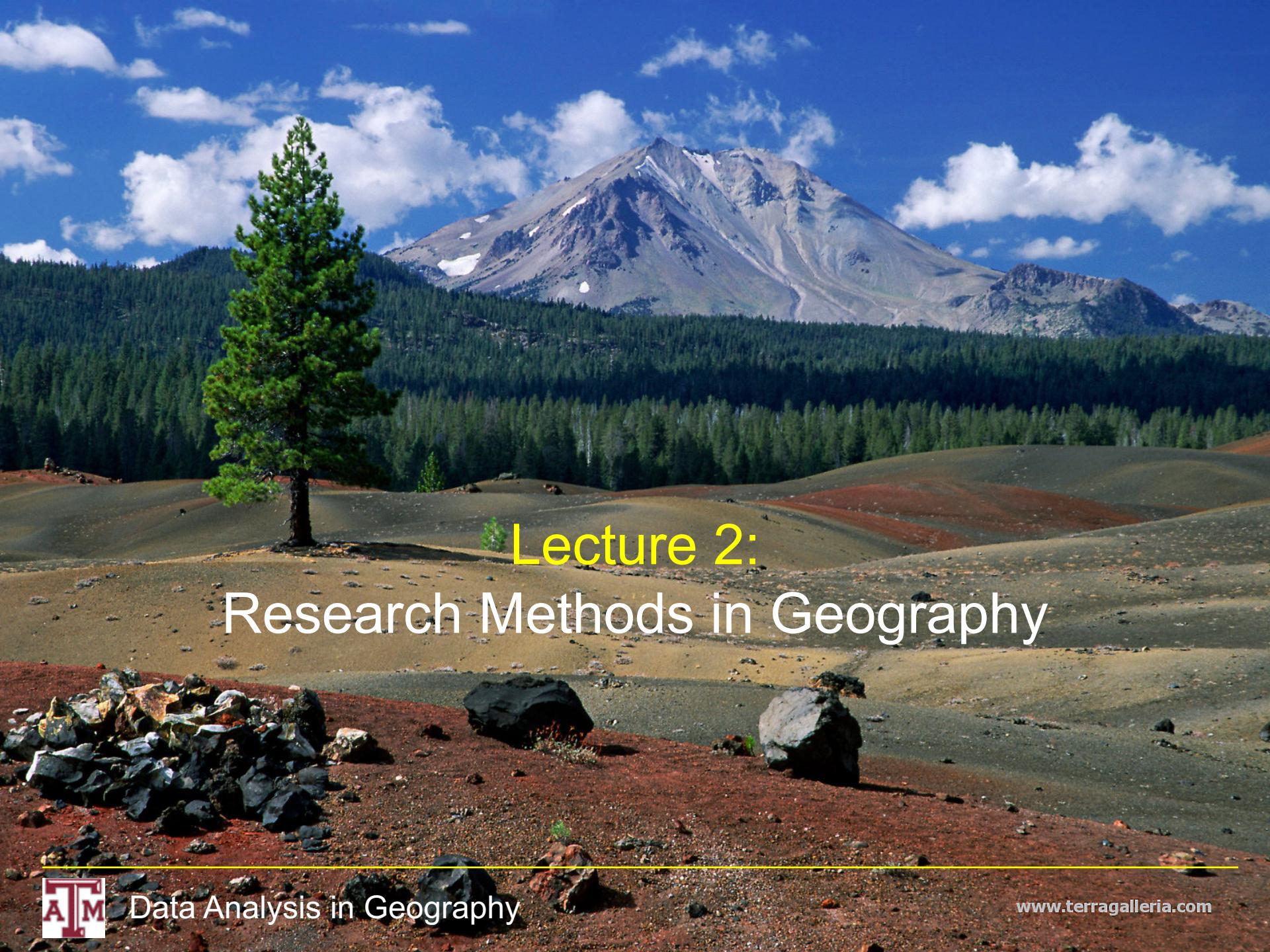


Announcements

1. Class is canceled next Tuesday, Jan 29th
2. Homework #0 is due next Thursday, Jan 24th. Find it on eCampus (under Assignments)
Readings are also posted on eCampus (under Course Materials)
3. The National Geospatial-Intelligence Agency (NGA) will be on campus recruiting on Wednesday, Jan 23rd:

Where	GEOSAT Center, Rm 807 O&M Bldg.
When:	Wednesday, January 23, 2019
Time:	3:30pm - 4:00pm – Information Session
Time:	4:00pm – 5:30pm – Resume Reviews / Meet & Greet
Time:	5:30pm -6:00pm – Information Session
Time:	6:00pm – 6:30pm – Closeout – Resume Reviews





Lecture 2: Research Methods in Geography

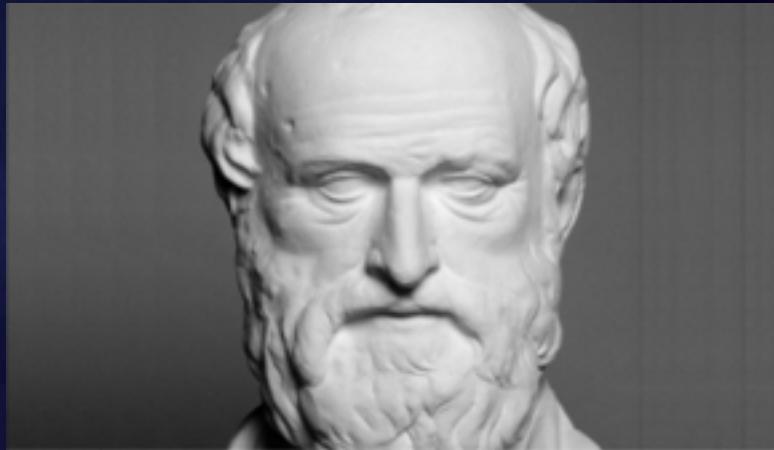


Data Analysis in Geography

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Geographic Research

- Literal translation of geography is “to describe or write about the earth”
 - Eratosthenes (276-194 BC)
- Modern geography seeks to understand the complexities of the natural and social environment
- Where?
 - Where does this occur?
- How and why?
 - How and why did this develop and change?
- What?
 - What conditions are necessary?



Eratosthenes

Geographic Research

- Developing a better understanding of the world around us through research is one of the most exciting parts of science
- The development of a scientific research project occurs with four basic steps:
 - assess existing knowledge
 - generate research ideas
 - design and execute research
 - interpret resulting data
- The results and conclusions of your study are only as strong as the methodology on which they developed

WHY DO RESEARCH?

Exploration

To investigate phenomena
To identify important variables
To generate research questions

Explanation

To explain a phenomenon
To explain why the phenomenon has particular characteristics

Description

To document and characterize a phenomenon

Understanding

To comprehend and understand process, interaction, phenomenon and people

Prediction

To predict future outcomes



Empirical Science

- Geography is an empirical science that is defined by the following principles:
 - *Empirical verification*: Observations are verified through measurement.
 - “Revealed truths” (because someone said so) are not a part of science.
 - *Operational definition*: Phenomenon must have a defined scale and form that can be measured.
 - Focus is placed on the practical and possible.
 - *Controlled observations*: Care is taken to isolate the experiment and remove confusing interactions and controls.



