean it up. Most of the time, supervisors read drafts of each chapter. She/he then sends it back with comments and suggestions.

No one should be upset if a chapter comes back covered in red ink, especially the first one. Supervisors want the thesis to be as good as possible, both for the scholar and for the supervisor's reputation. It takes a long time to learn how to write scientifically. Because of this, there will be many ways to make the first draught better. So keep a good attitude; each comment from the supervisor is a way to improve the thesis. Even for native English speakers who write well in other styles, there is a huge difference between the first drafts and the final chapters.

Academic writers use many of the same techniques that journalists and fiction writers do to get creative and show it, both to themselves as they write and to their readers as they read. Some people use metaphors and detailed language to help show how a scene, a place, or a person makes them feel. What matters most here is that we write in a way that feels natural to us. Many people who write research papers try to copy the formal style of most academic writing by using words that sound "harder" or more complicated and are often longer than "regular" words. Most of the time, new researchers make the mistake of taking not the best but the worst prose (Williams 1995). The text needs to make sense. The paper or thesis will be easier to read if it is written with good grammar, simple words, short sentences, and thought. Scientific writing has to be a bit more formal than writing for a newspaper or a textbook. Native English speakers should keep in mind that scientific English is a language used all over the world. A non-native speaker will find it harder to understand slang and informal writing.

Most of the time, it's better to use short, simple phrases and words than long ones. On the other hand, sometimes you need a complicated sentence because your idea is complicated. In many cases, you will also need to use some long, technical words. Sometimes it's easier to present information and arguments as a list of numbered points than as one or more long and awkward paragraphs. Most of the time, it's easier to write a list of points. One should be careful not to use this presentation too often: the thesis must be a connected, convincing argument, not just a list of facts and observations. One problem with academic writing is that, in our desire to "tell the facts," we may end up presenting those "facts" in a way that isn't very creative or even boring (DeLyser 2010). But, no matter how clear our evidence is, a research paper does a lot more than just list the "facts" about a topic. Even though research papers give facts, those facts are always coloured (to varying degrees) by the circumstances and the person doing the research and writing (Becker 1986). So, by its very nature, each research paper gives its author the chance to "tell the story"in many different ways.

The choice between the active voice and the passive voice is an important one in terms of style. Active voice is easier to understand than passive voice ("I classified the image") because it makes it clear what we did and what others did. Most technical communication teachers and authors shout for an active voice. "Sorting the wheat from the chaff (in the case of passive voice) can be hard, so a careful writer will stick to a simple and direct style that makes your ideas clear to readers and doesn't risk copying an embarrassing example of scholarly turgidity. Carefully read your writing out loud to yourself and listen for your voice. Try to see yourself in your writing, not someone else. (DeLyser 2010). Passive voice makes it easier to write sentences that don't make sense or aren't grammatically correct (Raman and Sharma 2004). "Watch out for dangling participles if you use the passive voice" (Raman and Sharma 2004). People avoid active voice in a thesis or scientific writing, though, for two reasons: 1) most scientific writings are written in the passive voice, and 2) some journal editors and teachers won't accept papers or theses written in the active voice. Also, if you use the active voice, you usually don't use "I" or "you" in the first person singular or second person singular or plural. This is because "I" and "you" are seen as rude. Look at this sentence: "As you can see, most of this book was written in passive voice. When using active voice, first-person singular and second-person singular/plural were avoided." (As you can see, I wrote most of this book in passive voice and avoided first person singular and second person singular/plural when using active voice.) Even though the second option is easier, clearer, and more effective, is it good enough for a formal scientific paper? But it's fine to use active voice, first-person singular, and second person singular or plural when talking about work you did yourself.

The way things are put together is also important. In general, students spend too much time on things like diagrams, font styles, decorations, etc., when they could be looking at the arguments, making the explanations clearer, thinking more about what they mean, and checking the algebra for mistakes. The reason is obvious: it's easier to decorate than to think. The decoration is not needed at all in scientific writing. Instead, it should be clean and straightforward, like a journal article. The examiner or reader might not take your writing seriously if it is too flowery. The length comes next. There isn't a strong link between how long something is and how good it is. Don't leave big gaps just to make the thesis longer. Also, readers won't like a lot of text that is vague or not necessary. In general, high volume makes the reader want to stop reading.

Lastly, the arguments are the most important part. When you don't think about writing, the word "argument" makes you think of a fight or disagreement. In academic writing, however, arguments are the key to a good research paper or thesis. Each research paper or thesis makes an argument: it makes a case and backs it up with evidence. Some academic arguments (called polemics) are strong and can feel like a fight. For example, they might take on the work of another scholar and show why it is wrong. But other arguments can be much more subtle or complicated.

A good research paper might even make an argument that shows more than one side of a problem. The argument might be that each side is valid and has its good points.

We have to find and put together evidence to back up our chosen argument, whether it's statistics, tables, or references to published works. We should try to leave out evidence that seems to go against our arguments. We might be able to make our arguments stronger if we include and answer such claims. Even when we try hard to explain and talk about everything we need to, we may find that our argument has gotten off track. If that's the case, you might want to move the parts of the argument that go in different directions to one or more endnotes or footnotes.

