

Degree Program Documentation Master's Program Land Management and Geospatial Science

Part A
TUM School of Engineering and Design
Technical University of Munich

General Information:

- Administrative responsibility: TUM School of Engineering and Design
Professional Profile Geodesy
- Name of degree program: Land Management and Geospatial Science
- Degree: Master of Science (M.Sc.)
- Standard duration of study and credits: Four semesters of enrollment and 120 credit points (CP)
- Form of study: Full-time
- Admission: Aptitude assessment (EV)
- Start: Winter semester (WiSe) 2020/2021
- Language(s) of Instruction: English
- Main Location: Munich
- Tuition fees for students from non-EEA countries: No tuition fees
- Academic Program Director: Prof. Dr. Christoph Holst
- Academic administrator (program design): Prof. Dr. Walter Timo de Vries
- Contact for further questions (regarding this document):
Person: Prof. Dr. Walter Timo de Vries
Email address: wt.de-vries@tum.de
Phone number: 089 289 25799
- Status as of: 10.07.2024

Table of Contents

1	Degree Program Objectives	4
1.1	Purpose	4
1.2	Strategic Significance	5
2	Qualification Profile	8
3	Target Groups	10
3.1	Target Audience	10
3.2	Prerequisites.....	10
3.3	Target Numbers.....	11
4	Demand Analysis	13
5	Competition Analysis	15
5.1	External Competition Analysis	15
5.2	Internal Competition Analysis	15
6	Program Structure	18
7	Organization and Coordination	30
8	Enhancement Measures	32

1 Degree Program Objectives

1.1 Purpose

According to the UN-Habitat¹, urbanization is increasing pressure on land, with people living in cities expected to grow by 175% by 2030. On the other hand, 70% more agricultural land is needed to increase food production by 2050. 90% of land holdings in developing countries are not documented, administered or protected, and land administration practices do not cater for the complexity of land issues with overlapping rights and claims. Consequently, about one billion people globally live in fear of losing their home or land due to land tenure insecurity.² Women and youth continue to have limited or insecure access to and control over land. Lack of secure land tenure exposes people to climate-related hazards and influences their adaptive capacity to climate change. For example, studies in Honiara, Mindanao, St Vincent and Grenadines, north-eastern Syria, and the Karamoja region in Uganda show that people without secure land tenure are the most sensitive to climate impacts, and the most exposed to climate risks such as flooding, storm surge, landslides, and drought.³ The land sector is crucial for peace and stability, sustainable economic development, and food security. Land professionals and people-centered policymakers are needed for managing land rights and use, and natural resources.

Deriving solutions to these problems typically requires a combination of contextual insights, technical-methodological instruments, and communication skills to resolve conflicts and thereby accelerate land rights documentation, land tenure security, and sustainable land use. It requires responsible governance of land tenure and fit-for-purpose land information systems to document people-land relationships in a politically, legally, and socio-culturally sensitive manner. However, in developing countries, there is a relatively narrow knowledge field of land information systems, cadastral data, and land registration. Given that the majority of the land is unregistered in these countries, this specific knowledge on how to adopt appropriate land information (digitization) policies in a developing context would involve the development and implementation of new technologies (such as voluntary geographic information, fit-for-purpose cadasters) which would not be possible with conventional European knowledge and resources.

The purpose of the master's program in Land Management and Geospatial Science (LMGS) at the School of Engineering and Design (ED) of the Technical University of Munich (TUM) is to educate land management professionals who can apply land and spatial-related concepts and tools, such as the continuum of land rights approach and fit-for-purpose land administration to analyze international contemporary land issues such as land tenure insecurity and land use change. In addition they have the executive soft skills to carry out land administration functions to solve these land issues. The LMGS program, therefore, equips graduates with sustainable land management tools for interventions such as smart and responsible land management, tenure-responsive land use

¹ <https://unhabitat.org/topic/land-tenure-security>

² <https://www.prindex.net/data/>

³ <https://unhabitat.org/sites/default/files/documents/2019-06/un-habitat-gltn-land-and-climate-vulnerability-19-00693-web.pdf>

planning, urban-rural land linkages, tenure-restoration nexus, and fit-for-purpose land administration that are aimed at delivering secure land tenure for all.

LMGS graduates will work at the interface of politics and technology applying existing land tools or design new policies and interventions for documenting, administering, or protecting land tenure in specific socio-legal contexts. Thus, they contribute their expertise to the development of creative, innovative, and sustainable solutions to complex and contextual spatial problems. They also contribute their technical-methodological expertise to the development of land and geospatial information systems that can capture, monitor, store and query multi-dimensional information on land use, land tenure and natural resource rights. Finally, they apply their interrelated geospatial, social and legal skills to reconciling different and competing stakeholder interests in land.