High Quality Research

- **Based on the work of others:** how have others done similar work and how can you improve on their work
- **Tied to theory:** questions are derived from theory and are used to help solve a problem with the theory/understanding
- **Can be replicated:** can be followed by someone else in a different place or time
- **Generalizable to other settings:** not tied to a specific time and place- too specific and unique
- **Generates new questions:** science is an ongoing process of search and discovery
- **Incremental:** completed in small simple pieces that are feasible in time, ability and money



Steps to Research

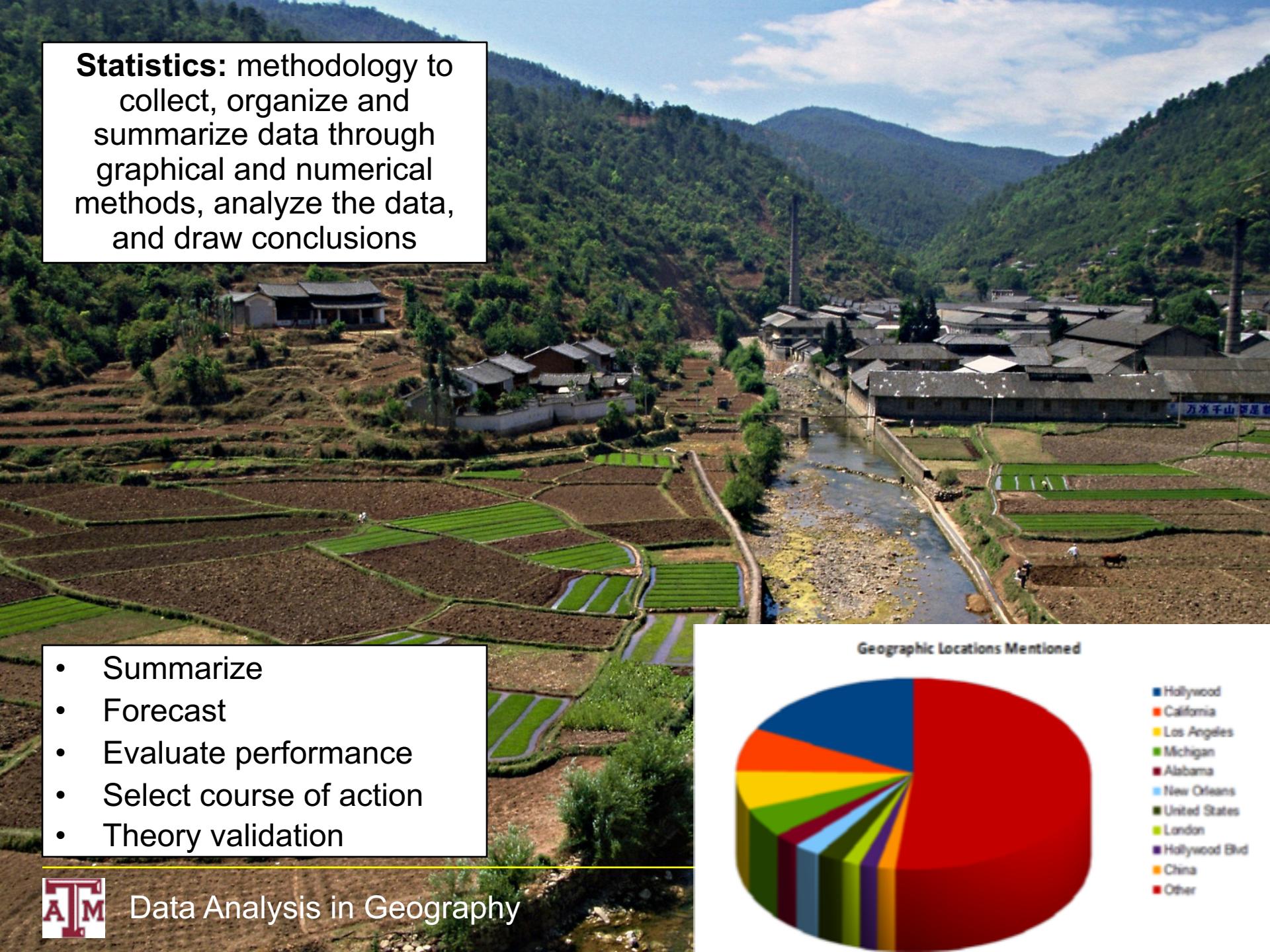
- Formulate the research problem
 - Ask question in a precise, testable manner
- Define the hypotheses
 - Statement of your assumptions
- Determine the type of data required
 - How much, when and where
- Collect the appropriate data
 - Based on pre-defined methodology using accepted tools and techniques
- Analysis
 - Selective appropriate statistical techniques
- State Conclusions
 - Results of study based only on presented findings

Not a linear process

The statistics that are most appropriate for testing the hypotheses should guide your methodology

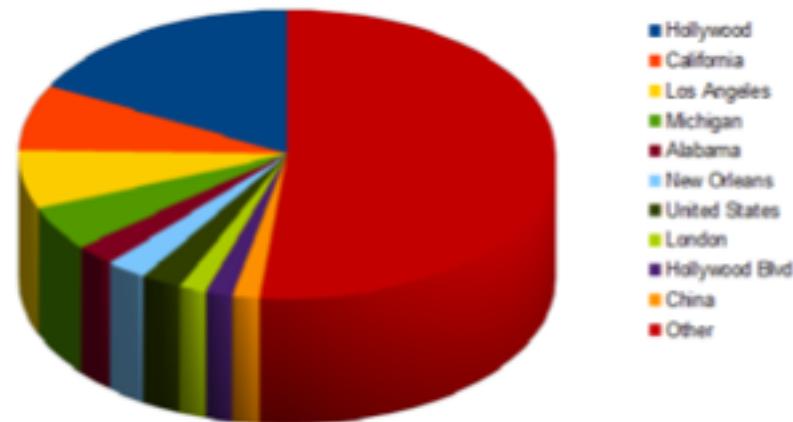
The statistics define the quantity, quality and type of data that you need to collect

Statistics: methodology to collect, organize and summarize data through graphical and numerical methods, analyze the data, and draw conclusions