Once the writing is finished, it's best to put it away for a while—a few days, a few weeks, or even a few months. Don't worry about anything. Then start making changes. Real revisions involve a lot more than just running a spellchecker. The point of revision isn't just to fix mistakes but to make things better. It is very important to polish your language, style, arguments, and structure. Remember that there is still room to do something, such as adding a new argument, figure, table, etc. It is important to proofread every word on every page very carefully as if you were listening to each one. Reading the paper out loud is often a good way to find small mistakes. Some parts of the paper or thesis, especially the introduction and conclusion, are often better read by someone other than the author(s). It might also be a good idea to ask friends to read parts of the paper or thesis that they might find interesting or relevant. They might be able to add something useful. In either case, only give them revised versions so they don't have to waste time fixing the grammar, spelling, poor construction, or presentation.

When you look back at this section, you might notice that writing is "very" hard and boring. Writing is indeed hard, especially for new researchers, but it is not "so" hard. Also, it is not at all boring. Writing is a formative process in and of itself. We come up with, build, and develop our ideas as we write. Our ideas come to us and change as we write. These ideas, along with the final paper or thesis, are a result not only of the data that is "out there," but also of how we found that data, how we approached the topic, and even who we are (writing gives the appearance and importance of the author). So, "the process of writing a research paper should be thought of as part of the research itself" (De Lyser 2010).

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CONCLUSION

GIS is a data and information integrator. One of the GIS's main advantages is its geographical analysis and exploration. Base maps at any geographic size can be linked to data at any scale and often at many scales. Data from a countywide study, for example, could be aggregated to a regional or statewide level later. Statistics' spatial patterns and distributions can assist explain otherwise invisible relationships.

We can use GIS to combine and query current data, but we can also create and store new data. GIS is a powerful analytical tool when used together.

Finally, GIS provides visual and numerical output options. This book is provided numerous studying like project objectives and define critical concepts and parameters for a study question, helps the learners to define research objectives, research methods and techniques, helps in to define the purpose of the research, types of data, kind of information required, sample designing, data collection, processing and analysis of the data, report writing and interpretation. Exported data are utilized for additional analysis in statistical software or discipline-specific modelling and may include final deliverables like maps, tables, and graphs. External packages can then feed their results back into ArcGIS as new datasets for use in further analysis and mapping. Do not try to impress the audience with excellent technology or data-loaded maps rendered in forty-seven hues of chartreuse with twelve distinct fonts merely to impress them.

TERMINAL QUESTIONS

1. Explain the meaning and scope of research?
2. Discuss the basic structure of a research report?
3. What is hypothesis? Explain the importance of hypothesis?
4. Explain questionnaire as a tool for data collection. Mention its advantages.
5. Select a suitable research topic on GIS. State different steps of doing the research by the descriptive method.
6. Give an account of the basic structure of a research report.
7. What is a research project? Throw light on the importance of conducting a research project?
8. Discuss various steps involved in research?
9. Write an essay on qualitative research.
10. Select a suitable research topic on remote sensing. State different steps of doing the research by the descriptive method.
11. Explain how to overcome with the project management issues?
12. Explain the detailed project report (DPR)?
13. How to prepared a research paper? Explain criteria tools and techniques of a good research?
14. Write an essay on project formulation?
15. Write the significance of project formulation?
16. Explain how to overcome with the project management challenges?
17. Explain Standard Operating Procedure (SOP)?
18. Which of the methodologies have you used in your projects?

19. What is Project Planning? Discuss in detail.
20. Write the elements of project formulation?
21. Write a short note on data collection?
22. Why do we need for research?
23. Write the characteristics of good hypothesis.
24. Write the importance of conducting project.
25. Write the concept of sample in research.
26. Discuss the concept and sources of literature review?
27. Write a short note on research components.
28. Why acknowledgement is important?
29. Discuss the importance of selecting research problem.
30. Write the short note on the following:
    Research proposal writing
    Developing a questionnaire
31. Why is review of literature important in educational research?
32. What is experimental research? Explain with an example.
33. Highlight the advantages and principles of hypothesis.
34. Define sampling?
35. Define title page?
36. Briefly explain APA style essentials.
37. What do you understand by project?
38. Define innovative project?
39. Briefly explain literature survey?
40. Write a short note on synopsis?
41. Define flow charts?
42. Define ISBN number?
43. Write a short note on references?
44. What do you understand by abstract?
45. Define project formulation?
46. What do you understand by formal project?
47. Briefly explain field survey?
48. Write a short note on research paper?
49. What do you understand by programme flow chart?
50. Define impact factor?
51. Define ISSN number?
52. Write a short note on citations?
53. What is the purpose of the research?
54. Where will the research be conducted?
55. What kind of information is required in research?
56. For how long will the research be conducted?
57. How will the sample design be created?
58. What data gathering procedures will be used in research?
59. What method will be used to analyze the data?
60. What format will the report be written in?