The LMGS is a separate program of its kind and with an international development relevance for TUM and beyond. It views land management from the multiple perspectives of land, water, and forest, with a specific focus on applying the technical skills and knowledge obtained from the program for development in developing/transition countries. The program is less geared towards employment in the German or European market unless there is a particular development connection (such as within BMZ/GIZ). Hence, TUM acts as a knowledge hub where international experts and students share and develop new knowledge about land management.

1.2 Strategic Significance

People, nature, and society are at the center of sustainable innovation progress at the Technical University of Munich.⁴ In the pursuit of responsible and socially acceptable innovations, TUM expands the concept of engineering and opens it up to the humanities and social sciences by incorporating the values, needs and expectations of society into the technologies to be developed. This line of thinking shapes the basic understanding of teaching and the objectives of TUM ED, which currently offers almost 40 degree⁵ programs and embraces a people-centered engineering approach to teaching and learning. TUM ED believes that new knowledge and methods are generated through the integration of different disciplines and cooperation across different sites. Therefore, its activities focus on the analysis, simulation, and development of expertise and talents in the fields of technology, mobility, energy, nature, materials and the built environment to tackle complex challenges with a sense of responsibility for people and planet Earth. Through innovation partnerships in these fields, future graduates will produce engineering solutions and innovations that are sustainable, fit-for-purpose, and responsive to the needs of society in terms of structure, process, and outcomes.

The degree programs at TUM are assigned to Professional Profiles (PPs). These profiles organize the degree programs and their competence and qualification profiles not only along the "classic" disciplines. Based on current and future challenges, they transfer research content with cross-sectional competencies across subject and school boundaries into teaching. This takes place along scientific framework systems and methods, but also along professional fields or industries. The

⁴ <https://www.tum.de/en/about-tum/goals-and-values/mission-statement>

⁵ <https://www.ed.tum.de/en/ed/studies/degree-programs/>

degree programs of the School of Engineering and Design are currently grouped into the following nine PPs:

1. Aerospace
2. Geodesy
3. Geo-Engineering
4. Civil Engineering
5. Environmental Engineering
6. Mechanical Engineering
7. Architecture and Design
8. Mobility
9. Interdisciplinary Engineering

Together with five other programs, the LMGS program belongs to the Professional Profile Geodesy:

- B. Sc. Land Management
- B. Sc. Geodesy and Geoinformation
- M. Sc. Geodesy and Geoinformation
- Ms. Sc. Earth Oriented Space Science and Technology
- M. Sc. Cartography

The Professional Profile Geodesy focuses on constructing and maintaining information about geospatial objects by defining, measuring, evaluating, visualizing, and mapping geospatial objects and their geospatial interrelations and populating databases with such information. A common denominator of the professional profile Geodesy is geospatial data and the design, construction, and operation of technical systems that fulfill essential human and existential needs, including land, to which the LMGS program aligns. The LMGS program is underpinned by the concept of intelligent and responsible land management that aims at designing land management interventions, which rely on geospatial information technologies and are responsive to the needs of society. This concept resonates with TUM ED's portfolio of "engineering with a sense of responsibility for people and planet Earth." Moreover, land management is at the core of sustainability, where responsible land governance and secure land tenure play pivotal roles in land restoration and neutrality of land degradation. Most importantly, land tenure security is a policy target of 5 of the 17 UN Sustainable Development Goals – no poverty, zero hunger, gender equality, sustainable cities and communities, and life on land^{6,7}. Therefore, the LMGS incorporates multiple perspectives of land in teaching and research approaches that enable our staff, students, and researchers to connect land management

⁶ <https://landportal.org/node/52263>

⁷ <https://sdgs.un.org/goals>

concepts with environmental and sustainability concepts such as land governance for climate change, machine learning for land use planning and use change, as well as food security. Following the interdisciplinary approach of TUM ED, modules from the TUM School of Social Sciences and Technology and TUM School of Life Sciences are included in the general elective modules and modules that are part of the area of concentration. These modules cut across sustainability, policy, governance, management, and research sciences, where multiple perspectives of land are introduced to make land-relevant connections to other fields.

The LMGS program complements the "human-centered engineering" approach of TUM ED by embracing human geodesy – placing humans at the center of traditional geodesy where technical interventions coincide and co-evolve with social changes and human organization. Beyond the division, measurement, and representation of the earth in traditional geodesy, the LMGS program fosters collaboration between geodetic engineers and social scientists to develop acceptable socio-technical solutions to manage land and natural resources in different social contexts. Such collaboration between geodesy and land management is highly manifested in the LMGS program, where about 50% of core modules in the LMGS program are offered by the Chairs of Geodesy and Geoinformation. The developing country focus of the LMGS program enables geospatial technology transfer for the sustainable use and management of land in these countries.