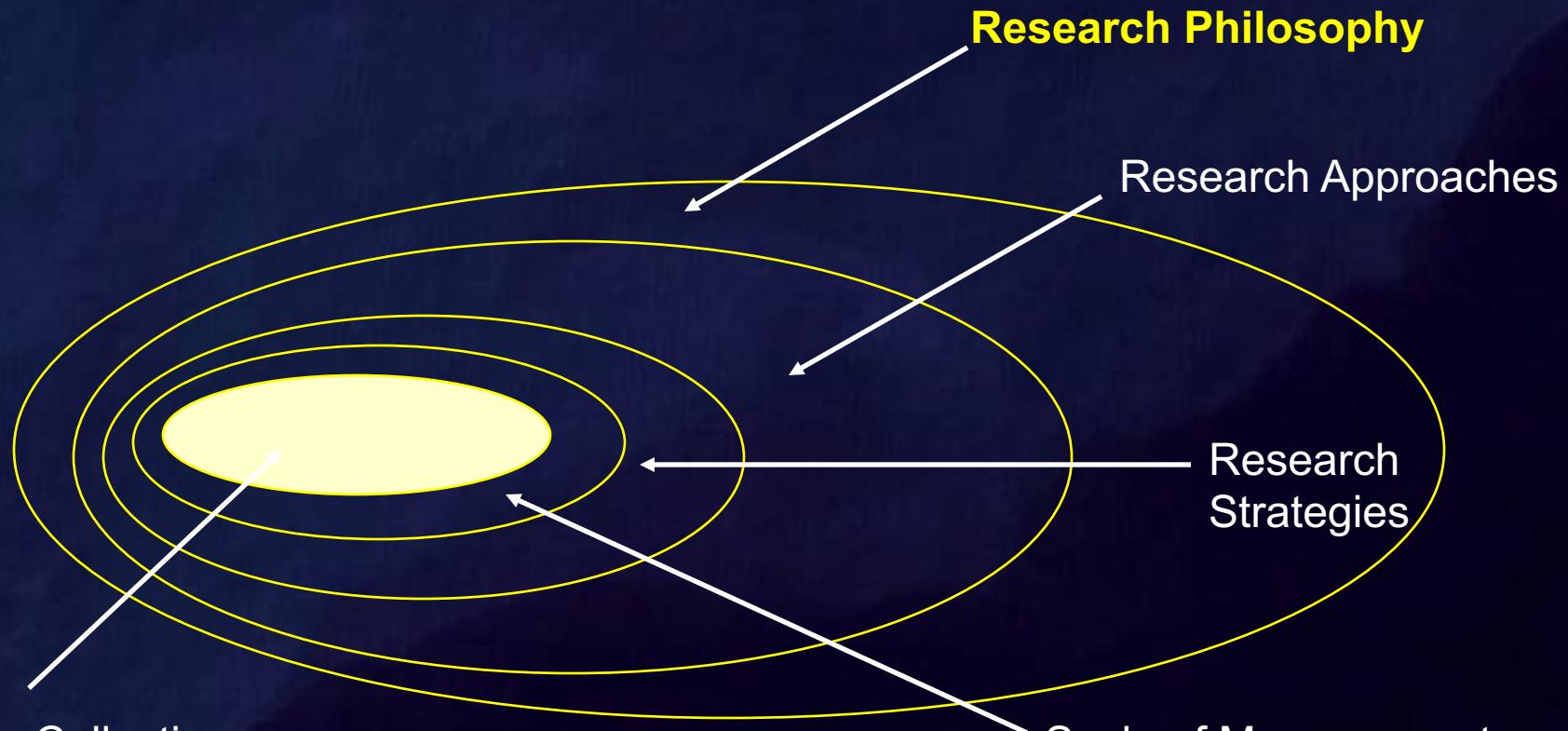


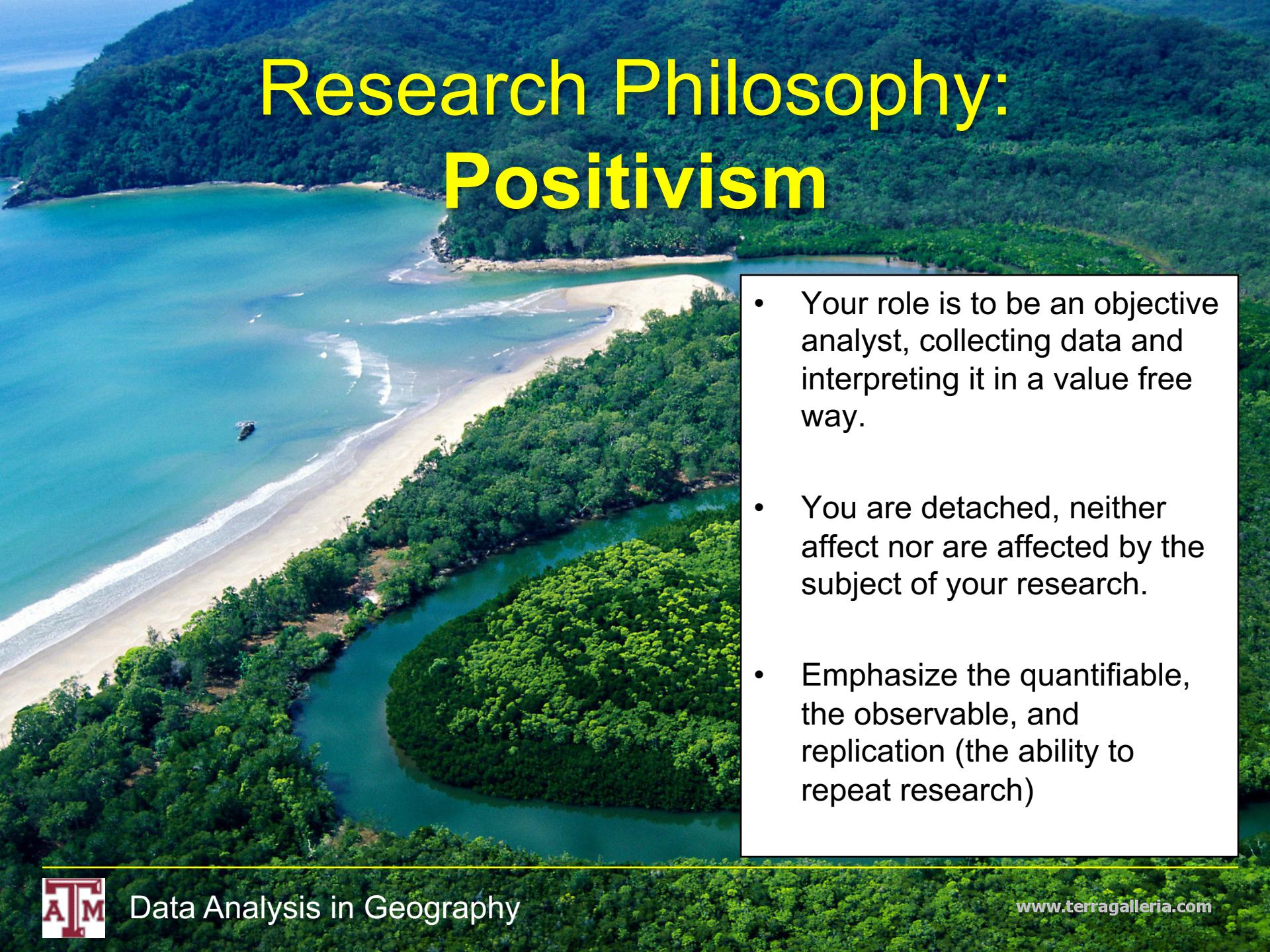
- Summarize
- Forecast
- Evaluate performance
- Select course of action
- Theory validation

Geographic Locations Mentioned



The research process ‘onion’





Research Philosophy: Positivism

- Your role is to be an objective analyst, collecting data and interpreting it in a value free way.
- You are detached, neither affect nor are affected by the subject of your research.
- Emphasize the quantifiable, the observable, and replication (the ability to repeat research)

