Adigrat University

College of Social Science and Humanities

Department of Geography and Environmental Studies

A Doctor of Philosophy (PhD) degree

in Geographic Information System & Remote Sensing

Proposal & Curriculum

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Adigrat, Tigray

Ethiopia

Contents

Background

GIS (Geographic Information System) and remote sensing are two rapidly growing fields in the realm of geospatial science. These two technologies are widely used for collecting, analyzing, and visualizing spatial data to gain insights into various aspects of the earth's environment, natural resources, and human activities. As a result, there is a high demand for professionals with advanced skills in these fields.

Despite the increasing demand, there is a shortage of PhD programs in GIS and remote sensing in many regions of Ethiopia, including Tigray. The existing programs are often limited in scope and capacity, and they do not always cater to the diverse needs of students and employers. Additionally, many students face challenges in accessing high-quality PhD programs due to financial and logistical barriers.

As a result, there is a pressing need to establish a PhD program in GIS and remote sensing that will meet the needs of students, employers, and society at large. Such a program would provide students with advanced research skills, critical thinking, and problem-solving abilities, enabling them to make significant contributions to their fields.

Furthermore, launching a PhD program in GIS and remote sensing would benefit Adigrat university in Tigray by enhancing its research capabilities and reputation, attracting top faculty and students, and generating new knowledge and innovation. It would also strengthen the institution's position as a leader in geospatial science and contribute to the development of the local economy.

Therefore, Adigrat University proposes to establish a PhD program in GIS and remote sensing to meet the growing demand for highly skilled professionals in Tigray, regional state of Ethiopia. The program will offer a rigorous and comprehensive curriculum, highly qualified faculty, and cutting-edge research facilities to ensure that students receive a world-class education and are well-prepared for successful careers in academia, industry, or government. The program will also provide opportunities for research and collaboration with local and international organizations to advance the use of GIS and remote sensing in various fields.

Importance and Need of the PhD Program in the Region

Ethiopia is a rapidly developing country with a growing need for highly skilled professionals in the fields of GIS and remote sensing. These two technologies have

tremendous potential for solving complex problems related to natural resource management, environmental monitoring, urban planning, disaster response, and more. However, the availability of highly trained professionals in these fields is limited, and there is a growing demand for advanced research skills to address the country's development challenges.

Launching a PhD program in GIS and remote sensing in Ethiopia is, therefore, critical for several reasons. Firstly, it will help to bridge the skills gap and produce highly trained professionals with advanced research skills to address the country's pressing needs in various sectors. These professionals will be equipped with the knowledge and skills to conduct cutting-edge research, develop innovative solutions, and provide evidence-based recommendations to policymakers.

Secondly, a PhD program in GIS and remote sensing will contribute to the development of the country's research capacity and promote knowledge transfer. The program will create a platform for collaboration and knowledge exchange between academics, researchers, and practitioners from Ethiopia and other countries. This will enable students to gain exposure to a diverse range of research methodologies, perspectives, and approaches and will facilitate the development of interdisciplinary research projects.

Finally, launching a PhD program in GIS and remote sensing will enhance Ethiopia's international reputation and competitiveness in the field of geospatial science. The program will attract top faculty and students from around the world and provide opportunities for international collaborations and partnerships. This will contribute to the development of Ethiopia's research ecosystem and position the country as a hub for geospatial science in the region.

In conclusion, the launch of a PhD program in GIS and remote sensing in Ethiopia is of critical importance. It will contribute to addressing the country's development challenges, enhancing research capacity, promoting knowledge transfer, and positioning Ethiopia as a hub for geospatial science in the region.

Brief profile of the department

The Geography Department is an academic department within Adigrat University, with a distinguished brief history of excellence in teaching and research. The department is committed to promoting the study of human-environment interactions and global systems, and it has a broad range of expertise across various sub-disciplines of geography.

The faculty members of the department are highly trained and renowned scholars in their respective fields. They have a diverse range of research interests, including cultural geography, environmental geography, economic geography, and geospatial science. The faculty members are dedicated to providing students with a quality education and research experience, and they actively engage in cutting-edge research projects.

The department has state-of-the-art facilities and resources that are critical for conducting high-quality research and providing students with practical training opportunities. These resources include a dedicated GIS and remote sensing laboratory, and a fieldwork laboratory. Additionally, the department has a strong partnership with various organizations in the public and private sectors, enabling students to gain practical experience and develop their professional skills.

The department offers a broad range of undergraduate and graduate programs, including Bachelor's, and Master's in Geography. These programs provide students with a comprehensive education that covers various sub-disciplines of geography and prepares them for successful careers in academia, government, and industry.

In conclusion, the Geography Department is a premier academic department within Adigrat University with a distinguished record of excellence in teaching and research. The department's faculty members are renowned scholars in their respective fields, and the department's state-of-the-art facilities and resources provide students with a world-class education and research experience.

The need for PhD in GIS and Remote Sensing

GIS and remote sensing technologies are increasingly becoming essential tools in addressing complex problems in various fields, including environmental management, urban planning, disaster management, and public health. These technologies require highly skilled professionals with advanced knowledge and expertise in research, development, and application of geospatial information. Therefore, there is a growing need for PhD programs in GIS and remote sensing to produce highly trained professionals who can conduct cutting-edge research and develop innovative solutions to these complex problems.

A PhD in GIS and remote sensing provides an opportunity for students to develop advanced research skills, including critical thinking, problem-solving, data analysis, and interpretation. These skills are essential in addressing complex problems that require an interdisciplinary approach and innovative solutions. A PhD program in GIS and remote sensing also provides students with an opportunity to specialize in a particular area of interest and contribute to the development of new knowledge and techniques in the field.

PhD graduates in GIS and remote sensing are highly sought after by employers in various industries, including government, private sector, and academia. They are equipped with the skills and knowledge to lead research projects, manage geospatial information systems, and develop innovative solutions to complex problems. Additionally, they are well positioned to fill leadership positions in research and development, policy formulation, and decision-making.

Furthermore, the need for PhD programs in GIS and remote sensing is becoming increasingly important in addressing global challenges, such as climate change, urbanization, and food security. These challenges require innovative and interdisciplinary approaches that can only be achieved through advanced research and development in GIS and remote sensing. Therefore, launching PhD programs in GIS and remote sensing is crucial in addressing these challenges and providing solutions for sustainable development.

In conclusion, the need for PhD programs in GIS and remote sensing is significant, and it is becoming increasingly important in addressing complex problems in various fields. The programs produce highly trained professionals with advanced research skills who can contribute to the development of new knowledge and techniques in the field. Additionally,

they are well positioned to fill leadership positions in research and development, policy formulation, and decision-making, and provide solutions for sustainable development.

Rationale

The increasing importance of geospatial information and technologies in addressing complex problems in various fields, coupled with the growing demand for highly skilled professionals in the field, makes launching a PhD program in GIS and remote sensing a critical and timely initiative. The following are some of the rationales for launching a PhD program in GIS and remote sensing:

Addressing the Growing Demand for Highly Skilled Professionals: The demand for highly skilled professionals in GIS and remote sensing is increasing, as these technologies become essential tools in addressing complex problems. A PhD program in GIS and remote sensing will produce highly trained professionals who can lead research projects, manage geospatial information systems, and develop innovative solutions to complex problems.

Filling the Gap in Advanced Research and Development: A PhD program in GIS and remote sensing will provide an opportunity for students to develop advanced research skills and contribute to the development of new knowledge and techniques in the field. This will fill the gap in advanced research and development, which is essential in addressing global challenges, such as climate change, urbanization, and food security.

Enhancing Interdisciplinary Approaches: The interdisciplinary nature of GIS and remote sensing requires professionals with a broad range of skills and expertise. A PhD program in GIS and remote sensing will provide an opportunity for students to specialize in a particular area of interest while also developing a broad range of skills and knowledge. This will enhance interdisciplinary approaches and provide solutions to complex problems.

Building Capacity for Sustainable Development: GIS and remote sensing technologies are essential tools for sustainable development. A PhD program in GIS and remote sensing will produce professionals who can provide solutions for sustainable development, such as environmental management, urban planning, disaster management, and public health.

In conclusion, launching a PhD program in GIS and remote sensing is a critical and timely initiative that will address the growing demand for highly skilled professionals in the field,

fill the gap in advanced research and development, enhance interdisciplinary approaches, and build capacity for sustainable development.

Objective

Launching a PhD program in GIS (Geographic Information System) and Remote Sensing will have several objectives, such as:

1. Advancing the field: A PhD program can help to advance the knowledge and understanding of GIS and remote sensing by promoting research, innovation, and the development of new methodologies and technologies.

2. Training future experts: The program can train the next generation of experts in the field, including researchers, educators, and practitioners, who can contribute to various sectors, such as environmental management, urban planning, public health, and disaster response.

3. Fostering interdisciplinary research: GIS and remote sensing are highly interdisciplinary fields that involve geography, computer science, engineering, environmental science, and many other disciplines. A PhD program can bring together students and faculty from diverse backgrounds to collaborate on interdisciplinary research projects.

4. Addressing societal challenges: GIS and remote sensing can be used to address a wide range of societal challenges, such as climate change, natural resource management, social justice, and disaster management. A PhD program can focus on developing solutions to these challenges by encouraging research that is socially relevant and responsive.

5. Creating employment opportunities: A PhD program can create employment opportunities for graduates in academia, industry, government, and non-profit organizations, as GIS and remote sensing skills are in high demand across various sectors.

Overall, launching a PhD program in GIS and remote sensing can contribute to the advancement of knowledge, the training of future experts, and the development of solutions to societal challenges while creating new employment opportunities.

Graduate Profile

The graduate profile for a PhD program in GIS and Remote Sensing would include the following:

1. Advanced knowledge of GIS and remote sensing: Graduates of the program should have a deep understanding of the theoretical and practical aspects of GIS and remote sensing, including data acquisition, processing, analysis, and interpretation.

2. Expertise in research methods: Graduates should have expertise in a range of research methods, including quantitative and qualitative methods, spatial analysis, and remote sensing techniques.

3. Ability to conduct independent research: Graduates should be able to design and conduct independent research projects that make original contributions to the field of GIS and remote sensing.

4. Interdisciplinary skills: Graduates should have interdisciplinary skills and be able to apply GIS and remote sensing techniques to a wide range of fields, including environmental science, urban planning, public health, and disaster response.

5. Professional skills: Graduates should have professional skills, such as project management, teamwork, communication, and ethical reasoning, that are essential for successful careers in academia, industry, government, and non-profit organizations.

6. Ability to communicate research findings: Graduates should be able to communicate their research findings effectively through publications, presentations, and other forms of scholarly dissemination.

