MSc Research Skills

Lecture: Research methods

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Topic: Selecting research methods

Recall: At this point the research has been structured as:

1. Social, contextual problems
2. Research **problems**
3. Research **objectives**
4. Research **questions**, several per objective
5. Research **hypotheses** for each question
6. Research **assumptions**, not to be tested

The next step is to select **research methods** to answer the questions.

Research methods

Choose methods to **answer** the research questions; for each method state:

1. Either:

   (a) the **name** of the method that was chosen, with a **reference** to the literature that describes it; *or*
   (b) a **detailed description** of the method, if it is being developed as part of this project;

   In both cases the method must be described in sufficient detail (either here or in the references) for someone else to be able to apply it.

2. The **materials** necessary to apply the method;

   - Field equipment, lab. supplies, computer programs . . .

   (continued . . .)

Research methods (2/2)

3. **Why** this method was chosen:

   (a) Why is it **applicable** in this study?
   (b) Why is it **preferred** to other methods that could have been applied?
   (c) What are the **assumptions** for applying this method, and how are they met in this study?

Sequence of methods : 1 (with fieldwork)

The order in which methods are described should be logical; often they follow the **time sequence** of the research.

In the case of a project with fieldwork, a typical breakdown is:

1. pre-fieldwork;
2. fieldwork;
3. post-fieldwork.

These are broken down further by activity.

Example of field methods

Adapted from Fekerte MSc (2006)

1. Field data collection
   (a) Sampling scheme
   (b) Site description procedure
   (c) Soil sampling procedure

2. Laboratory analysis
   (a) Atterberg limits
   (b) Free swell tests
   (c) Cation exchange capacity determination
   (d) Spectral measurements
      i. The ASD field spectrometer
      ii. The PIMA field spectrometer
      iii. Measurement of soil reflectance

Sequence of methods : 2 (no fieldwork)

In the case of a project without fieldwork, the sequence is typically one of **dependence**: which steps must be performed before others.

For system design, this might be:

1. System **specification** methods;
2. System **design** methods;
3. System **implementation** methods;
4. System **evaluation** methods.

Topic: Examples

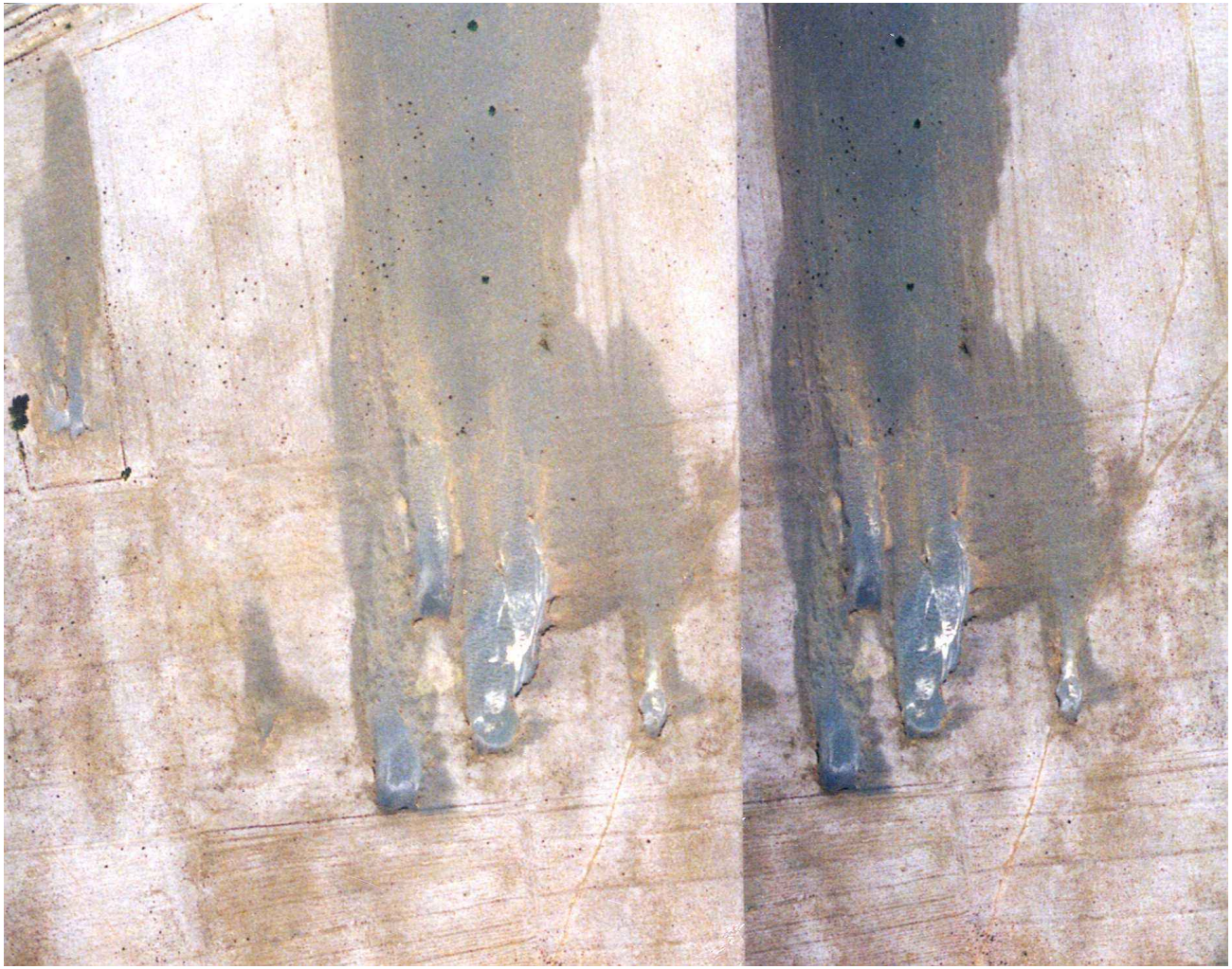
These examples follow the example research problems, objectives, questions of the previous lecture.