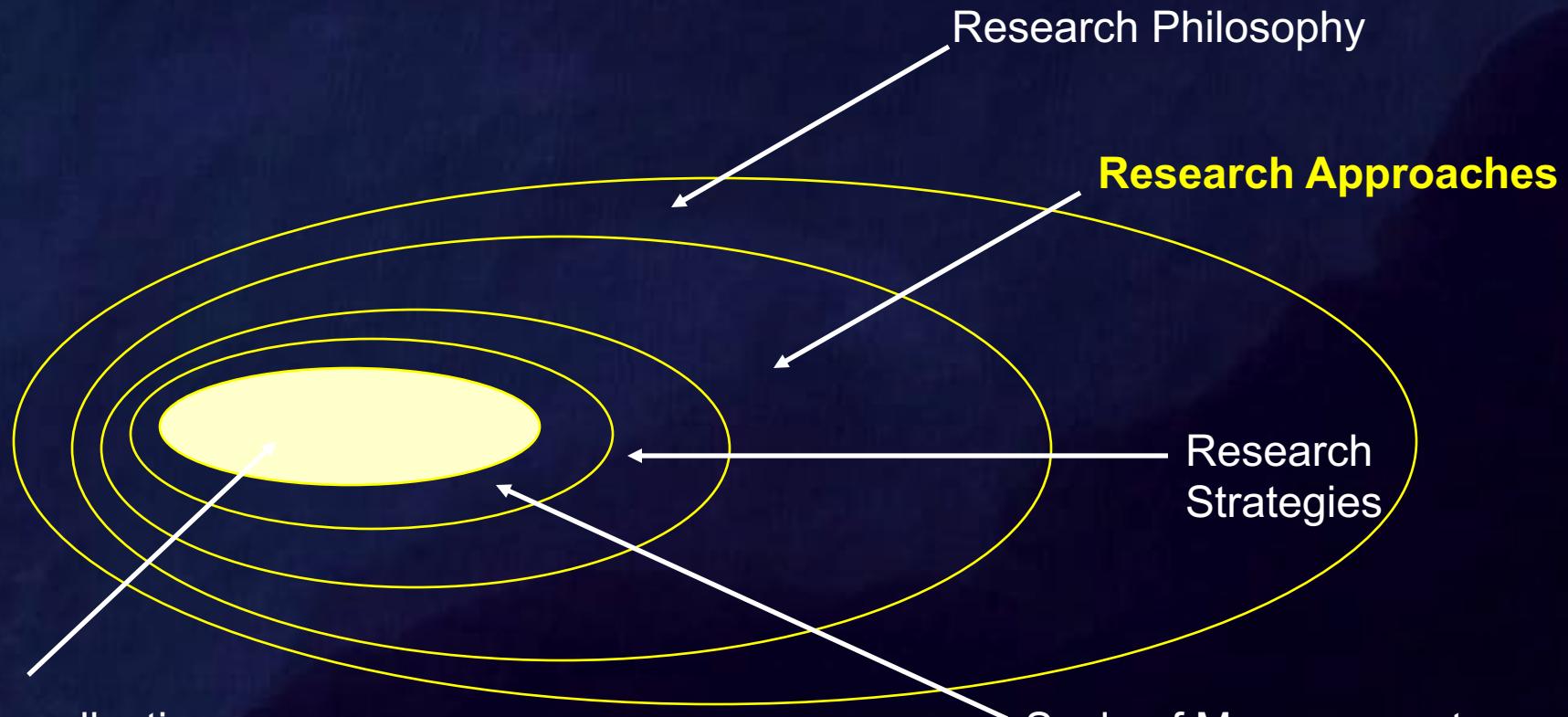


Research Philosophy: Phenomenology

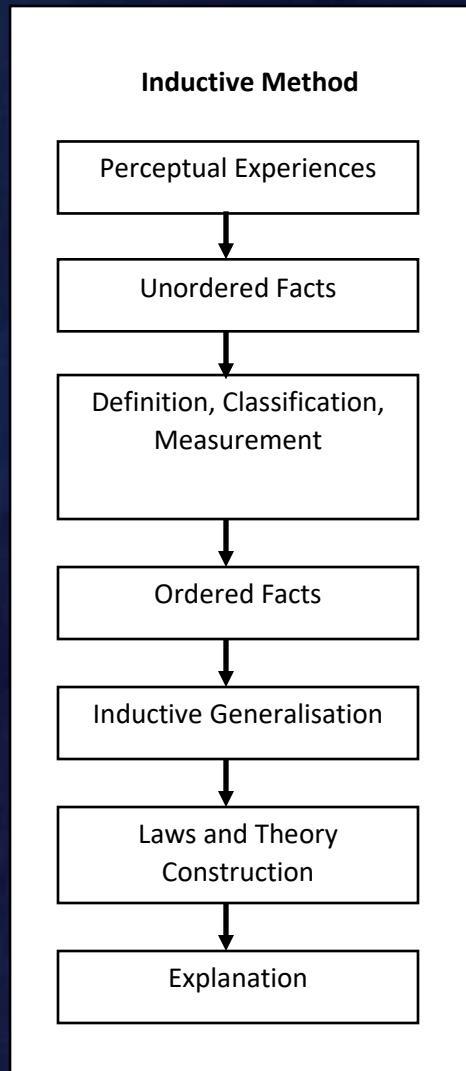


- The world is too complex to be reduced to a series of law-like generalisations.
- Uniqueness of people, and circumstances and the constant nature of change
- Details matter - in an attempt to dig into deeper layers of reality.
- Subjective reality matters.

The research process ‘onion’