Overall, the graduate profile for a PhD program in GIS and Remote Sensing would emphasize advanced knowledge and expertise in GIS and remote sensing, interdisciplinary skills, and professional skills, with a focus on conducting independent research and communicating research findings.

Admission and registration

Candidates must fulfil the criteria for admission to the PhD education, registration, training and examination at both universities and should undertake joint research projects with supervisors from both universities. Recruitment to the doctoral program is done on

a one-to-one basis and can happen at any time of the academic calendar. However, a candidate must fulfil the following conditions to join the doctoral program in public health:

- Must have a Master degree (MA/MSc/ masters with thesis in related field /Masters without thesis plus one published article);
  - The published article shall be evaluated for quality and also to confirm the candidate's contribution to the article.

- Must have a good research plan and funding; and

- Must have identified a qualified supervisor (PhD holder with an academic rank in accordance with the legislations of both Universities) from both Universities launching this joint PhD degree programme before admission into the programme. The Universities may support the potential candidates in identifying supervisors.

If accepted the candidate will register at Adigrat University.

Duration of studies

Duration of the PhD education is 3 years full-time or up to 6 years part-time. The maximum duration of study shall be 6 years.

Supervision

There shall be one supervisor at Adigrat university, He will be the main supervisor. Adjunct supervisors' other university may be appointed as needed.

Instructional Methodology

The course works are organized in blocks and method of instruction will be in the form of lectures and seminars that are supported by tutorials, individual assignments, project papers, and guest lectures. Most courses and seminars will be largely student centred and candidates are expected to make significant contributions to the learning process. All candidates must spend time in teaching in order to receive adequate academic stimuli to pursue academic excellence in their studies.

Training part

The training component shall consist of 30 ECTS credits, equivalent to one semester's

workload, and shall be relevant for the research conducted by the candidate. Students can attend and get credits for courses at both Hawassa University and at the University of Bergen. There shall be joint recognition of courses included in the study programme given at Adigrat university. The documentation of course work shall be done through approved transcripts in English from Adigrat university.

Courses

The following courses (Table below) will be available for PhD students for this programme. This list may be expanded later, in case there is a need. Registration to these courses will be done at the beginning of each year accordingly. With regard to elective courses, consultation with and approval of the supervisor(s) is mandatory.

Year of study	Course name	Course type	ECTS Credits	Grading
I	Advanced GIS and Remote Sensing	Compulsory	6	Letter grade
	Research Methods in GIS and Remote Sensing	Compulsory	5	Letter grade
	Geodatabase Management	Elective	5	Letter grade
	Spatial Data Visualization	Elective	5	Letter grade
	Spatial Analysis and Modeling	Elective	2	Letter grade
II	Research seminars on multivariate methods*	Elective	2	Letter grade
	Mid way evaluation	Compulsory	1	Pass/Fail
III	Scientific presentations#	Compulsory	6	Pass/Fail
	Total**		30	

*Each student should be able to organize and lead a research seminar on multivariate analysis methods. Type of model to be presented should be decided by the supervisor and it should be in line with the PhD research work of the candidate.

#Dissemination credits can be earned by participating in national (1 ECTS per presentation), or international congresses (2 ECTS per presentation), through lectures (1 ECTS per lecture) or articles (1 ECTS per article- maximum 2 articles- the articles should be unrelated to the students PhD research work). It is expected that the student should have at least one national and one international scientific

presentation.

^{**}This refers to the total expected ECTS to be taken by the student (not the total of ECTS of courses presented here).

However, during the coming years, the number of courses available at Adigrat University will be expanded as we manage to provide these courses at Adigrat University, and by thetime the course coding will be made in-line with the Adigrat University legislation.

The Dissertation

The research work constitutes the largest part of the doctoral training and is stipulated to take two and a half years of the PhD study period. The research work is written up as a collection of articles with a synopsis. The candidate should produce three manuscripts with aquality for publication to be the bases for the synopsis.

Progress and reporting

The candidates shall submit an annual progress report on progression on the PhD project tothe Adigrat universities.

Assessment of dissertation/Graduation requirement

Basis for assessment:

 The PhD candidate must satisfy:

- Approved academic training component (30 ECTS). The candidate should score, in allcourses, a passing grade according to the legislations of the Universities.

- Approved written dissertation by the assessment committee; and

- An approved trial lecture on a given topic and a satisfactory defense in a public disputation (graded as "Pass")

The candidate shall only present herself/himself to the assessment of the dissertation at Adigrat University. Adigrat university shall appoint a joint assessment committee to evaluate the work of the PhD student. The joint assessment committee must have members from both universities, as well as external members. The candidate's supervisors cannot serve on the assessment committee.

Degree Nomenclature and certificate

The nomenclature of the degree shall be:

"*Doctor of Philosophy*"

The degree certificate for the *joint degree* shall be in English. Only one degree certificate willbe issued presenting both University logos. It shall contain the title of the degree in English, the candidate's name and sex, date of award, signatures of the two authorities and embossed University seals. The design of the degree certificate and the front page of dissertation shall reflect the joint nature of the degree.

Accompanying explanatory notes shall be in English in a form of a degree certificate Supplement. The degree certificate Supplement issued with a joint degree or a multiple degree must clearly describe all parts of the degree, and it must clearly indicate the institutions and/or study programmes at which the different parts of the degree have been earned.

Quality Assurance

- Review of PhD proposals by the institutional review board

- Involving external examiners in the PhD dissertation evaluation and public defense

- Ensuring at least two publications in reputable journals as a condition of PhD completion

- Annual assessment of the program by teaching staffs

- Feedback from stakeholders and beneficiaries of the programme

- Exit questionnaire to obtain feedback from students who are completing their PhDs

- Monitoring the proportion of candidates who complete their PhDs within a stipulated period.

- Establishing Alumni of graduates as a mechanism of tracing their career development

Available Resources Human resource

- The number of potential supervisors from the University will depend on the topics the PhD students choose. However, it is expected that four to six full professors can take part in this joint programme.

- Currently the department of Geography has a total of two PhD holders who may serve as co-supervisors with which they develop the necessary capacity of PhD supervision in due course to fully own the PhD programme.

- The university will secure funds for adjunct supervisors (if needed) from other Universities in Ethiopia, mainly Mekelle and Addis Ababa University.

Available Material resource

- College of Social Sciences and humanities of Adigrat University will arrange teachingclassrooms with necessary facilities.

- College of Social Sciences and humanities of Adigrat University shall provide an office(with office equipment and internet access) to each PhD candidates during their stay at the college.

- The PhD candidates are entitled to use the university library and also, they can orderbooks of their choice in consultation with the supervisor.

- PhD students will have full access to digital Library with online full text journals.

- PhD students will have full access to GIS laboratory.

- They can also download and use software needed for their research such as SPSS and ARCGIS.

Collaborative Partners

Among others, partners pledged to support our PhD programs in course handling, advising and joint research includes the following.

S.No.   Institution

1. Soil & Water Resource Department, EARI
2. Ethiopian Mapping Authority
3. Addis Ababa University, Department of Geography and Environmental Studies
4. National Soil Research centre
5. Addis Ababa University, Department of Earth Science
6. Forestry Research Center
7. African Highlands Initiative
8. International Water Management institute
9. BOARD, Tigray
10. Information & Statistical Development (BOFED Tigray)

Outline of PhD proposal and Dissertation

- The general outline of the PhD proposal and dissertation is indicated in Annex 3. According to the nature of the PhD study, some modifications are acceptable given that the supervisors approve it and the necessary elements are not missing.

Course Descriptions

Course Title: Advanced GIS and Remote Sensing

Course Code: GeES 601

ECTS Credit Hour: 6

Course Category: Compulsory

Co-requests No

Description:

This course provides an in-depth understanding of geographic information systems (GIS) and remote sensing, with a focus on their applications in PhD-level research. The course is designed to equip students with the theoretical and practical skills necessary to use GIS and remote sensing effectively in their research projects.

The course covers a range of topics, including:

- Overview of GIS and remote sensing technologies, including their applications and limitations

- Introduction to GIS and remote sensing software and tools, including ArcGIS, QGIS, ENVI, and Google Earth Engine

- Spatial data acquisition, management, and manipulation, including data preprocessing and quality control

- Spatial data analysis techniques, including spatial statistics, spatial interpolation, and geostatistics

- Image interpretation, image processing, and classification techniques for remote sensing data

- Advanced GIS and remote sensing topics, such as LiDAR data processing, time-series analysis, and machine learning algorithms

- Application of GIS and remote sensing techniques in PhD-level research projects

- Collaboration with peers and instructors, and sharing of experiences

- Presentation of research work and feedback from peers and instructors

- Ethical, legal, and social implications of GIS and remote sensing research and applications

The course will consist of a combination of lectures, hands-on exercises, and group projects. Students will work with real-world datasets and will be encouraged to apply GIS and remote sensing techniques to their own research projects. By the end of the course, students should have a strong understanding of the fundamental concepts and practical skills needed to use GIS and remote sensing effectively in their research.

Rationale

The Advanced GIS and Remote Sensing course for PhD students aims to provide an in-

depth understanding of the theoretical and practical aspects of geographic information systems (GIS) and remote sensing. The course is designed to equip students with the necessary skills and knowledge to use these technologies effectively in their research.

GIS and remote sensing are powerful tools for collecting, managing, analyzing, and visualizing spatial data. With the growing availability of high-resolution satellite imagery, LiDAR data, and other geospatial datasets, researchers across a wide range of disciplines can benefit from these technologies. Some of the applications of GIS and remote sensing include environmental monitoring, land use planning, disaster response, and natural resource management.

In this course, PhD students will learn how to use GIS and remote sensing software and tools, such as ArcGIS, QGIS, ENVI, and Google Earth Engine. They will also gain knowledge of spatial data analysis techniques, including spatial statistics, spatial interpolation, and geostatistics. Additionally, the course will cover the principles of remote sensing, including image interpretation, image processing, and classification techniques.

The overall goal of this course is to enable PhD students to apply GIS and remote sensing techniques in their research projects, as well as to critically evaluate and interpret spatial data. By the end of the course, students should have a strong understanding of the fundamental concepts and practical skills needed to use GIS and remote sensing effectively in their research.

Course Objectives

Following are some specific objectives of the Advanced GIS and Remote Sensing course for PhD students:

1. Provide an overview of GIS and remote sensing technologies, including their applications and limitations.

2. Introduce students to GIS and remote sensing software and tools, including their interfaces, functions, and workflows.

3. Develop students' skills in spatial data acquisition, management, and manipulation, including data preprocessing and quality control.

4. Teach students how to perform spatial data analysis, including spatial statistics, spatial interpolation, and geostatistics.