Example of methods (Naivasha SFAP)

Research question **“Can blow-outs and dunes caused by wind erosion be seen on SFAP, and if so, of what dimensions?”**

First we visualize the setting, then list the methods that must be specified.

Naivasha wind erosion – SFAP products



Stereogram showing blowouts and dunes

Naivasha wind erosion – field photos

Sequence of methods

1. Make a legend of wind erosion features;
   - e.g. blowouts, dunes (by type?) . . .
2. Specify how they are to be identified in the field;
3. List the characteristics of each feature to be measured in the field;
   - e.g. for blowouts: length, width, maximum depth
4. Specify how the characteristics are to be measured in the field;
   - e.g. meter stick? total station?; replicate measurements? if so, average or take maximum/minimum?

5. Make a sampling plan (transect? block? stratified by land use?)
   - What to do if a planned location is inaccessible?
6. Identify test features in the field and geo-reference them;
7. Produce the SFAP;
   - flight planning, equipment . . .
   - capture and save digital photos
8. Geo-reference the SFAP;
9. Interpret the SFAP at the locations of test features according to the legend;
10. Compare the interpreted features with the known features;
11. Quantify the degree of agreement.

Example of methods (animation)

1. Task analysis
2. Development of conceptual framework
3. Creation of animated representations
4. Evaluation
5. Synthesis and recommendations

These are then broken down into specific methods, e.g.

- What method(s) to create animations?

Must also specify the **computer programs** and **design tools** to be used.

Topic: Finding methods

There are many resources for **finding** methods:

- their **description**
- their **applicability** (which situations they fit)

These can be found in:

- handbooks
- review articles in journals, or review book chapters
- technical manuals
- texts (n.b. often not described in enough detail)

Finding methods – handbooks

All fields have "methods" handbooks, e.g.

- Miles & Huberman (1994): methods for **qualitative data analysis**, e.g. in social sciences research
- Ryerson (ed.) (1998): methods in **remote sensing**
- Maidment (ed.) (1993): methods in **hydrology**
- Knuth (1997): computational **algorithms**
- de Gruijter *et al.* (2006), Cochran (1977): **sampling designs**
- FAO (2002): methods for describing **soil profiles** in the field
- van Reeuwijk (ed.) (2002): **laboratory methods** for soil analysis

You should know the main methods handbooks in your field.

Finding methods – review articles

There are also review articles or book chapters that describe and compare methods; these are excellent resources to help you choose among methods. For example:

- Foody (2002): review of methods for **accuracy assessment** of land cover maps

Finding methods – texts

Advanced texts often explain and compare methods. This is common in statistics:

- Legendre & Legendre (1998) on statistical methods in ecology
- Bishop *et al.* (1975) on discrete multivariate statistics
- Davis (1998) on statistics and data analysis in geology

Finding methods – online

This can be a useful **starting point**, but very rarely provides a definitive method.

Use it to find reliable references (handbooks, review articles, texts).

Some handbooks may have been placed on-line as a convenience.

There are some complete handbooks on-line; if from a reputable source they can be used and cited, for example:

- NIST (2003) on statistical methods for quality control.

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Topic: Applicability of methods

There are many methods but some may not be **applicable** to your situation.

Example: **Laboratory tests** for the cation exchange capacity of the soil; methods developed for young soils in temperate climates give very misleading results for most tropical soils.

Example: Some **image processing methods** may only be feasible for small images.

You must argue that the selected methods fit the research context.

Topic: Study area or case study

If the research is carried out in a specific geographic area, the **study area** must be described.