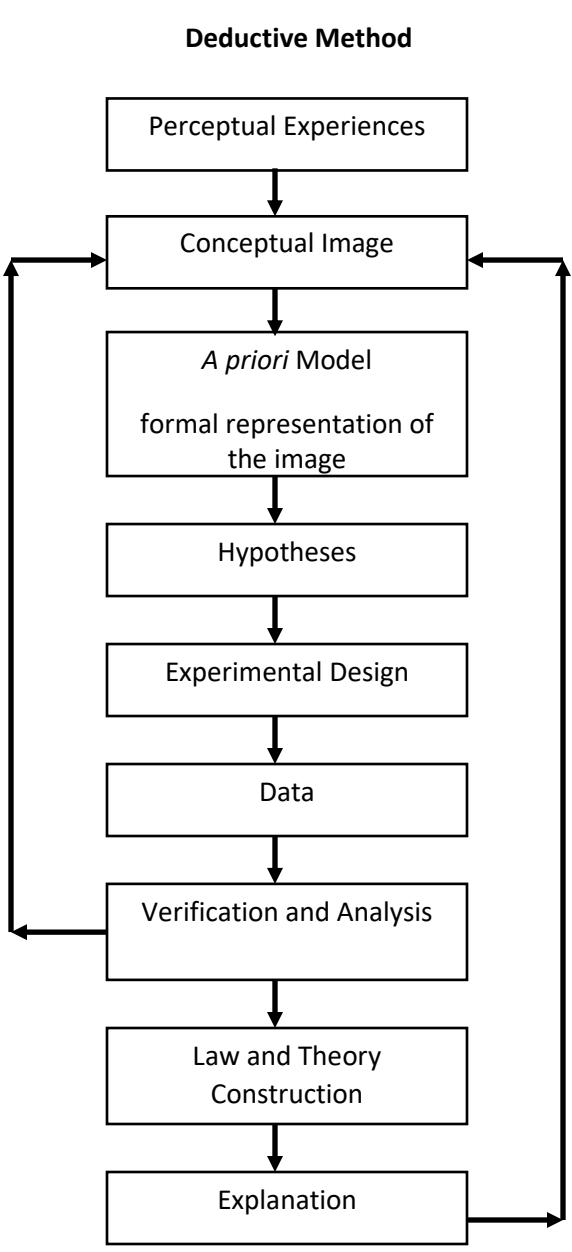


Research Approaches: Induction



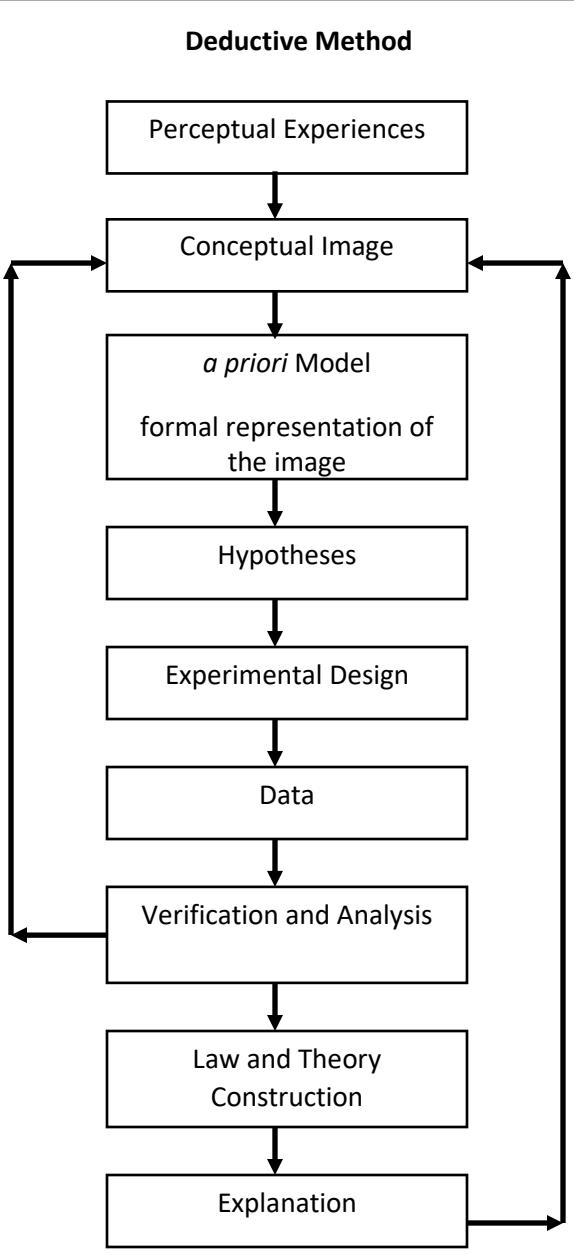
- Example: “*Every raven ever seen was black, therefore all ravens are black*”
- Argument through which general statements are derived from particular ones
- Truth of premises provides a reasonable basis for belief in a conclusion

Research Approaches: Deduction



- Example: “All dogs are animals; this is a dog; therefore this is an animal”
- Derivation of a particular truth from a general statement
- Inference through which some premises and propositions are taken as basic and all other propositions are seen as logically following
- Truth of the conclusion is dependent only on the method

Research Approaches: Deduction



- General statement is in essence a model of how you believe the world works
- Good Models
 - Accurate reflection of the world
 - Clear and concise
 - Predicts past and future events
 - Practical guidance in problem solving
 - Internally consistent
 - Few unproven assumptions
 - Can be disproven
 - Convincing evidentiary support
 - Can accommodate new ideas
 - Provides reasonable answers
 - Stimulates new techniques and ideas
 - *Plays to the camera*

Research Approaches: Deduction

- The search for knowledge does not start from observations or the collection of data or facts but from problems
- Problems arise from the discovery that something is not in order with our supposed **knowledge** - our theories and expectations do not agree with one another or they do not agree with our observations
- It is only through a problem that we become conscious of holding a theory. **It is the problem that encourages us to learn, to advance our knowledge, to experiment and to observe**



Research Approaches: Abduction

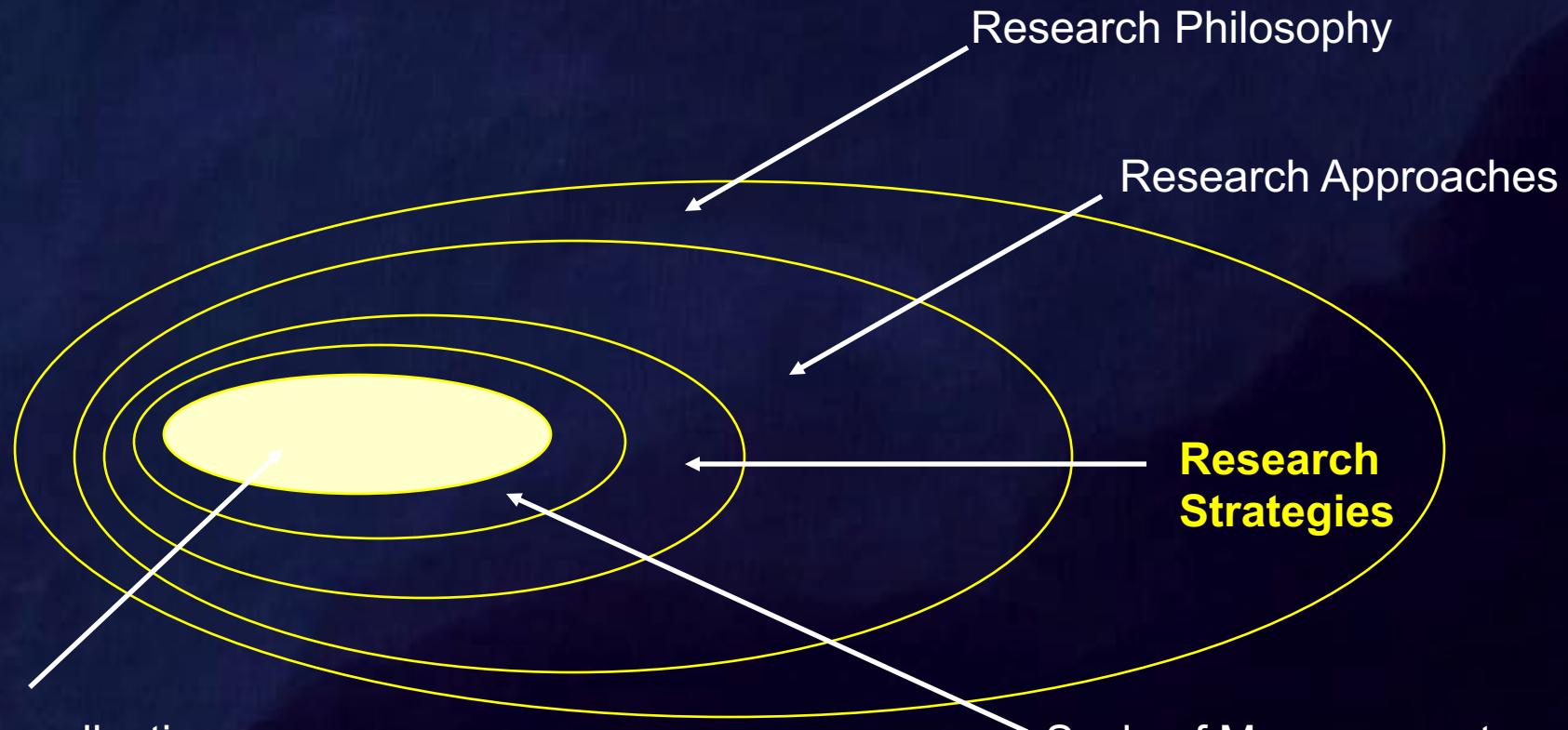


- Starts with an observation then seeks to find the simplest and most likely explanation for the observation.
- Yields a plausible conclusion but does not positively verify it

Examples

- Bill Gates is rich. Therefore, Bill Gates owns Fort Knox.
- If I have the flu, then I have a sore throat. I have a sore throat. Therefore, I have the flu.
- If the grass is wet the most probable explanation is that it recently rained.