5. Familiarize students with image interpretation, image processing, and classification techniques for remote sensing data.

6. Introduce students to advanced GIS and remote sensing topics, such as LiDAR data processing, time-series analysis, and machine learning algorithms.

7. Enable students to apply GIS and remote sensing techniques in their research projects, as well as to critically evaluate and interpret spatial data.

8. Encourage students to collaborate with peers and instructors, share their experiences, and develop a network of professionals in the field.

9. Provide opportunities for students to present their work and receive feedback from their peers and instructors.

10. Foster an appreciation for the ethical, legal, and social implications of GIS and remote sensing research and applications.

Course contents

course content for the Advanced GIS and Remote Sensing course for PhD students:

Module 1: Introduction to GIS and Remote Sensing
- Introduction to spatial data and spatial analysis
- Overview of GIS and remote sensing technologies
- Applications of GIS and remote sensing in PhD-level research

Module 2: GIS Software and Tools
- Introduction to ArcGIS, QGIS, and Google Earth Engine
- Data acquisition and management
- Data preprocessing and quality control

Module 3: Spatial Data Analysis Techniques
- Spatial statistics, including point pattern analysis and spatial autocorrelation
- Spatial interpolation, including kriging and inverse distance weighting
- Geostatistics, including variogram analysis and spatial regression

Module 4: Remote Sensing
- Introduction to remote sensing and principles of electromagnetic radiation
- Image interpretation, including visual and digital image interpretation
- Image processing, including filtering, enhancement, and transformation
- Classification techniques, including supervised and unsupervised classification

Module 5: Advanced GIS and Remote Sensing Topics
- LiDAR data processing and analysis
- Time-series analysis
- Machine learning algorithms for spatial data analysis

Module 6: Applications of GIS and Remote Sensing in PhD-level Research
- Case studies and examples of GIS and remote sensing applications in different fields of research
- Group projects applying GIS and remote sensing techniques to PhD-level research questions

Module 7: Ethics, Legal, and Social Implications of GIS and Remote Sensing
- Ethical considerations in spatial data collection and analysis
- Legal issues related to spatial data, including privacy and intellectual property rights
- Social implications of GIS and remote sensing research and applications

Module 8: Presentations and Feedback
- Presentation of group projects
- Feedback from peers and instructors
- Reflection and evaluation of learning outcomes

Recommended knowledge

To take the Advanced GIS and Remote Sensing course for PhD students, you will need the following computer skills:

1. Basic computer literacy: You should be comfortable using a computer, including knowledge of basic computer hardware and software components, such as the operating system, file management, and the internet.

2. Proficiency in using Windows or Macintosh operating system: You should be able to navigate the computer file system, install and manage software applications, and

troubleshoot common software issues.

3. Familiarity with GIS and Remote Sensing software: While the course will provide an introduction to GIS and Remote Sensing software, having prior experience using these tools will be helpful. Familiarity with ArcGIS, QGIS, ENVI, or Google Earth Engine is preferred.

4. Basic knowledge of statistics: You should have basic knowledge of descriptive statistics and inferential statistics.

5. Proficiency in using Microsoft Office: You should be proficient in using Microsoft Word, Excel, and PowerPoint for report writing, data analysis, and presentations.

6. Basic programming skills: Basic knowledge of programming skills, such as Python or R, will be helpful but not mandatory.

It is also recommended that you have access to a computer with a reliable internet connection throughout the course.

Teaching methods

Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on Epidemiological topic (10%)
- Data analysis exercise (20%)
- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Here are some recommended books for the Advanced GIS and Remote Sensing course for PhD students:

1. "Remote Sensing and GIS for Ecologists: Using Open-Source Software" by Martin Wegmann, Benjamin Leutner, and Stefan Dech

2. "Geographic Information Science and Systems" by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind

3. "Introductory Digital Image Processing: A Remote Sensing Perspective" by John R. Jensen

4. "Geostatistics for Environmental Scientists" by Richard Webster and Margaret A. Oliver

5. "Python Scripting for ArcGIS Pro" by Paul A. Zandbergen

6. "Mastering QGIS: Go beyond the basics and unleash the full power of QGIS with practical, step-by-step examples" by Kurt Menke, GISP, Dr. Richard Smith Jr., GISP, Dr. Luigi Pirelli, and John Van Hoesen.

These books cover a range of topics related to GIS and remote sensing, including software and tools, image processing and interpretation, spatial data analysis techniques, and Python scripting for GIS applications. They are recommended as supplementary resources to the course materials and may be useful for further self-study and reference.

Course Title: Research Methods in GIS and Remote Sensing

Course Code: GeES 602

ECTS Credit Hour: 5

Course Category: Compulsory

Co-requests No

Description:

The Research Methods in GIS and Remote Sensing course for PhD programme provides an introduction to research methodologies that are relevant to GIS and remote sensing. The course covers the theoretical and practical aspects of conducting research using these technologies, including research design, data collection, and data analysis techniques. The course also covers how to write research proposals, literature reviews, and research papers, as well as how to disseminate research findings through various channels. This course is designed to equip students with the necessary skills to conduct independent research using GIS and remote sensing technologies and to prepare them for comprehensive exams or their thesis/dissertation defense.

Rationale

The Research Methods in GIS and Remote Sensing course for PhD programme is important for several reasons:

1. Enhances research skills: The course equips students with the necessary research skills and tools to design and conduct research using GIS and remote sensing technologies.

2. Improves data analysis: GIS and remote sensing data are complex and require advanced data analysis techniques. This course provides students with knowledge of these techniques to effectively analyze and interpret spatial data.

3. Prepares students for future research: As PhD students, the course provides them with the necessary skills to conduct independent research in their respective fields and to apply GIS and remote sensing to their research questions.

4. Provides relevant knowledge: As GIS and remote sensing technologies continue to evolve, this course ensures that students have the most up-to-date knowledge and skills to conduct research.

5. Promotes interdisciplinary research: The course encourages interdisciplinary research by exposing students to GIS and remote sensing techniques and how they can be applied in various fields.

Overall, the Research Methods in GIS and Remote Sensing course for PhD programme is important for students pursuing a PhD degree in GIS and remote sensing as it prepares them with the necessary skills and knowledge to conduct independent research using these technologies

Course Objectives

The objectives of the Research Methods in GIS and Remote Sensing course for PhD programme may include the following:

1. To provide an overview of research methodologies used in GIS and remote sensing and

their application in various research fields.

2. To introduce students to the process of developing research proposals, including formulating research questions, conducting literature reviews, and designing research methodologies.

3. To provide students with knowledge of data collection methods for GIS and remote sensing, including fieldwork, remote sensing, and survey design.

4. To teach students advanced data analysis techniques for spatial data, including spatial statistics, spatial interpolation, and spatiotemporal analysis.

5. To provide students with knowledge of research writing and dissemination, including writing research papers, presenting research findings, and disseminating research through various channels.

6. To expose students to advanced topics in research methods in GIS and remote sensing, such as machine learning, time-series analysis, and spatial econometrics.

7. To guide students in developing their own research proposals and receive feedback from peers and instructors.

8. To evaluate students' knowledge and skills in research methods in GIS and remote sensing, and provide feedback for improvement.

Overall, the objectives of the Research Methods in GIS and Remote Sensing course for PhD programme are to provide students with a comprehensive understanding of research methods in GIS and remote sensing and prepare them for independent research in their respective fields

Course contents

Module 1: Introduction to Research Methods in GIS and Remote Sensing
- Overview of research methodologies used in GIS and remote sensing
- Research design, planning, and implementation
- Quantitative and qualitative research methods

Module 2: Literature Review and Research Proposal
- Conducting a literature review and synthesizing relevant research
- Developing a research proposal and refining research questions
- Ethical considerations in research design and implementation

Module 3: Data Collection Methods for GIS and Remote Sensing
- Data collection methods, including remote sensing, fieldwork, and survey design
- Sampling design and selection
- Data management and quality control

Module 4: Spatial Data Analysis Techniques for Research
- Spatial statistics, including exploratory spatial data analysis and spatial regression
- Spatial interpolation techniques, including kriging and inverse distance weighting
- Geostatistics and spatiotemporal analysis techniques

Module 5: Research Writing and Dissemination
- Writing a research paper, including the introduction, methods, results, and discussion sections
- Using visualization techniques for research presentation

- Disseminating research findings through conferences, publications, and social media

Module 6: Advanced Topics in Research Methods in GIS and Remote Sensing
- Machine learning techniques for spatial data analysis
- Time-series analysis and change detection
- Spatial econometric models and spatial decision support systems

Module 7: Research Proposal Development and Feedback
- Developing a research proposal and receiving feedback from peers and instructors
- Refining research questions, study design, and data collection methods
- Preparing for comprehensive exams or thesis/dissertation defense

Module 8: Reflection and Evaluation
- Reflection on learning outcomes and development of research skills
- Evaluation of the course content and feedback for improvement.

Overall, this course will equip students with the necessary skills to design and implement research projects using GIS and remote sensing technologies, and to analyze and interpret spatial data for their PhD-level research.

Recommended knowledge

To succeed in the Research Methods in GIS and Remote Sensing course for PhD programme, students are recommended to have the following knowledge:

1. Fundamental knowledge of GIS and remote sensing technologies, including their data types, formats, and processing workflows.

2. Proficiency in GIS and remote sensing software, such as ArcGIS, QGIS, ENVI, and ERDAS IMAGINE.

3. Basic knowledge of statistical analysis and hypothesis testing, including descriptive statistics, inferential statistics, and hypothesis testing.

4. Familiarity with programming languages used in GIS and remote sensing, such as Python, R, and MATLAB.

5. Understanding of spatial data structures and their applications in GIS and remote sensing, including vector data, raster data, and point cloud data.

6. Basic knowledge of survey design, including sampling techniques, questionnaire design, and data collection methods.

7. Familiarity with research design and methodology, including formulating research questions, conducting literature reviews, and designing research frameworks.

   Overall, students who have prior knowledge and experience in GIS and remote sensing, statistical analysis, programming, and research methodology will have an advantage in the Research Methods in GIS and Remote Sensing course for PhD programme.

Teaching methods

Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on topic (10%)

- Data analysis exercise (20%)

- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Here are some recommended books for the Research Methods in GIS and Remote Sensing course for PhD programme:

1. Longley, P., Goodchild, M., Maguire, D., & Rhind, D. (2015). Geographic Information Science & Systems. Wiley.
2. Jensen, J. R. (2015). Introductory digital image processing: A remote sensing perspective. Pearson.
3. De Smith, M. J., Goodchild, M. F., & Longley, P. A. (2018). Geospatial analysis: A comprehensive guide. Troubador Publishing Ltd.
4. Bivand, R. S., Pebesma, E. J., & Gómez-Rubio, V. (2013). Applied spatial data analysis with R (Vol. 747248879). Springer.
5. O'Leary, J. (2017). The essential guide to doing your research project. Sage Publications.
6. Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.
7. Goodchild, M. F., & Janelle, D. G. (Eds.). (2010). Spatially Integrated Social Science. Oxford University Press.