2 Qualification Profile

Graduates of the LMGS program are specialized generalists with a broad overview of land management and geospatial science topics and approaches. This includes fit-for-purpose land administration, continuum of land rights, and geospatial techniques for land administration functions such as land use planning, land valuation, land taxation, land adjudication, and land development. In addition, the graduates are able to abstract and synthesize key scientific issues in land management from multiple perspectives, such as land grabbing, food insecurity, and climate change, and can apply sustainable land management concepts and methods to develop responsible land interventions. The graduates understand complex people-land relationships and can design land and property information systems to document these relationships under specific technical, economic, legal, political and social conditions.

They are able to facilitate interaction between different built environment organizations such as land registration departments, surveying departments, land use planning departments, etc. LMGS graduates understand and use institutional and organizational systems to design, administer, govern, discuss and enforce land policies and land administration functions.

They are also able to conduct cutting-edge research on land-related problems such as climate change, transboundary conflicts, and land use change from multiple perspectives.

Graduates are specialists in one chosen area of concentration and have tailored expertise to evolving land management roles in international organizations, local governments, and non-governmental organizations.

Three areas of concentration

Graduates have in-depth knowledge and skills in one of the following areas of concentration – (i) systems of land use and land rights, (ii) systems of geospatial engineering for land, water, and forestry management, and (iii) systems of planning, policy, and governance. Graduates, who concentrate on **Systems of Land Rights and Land Use**, are able to:

- Analyze, interpret, and compare international land tenure systems and property rights frameworks.
- Design and implement sustainable and responsible land administration systems and land interventions that promote equitable land distribution and secure land rights.
- Evaluate land use policies and their impacts on sustainable development and social justice.
- Conduct land and property valuation and evaluate the cost-efficiency and cost-effectiveness of land interventions using economic techniques such as the highest and best use of land.
- Advise on the legal and regulatory aspects of land use and ownership, including dispute resolution and land reforms.
- Apply conventions related to informal and customary land for the implementation and management of land and geospatial interventions in areas where formal legal regulations are not applicable. In particular, graduates can identify and recommend

suitable approaches to deal with intangible land values, such as tenure security, the role of women, and customary rights systems.

- Design fit-for-purpose land use and information systems that maintain information about land rights, land use, land value, and restrictions on land.

Graduates who concentrate on the **Systems of Geospatial Engineering for Land, Water and Forestry Management**, are able to:

- Develop and apply geospatial technologies for the efficient management of land, water, and forestry resources.
- Apply airborne and space technologies to capture information about spatial boundaries, land use, land cover, and spatial changes.
- Design and manage databases for geospatial information related to land, water, and forestry resources using fundamental geodetic reference systems.
- Implement remote sensing and GIS techniques to monitor and assess environmental and land use change.
- Conduct spatial analysis and modeling to support decision-making in natural resource management and land-related issues such as renewable energy transition, large-scale land investments, agricultural intensification, and livelihoods of local communities.
- Apply smart and fit-for-purpose geospatial tools to capture, process, document, and manage rights in natural resources such as land, water, and forests.
- Collaborate with environmental scientists and engineers to develop sustainable nature-based solutions to natural resource management and environmental conservation.

Finally, graduates who concentrate on **Systems of Planning, Policy and Governance**, are able to:

- Formulate and evaluate land use policies that align with sustainable development goals.
- Analyze land issues from global perspectives and develop policies and guidelines adapted to different socio-legal country situations.
- Deconstruct and translate complex social, technical, and legal land matters into policy interventions.
- Design progressive policies to address land issues such as land grabbing, land use change, land tenure security and climate change.
- Communicate internationally and interculturally by working in intercultural teams and analyzing international land policies and case studies of land interventions in different legal and socio-political contexts.
- Develop strategic plans for urban and rural land use that incorporate community needs and environmental considerations.
- Analyze governance structures and processes to improve transparency and accountability in land governance.
- Understand current methodological approaches for land policy analysis, implementation, monitoring and evaluation, as well as stakeholder mapping, analysis and engagement.

- Engage with diverse stakeholders to facilitate participatory planning and land governance practices.
- Advocate for policy changes and influence legislative processes related to land use and land governance. They drive policy innovation by developing solutions to current policy issues, such as food insecurity and land conflicts, based on their familiarity with ratified charters and guidelines on global best practices in land governance.

3 Target Groups

3.1 Target Audience

The main target groups of the LMGS program are international and national applicants who are particularly interested in land issues in developing countries' contexts. Before entering the LMGS program, candidates should have a basic understanding of (geo)spatial reasoning and information sciences and have an affinity for land-related issues. The required academic background for applicants is a bachelor's degree in one of the following fields:

- Land Management/Administration,
- Geomatic Engineering, Geoinformatics,
- Spatial Planning,
- Land Surveying,
- Real Estate,
- Geography,
- Natural Resource Management,
- Geographic Information Science,
- Environmental Resource Management,
- Environmental Engineering,
- Property Law,
- Earth or Environmental Science,
- Architecture,
- Urban and Rural Development,
- Land Use Planning,
- Geodesy, and
- Other built environment professionals who have an interest in or who are working with land and spatial data.

