Your Master Thesis in the Environmental Remote Sensing group

This document is aimed at providing guidelines about how to develop, conduct and successfully finish a Master Thesis in the Environmental Remote Sensing group at TU Dresden. Following these guidelines will help you and your supervisors to efficiently prepare and organise your thesis.

1 Recommendations and important dates and deadlines

1.1 Before your thesis

1.1.1 Demonstrate your interest in environmental remote sensing *[during your studies]*

- Show interest and be engaged in our modules. Why are you interested in a thesis in environmental remote sensing? What are your plans for the future?
- We expect you to pass the modules in environmental remote sensing with an above average grade and on time.
- Regularly attend the colloquium for environmental remote sensing to get to know our research topics.
- Think about and answer the following questions:
  - At which spatial scale do you want to work?
  - At which temporal scale do you want to work?
  - What kind of remote sensing data do you want to use?
  - Which question/problem/gap in the knowledge would you like to address?
  - Which analysis techniques and methods would you like to use?

1.1.2 Develop your topic idea *[May-Jun for WiSe / Nov-Dec for SoSe]*

- Select a topic that genuinely interests you and aligns with your field of study, otherwise you'll find it difficult to maintain enthusiasm.
- You can find some topics on our website: https://tu-dresden.de/bu/umwelt/geo/ipf/envrs/studium/msc_topics#section-4
- Ensure your topic is specific and researchable within the scope of your thesis. Be realistic about what you can achieve in the time allowed.
- Discuss your ideas with us. → Make an appointment with us during office hours. Please note that we cannot afford to make several appointments with you at this point in order to develop a topic. Be prepared for the appointment!

1.1.3 Apply for the supervision of your thesis *[**15.06.** for WiSe / **15.12.** for SoSe]*

- Send the Application form (end of this document) to matthias.forkel@tu-dresden.de
- You will be informed a few days later if we accept your proposed topic and who can supervise your thesis under which conditions.
- Please note that we usually get much more requests for supervising theses than we are able to do. This means that we might recommend you to do your thesis with external supervisors or we might not consider all requests for supervision.
- After acceptance, make an appointment with your supervisors to develop the topic further.

1.1.4 Submit your research proposal to your supervisors *[**31.08.-30.09.** for WiSe / **28.02.-31.03.** for SoSe]*

- Write your thesis proposal (extended research proposal) in July (for thesis in coming WiSe) or February (for thesis in coming SoSe). Plan around 1 week for the development and writing of your proposal.
- Guidelines for the content of the research proposal can be found in Chapter 2.
- You will be informed if your thesis proposal is accepted or if we consider revisions are necessary.
- If you do not submit a proposal during this period or if the proposal is not sufficient, we will decline to supervise your thesis.
- → Supervisors write the task description (Aufgabenstellung) and set-up access rights and IT resources with the IT team.

1.1.5 Submit the registration for a thesis (*Anmeldung der Abschlussarbeit*) to the examination office *[**13.09. or 13.10.** for WiSe / **13.03. or 13.04.** for SoSe]*

- Form: https://tu-dresden.de/bu/umwelt/geo/studium/beratung-und-service/formulare#section-7
- You will normally be instructed to start your thesis a few days later. If you do not register before **13.11./13.05.**, we will decline to supervise your thesis during that semester.

1.2 Work on your thesis

1.2.1 Getting started *[around 2 weeks in Sep-Oct or Mar-Apr]*

Conduct an extensive literature review:

- Make a literature research on your topic. Use appropriate search engines such as GoogleScholar, Scopus or Web of Science
- Identify gaps or areas where your research can contribute new insights and/or approaches.
- Keep track of your references and notes using referencing software e.g. ZOTERO
- Use one system to make notes (e.g. notebook, text document, comments in referencing software, analogue or digital card boxes, etc.)

Update your initial research proposal:

- Do you need to refine your aim or objectives?
- Do you need to refine the initially proposed data and methods?
- Try to imagine the final results of your thesis: Take a pen and paper and sketch how the main figures of your thesis will look like. What are they supposed to show?

1.2.2 Collect and pre-process your data *[around 2-6 weeks]*

- Use your directory in drive :stdnt to save your original data, pre-processed data and results. This folder is in the back-up of ZIH, so you will not lose anything.
- Data gathering and pre-processing can often take much longer than initially estimated. Talk with your supervisors early if you have the feeling you are overwhelmed by data and cannot stick to your schedule.
- Collect and analyse data rigorously, ensuring that your methods align with your research question and goals.