These books cover a range of topics in GIS, remote sensing, research methods, and data analysis, and can serve as a useful reference for students pursuing a PhD degree in GIS and remote sensing.

Course Title: Geodatabase Management

Course Code: GeES 603

ECTS Credit Hour: 5

Course Category: Elective

Co-requests No

Description:

The Geodatabase Management course for PhD students in GIS and Remote Sensing is designed to provide students with advanced knowledge and skills in managing and analyzing spatial data using geodatabases. The course aims to provide students with an in-depth understanding of the various components of geodatabases, their structure, and their use in managing complex spatial datasets

Rationale:

The Geodatabase Management course for PhD students in GIS and Remote Sensing is essential because geodatabases have become an essential part of GIS data management. With the increasing complexity and size of spatial datasets, it is essential for GIS professionals to have the knowledge and skills to manage and analyze such data using geodatabases.

This course aims to provide students with advanced knowledge and skills in geodatabase management, which is essential for conducting research in GIS and remote sensing. By the end of the course, students should be able to design and implement geodatabases, manage and analyze spatial data using geodatabase tools and techniques, and integrate geodatabases with other data sources.

Furthermore, the course is intended to prepare students for careers in GIS and remote sensing, where geodatabase management is an essential skill. Graduates of the course will be well-equipped to work as GIS analysts, GIS developers, or GIS administrators, or pursue further research in GIS and remote sensing.

Course Objectives

The objectives of the Geodatabase Management course for PhD students in GIS and Remote Sensing may include:

1. To provide students with a comprehensive understanding of geodatabases, including their components, structure, and use in managing spatial data.

2. To introduce students to the principles and techniques of data modeling and database design for GIS applications.

3. To equip students with the knowledge and skills to manage and analyze spatial data using geodatabase tools and techniques, including data loading, editing, versioning, and replication.

4. To introduce students to spatial analysis using geodatabase tools and techniques, including spatial queries, geoprocessing, and spatial statistics.

5. To provide students with an understanding of geodatabase administration, including user management, security, and backup and recovery procedures.

6. To familiarize students with the integration of geodatabases with other data sources, including data warehouses, web services, and cloud platforms.

7. To explore advanced topics in geodatabase management, including data quality assessment, metadata management, and data sharing.

Overall, the course aims to provide students with the knowledge and skills to design and implement geodatabases for GIS and remote sensing applications, manage and analyze spatial data using geodatabase tools and techniques, and integrate geodatabases with other data sources. By the end of the course, students should be able to apply these skills to real-world problems in GIS and remote sensing research.

Course contents

The contents of the Geodatabase Management course for PhD students in GIS and Remote Sensing may include:

1. Introduction to Geodatabases:
- Concepts and components of geodatabases
- Data models and schema design for geodatabases
- Types of geodatabases (file geodatabases, personal geodatabases, and enterprise geodatabases)
2. Data Loading and Editing:
- Loading data into a geodatabase
- Editing geodatabase features and attributes
- Advanced editing techniques (topology, geometric networks, etc.)
3. Geodatabase Versioning:
- Versioning concepts and terminology
- Types of versioning (traditional, branch, and merge)
- Version management and conflict resolution
4. Spatial Analysis in Geodatabases:
- Spatial queries and selections
- Spatial statistics (interpolation, density analysis, etc.)
- Geoprocessing (buffering, clipping, etc.)
5. Geodatabase Administration:
- User management and security
- Backup and recovery procedures
- Database maintenance and optimization
6. Integration with Other Data Sources:
- Geodatabase connectivity with data warehouses
- Geodatabase web services (WFS, WCS, etc.)
- Geodatabase cloud integration (Amazon AWS, Microsoft Azure, etc.)
7. Advanced Topics:
- Data quality assessment
- Metadata management
- Data sharing and collaboration

The course may also involve hands-on training in using geodatabase software such as Esri ArcGIS, QGIS, or open-source tools for geodatabase management. Through lectures, discussions, and practical exercises, students will gain a solid understanding of geodatabase management principles and techniques for GIS and remote sensing applications.

Recommended knowledge

To successfully undertake the Geodatabase Management course for PhD students in GIS and Remote Sensing, it is recommended that students have the following knowledge:

1. Fundamentals of GIS:

- Knowledge of basic GIS concepts and techniques, including spatial data management, spatial analysis, and cartography.

2. Database Management:

- Understanding of database management concepts, such as database design, data modeling, SQL, and relational database management systems.

3. Programming:

- Basic programming skills, such as Python or R, will be useful for automating geodatabase management tasks.

4. Spatial Data Formats:

- Understanding of common spatial data formats, such as shapefiles, GeoTIFFs, and raster datasets, as well as their advantages and disadvantages.

5. Remote Sensing:

- Familiarity with remote sensing concepts, techniques, and data types will be useful for integrating remote sensing data with geodatabases.

Overall, a strong foundation in GIS and database management concepts is essential for the successful completion of the Geodatabase Management course. Students who are not familiar with these concepts are advised to take prerequisite courses before enrolling in this course.

Teaching methods

Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on topic (10%)
- Data analysis exercise (20%)
- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Here are some recommended books for the Geodatabase Management course for PhD students in GIS and Remote Sensing:

1. "Geodatabase Workbook: ArcGIS 10" by David W. Allen
- This book provides a comprehensive guide to designing, building, and managing geodatabases using ArcGIS 10. It includes hands-on exercises and step-by-step instructions for creating a variety of geodatabase features and applications.
2. "Mastering ArcGIS Enterprise Administration" by Chad Cooper and Khaled Hassen

- This book covers the administration and management of ArcGIS Enterprise geodatabases, including user management, security, backup and recovery, and database performance optimization.
3. "PostGIS in Action" by Regina O. Obe and Leo S. Hsu
- This book provides a practical guide to managing and analyzing spatial data using PostGIS, an open-source geodatabase management system based on PostgreSQL.
4. "Geospatial Power Tools" by Tyler Mitchell
- This book provides an overview of open-source geospatial software tools for data management and analysis, including PostGIS, GeoServer, GDAL/OGR, and QGIS.
5. "Building a GIS: System Architecture Design Strategies for Managers" by Dave Peters
- This book provides guidance for designing and implementing a GIS system architecture, including database design, data management, and data sharing strategies.
6. "Geospatial Analysis: A Comprehensive Guide to Principles, Techniques, Tools & Software" by Michael J. De Smith, Michael F. Goodchild, and Paul A. Longley
- This book covers the principles and techniques of geospatial analysis, including database management, spatial statistics, and spatial modeling. It includes examples and case studies using a variety of GIS software tools.

These books can provide a solid foundation for understanding the principles and techniques of geodatabase management for GIS and remote sensing applications.

Course Title: The Spatial Data Visualization

Course Code: GeES 604

ECTS Credit Hour: 5

Course Category: Elective

Co-requests No

Description:

The Spatial Data Visualization course for PhD students in GIS and Remote Sensing aims to provide students with the knowledge and skills required to effectively visualize and communicate spatial data. The course covers a range of techniques and tools for spatial data visualization, including both static and interactive visualizations.

Rationale

The Spatial Data Visualization course is designed for PhD students in GIS and Remote Sensing as an essential tool for effectively communicating spatial data. Visualizing spatial data is crucial to making sense of complex geographic patterns and relationships, and it enables researchers to communicate their findings in a way that is accessible and easily understood by a wide audience.

The course aims to provide students with a comprehensive understanding of the principles of spatial data visualization and the techniques and tools used for designing effective visualizations for different types of spatial data. This will enable students to communicate complex spatial data in a clear, concise, and compelling manner.

Effective data visualization is an important skill for researchers in GIS and Remote Sensing, as it helps to identify patterns, trends, and relationships that may not be immediately apparent from the raw data. Additionally, it enables researchers to convey their findings to other researchers, policymakers, and the public in a way that is easily understood.

Spatial data visualization is also an important tool for decision-making in a range of industries, including urban planning, natural resource management, and public health. Thus, the Spatial Data Visualization course is highly relevant for PhD students in GIS and Remote Sensing who are interested in pursuing careers in academia, government, or industry.

Course Objectives

The course objectives may include:

- To understand the principles of spatial data visualization and the different types of spatial data visualizations available.
- To become familiar with a range of software tools used for spatial data visualization, including GIS software, data visualization tools, and programming languages.
- To learn how to design effective visualizations for different types of spatial data, such as point data, line data, and raster data.
- To develop skills in creating static and dynamic maps, charts, graphs, and other

visualizations for spatial data.

- To understand the principles of cartography and map design, including color theory, typography, and layout.
- To learn how to use interactive visualization tools and techniques to engage with spatial data and communicate insights effectively.

Course contents

Some of the topics that may be covered in the Spatial Data Visualization course for PhD students in GIS and Remote Sensing include:

1. Introduction to spatial data visualization

- Principles of spatial data visualization
- Types of spatial data visualizations
- Overview of software tools for spatial data visualization

2. Designing effective visualizations

- Understanding your audience and data
- Principles of cartography and map design
- Data visualization best practices

3. Creating static visualizations

- Mapping techniques for point, line, and raster data
- Designing effective charts and graphs
- Visualizing uncertainty and variability in spatial data

4. Creating dynamic visualizations

- Introduction to interactive visualization tools
- Creating interactive maps and charts
- Visualizing temporal and spatio-temporal data

5. Communicating insights through visualization

- Creating effective visual narratives
- Using visualization to communicate complex information
- Principles of data storytelling

Recommended knowledge

To succeed in the Research Methods in GIS and Remote Sensing course for PhD The Spatial Data Visualization course for PhD students in GIS and Remote Sensing typically assumes that students have a good understanding of the fundamentals of GIS and Remote Sensing. Some specific recommended knowledge areas include:

1. Familiarity with GIS software and spatial data formats, such as shapefiles, GeoTIFFs, and NetCDF files.

2. Knowledge of basic statistics and data analysis techniques used in GIS and Remote Sensing.

3. Familiarity with data visualization techniques, such as bar charts, scatterplots, and histograms.

4. Familiarity with basic programming concepts and syntax, such as variables, loops, and functions.

5. Basic knowledge of web development concepts, such as HTML, CSS, and JavaScript.

While these are not strict prerequisites, students who have some background in these areas will be better equipped to understand and apply the concepts and techniques covered in the course.