3.2 Prerequisites

In their undergraduate studies, applicants should have acquired knowledge in geospatial engineering sciences, land and natural resource sciences, and social sciences, which is demonstratable through courses taken in these areas.

It is recommended that applicants have some basics in geo-information and working with geospatial data and software. A good command of the English language and good communication skills are also required. Therefore, during the application process, the applicants must hand in the following:

- Motivation letter (of a minimum of 500 words and a maximum of 800 words).
- English Language certificate, it should be one of the following:
 - Certificate for Test of English as a Foreign Language (TOEFL) with a minimum of 88 (Internet-based).
 - IELTS: Band Score 6.5; academic module or Cambridge Main Suite of English Examinations
 - Proof of English as a language of instruction in “Diplom” or Bachelor’s degree program
 - Further, the proof can be provided by a language qualification at C1 level of the Common European Framework in the amount of at least 3 credits; English language skills are also demonstrated by successfully completing and passing a total of 12 credits of English language courses in the undergraduate study.

With reference to the above list, proficiency test certificates of IELTS, TOEFL, or Cambridge Main Suite of English Examination are required for non-native English speakers unless they already hold an academic degree in which the medium of education has been English. Native English speakers or applicants who have completed an academic program (Bachelor or Master) in English do not need to submit the results of an English proficiency test. Applicants who have completed a program in English must submit a certificate of medium of education (English) from the respective institution. The procedure for enrolment involves candidates enrolling through TUM’s online portal. One by one, oral interviews are conducted in person (in cases where candidates are willing to make themselves physically available) or by telephone (in cases where candidates are unable to be physically present). The results of preliminary assessments and interviews lead to a ranking.

3.3 Target Numbers

The program aims to attract 20-30 students per year, which offers the advantage of better interaction with students and the provision of student advisory services tailored to the specific needs of the students.

In the last three academic years, from 2020/2021 to 2023/2024, the LMGS program has received significant interest, with an average of 137 applications per year. The program can be started in the winter semester of each academic year. In its first academic year, 2020/2021, the program met its target numbers with 20 students. Due to Covid restrictions and delays with visas, only 7 and 8 students were enrolled in the academic years 2021/2022 and 2022/2023, respectively. In the academic year, 2023/2024, the program met its target numbers with 20 students again. By adopting

a continuous admission approach, the current program has solved the visa problem (see chapter 8). Figure 1 shows how the LMGS program has performed in terms of meeting its target numbers.