- Use appropriate statistical and software tools. Don't be afraid to ask your supervisor about what is appropriate and what isn't!
- Be realistic about what data is available and its limitations.
- Remember to cite the sources of **all** your data.

1.2.3 Thesis proposal presentation *[after 3-4 weeks after your thesis start]*

- Present your research plan in the Colloquium for Environmental Remote Sensing or with the Proposal Assessment Board (MSc Cartography)
- Present your (revised) research proposal and show your data
  - Structure your presentation according to your (updated) proposal.
  - Make sure the aim, objectives and hypotheses are clear.
  - Include figures from the relevant papers and include sketches of your expected results

1.2.4 Mid-term presentation *[in the third month of your thesis]*

- Present your work progress in the Colloquium for Environmental Remote Sensing or with the Thesis Assessment Board (MSc Cartography)
- Present and discuss any modifications to your research plan.
- Present the intermediate results and outline the next steps.
- Be open about any obstacles and be open for comments and constructive criticism.

1.2.5 Pre-submission presentation *[3-4 weeks before submission]*

- Present your (almost) final results and the outline and structure of the thesis in the Colloquium for Environmental Remote Sensing

1.2.6 Regularly meet with your supervisors

- Seek the guidance of your supervisors
- Maintain regular communication with your thesis supervisors, but do not overload them with repeated requests.
- Ensure that if you book a meeting, you come to the meeting with a clear set of questions. Be prepared. Make notes. Ask questions if you do not understand.
- Be honest with the supervisors about your progress and concerns.
- Expect feedback and be open to making revisions based on your supervisors' feedback.
- In total, we can invest around 10 h in supervision meetings for each student. This can be e.g. meetings of 30 min/week, or 1 h/2 weeks, or 2 h/month.

1.2.7 Discuss with your fellow students: "Remote Sensing Master class"

- We plan to organise a "Remote Sensing Master class", where you can connect with your fellow Master students to discuss your work and gain insight and hints (e.g. about literature management, thesis structure, coding, statistics etc.).
- Share your problems and experiences with your fellow students to learn from each other or to develop new ideas.

1.3 Finish

1.3.1 Submit your thesis *[before the deadline!]*

- Send digital copies to all supervisors.
- Submit printed and digital copies to the examination office (according to the regulations of your study programme).
- Submit your thesis before the deadline. Don't wait until 5 minutes before midnight; there might be always technical issues.

1.3.2 Clean-up your data and code *[max. 2 weeks after deadline]*

- Provide a short summary of the thesis in easy to read language (approx. 500 words) and one figure (graphical abstract) for the website of the professorship.
- The thesis, data, results, scripts and software shall be delivered digitally within 2 weeks after submission of your written thesis.

1.3.3 Defence

- Plan a date well in advance for your defence with your supervisors.
- Prepare for your thesis defence by practicing your presentation and anticipating questions.
- Remember, the defence is also your chance to demonstrate what you have learned as a Master's student such as specific analysis techniques as well as the actual subject matter.
- The defence is the highlight of your study. It is a celebration of science and of your achievements. Dress accordingly (but don't over-dress, you still need to feel comfortable).
- Make sure you arrive with plenty of time to set-up your presentation, the room and the technical equipment.

2 Contents of thesis proposal (extended research proposal)

The aim of the proposal is for you to develop the topic and to ensure that you really like the topic. It also helps to get a common understanding about the proposed topic. We will discuss your questions or concerns that might arise during the preparation.

Conduct a first literature review (2-5 publications):

- Familiarise yourself with the existing research on your topic and differing approaches and, in some cases, opinions.
- Identify gaps or areas where your research can contribute new insights and/or approaches.
- Keep track of your references using referencing software e.g. ZOTERO

Define your research aim, hypothesis and objectives.

- Define the lack of knowledge.
- Aim: What is your goal to address this lack of knowledge?
- Objectives should be defined in a “smart” way: specific, measurable output, achievable, relevant, time-bound

Propose a methodology

- Create a research plan that outlines your research methodology, data collection methods, and data analysis techniques.
- Establish a realistic timeline for your thesis project with milestones and deadlines for each phase of your work. Include plenty of time for revisions and editing, remember your potential supervisors need to plan for reviews.