Teaching methods

Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on topic (10%)
- Data analysis exercise (20%)
- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Some recommended books for the Spatial Data Visualization course for PhD students in GIS and Remote Sensing are:

1. "Making Maps: A Visual Guide to Map Design for GIS" by John Krygier and Denis Wood

2. "Cartography: Thematic Map Design" by Borden Dent and Jeffrey Torguson

3. "Python for Data Analysis" by Wes McKinney

4. "Data Visualization: A Practical Introduction" by Kieran Healy

5. "Interactive Data Visualization for the Web" by Scott Murray

Course Title: Research seminars on multivariate methods

Course Code: GeES 605

ECTS Credit Hour: 5

Course Category: Elective

Co-requests No

Description:

Research seminars on multivariate methods for PhD in GIS and Remote Sensing typically aim to introduce students to advanced statistical techniques for analyzing complex datasets with multiple variables. These seminars may cover a wide range of topics related to multivariate analysis, including exploratory data analysis, multivariate regression analysis, cluster analysis, factor analysis, principal component analysis, discriminant analysis, and more.

Rationale

During these seminars, students will likely learn about the theoretical foundations of these techniques, as well as their applications in GIS and remote sensing research. Students will also have the opportunity to work with real-world datasets and apply these methods using statistical software such as R or Python.

Course Objectives

The objectives of research seminars on multivariate methods may include:

1. Understanding the theoretical underpinnings of multivariate methods and their applications in GIS and remote sensing research.

2. Gaining practical experience in applying multivariate analysis techniques to real-world datasets.

3. Developing critical thinking skills to evaluate the appropriateness of different multivariate methods for different types of research questions and datasets.

4. Learning how to effectively communicate results of multivariate analysis to a diverse audience, including researchers and stakeholders from different fields.

Course contents

Some possible topics that may be covered in a research seminar on multivariate methods for PhD in GIS and Remote Sensing include:

1. Introduction to multivariate analysis techniques and their applications in GIS and remote sensing research.

2. Exploratory data analysis and visualization techniques.

3. Multivariate regression analysis and its applications in spatial modeling.

4. Cluster analysis and classification techniques for remote sensing data.

5. Factor analysis and principal component analysis for dimension reduction and data visualization.

6. Discriminant analysis for classification and prediction in GIS and remote sensing

applications.

7. Canonical correlation analysis and other advanced multivariate techniques for analyzing complex datasets.

   The specific topics covered in a research seminar on multivariate methods may vary depending on the instructor and the needs of the students.

Recommended knowledge

To successfully participate in research seminars on multivariate methods for PhD in GIS and Remote Sensing, students should have a strong foundation in basic statistics and GIS concepts. Specifically, they should be familiar with statistical concepts such as probability distributions, hypothesis testing, and regression analysis. They should also be comfortable with data handling and analysis in GIS software such as ArcGIS or QGIS.

In addition, students should have some background knowledge in remote sensing techniques and applications, including image processing and analysis. Familiarity with programming languages such as R or Python may also be beneficial, as these languages are commonly used for statistical analysis and data visualization.

Overall, students should have a strong quantitative background and an interest in using advanced statistical techniques to analyze complex spatial datasets. They should also be motivated to learn and apply new techniques to real-world research problems in GIS and remote sensing.

Teaching methods

   Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on topic (10%)
- Data analysis exercise (20%)
- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Here are some recommended books for research seminars on multivariate methods for

PhD in GIS and Remote Sensing:

1. Multivariate Analysis in Vegetation Research by Janos Podani - This book provides a comprehensive overview of multivariate methods used in vegetation research, including cluster analysis, principal component analysis, and canonical correspondence analysis.

2. Applied Multivariate Statistical Analysis by Richard Johnson and Dean Wichern - This classic textbook covers a wide range of multivariate techniques, including principal components analysis, factor analysis, and discriminant analysis, and provides examples of their application in various fields, including remote sensing

and environmental science.

3. Multivariate Statistical Methods in Physical Anthropology by Maurice S. Lipschutz - This book provides a detailed introduction to multivariate analysis techniques, including cluster analysis and principal component analysis, and their applications in physical anthropology.

4. Remote Sensing and GIS Analysis of Coastal Ecosystems by Richard C. Smardon - This book provides an overview of the use of remote sensing and GIS techniques for analyzing coastal ecosystems, including multivariate analysis techniques for image classification and vegetation mapping.

5. Multivariate Statistics for Wildlife and Ecology Research by Kevin McGarigal and Alistair J. Hobday - This book provides an introduction to multivariate statistical methods for analyzing ecological and wildlife data, including cluster analysis, factor analysis, and principal component analysis.

6. Multivariate Analysis of Ecological Data Using CANOCO 5 by Jan Lepš and Petr Šmilauer - This book provides a practical guide to using the CANOCO software package for multivariate analysis of ecological data, including ordination methods, permutation tests, and other multivariate techniques.

Course Title: Spatial Analysis and Modeling

Course Code: GeES 602

ECTS Credit Hour: 5

Course Category: Compulsory

Co-requests No

Description:

The Spatial Analysis and Modeling course is designed for PhD students in GIS and Remote Sensing as a means of exploring and understanding the complex spatial relationships that exist in geographic data. Spatial analysis and modeling techniques are critical to effective decision-making in a wide range of industries, including urban planning, natural resource management, and public health.

Spatial analysis and modeling allow researchers to explore and understand the relationships between different spatial data sets, and to identify patterns and trends that may not be immediately apparent from the raw data. This is essential for effective decision-making in a range of industries, as it allows decision-makers to make informed choices based on the best available data.

Rationale

The Spatial Analysis and Modeling course is highly relevant for PhD students in GIS and Remote Sensing who are interested in pursuing careers in academia, government, or industry. It provides students with the knowledge and skills necessary to analyze complex spatial data, develop spatial models, and make informed decisions based on spatial data analysis.

Course Objectives

The course aims to provide students with a comprehensive understanding of spatial analysis and modeling techniques and tools. This includes the development of spatial models, the use of GIS software to analyze spatial data, and the use of statistical and machine learning techniques for spatial analysis.

Course contents

The Spatial Analysis and Modeling course for PhD students in GIS and Remote Sensing typically covers the following topics:

1. Introduction to spatial analysis and modeling
    - Basic concepts and principles of spatial analysis and modeling
    - Spatial data models and types
    - Spatial statistics
2. Spatial data manipulation and transformation
    - Data management and preprocessing
    - Spatial data transformations
    - Geoprocessing tools in GIS software

3. Spatial analysis techniques
   - Spatial interpolation
   - Spatial autocorrelation
   - Spatial regression
   - Point pattern analysis
4. Spatial modeling techniques
   - Spatial regression models
   - Geostatistical models
   - Agent-based models
   - Cellular automata models
5. Machine learning for spatial analysis and modeling
   - Introduction to machine learning for spatial data
   - Decision trees and random forests
   - Support vector machines
   - Neural networks
6. Applications of spatial analysis and modeling
   - Case studies in urban planning, natural resource management, public health, and other domains
   - Examples of spatial decision-making using spatial analysis and modeling

Throughout the course, students will have hands-on experience working with real-world spatial data sets using GIS software and statistical programming languages such as R or Python. The course may also involve guest lectures from practitioners in the field, as well as assignments and projects designed to help students apply the concepts and techniques learned in the course.

Recommended knowledge

The Spatial Analysis and Modeling course for PhD students in GIS and Remote Sensing typically assumes that students have a solid foundation in GIS and Remote Sensing, as well as some background in statistical analysis and programming. Some specific recommended knowledge areas include:

1. A solid understanding of GIS software and spatial data formats, such as shapefiles, GeoTIFFs, and NetCDF files.
2. A good understanding of basic statistical analysis techniques, such as hypothesis testing, regression analysis, and data visualization.
3. Familiarity with at least one statistical programming language such as R or Python.
4. Knowledge of basic spatial analysis techniques, such as distance analysis and overlay analysis.
5. Familiarity with basic machine learning concepts such as decision trees, random forests, and support vector machines.

While these are not strict prerequisites, students who have some background in these

areas will be better equipped to understand and apply the concepts and techniques covered in the course.

Teaching methods

Lectures, reading notes, computer practical sessions

Evaluation

- Assignments on topic (10%)
- Data analysis exercise (20%)
- Critical appraisal of scientific article (presentation) (10%)
- Final Exam (60%)

Recommended Books

Here are some recommended books for the Spatial Analysis and Modeling course for PhD students in GIS and Remote Sensing:

1. "GIS and Spatial Analysis for the Social Sciences: Coding, Mapping, and Modeling" by Robert Nash Parker and Emily K. Asencio. This book provides an introduction to GIS and spatial analysis techniques specifically geared towards social science researchers.

2. "Spatial Analysis: A Guide for Ecologists" by Richard B. Harris. This book provides an overview of spatial analysis techniques and their applications in ecology and environmental science.

3. "Applied Spatial Data Analysis with R" by Roger S. Bivand, Edzer J. Pebesma, and Virgilio Gómez-Rubio. This book provides an introduction to spatial data analysis using the R programming language.

4. "GIS Tutorial for Python Scripting" by David W. Allen. This book provides an introduction to using Python for GIS programming and automation.

5. "Spatial Modeling in GIS and R for Earth and Environmental Sciences" by Hamid Reza Pourghasemi and C. Emre Bektas. This book provides an introduction to spatial modeling techniques and their applications in earth and environmental sciences.

6. "Machine Learning for Spatial Environmental Data: Theory, Applications, and Software" by Alexander Brenning. This book provides an introduction to machine learning techniques for analyzing spatial environmental data.

These books are intended to supplement the course materials and provide students with additional resources for learning about spatial analysis and modeling.

Annexures

Annex 1: The PhD candidate's responsibilities

Your responsibilities as a PhD candidate are:

1. To carry out your research effectively, to a high standard and within the prescribed period of study
2. To attend PhD events at the university, faculty and department and to attend the courses agreed with your main supervisor.

3. To agree and strictly abide by a timetable for regular contact with the main supervisor, at least once a month, and for the submission of your written work

4. To submit your written work by agreed deadlines to allow sufficient time for comment and discussion. Drafts or parts of the thesis should be submitted at regular intervals, in accordance with the PhD regulations, at least three times per semester.

5. To present your work or findings at seminars/conferences from time to time if encouraged by the main supervisor.

6. To comply with the ethical standards for research that apply to the academic field in question.
7. To submit an annual standard report to the department/faculty about the progress of your doctoral training, in consultation with your main supervisor.

8. To participate in a midway evaluation of the progress of your doctoral training.
9. To responsibly keep track of all documentation of the courses, seminars and activities you complete as part of the training component.