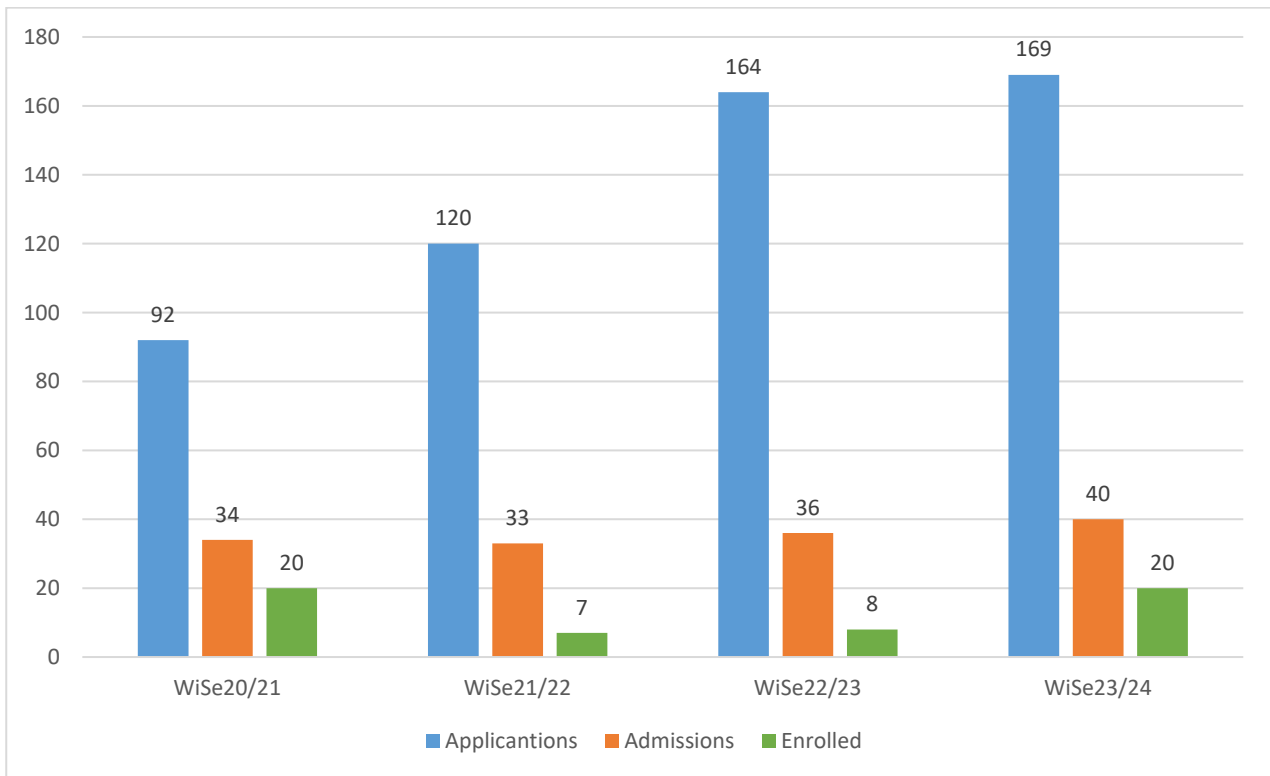


Figure 1: Yearly number of applications, admissions, and students who enrolled in the LMGS program

4 Demand Analysis

Projections from government agencies and market research firms alike point toward significant growth of the geospatial technology industry as well as growth in GIS-related employment sectors and fields such as land management. The global geographic system market is predicted to reach \$25, 121 million by 2030, at a cumulative growth rate of 12.2% between 2021 and 2030.⁸ There are currently an estimated 287,200 geospatial information scientists in the United State with an expected 9.3% growth of the geospatial information scientist job market between 2016 and 2026.⁹ In Europe, Real Estate and Investment Trusts industry is expected to register a cumulative annual growth rate of more than 5.70% between 2024 to 2029. In this same period, the Europe Residential Real Estate Market size is estimated at USD 1.95 trillion in 2024, and is expected to reach USD 2.43 trillion by 2029, growing at a cumulative annual growth rate of 4.5%.¹⁰ These market dynamics pose implications for land use and have prospects for land professionals. Hence, the following types of national, international and multilateral organizations need skilled professionals to deal with land policy, land governance, land development, spatial planning, as well as urban and rural development:

- National and local cadastres and land registration organizations need professionals who can design and manage land information systems, which can deliver information services (on existing land rights, land use, land value, spatial restrictions) to notaries, planning agencies, buyers, and sellers of houses and land and real estate agencies.
- Spatial development agencies require professionals who are capable of evaluating where and why land-related problems occur and how these can be solved given a local political context.
- NGOs and interest groups concerned with land reform, land rights, and land restitution rely on educated staff members who do not only have a solid background in legal issues, such as land rights, but also in technical issues, such as how to register land rights in information systems, and how to convince politicians on alternative land management solutions.
- Ministries for land, housing, and (re)settlement typically need to design national land policies that are in line with other spatial policies. As a result, they require capacity in land management and geospatial science in order to design and compare scenarios, both as discussion and consultation documents and as final land policies.
- Municipalities are often responsible for raising land taxes and drafting land policies where expertise in land management are needed.
- Authorities, private companies and NGOs involved in spatial planning.

⁸ <https://www.psmarketresearch.com/press-release/global-geographic-information-system-market#>

⁹ <https://www.careerexplorer.com/careers/geospatial-information-scientist/job-market/>

¹⁰ <https://www.mordorintelligence.com/industry-reports/residential-real-estate-market-in-europe>

- European and UN agencies dealing with land politics constantly need land consultants in developing countries.
- Authorities, private companies, and NGOs dealing with land development, participation, and community development (e.g., regional land development agencies, urban or rural planning actors, village and city administrations).

5 Competition Analysis

5.1 External Competition Analysis

Within Germany, few similar programs combine the domain of land management or closely related fields (such as geodesy, civil engineering, spatial planning, and landscape architecture) to development. In Germany, these are:

- Geodesy and Geoinformatics, Leibniz University Hannover
- Geodetic Engineering, Rhenish Friedrich Wilhelm University of Bonn
- Geodesy and Geoinformation, specialization in Land Management, Technical University of Darmstadt
- Geoinformatik and Landmanagement, OTH – Technical University of Applied Sciences

Internationally some Master programs offer a similar combination of a focus on land and on development. International comparable programs include:

- Spatial Development and Infrastructure Systems, Federal Institute of Technology Zurich (ETH Zürich), Switzerland
- Bioscience Engineering: Land Management, KU Leuven, Belgium
- Surveying, Planning, and Land Management (specialization in Land Management), Aalborg University, Denmark
- Geoinformation Science and Earth Observation (specialization Land Administration), Spatial engineering, University Twente / ITC
- International Land and Water Management, Wageningen University, The Netherlands
- Rural Estate and Land Management, Harper Adams University, UK
- Rural Land and Business Management, Spatial Planning and Development, University of Reading, UK
- Surveying and Land/Environmental Management, University of Exeter, UK
- Environmental Surveying, Birmingham City University, UK
- Environmental Sciences, Policy and Management (MESPOM), Central European University, Hungary
- Land Governance and Policy, Kwame Nkrumah University of Science and Technology, Ghana
- Land Management, SD Dombo University of Business and Integrated Development Studies, Ghana

Compared to other programs, the LMGS program is different in the following points:

- LMGS considers land management broader than land administration and the application of geospatial technologies for land administration only. As LMGS professionals will work at the interface of politics and technology, they need to be able to judge the relevancy of certain

geospatial technologies in a broader spectrum of land management applications. The other programs are either more tool-oriented (e.g., focusing on the development and application of GIS technology) or focus more on an entirely different sector (e.g., environment). LMGS focuses on designing and evaluating interventions that help to redistribute socio-legal aspects of land rights, land access, and land use in a multidimensional and responsible manner.