The proposal should include the following points:

- Proposed title
- Abstract (max. 200 words)
- Introduction (max. 500 words), including: motivation, scientific and/or methodological state-of-the art, statement on the lack of knowledge
- Aims and objectives or hypotheses
- Data and methods: proposal on how to address the topic (max. 500 words)
- Expected results (e.g. product, outcome of the analyses, advantages over existing approaches etc.) (max. 200 words)
- Time schedule (1 figure or table) including milestones
- Estimate the IT resources you will need (RAM, CPUs, OS) and name the required software.

3 General guideline for the thesis

3.1 Organise Your Thesis

- Structure your thesis with a clear abstract (< 500 words), introduction, methodology (including data), results, discussion, and conclusion.
- Use subheadings to organise content within each section. However, try not to use too many subheadings for example; Section 4.1.2.3 would be too much.
- The abstract should have a clear structure. As a guideline for the structure you can follow the recommendations from Nature, which are adopted by many authors in other journals: https://www.nature.com/documents/nature-summary-paragraph.pdf
- The Introduction should present the background of your work, it should review the state of the art on methods, data and research findings based on classical and recent literature and identify the lack of knowledge and thus lead directly to the research questions, aims, objectives and/or hypotheses. Write your Introduction targeted towards your objectives. Do not repeat fundamental text-book knowledge. Finish the Introduction with a very short description of the structure of your thesis.
- The Data section can be separate or a part of a "Data and Methods" chapter. Clearly describe the main properties and source of each dataset, including its spatial and temporal resolution and coverage. Also describe how you modified or pre-processed each dataset before your analysis. Explanation why you used specific variables or type of datasets should be covered in the introduction. The reasoning why you used a specific dataset should be made in the Data section.
- Ideally the Methods section should provide an initial overview about the methodological steps that you applied and how they are connected and then go into details about each method. Again, do not repeat textbook knowledge. For standard methods, say how you applied them (e.g. how you specified hyper-parameters). Don't forget to mention the software and version that you used to apply your methods. Important: The Method section should describe how you applied the methods or why and how you developed a certain method. Please avoid certain pitfalls:

Don't do this	**Better way**
"For the analysis the data was prepared in QGIS before proceeding with R". ➔ This is not informative.	"The raster dataset was cropped for the study area and resampled to the WGS84 / UTM zone 32U projection using nearest neighbour resampling (in QGIS 3.3). All further statistical analysis were conducted in R version 4.3 …"
"I first cropped the data with the crop function. This file was then read with the rast function from the terra package and then I used the tapp function for the aggregation. At the end I saved the file as GeoTiff." ➔ A thesis is not a software cookbook.	"The dataset was cropped to the study region and temporally averaged to monthly mean values (…) All steps were conducted in R version 4.3 with the terra package (version 1.7)."
"The results of this analysis are shown in Figure 1" ➔ Better say *what* the figure shows.	"This analysis shows that the relationship between X and Y is positive (Fig. 1).

- Results and Discussions can be separate chapters or can be combined. If they are separate, the Discussions can be also combined with Conclusions.
- The Discussions should provide an overall assessment of your results, compare your results with the literature, assess potential errors or limitations, and suggest potential improvements. It should clearly describe how your results advance over the state of the art (as defined in the Introduction). Provide a clear reply to your research questions, hypotheses and/or objectives.
- There are no minimum or maximum limits or word count for a thesis. Write as much as necessary, as little as possible. However, based on our experiences good theses have between 20,000-30,000 words in the main text (without references and appendences) and include between 6-20 figures and/or tables.

3.2 Maintain Consistent Citation and Referencing

- Make sure to use relevant literature. Cite references that really investigated an objective. Don't cite reference that only mention a very general statement in the introduction.
- Avoid too many second-order references. Try to always refer to the original research articles.
- Cite all sources accurately according to one consistent referencing system which follows the general Harvard style.
- Use a software like Zotero to manage your references and bibliography.
- Avoid plagiarism by properly referencing others' work. Thesis are checked for plagiarism.
- Each reference in your bibliography needs to be mentioned at least once in your text. Every reference in your text needs to appear in your bibliography.