10. To inform your main supervisor about all matters that may have a bearing on supervision. You should feel free to bring any problems, including problems of a social or medical nature, to the attention of your main supervisor or head of department/administrative PhD coordinator.

11. To consult in confidence the head of department/administrative PhD coordinator if you feel that a change of supervisor is desirable for any reason.

12. To consult the co-supervisor when advised to do so by your main supervisor.
13. To inform the external party (for those financed or supported otherwise by an external party) about any matters that could have a significant bearing on the cooperation and the progress of the project.

14. To follow the procedures for study, leave or interruption of doctoral training. If you have sickness absence or other types of approved study leave, you must inform your assigned PhD administrative coordinator.

15. To discuss all matters regarding expenses relating to the financing of your research project with your supervisor, if relevant, with representatives of the institution that is financially responsible for your position.

16. To keep track of all working hours spent as part of your 25% obligatory workload for PhD candidates with university fellowships of four years. Expect your supervisor to help you keep within the workload limits for duty work.

Annex 2: Expectations of the supervisory team

Main supervisor

Students can expect your main supervisor to:

1. Participate actively in discussing and designing your research project and in selecting relevant courses and activities for your training component.

2. Be responsible for your budget for project expenses.

3. Provide quality advice/supervision of your research work, consider which hypotheses and methods may be suitable, and provide you with feedback on written texts as they develop (outline, contents, writing style, documentation etc.)

4. Ensure that it is possible to complete the thesis work within the normal timeframe of three years for doctoral training.

5. Provide you, within a reasonable timeframe, with constructive criticism and reactions to submitted draft work in order to facilitate timely completion of your thesis. Such follow-up should take place at least three times per semester.

6. Introduce you to specialist literature and basic data sources (libraries, archives etc.)

7. Introduce you to the department, its facilities and procedures, and to other PhD candidates and relevant staff, and encourage attendance at events and seminars related to doctoral training in general and to your research field in particular. To allow for the planning of relevant study-abroad periods, the supervisor shall at an early stage of your studies introduce you to other relevant academic environments outside the department, also internationally.

8. Advise you on the name of the person in charge of doctoral training (PhD-coordinator) in the department/faculty and ensure that you can contact him/her to discuss relevant matters, including difficulties that may arise in your relationship with your supervisors and your study progress.

9. Decide, in consultation with the Head of Department, at the start of your PhD project, whether assignment of Intellectual Property Rights (IPR) is necessary and, if so, ensure that an agreement on IPR is established at the outset of the project.

10. Ensure that a risk assessment of any laboratory and/or field-based activities has been carried out in accordance with departmental procedures and that you receive the necessary safety training.

11. Ensure that ethics approval has been obtained in accordance with the regulations, and provide guidance on questions of research ethics related to the thesis work. Arrange for you to familiarise yourself with your responsibility to avoid any form of misconduct.

12. Ensure that you maintain records of your research data in a systematic manner so that they can be consulted and understood by anyone with a legitimate right to enquire, such as the evaluation committee.

13. Discuss incidents with you that may seem to be related to research misconduct or plagiarism and report to the department on any suspected instance of research misconduct, including plagiarism.

14. Organize and take part in your midway evaluation.

15. Agree with you after your midway evaluation on a realistic timetable for completion of the research and writing up of your thesis.

16. Submit annually by 1 November to the department/faculty, as appropriate, a standard report about the progress of your doctoral training.

17. In consultation with co-supervisors and the department/faculty, make satisfactory arrangements for supervision if the main supervisor is absent for a period of more than four weeks. Keep you informed about all matters that could have significant bearing on the supervision.

18. Encourage you to present your work in progress from time to time and attend relevant conferences, meetings and workshops, and to consult relevant sources of information and advice inside and outside your department.

19. Encourage you to develop and improve your general and transferable skills.

20. Help you to ensure that duty work does not exceed 25% of your total workload.

Co-supervisor

You can expect your co-supervisor to:

1. Participate in planning your research project and the training component, which is necessary for your admission and enrolment as a PhD candidate

2. Supervise you in connection with your research project

3. Keep updated on the progress of your work and be present at (at least) quarterly supervisory team meetings.

4. Provide quality advice concerning your research work, consider which hypotheses and methods may be suitable, and provide you with feedback on written texts as they develop. This is to ensure that you are able to complete the thesis within the normal timeframe, which is three years for PhD studies.

5. Improve the effective supervision of your work by contributing a second opinion or additional areas of expertise, if the main supervisor considers it desirable

6. Provide for continuity of supervision in the event of the absence or departure of the main supervisor. Arrange (in consultation with the main supervisor and the department) for a replacement in the event of his or her parallel absence with the main supervisor.

7. Take part in your midway evaluation

Annex 3: Format for PhD research proposal and dissertation

A) The PhD research proposal

These recommendations are intended to help the students to conceptualize and prepare a PhD research proposal. If you plan to register for a PhD study, you are expected to hand in a "detailed and precise description of study or research proposal as well as information on any previous study or research projects of particular relevance to a decision of award."

The purpose of the proposal is to ensure the candidates have done sufficient preliminary reading of about their interest that they have thought about the issues involved and can provide more than a broad description of the topic which they are planning to research.

Some general comments about writing style of the research proposal:

Please verify that the title, the abstract and the content of your proposal clearly correspond to each other.

Keep a reasonable, clear, declarative writing style (active verbs!) throughout the document. Remember to number your pages.

Make sure your PhD proposal does not contain any grammatical or spelling mistakes or typos.

The protocol should contain the following elements:

Title-Page

The title states the main purpose or the principal research question.

The title should be short (not more than 15 words) and informative. It should indicate the research area, research question and research design. The title requires much more careful consideration per word than any other section.

To develop a clear title, you must also be clear about the focus of your research.

On the title-page, please also indicate a realistic time frame toward project completion, followed by the name(s) of your supervisor(s), and information about other academics with whom you plan to collaborate.

Summary

This one-page summary focuses on the research topic, its new, current and relevant aspects. The summary should

- Be a research protocol in miniature
- Give the key points only
- Not exceed the length or space allowed (400 words)
- Please use the following subheadings: Background, Objectives, Methods and Relevance of study.

Background

This should include a short and precise overview (about 3 pages) about the current state of research that is immediately connected with your research project. Reference the most important contributions of other scientists. Discuss the theoretical scope or the framework of ideas that will be used to back the research.

Indicate the open problem, which then will be the motive for your project. State clearly how your research will contribute to the existing research.

The background gives an introduction to your study. You should include the following:

- The importance of the topic
- A brief review of current research
- The need for further research
- The broad long-term goals of proposed research

Objective of the research project

Give a concise and clear outline of the academic objectives that you want to achieve through your project. This section is where you should list the hypotheses your study will test or the research questions it will address.

The aims of your study should be briefly stated, and you may include four specific objectives. Do not include aims for which your study cannot provide results.

Plan

This is the central part of your research outline. The plan of the investigation presents the study design in detail. It is the longest section of the Application, often running to 4 or 5 pages.

The Plan of the Study should

- Give an overview
- Specify the study design
- Define the study subjects/patients
- Describe how the data will be collected
- Outline the study procedures
- Describe briefly the statistical analysis.

For each of the planned papers write a brief summary (½ page) using the following headlines:

- Objective:
- Method:
- Study design:
- Sample size:
- Primary outcome:
- Comparison group:
- Covariate variables:

Sample size

Formal sample size calculations are required for all research studies. These indicate how many study subjects are needed so that, if the research ideas are correct, it is very likely that a statistically significant result will be obtained. If the study is too small a real effect may be overlooked. If it is too large, resources will be wasted.

A reference should be made to the method used for the calculation. In simple cases, sufficient information should be in your application for a reviewer to check your calculation. You should calculate sample size for all of your outcome measures or specific objectives as needed.

Purpose and Potential

We would encourage you to explain the likely impact of the study findings on health care delivery.

You may feel it is self-evident that your topic is crucial and that there is no need for a justification. But you must still give the rationale in the application. Explain what the results will do for public health, policy, or patient care, or how they will improve it, or save money. Clarify how the implications are not limited to the narrow confines of the project, but will carry across to much wider areas of health care.

Ethics

The main ethical concerns are whether the research will place the subjects under undue risk, and whether the subjects are fully informed about the nature of the study. The ethics committee will review the study documentation, including the procedures to obtain informed consent.

Timetable and Milestones

The timetable should explain what activities will take place at specified times during the study. It may be helpful to use a project management chart to illustrate the timing of activities, particularly if they overlap each other in time.

Financial Plan

The financial plan is not a section which can be hurriedly completed at the last minute. If you have a good project, it can be ruined by a failure to ask for enough resource to complete it. On the other hand you can harm your project if you ask for costs that are not relevant for the study.

Here is a list of items you should think about under each section of the financial plan. These may include: Additional support staff, equipment, consumables and travel and subsistence

Justification of costs

The NORHED project will meet reasonable costs encountered during the conduct of a research study. However, you must explain why the specified costs are reasonable.

References

The Vancouver style for references is recommended as it is used by almost all medical journals. It uses numbers in the text and lists the references in numerical order. The advantage of this style in grant applications is that it minimizes the space used for references in the Plan, the one place where space is at a premium.

The following advice is based on the instructions given by the British Medical Journal.

References should be numbered in the order in which they appear in the Plan. In the list of references, you should give the names and initials of all authors (unless there are more than six, when only the first six should be given followed by et al). The authors names are followed by the title of the article: the title of the journal abbreviated according to the style of Index Medicus (see list of journals indexed, printed yearly in the January issue of Index Medicus): the year of publication; the volume number: and the first and last page numbers:

21   Soter NA, Wasserman SI, Austen KF. Cold urticaria: release into the circulation if histamine and eosinophil chemotactic factor of anaphylaxis during cold challenge. N Engl J Med 1976:294:687-90. References to books should give the names of any editors, place of publication, editor, and year:

22   Osler AG. Complement: mechanisms and functions. Englewood Cliffs: Prentice-Hall, 1976.

Information from manuscripts not yet in press, papers reported at meetings, or personalcommunications should be cited only in the text, not as a formal reference.

You should use a reference manager preferably EndNote to handle your references.

Supervision

Please state the name of your supervisors (minimum two supervisors), and attach a letter of recommendation from the main supervisor.

Curriculum vitae

Your CV should be brief and certainly not more than one page. It should include:Your
Name.
Your age.
Your degrees, where obtained and the year awarded.
Your current and past appointments.
References to your own papers in the field or related fields.