- Within the LMGS program, there is comparatively much more attention on ‘fit-for-purpose’ and adaptable technical-legal aspects of land rights, land registration, and cadastral systems. In addition, there is more attention on how to deal with informal systems alongside formal systems of land.
- The relation of land use and land rights as part of development strategies is more prominent in the LMGS program as compared to other programs.
- Compared to other programs more attention is paid to intangible land values (such as tenure security, role of women, and customary rights systems) than on economic and financial values.

The LMGS master’s program is unique in its holistic and integrated view of land management. It has a number of unique selling points:

- The program is based on the fundamental assumption that land management and land-related problems do not stop at borders. Knowledge and skills need to be shared internationally as solving land management problems requires social sensitivity and cross-cultural interaction. The required modules in land management and geospatial engineering provide a good overview of the importance of the social context for establishing and recognizing land rights, which varies across regions and nations. In addition, a wide variety of maps and spatial data from different countries are studied to understand different international data formats.
- Through the ‘open’ elective semester, each student has the possibility for knowledge mobility and designing their own type of specialization – either more land tenure systems-oriented, more geospatially oriented, or more planning and governance oriented. The international and integrated nature of the degree makes the LMGS program unique.
- Career and research opportunities in international organizations. In the same way, as for the topic formulation, the students benefit from the already existing alumni network of the former master’s degree program Land Management and Land Tenure. The degree program coordinator is also using established contacts for ongoing research projects in target countries for field research. Besides that, to keep the network alive and fully functioning, summer schools and refresher courses are organized regularly in different locations for TUM ED alumni all over the world. (e.g., Ghana refresher course in the summer of 2017, China summer school in 2017, a refresher course in Indonesia in 2016, Land Management and Land Tenure Alumni Seminar 2021).

5.2 Internal Competition Analysis

LMGS integrates other disciplines for the creation of both suitable and politically acceptable land, water, and forest solutions. The LMGS program has connection with the following Master programs at TUM:

- Geodesy and Geoinformation (GuG) – TUM ED
- Environmental Engineering (EE) – TUM ED
- Landscape Architecture (LA) – TUM ED
- Sustainable Resource Management (SRM) – TUM School of Life Sciences
- Governance – TUM School of Social Sciences and Technology

Nonetheless, some LMGS-specific distinctions are highlighted below.

While GuG emphasizes learning to design and develop geospatial technology, LMGS focuses on embedding and applying geospatial technology in organizational, policy and legal processes for land interventions. For example, in GuG students will learn how to design photogrammetric systems, whereas in LMGS they will embed and apply photogrammetric technology in land policy design and evaluation processes. Apart from that, there is also a similar program at Bachelor level, Land Management (BoLe), which is taught in German only. Compared to BoLe, LMGS offers a broader spectrum of land interventions and the integration of geospatial technologies in land reform processes, combining both legal regulatory frameworks and alternative soft governance solutions, such as systems for the legitimate use of land rights or voluntary guidelines. Whereas governance is broad, the LMGS focuses on land governance, which has spillover effects on society and the environment.

While dealing with housing and property issues is common to both EE/LA and LMGS, knowledge of property rights and how to reform, reshape and redistribute property rights, both formal and informal, is explored more critically in LMGS. Here, multi-level land policies that link land rights to land development are designed with multiple depths of focus.

The main difference between SRM and LMGS is the way in which land as a resource is externally viewed and analyzed. LMGS focuses on the characteristics of what happens on the land surface (location, boundaries, ect.) and the processes (legality and legitimacy) that regulate it. Whereas SRM considers land as one of the economic resources alongside other subsoil resources and resources such as water, energy and food. In SRM, land parcels and division are not the primary focus, which is more strongly represented in LMGS by looking at methods of spatial distribution and analysis of land interests, claims and rights.

In conclusion, compared to all programs, LMGS is much more internationally oriented as land-related matters do not stop at the borders of countries or regions. The primary emphasis is on developing expertise in a variety of legal and institutional systems and perspectives, rather than knowledge of construction-oriented or technology-oriented methods.