3.3 Edit and Proofread

- Proofread your thesis carefully for grammar, spelling, and formatting errors.
- Consider seeking external editing or proofreading assistance if needed.

3.4 Include Figures, Tables and Appendices

- Incorporate relevant visuals (tables, figures) to enhance the presentation of your data.
- Select your figures and tables carefully. Not every figure that your produced during your analysis, needs to be included in your thesis.
- There is no need to copy-paste several figures from the literature. If you take figures from others, ask yourself what the purpose is. Are they really relevant to support your own work?
- Figures should contain information. Avoid unnecessarily large figures that contain mostly white space.
- Make sure the text in figures is large enough.
- Check your figures if they are suitable for people with a colour-blindness: https://www.color-blindness.com/coblis-color-blindness-simulator/
- Check if the symbols used and colours in figures are intuitive.
- Make sure that axis labels and legends contain the necessary information (variables, units, groups).
- Avoid too many abbreviations. However, the use of acronyms can keep it tidy, always give the full name in the caption though.

- Each figure needs a caption (as sub-caption below a figure) and a figure number. The caption should be informative.
- Refer to each figure at least once in your text at an appropriate place (e.g. “The relationship between X and Y is positive (Fig. 1)”).
- Include appendices for any additional information that supports your thesis but may be too detailed for the main text.
- Whilst diagrams, maps and charts can help “tell the story” of your research, only include essential visuals. Other charts etc. can be included in the supplementary material and in your defence.

3.5 Look after yourself!

- Manage your time and stress effectively to maintain a healthy balance between work, hobbies, and time for friends or family during the thesis writing process.
- Try to follow a fixed daily work schedule. Avoid procrastination.
- Take weekends off during your thesis.
- Don’t be afraid to talk to your supervisor about any problems you’re having, we have all been there and experienced them ourselves. Remember that a master's thesis is a substantial piece of academic work, and it is important to approach it with dedication, patience, and a systematic approach. Seek support and guidance when needed, and don't hesitate to ask for help or clarification from your supervisor.

Application for supervision of a MSc thesis in Environmental Remote Sensing

Name: _____

Study: _____ **Semester:** _____

Which remote sensing modules did you attend during your BSc and MSc studies and when did you successfully pass them?

Rate your technical skills.

	Regular use	Sometimes used	Learned in one class	None
R (including terra)	[ ]	[ ]	[ ]	[ ]
Python (including xarray, scitkit)	[ ]	[ ]	[ ]	[ ]
SNAP	[ ]	[ ]	[ ]	[ ]
QGIS or **ArcGIS**	[ ]	[ ]	[ ]	[ ]
Other: _____	[ ]	[ ]	[ ]	[ ]

Please specify your interests in environmental remote sensing.

At which spatial scale do you want to work?

[ ] global [ ] regional [ ] local → specify the region or place: _____

At which temporal scale do you want to work?

[ ] single observations [ ] short-term changes, seasonal changes, extreme events

[ ] long-term trends and anomalies

What kind of remote sensing data do you want to use?

[ ] High-resolution optical data [ ] Medium-resolution optical data [ ] Radar

[ ] Passive microwave [ ] Thermal [ ] Satellite and climate products [ ] Field work

[ ] Other: _____

Which application would you like to address?

[ ] Forestry [ ] Water cycle [ ] Carbon cycle [ ] Wildfires [ ] Biodiversity [ ] Climate
[ ] Agriculture [ ] Other: _____

Which analysis techniques and methods would you like to use?

[ ] Retrieval of biophysical variables [ ] Time series analysis [ ] Change detection

[ ] Machine learning [ ] Radiative transfer modelling [ ] Explorative data analysis

[ ] Deep learning [ ] Environmental modelling [ ] Other: _____

Please provide us some preliminary information about your preferred thesis topic.

Preliminary title/topic: _____

_____

Proposed supervisors: _____

What is the objective of your thesis? Try to specify the objective in a way that it is …

- Specific: What are the target variables? What is the thing you want to observe/investigate?
- Measurable: What is the intended outcome (new map/dataset/method, increased knowledge)?
- Achievable: Which data or methods do you plan to use in order achieve your aim?
- Relevant: Why is it important?
- Time-bound: How do you make sure to achieve the aim(s) within the duration of your thesis?