The research process ‘onion’



Research Strategies

- **Exploratory Research:** gather information to further develop a research question or to establish priorities for further research
 - Literature search, surveys, analysis of selected cases
- **Descriptive Research:** describe the characteristics of a certain group, sample or population (not answering how/when/why)
- **Causal Research:** Field or laboratory experiments to define the causal relationship between variables
- **Distinctions are not very clear-** most research is based on some combination of these approaches

Cycle of Research

Exploratory research is often the result of unexpected results in causal research or variability in descriptive research

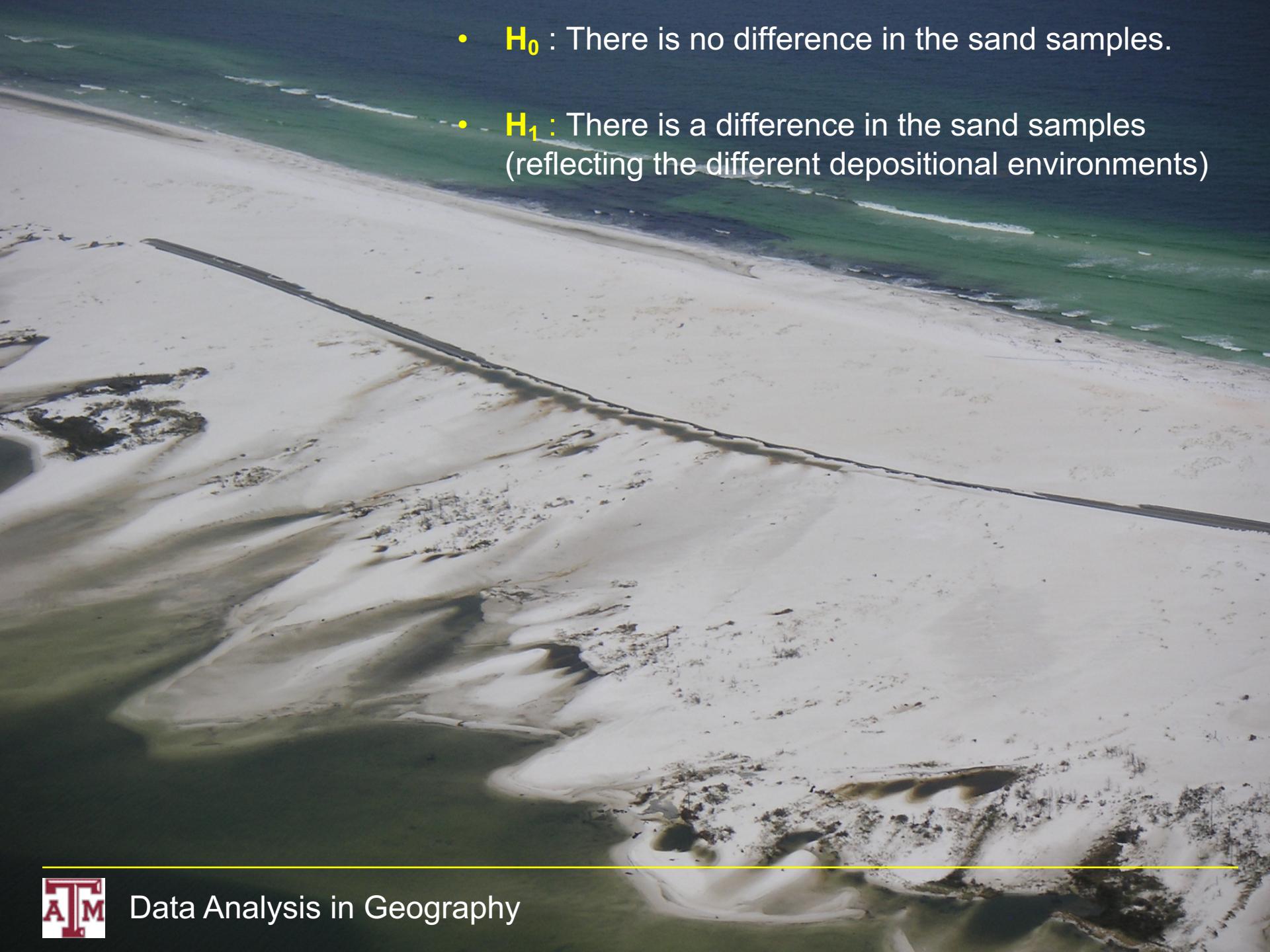


Hypotheses

- Tentative assumption (the general model) that is made for the purpose of empirical scientific testing
- Becomes a theory of science when repeated testing produces the same conclusion
- According to Popper (1959), we cannot conclusively affirm a hypothesis, but we can conclusively negate it
- Null hypothesis (H_0): the opposite of your assumption
- Alternate hypothesis (H_1): your assumption

- H_0 : There is no difference in precipitation levels between urban and adjacent rural areas
- H_1 : There is an increase in precipitation levels in urban areas relative to adjacent rural areas (because of the heating differences of the two surface types)



- 
- H_0 : There is no difference in the sand samples.
 - H_1 : There is a difference in the sand samples
(reflecting the different depositional environments)



- H_0 : There is no difference in the height of boys and girls
- H_1 : There is a difference in the height of boys and girls

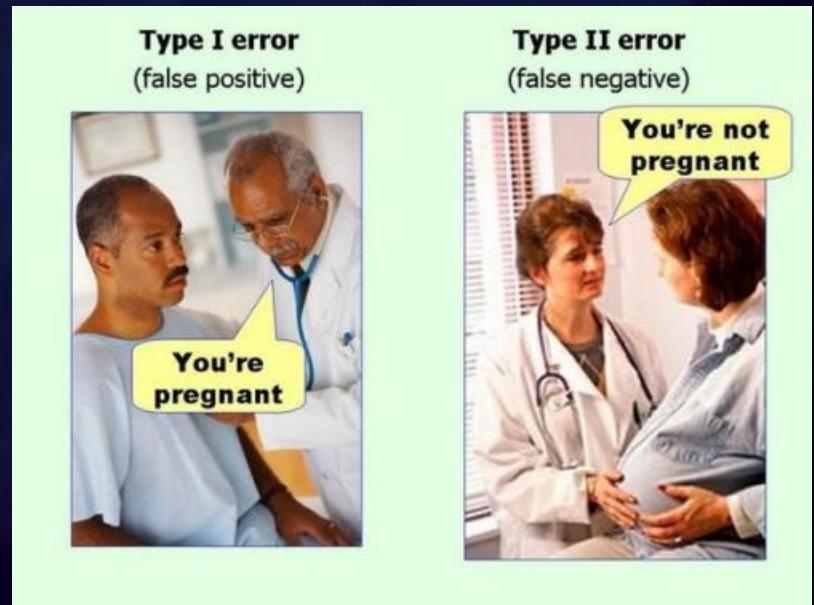


Error

- Statistical error: caused by inherently unpredictable fluctuations in the measurement apparatus
- Systematic error: caused by non-random fluctuations from an unknown source
- Can be caused by carelessness or lack of attention to scale and population

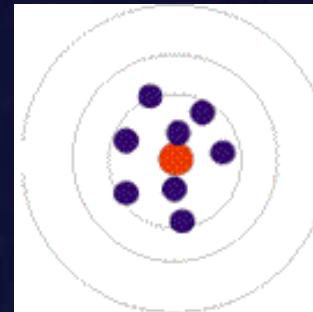
Error

- **Type I Error:** A decision is made to reject the null hypothesis when it is true
 - False positive
- **Type II Error:** A decision is made to accept the null hypothesis when it is false
 - False negative

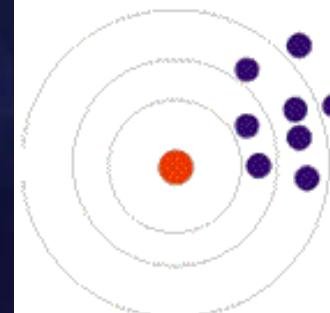


Accuracy and Precision

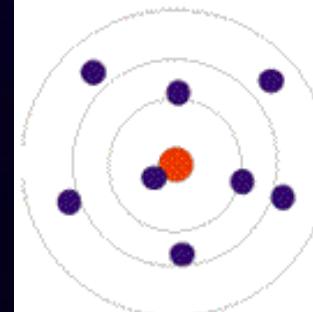
- **Accuracy:** amount by which a measurement or quantity differs from the actual, real-world value it represents
- **Precision:** Repeatability of measurements
- Each form of measurement and tool is inaccurate and imprecise to varying degrees



This grouping of dart throws is both precise and accurate.