6 Program Structure

The LMGS degree program can be started in the winter semester. The language of the program is English. The standard study period for the LMGS program is four semesters. The required number of credits to be earned for the entire duration of the program is 120 credits. These 120 credits are distributed as follows:

- | | |
|---|-------|
| • Required modules | 45 CP |
| • General elective modules | 15 CP |
| • Area of concentration elective modules | 20 CP |
| • General or area of concentration elective modules | 10 CP |
| • Master's thesis | 30 CP |

The typical teaching formats in the LMGS program are a combination of lectures, exercises, written project works and seminars. Lectures and integrated exercises are dominantly used in the required modules, while seminars and project work are dominant in the general elective modules and area of concentration elective modules. Throughout the LMGS program, students train and acquire cross-cultural aspects. Students are required to work together in most modules and to work with examples from different countries. This will stimulate having to accept different work perspectives and deriving non-standard results because there are no one size fit all solutions for all socio-legal contexts.

Overall, the LMGS program is structured to provide all students with a general understanding of land management and its operational aspects for securing land rights and putting land into good effect. Simultaneously the program offers students the flexibility to design their professional qualification according to their preference by focusing on one of three areas of concentration namely (i) systems of land use and land rights, (ii) systems of geospatial engineering for land, water, and forestry management, and (iii) systems of planning, policy, and governance.

General structure of the master's program Land Management and Geospatial Science

Table 1 shows a general overview of the curriculum of the LMGS program. In the first semester of the LMGS program, students take five out of 9 required modules (5 CP per module, 25 CP in total) – two of the required modules relate to land management sciences, two relate to geospatial engineering sciences while the remaining one relates to professional development and practice. The fundamental knowledge, theories, concepts, and principles of land management and geospatial sciences are thus acquired. These required modules are supplemented by at least one general elective module in which the students start to develop competencies in other land-related fields like sustainability, governance, policy, management, and research sciences.

Table 1: Sample degree chart for a four-semester master's program.

Semester	Modules						CP/ Exams
	Land Management Sciences		Geospatial Engineering Sciences		Professional Development, Sustainability, Policy, Governance, Management and Research Sciences		
1.	Required Module 5 CP	Required Module 5 CP	Required Module 5 CP	Required Module 5 CP	Required Module 5 CP	Elective Module 5 CP	30/6
2.	Required Module 5 CP	Required Module 5 CP	Required Module 5 CP	Required Module 5 CP	Elective Module 5 CP	Elective Module 5 CP	30/6
3. (Mobility Window)	Systems of Land Use and Land Rights Elective Modules 20 CP				Elective Module 5 CP	Elective Module 5 CP	30/6
	Geospatial Engineering for Land, Water, and Forestry Management Elective Modules 20 CP				Elective Module 5 CP	Elective Module 5 CP	30/6
	Planning, Policy, and Governance Elective Modules 20 CP				Elective Module 5 CP	Elective Module 5 CP	30/6
4.	Master Thesis (plus optional internship)						30/1
Key	Orange = Required Modules Blue = Area of Concentration Grey = General Electives Green = Master Thesis						

In the second semester, students complete the remaining 4 required modules (5 CP per module, 20 CP in total) - two of which relate to land management, two relate to geospatial engineering sciences. They learn to work on application-oriented tasks in designing cadasters and land information systems in which they appreciate the interactions between land management systems and geospatial information systems. These required modules are also supplemented by general elective modules in which students further develop their competencies in other relevant disciplines for land management. The elective modules in the first and second semesters should sum up to at least 15 CP. In the general elective modules, there is also targeted training of independent scientific work through scientific paper writing or the geodetic seminar.

Before the beginning of the third semester, students are advised on the areas of concentration and the combination of elective modules to select based on their specific interests. In the third semester of the LMGS program, the students self-select an area of concentration in consultation with the program coordinator. One area of concentration must be completed by achieving at least 20 credits in that area. The remaining 10 credits can be freely chosen from any of the three areas of concentration or general elective modules, thereby maintaining the flexibility of the program and allowing students to pursue their interests. Thus, the total number of credits to be earned in the third semester should sum up to at least 30 credits. By taking the modules in the areas of concentration, students design their own career paths by combining several elective modules to build a professional qualification tailored to specific land management aspects. Within the elective modules, there is also targeted training in independent scientific work and presentation (communication) skills through geodetic seminars.

The competence in independent scientific work is further deepened through the master's thesis (30 CP) in the fourth semester of the LMGS program.