This is true for **fieldwork**, but also for desk studies with **secondary data** from a specific area (e.g. imagery).

These both may be called **case studies**.

Justifying a study area

Three aspects:

1. **Scientific**: the area should be suitable to answer the research questions;

2. **Practical**: there should be sufficient secondary data; primary data collection should be feasible

   - access, permissions, transport, language, security.

3. **Social/contextual**: the area should be important to the social problem

   - e.g. transport planning in a city with known acute mobility problems

Describing a study area

- **Where** is the study area located? Almost always a **location map** is presented.
- What are its geographic **limits**?
- Is the entire geographic area included or are only some sub-areas investigated?
- **Why** was this area selected? What makes it **appropriate** for the research problem?
- If **sub-areas** were selected, why these? Are they **representative** of the whole area? If not, what are their **special characteristics**?
- What are the **characteristics** of the study area that are **relevant** to the problem?
  - Demographics, land-use pattern, geology, geomorphology, soils, data availability, importance of social or environmental problem, target area for larger project . . .

Justifying a study case

- **Scientific**: Why is this case appropriate to the research question? What advantages does it offer over other
- **Practical**: The study should be feasible
  - Data availability, institutional collaboration, language
- **Social/contextual**: the case should represent the social problem

Topic: The "design" research proposal

Some research is in the form of a **design**, e.g.

- a computer program
- a user interface
- a database structure
- an algorithm

Key question: when is a design **research**, not just a **project**?

Similar distinction in engineering **"research"** vs. **"development"** ("R&D")

What makes a design "research"?

- Clear **research objective**: results from the proposed project that others can use
  - including the audience for the results
- **Research questions** that make the objective explicit
  - if these questions can be answered, the objective has been reached.
- A high level of **innovation** (also called **novelty**):
  - create something really **new**
  - or at least a new **synthesis**
- It must result in a design that is demonstrably **"better"** than the alternatives;
- The thesis must both **define** and **demonstrate** this superiority.

Statement of innovation

The **hypothesis** of the “research” thesis is replaced with:

- a statement of the proposed **innovation** and
- **evaluation criteria** to asess this.

Superiority is often established by a **demonstration** that certain **design criteria** have been met, which were not met in other products.

Example

Proposal: Design a new structure for soil geographic databases.

Definition of "better":

- "allows the **representation** of real-world objects that can not be represented in any existing design"
- "supports a **class of queries** that can not be carried out in any existing design".

Research sequence for this design

1. Establish that there is a **demand** for a design;
2. Review existing designs and identify their **shortcomings**;
3. Show the proposed design and its **innovations**;
4. Show how it is used on some sample data, i.e. a **proof-of-concept**;
5. Show that it can **represent concepts** that are impossible with existing designs.
6. Show that this improved design is useful for answering a **richer class of questions**

Topic: The "modelling" research proposal

Some thesis research is centred on **models** of a process.

These are important in **management**. For example:

- models of **river basin hydrology**
  - predict floods, droughts, and navigable periods
  - plan release and storage in reservoirs.
- spatial models of potential or actual **soil erosion**
  - identify priority areas ("hot spots") for intervention
  - plan soil conservation measures
  - design sediment controls

Evaluating the success of a model

Models should **reproduce the behaviour** of the natural or social system under **known** scenarios, so we have some confidence in their usefulness for **future** scenarios.

As with a design thesis, we expect **improvement** over existing approaches, for example:

- Gives more accurate or precise predictions
- Requires less or less-expensive input data
- Is easier to parameterize
- Is applicable in a wider range of scenarios

So there must be some **method** for evaluating the success.

Topic: The "social" or "organizational" research proposal

Social analysis: the study of humans and human societies or their organizations.

The **hypothesis** takes the same form as a research thesis.

However, the research **method** is different:

- **evidence can be subjective and anecdotal**, rather than the objective result of a measurement;
- The **results** takes the form of a reasoned **argument** from evidence as interpreted by the researcher;
- The evidence is interpreted within a **conceptual framework**, which must itself be justified.

Difficulties in social analysis

- “Humans are non-linear”
- Humans (researcher) studying humans (subjects)
- Formulating and justifying a conceptual framework for interpretation.

Additional elements in a “social” proposal

Concepts must be well-defined, so that they can be consistently identified in the research.

So there is generally a section on **Concepts** and perhaps a **glossary** with **definitions**.

- E.g. what is meant by “sustainability”, or “hierarchical organization” or “spatial data infrastructure” (SDI)?
- E.g. what is a “metaphor” applied to SDI?

Summary and next step

1. Social, contextual problems
2. Research **problems**
3. Research **objectives**
4. Research **questions**, several per objective
5. Research **hypotheses** or **innovation**
6. Research **assumptions**, not to be tested
7. **Methods** to answer questions / test hypotheses

All that is left to begin the research is **logistics** and **scheduling**.