B) Brief outline of PhD Dissertation

The PhD dissertation shall have the following sections:

1. Title page
2. Dedication page (Optional)
3. Acknowledgment
4. Summary
5. List of original papers
6. Abbreviations
7. Chapter I: Introduction (divided into sub-sections)
8. Chapter II: Objectives
    a. General
    b. Specific
9. Chapter III: Methods
10. Chapter IV: Results (organized according to objectives/original papers)
11. Chapter V: Discussion
    a. Methodological discussion
    b. Discussion of main findings
    c. Implications for policy
12. Chapter VI: Conclusions and Recommendations
    a. Conclusions
    b. Recommendations
13. References
14. Original articles
15. Study instruments or anything that need to be annexed

Annex 4: Need Assessment Survey Results and Questionnaire

Adigrat University

College of Social Sciences and Languages

Department of Geography and Environmental Studies

A. Need Assessment survey results.
B. Questionnaire prepared for Field Survey and Consultations as a part of Need assessment.
C. Questionnaire prepared for Field Survey and Consultations as a part of Curriculum preparationfor PhD Programme in GIS and Remote Sensing.

Adigrat University

College of Social Sciences and Humanities

Department of Geography and Environmental Studies

Summary Result of Need Assessment

I. Background

The department of Geography and Environmental Studies, at Adigrat University (AU) has been offering undergraduate program since 2011 GC and post graduate program since 2018.

The Department is committed to produce competent students in GIS and Remote Sensing that have the desired academic knowledge, sufficient GIS and remote sensing skill, appropriate citizenship and respect for those ethical values enshrined in the Ethiopian Constitution.

In response to the growing demand, Academics, Adigrat University and the request of the government for competent and qualified man power in GIS and Remote Sensing, now the department decided to commence a PhD programme in GIS and Remote Sensing along with thesis.

Generally, the fundamental mission of the PhD progamme is to continually improve its provision   of services and to pursue the standards of excellence in and thereby to meet the needs of the country and the community. For opening of this program, the department has undertaken need assessments.

II. Surveyed Stakeholders

In the need assessment survey, important institutions, alumni and other potential trainees have been consulted.

III. Surveyed institutions

a. Municipal office, Adigrat.
b. Land administration and Planning, Adigrat.
c. Adigrat University
   College of Natural Science
   College of Natural Resource Management
   College of Commerce
d. Poly - Technique College
   2. Alumni and other potential trainees

IV. Result of Institution

All surveyed institutions deal with GIS and Remote sensing issues for efficient governance. The extent of their work dealing with GIS and Remote Sensing is greater than 25 % of their business (Table 1). This indicates that the absolute contribution of their view is believed as an essential for the development of the curriculum in the department.

Table 1. The response of institutions on the extent of their work dealing with GIS and RS

no	Item	Respondent	Percentage	Remark
1	Less than 25%	0	0	
2	25- 50%	4	20.0	
3	50-75%	6	30.0	
4	More than 75%	10	50.0	

The contacted institutions are believed to contribute in ranking the pre-selected courses by the curriculum development task force. Ranking the courses is important to prioritize for the addition of valuable course with the orientation of the countries development programme.

Accordingly, contacted institutions have been asked to rank courses to be included in the curriculum in the order of importance of courses (1st rank the most important and 17th rank least important). The result of the survey is shown in Table 2.

Table 2. Priority lists of courses as responded by institutions

SN	TENTATIVE COURSE LIST	RANK
1	Advanced GIS and Remote Sensing	1
2	Research Methods in GIS and Remote Sensing	2
3	Geodatabase Management	3
4	Spatial Data Visualization	4
5	Spatial Analysis and Modeling	5
6	Advanced GIS and Remote Sensing	6
7	Web GIS	7
8	GIS and remote sensing for urban planning	8
9	Advance remote sensing	9
10	GIS and Remote sensing in Land cover, land use change analysis	10
11	Terrain Analysis	11
12	Town Planning with GIS	12
13	Watershed development	13
14	Municipal GIS	14
15	Climate Change and adaptation with GIS and Remote Sensing	15
16	Natural Resource Assessment with GIS and Remote sensing	16
17	Hydrological analysis with GIS and remote sensing techniques	17

Apart from courses given options, institutions have been asked to include some courses that they think are important and to be considered in the curriculum. In this regard 4 courses have been suggested (Table 3).

Table 3. Courses suggested to be included other than courses listed above

SN	Courses
1	Route Network Analysis
2	GIS for crime analysis
3	GIS and remote sensing for agriculture planning
4	GIS for market analysis

Since institution collaboration is basic for the successful implementation of the program, the surveyed institutions have been asked the extent of their agreement, whether they can collaborate with the department for the intended postgraduate program. From the survey results we have learnt that 70 % of the institutions have responded strongly agree to form institutional collaboration and links (Table 4).

Table 4. Agreement or disagreement of intuitions to form institutional collaboration or link with department of Geography pertaining the PhD program

Scale	Response	Frequency	%
1	Strongly agree	14	70
2	Agree	4	30
3	Neither agree nor disagree	0	0
4	Disagree	0	0
5	Strongly disagree	0	0

There are many ways for organizations to work together which may vary in nature, purpose, degrees of commitment and levels of formality. In order to gain our students a practical oriented, and thorough knowledge on the proposed field of specialization, knowing collaboration type of institution is very important for consideration. The indicated areas of collaboration/links, were research, Co-advising of PhD theses, Teaching and research materials exchange, staff exchange respectively by 23, 17, 27 and 33 of institutions (Table 5).

Table 5. Indicated areas of collaboration/links

S. No.	Areas of collaboration	Frequency	%
1	Staff exchange in course deliberation	7	23.33
2	Co-advising of PhD Theses	5	16.67
3	Research collaboration	8	26.67
4	Teaching and research material exchange	10	33.33

In the above indicated areas of collaboration 1-3,

a. Staffs (professionals) with qualification of Ph.D. or equivalent are 5

b. Indicated courses to be handled and areas of advising and research collaboration

Table 6. Professional with their area of competence and their institutions who have agreed to give courses, advising or research collaboration

S. No	Courses, areas of advising and research collaboration	Institution
1	Natural resources management	Adigrat University
2	Geology Department	Adigrat University
3	College of Commerce and Business	Adigrat University
4	Faculty of Agriculture	Adigrat University
5	College of Engendering	Adigrat University
6	Biology Department	Adigrat University

In order to decide whether the department can open the PhD program based on the relevant of the courses and the future contribution of graduates to the development of the country, incorporatinginstitutions view in this regard is very fundamental.

Table 7. Opening of PhD programme in GIS and Remote Sensing in the department ofGeography, AU with the above suggested courses (curriculum) will contribute in producing important professionals required by the country to participate in development areas. Institution responses

Scale	Response	Frequency	%
1	Strongly agree	16	80
2	Agree	3	15
3	Neither agree nor disagree	1	5
4	Disagree	0	0
5	Strongly disagree	0	0

The broad sweep of Geography as a discipline and the range of options available in graduating with proposed postgraduate programme in the department shall forecasted from the institution point of view to ensure that GIS and Remote Sensing graduates have a wide range of career opportunities open to them. This can be predicted from the courses to be given and the assumption with a wide range of expected employers who can appreciate the range of personal and transferable skills in terms of team work, field work, presentation skills, and technical abilities.

Table 8. Employment opportunities to graduates with PhD Programme in GIS.

Scale	Response	Frequency	%
1	Certainly, will get employment opportunity	14	70
2	Likely will get employment opportunity	5	25
3	Difficult to predict whether they will get employment or not	1	5
4	Unlikely will get employment opportunity	0	0
5	Certainly will not get employment opportunity	0	0

V. Results of Alumni and other potential trainees

As it is depicted in Table 9, most of the respondents were completed their education in current year only. For instances almost 60 percent of them have completed their education in the current year and one year ago.

Table 9. Years of completion of undergraduate

Years of completion	No	Percentage
Current year	20	40
A year ago,	10	20
Two years ago,	7	14
Three years ago,	5	10
Four years ago,	4	8
Before four years ago	4	8
Total	**50**	**100**

Respondents were also asked whether they deal with GIS and Remote Sensing in their current profession. A large majority 75 % of them replied that most of the issue raised and done in their respective job /profession has a great relationship with subject GIS and Remote Sensing.

Table 10. In your current profession do you deal with geographical environmental and developmental studies?

Alternatives	Number	Percentage
Yes	15	75
No	5	25
Total	20	100

We also asked our respondents to indicate the proportion of their current work to what extent it focuses on GIS and Remote Sensing. Table 11 shows the results.

Table 11. What proportion of your work is focusing on geography and environmental studies?

Alternatives	Number	percentage
Very low (<25%)	2	13.33
Low (25-50%)	1	6.67
Medium (50-75%)	2	13.33
High (> 75 %)	10	66.67
Total	15	100

Regarding pursuing postgraduate study, almost 67 % of them replied that they will start postgraduate enrollment very shortly. Table 12 shows values of other alternatives.

Table 12. Respondents attitude whether to peruse postgraduate study or not

Alternatives	Number	percentage
A) Yes, very shortly	10	66.67
B) Yes after one year	2	13.33
C) Yes, after 2-3 years	2	13.33
D) Yes, but after 4 years	1	6.67
Not at all	0	0
Total	15	100

Out of the consulted sample respondents about all of them preferred to join PhD program in GIS and Remote Sensing. Other results are shown in table 13.

Table 13. If your answer is A-D, do you enroll in the PhD program in GIS and RS?

Alternatives	Number	Percentage
Strongly disagree	0	0
Disagree	0	0
Neither agree nor disagree	0	0
Agree	3	20
Very agree	12	80
Total	15	100

As indicated in Table 14 courses are ranked by the respondents in the following manner:

1st >> Fundamentals of GIS

2nd >> Fundamentals of Remote Sensing

3rd >> Advanced Quantitative Methods in Geog. & Env. Studies

4th >> Global Positioning System

COURSE LIST	RANKING (R) AGAINST FREQUENCY (F)								∑f	∑(r*f)	∑(r*f)/∑f	GROUP RANK
Advanced GIS and Remote Sensing	5	3	2				2			377	7.54	1
Research Methods in GIS and Remote Sensing	8	2	3				2			420	8.40	2
Geodatabase Management	3	8	2				3			449	8.98	3
Spatial Data Visualization	1	3	7				2			466	9.32	4
Spatial Analysis and Modeling	1	2	1				3			479	9.58	5
Data Analysis in GIS	1	2	2				3			495	9.90	6
Web GIS	2	1	2				2			504	10.08	7
GIS and RS for urban planning	1	2	1				2			514	10.28	8
Advance remote sensing	1	1	2				3			537	10.74	9
GIS and RS in Land cover, land usechange analysis	1	1	2				2			542	10.84	10
Terrain Analysis	1	2	1				2			576	11.52	11
Town Planning with GIS	1	1	2				3			583	11.66	12
Watershed development	1	2	2				2			601	12.02	13
Municipal GIS	2	1	1				2			619	12.38	14
Climate Change and adaptation	1	1	1				2			645	12.90	15
Natural Resource Assessment	1	1	1				2			654	13.08	16
Hydrological analysis with GIS and remote sensing techniques	0	0	0				0			729	14.58	17

In addition, Alumni and other potential trainees have been asked to include some courses that they think are important and to be considered in the curriculum and they suggested thefollowing areas.