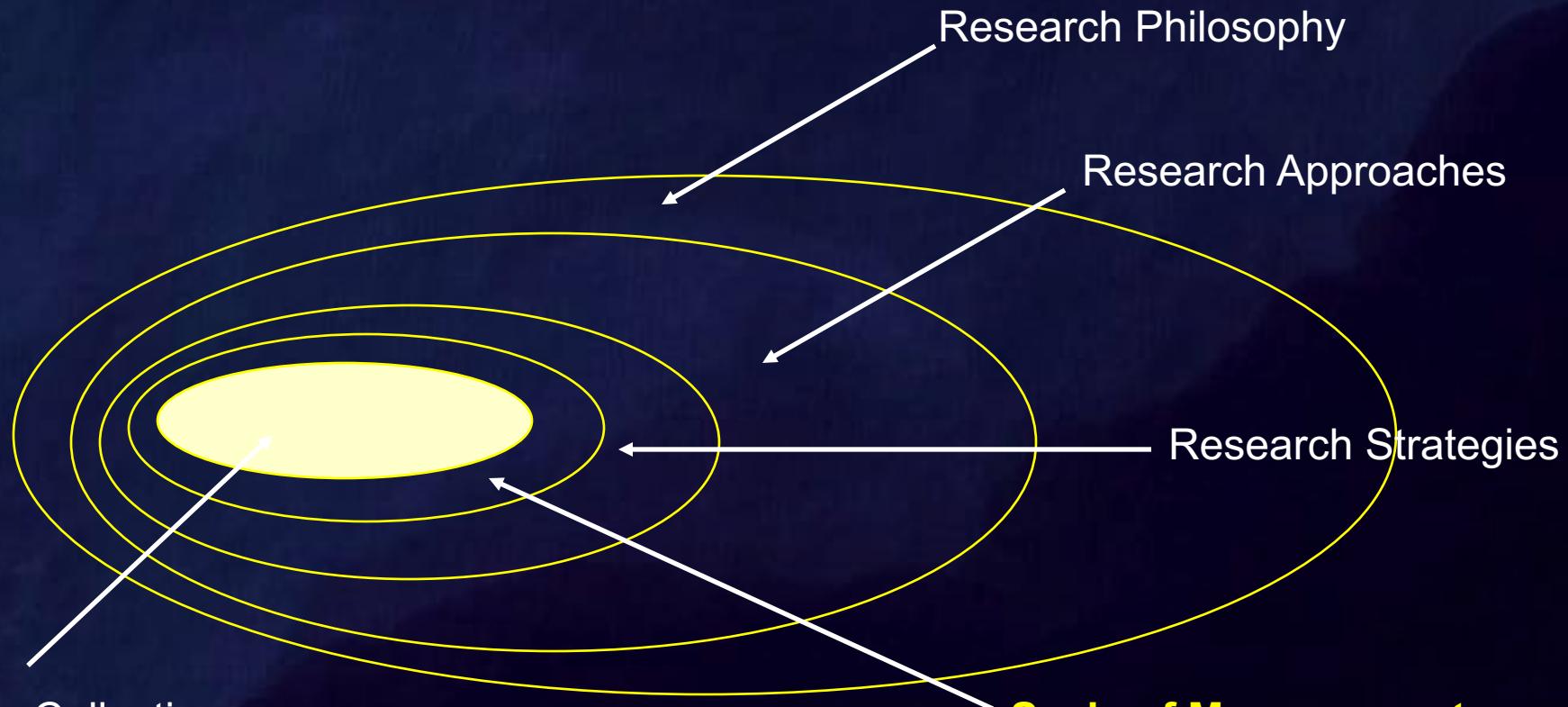


This grouping is precise and inaccurate.



This group of dart throws is imprecise but it is accurate. Its center of gravity falls close to the bulls-eye.

The research process ‘onion’



Validity

- “**Validity**...tells us whether an item measures or describes what it is supposed to measure or describe.
- If an item is unreliable, then it must also lack validity, but a reliable item is not necessarily also valid.
- It could produce the same or similar responses on all occasions, **but not be measuring what it is supposed to measure.**

External validity. A large number of studies in geography are focused on unique places and events

Internal validity. Many studies deal with complex systems with multiple interacting processes, making it difficult to complete a controlled experiment

Construct validity. Research results depend on the instrumentation, sampling and analysis techniques used





Ways to be Wrong

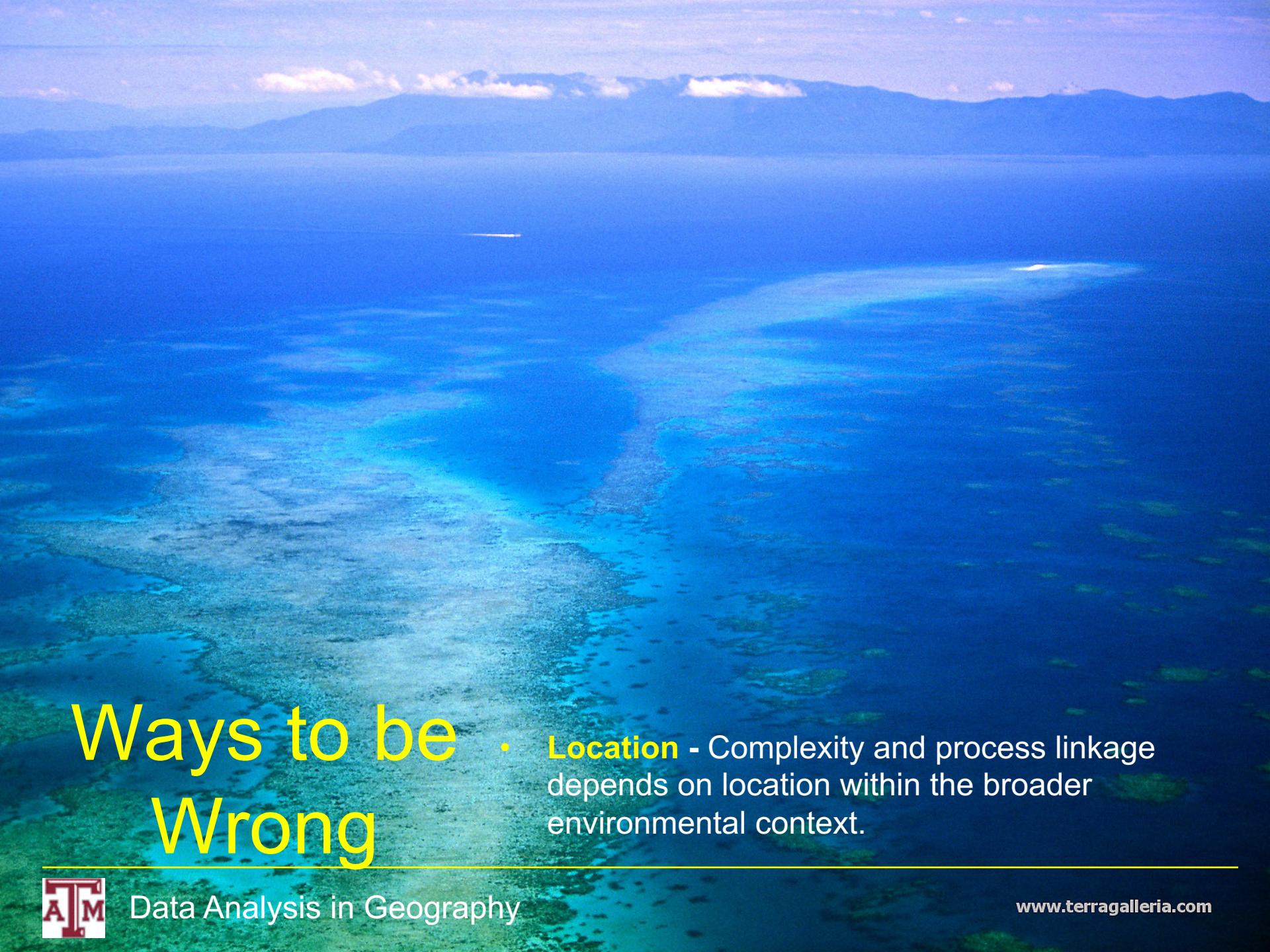
- **Temporal Scale** - Physical systems operate over varying time spans- the perception of a system depends on the time span studied. Limited sampling time relative to relevant processes and evolution