I. Marketing GIS
II. Remote Sensing for weather forecasting
III. GIS for Journalism
IV. GIS for crime analysis

Priority lists of courses as by institutions and Alumni and other potential trainees have been combined (Table 15). The combined result indicates the following courses were in the front priority lists.

1. Fundamentals of GIS
2. Fundamentals of Remote Sensing
3. Advanced Q. Methods in Geog. & Environmental Studies

Table 15. Combined priority lists (institution + Alumni and other potential trainees) of courses

COURSE LIST	Alumni & potential Trainees Rank	Institution Rank	Combined value	Combined Rank
Advanced GIS and Remote Sensing	1	1	1	1
Research Methods in GIS and Remote Sensing	2	2	2	2
Geodatabase management	3	3	3	3
Spatial Data Visualization	4	4	4	4
Spatial Analysis and Modeling	5	5	5	5
Data Analysis in GIS	6	6	6	6
Web GIS	7	7	7	7
GIS and RS forurban planning	8	8	8	8
Advance remote sensing	9	9	9	9
GIS and RS in Landcover, land use change analysis	10	10	10	10
Terrain Analysis	11	11	11	11

Respondents were also requested concerning their feeling whether to open PhD program in GIS and Remote Sensing. Consequently 90% of them were in favor of opening the program (Table 16).

Table 16. Suggestions of the respondents on opening of PhD program in GIS and Remote Sensing:

Alternatives	Number	Percentage
Strongly Agree	35	70
Agree	10	20
Neither agree nor	5	10
Disagree	0	0
Disagree	0	0
Very disagree	0	0
Total	50	100

With regard to employment opportunities of the would be graduate in GIS and RS, almost all 60% of them argued that graduates will definitely secure job opportunity in the job market (Table 17). Only 10% of the respondents were not sure about what to happen in the future. Thiscan also be a good reason behind opening PhD program in GIS and Remote Sensing in our department.

Table 17. What is your judgment about the job opportunities of scholars in GIS andRS?

Alternatives	Number	Percentage
Certainly, will get employment opportunities	30	60
Likely will get employment opportunities	15	30
Difficult to predict	5	10
Unlikely to get employment opportunities	0	0
Certainly, will not get employment opportunities	0	0
Total	50	100

V. Summary of the Results

The result of the need assessment obviously indicates that there is a strong desire from the side of many scholars towards the opening of the programme.

Adigrat University

Department of Geography & EnvironmentalStudies

*Questionnaire prepared for Field Survey and Consultations as a part of **Need assessment and Curriculum preparation** for* **PhD in GIS and Remote Sensing.**

Part 1B (to be completed by Alumni and other potential trainees to be enrolled in post-graduate program of Geography and Development Studies)

March
2023
Adigrat

Note: Department of Geography and environmental studies of Adigrat University (AU) is planning to commence a postgraduate studies program in 2008/9. Now we are at ***curriculum document preparation and need assessment phase***. Very soon, we will have in campus and National curriculum review workshop at Adigrat University. For the opening of the program and designing of relevant curriculum for the anticipated program, survey is basic in order to collect important information from important stakeholder. For this purpose, we have designed avery brief questionnaire to be completed by you. In any circumstances, it is our professional responsibility to contain your (individual) information secrete.

We are very much grateful for your assistance in completing this questionnaire by sharing us your invaluable time.

Date of Consultation: _____

Institution/department/section consulted: _____

1. When did you complete your undergraduate/post graduate program?
     a) one year ago
     b) two years ago
     c) three years ago
     d) four years ago
     e) Before four years ago
2. In your current professional engagement do you deal with Geographical, Environmental & Developmental issues of Ethiopia? Yes No

3. If the answer to question 2 is yes: What percent of your work is focusing in this area?

      a) Less than 25%

      b) 25-50%

      c) 50-75%

      d) Greater than 75%

4. Do you have a plan to have a post-graduate study?

      a) Yes, very shortly
      b) Yes, but after 1 year
      c) Yes, but after 2-3 years
      d) Yes, but after 4 years
      e) Not at all

5. If your answer to question 4 is "a" to "d", do you want to enroll in the PhD program in GIS and Remote Sensing?

      a) Strongly disagree
      b) Disagree
      c) Neither agrees nor disagrees
      d) Agree
      e) Very agree

6. If your answer for question 4 is "e" would you please indicate your reason(s)?

_____

_____

7. If your answer to question 4 is "a" to "d", What courses do you think to be included in **PhD program in GIS and Remote Sensing***? Would you please rank the courses in order of their importance (rank 1st = very important and Rank 21st = least important from the courses indicated in the list. Please give ranking for all courses listed.*

TENTATIVE COURSE LIST	RANKING
Fundamentals of GIS & Remote Sensing	
Population & Natural resource management	
Advanced Quantitative Methods in Geography & Environmental Studies	
Global Positioning System	
Geodatabase Management in GIS - Common	
Data Analysis in GIS	
Web GIS	
GIS and remote sensing for urban planning	
Advance remote sensing	
GIS and Remote sensing in Land cover, land use change analysis	
Terrain Analysis	
Town Planning with GIS	
Watershed development	
Municipal GIS	
Climate Change and adaptation with GIS and Remote Sensing	
Natural Resource Assessment with GIS and Remote sensing	
Hydrological analysis with GIS and remote sensing techniques	

8. If not mentioned in the above list of courses, as a professional, would you please, indicate important courses to be included in the curriculum of **PhD program in GIS and Remote Sensing**, which would particularly be relevant to Ethiopian and Tropical Highland development?

1. _____

2. _____

3. _____

4. _____

9. Opening of **PhD program in GIS and Remote Sensing** in the department of Geography, AU with the above suggested courses (curriculum) will contribute in producing important professionals required by the country to participate in development areas?

      a) Strongly agree

      b) Agree

      c) Neither agree nor disagree

      d) Disagree

      e) Very disagree

10. In your judgment, graduates with **PhD program in GIS and Remote Sensing**:

      a) Certainly, will get employment opportunity

      b) Likely will get employment opportunity

      c) Difficult to predict whether or not they will get employment

      d) Unlikely will get employment opportunity

      e) Certainly, will not get employment opportunity

Thank you very much once again for your cooperation!

Adigrat University

Department of Geography & Environmental Studies

Questionnaire prepared for Field Survey and Consultations as a partof Curriculum preparation for **PhD Program in GIS and Remote Sensing.**

Part 1A (to be completed by institutions/departments, sections that involve in the area of Geography and Development issues)

March 2023Adigrat

Note: Department of Geography and environmental studies of Adigrat University (AU) is planning to commence a postgraduate studies program in the session 2015-16. Now we are at curriculum document preparation phase. First, we will have in campus curriculum review and later National curriculum review will be held at Adigrat University. For the purpose of designing relevant curriculum for the anticipated program, survey is basic in order to collect important information from important stakeholder. For this purpose, we have designed a very brief questionnaire to be completed by your good institution/department/section.

In any circumstances, it is our professional responsibility to contain your (individual) information secrete.

We are very much grateful for your assistance in completingthisquestionnaire by sharing us your invaluable time.

Date of Consultation: _____

Institution/department/section consulted: _____

1. Is your Institution/department/section dealing with GIS and Remote Sensing issues ofEthiopia? Yes No

2. If the answer to question 1 is yes: What percent of your work is focusing in this area?
    a) Less than 25%
    b) 25-50%

    c) 50-75%

    d) Greater than 75%

3. What courses do you think to be included in the PhD program in GIS and Remote Sensing*? Would you please rank the courses in order of their importance (rank 1st = very important and Rank 21st = least important from the courses indicated in the list. Please give ranking for all courses listed.*

TENTATIVE COURSE LIST	RANKING
Fundamentals of GIS & Remote Sensing	
Population & Natural resource management	
Advanced Quantitative Methods in Geography & Environmental Studies	
Global Positioning System	
Geodatabase Management in GIS - Common	
Data Analysis in GIS	
Web GIS	
GIS and remote sensing for urban planning	
Advance remote sensing	
GIS and Remote sensing in Land cover, land use change analysis	
Terrain Analysis	
Town Planning with GIS	
Watershed development	
Municipal GIS	
Climate Change and adaptation with GIS and Remote Sensing	
Natural Resource Assessment with GIS and Remote sensing	
Hydrological analysis with GIS and remote sensing techniques	

4. As a professional, would you please, indicate important courses to be included in the curriculum of PhD program in GIS and Remote Sensing, which would particularly be relevant to Ethiopian and Tropical Highland development?

1. _____

2. _____

3. _____

4. _____

5. Department of Geography and Environmental Studies of AU would like to form institutional link to your institution particularly in the area of this Higher Studies *(Geography and Development Studies)*. What is your agreement/disagreement from your side/institution to form institution linkage to our department?
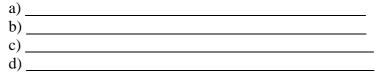
a) Strongly agree
b) Agree
c) Neither agree nor disagree
d) Disagree
e) Strongly disagree

6. In question 5 if your choice is "a" or "b", in which of the following area(s) your

institution/department/section can form the institutional linkage?

     a) Staff exchange in course deliberation

     b) Co-advising of PhD Theses

     c) Research collaboration

     d) Teaching and research material exchange

7. In question 6 if your indication is (are) "a", "b", and/or "c", how many staff (professionals)do you have with qualification of Ph.D. or equivalent? ___

8. For the purpose of our data-bank and immediate contact and correct selection, whenever weneed to ask you cooperation in the area (s) your positive indication in question 6, would you please give us field of specialization of your professionals with qualification of Ph.D. orequivalent and above?

     a) _____

     b) _____

     c) _____

     d) _____

9. Opening of PhD program in GIS and Remote Sensing in the department of Geography, MU with the above suggested courses (curriculum) will contribute in producing important professionals required by the country to participate in development areas?

     a) Strongly agree

     b) Agree

     c) Neither agree nor disagree

     d) Disagree

     e) Very disagree

10. In your judgment, graduates with *PhD program in GIS and Remote Sensing*:

     a) Certainly will get employment opportunity

     b) Likely will get employment opportunity

     c) Difficult to predict whether or not they will get employment

     d) Unlikely will get employment opportunity

     e) Certainly will not get employment opportunity

Thank you very much once again for your cooperation!