Ways to be Wrong

- **Spatial Scale** - Complexity of the subject will increase as size increases (small to large) and as scale becomes larger (low to high resolution).





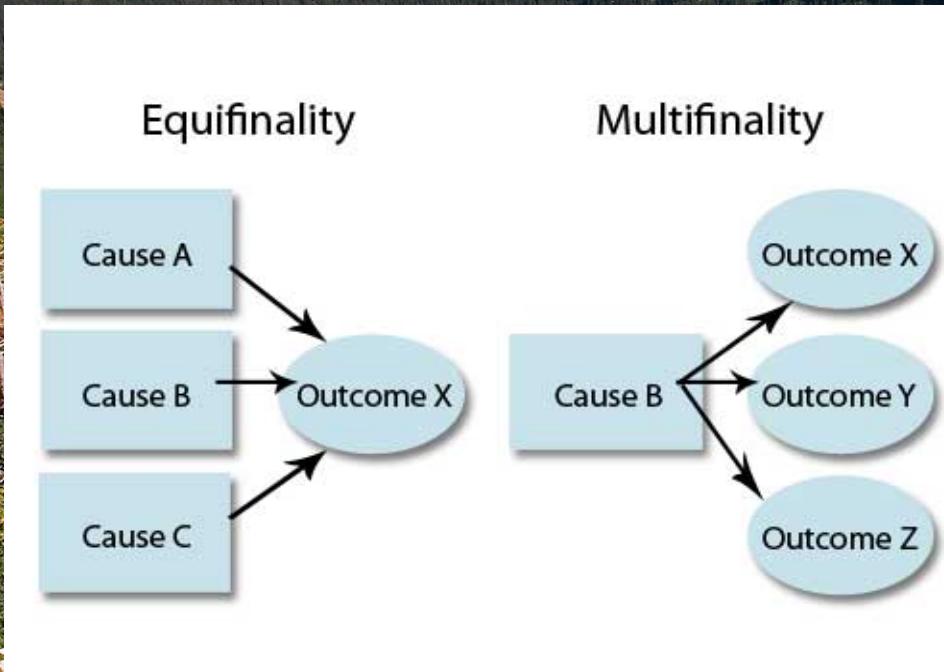
Ways to be Wrong

• **Location** - Complexity and process linkage depends on location within the broader environmental context.



Ways to be Wrong

- **Equifinality** - If different causes or processes produce similar effects then the use of analogy breaks down. Difficult to infer processes and cause from effect- may commit *genetic fallacy*.



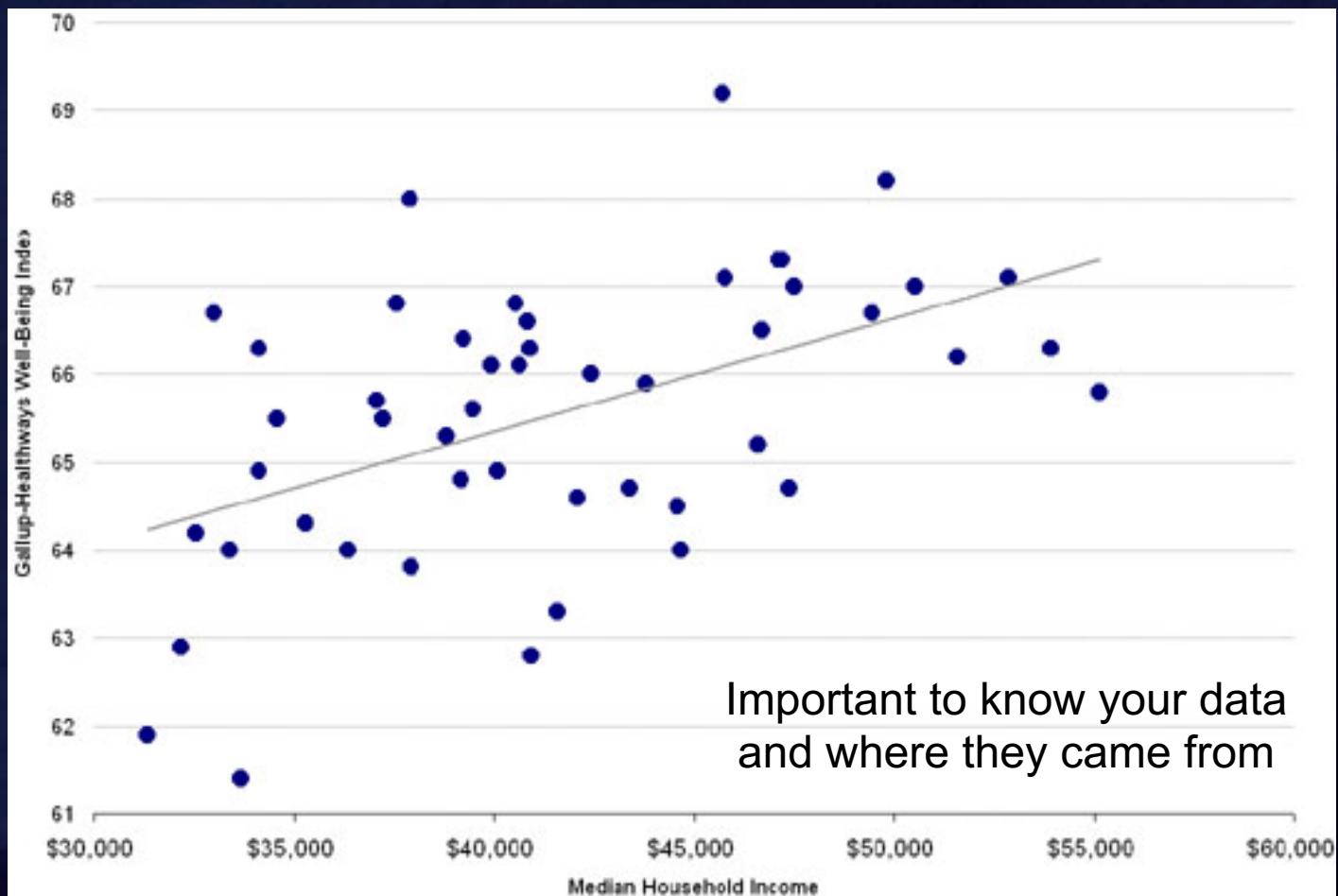
Ways to be Wrong

- **Multiplicity** - When dealing with complex systems, single explanations in most cases will not be sufficient (composite hypothesis)



Ways to be Wrong

- Singularity - There are no natural kinds- geography becomes an ideographic science.





Let's open up R!



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