Required Modules

In total, the LMGS program offers ten required modules designed to provide students with a foundation in land management and the practical interrelationships between land management systems and geospatial systems. Students acquire knowledge of land tenure and land administration systems and concepts of how they interact and integrate with geoinformation and decision support systems. They are also equipped with research and professional ethical skills. These are achieved in the first year of the program with 9 required modules, namely:

Land Management Sciences

- Land management
- Real estate economics
- Geodesy (for land management)
- PRL+IPL - Introduction to photogrammetry, remote sensing and digital image processing

Geospatial Engineering Sciences

- Property rights and land tenure systems
- Land administration and land information systems
- Geoinformatics for Land Management
- Decision support systems

Professional Development

- International Professional Practice in Land Management and Geospatial Science

These modules are required to provide a level playing field for students of mostly diverse undergraduate backgrounds and equip them with the basics of land management and geospatial engineering concepts and principles based on which students can further deepen their knowledge in focused thematic areas of land management in higher semesters. Here also, general tools and techniques for measuring property boundaries, registering properties and recognizing land boundaries and land use are dealt with in the required modules. The module "International

Professional Practice in Land Management and Geospatial Science” exposes the students to land management practice in different country contexts; allowing students to understand their roles as professionals and be better informed to tailor develop their expertise in one of the three areas of concentration in the third semester.

General Elective Modules

Aside from the eight required modules in the first year, students are to choose general electives totaling at least 10 CP from a variety of general elective modules dealing with sustainability, policy, governance, management, and research, as well as land-relevant modules from other departments within and outside of TUM ED that relate to sustainability and the environment. Examples of these general elective modules are

- EuroTeQ Collider – Theme 2023-2025: Enhance Connections for Sustainable Futures¹¹,
- Digital Sustainability Transformation of, by and for TUM,
- Intercultural Science Communication and Ethics in Science,
- Politics for Rocket Scientists,
- Scientific Paper Writing – Theory and Practice
- Land Management International – Theory and Practice
- Geodetic Seminar
- ...

It is recommended that students complete the 15 CP general electives within the first year by taking at least 5 CP per semester. However, the students are free to decide the distribution of their general electives per semester.

Areas of concentration and mobility window of the LMGS program

The LMGS program offers students areas of concentration in the third semester, which allows them to acquire specialized and advanced knowledge in land management and geospatial sciences based on the student's interests and the career paths they want to pursue. The three areas of concentration are as follows:

- (i) Systems of land use and land rights
- (ii) Systems of geospatial engineering for land, water, and forestry management,
- (iii) Systems of planning, policy, and governance

Area of Concentration 1 (Systems of Land Rights and Land Use)

<https://landportal.org/node/52263>

¹¹ <https://sdgs.un.org/goals/tives/the-euroteq-collider/collider-theme/>

This area of concentration focuses on land management professional skills and operational aspects of land management by training international expertise in securing and transferring rights in land and natural resources, valuation and taxation of landed properties, planning and control of the use of land and natural resources, and implementing utilities, infrastructure, and construction planning. Graduates in this area of concentration are equipped with the expertise to design land use and land-based rights systems and fit-for-purpose methods for adjudicating changing land uses, property classification, and rights systems at local and global levels. The elective modules in this area of concentration include:

- International land rights
- New Fields in Urban Design
- International Rural Development
- Urban Ecology
- Spatial planning and policies
- Geodetic Seminar
- ...

Figure 2 shows an example of a possible combination of modules for the area of concentration systems of land rights and land use.

Table 2: Sample degree chart for a four-semester master’s program – **area of concentration systems of land rights and land use.**

Semester	Modules						CP/ Exams
	Land Management Sciences		Geospatial Engineering Sciences		Professional Development, Sustainability, Policy, Governance, and Research Sciences		
1.	Land Management 5 CP	Real Estate Economics 5 CP	PRL + IPL - Introduction to Photogrammetry, Remote Sensing and Digital Image Processing 5 CP	Geodesy (for Land Management) 5 CP	International Professional Practice in Land Management and Geospatial Science 5 CP	Spatial Planning and Policies 5 CP	30/6
2.	Property Rights and Land Tenure Systems 5 CP	Land Administration and Land Information	Geoinformatics for Land Management 5 CP	Decision Support Systems 5 CP	Scientific Paper Writing - Theory and Practice 5 CP	Land Management International - Theory and	30/6

Semester	Modules						CP/ Exams
		Systems 5 CP				Practice 5 CP	
3. (Mobility Window)	Introduction to Earth System Science 5 CP	Urban Ecology 5 CP	Geodetic Seminar 5 CP	International Rural Development 5 CP	RSC remote sensing – selected chapters 5 CP	Remote Sensing of Agriculture and Vegetation 5 CP	30/6
4.	Master Thesis 30 CP						30/1
Key	Orange = Required Modules Blue = Area of Concentration Grey = General Electives Green = Master Thesis						

Area of Concentration 2 (Systems of Geospatial Engineering for Land, Water and Forestry Management)

This area of concentration focuses on training expertise in applying geospatial technologies and interventions in managing and conserving land and natural resources. Graduates from this area of concentration are equipped with tools to analyze, model, simulate, and visualize land use and land use change dynamics and scenarios using spatial data. They facilitate land use and natural resource management decision-making by applying spatial data and techniques as decision-support systems to contemporary land and natural resource issues. Elective modules that qualify a student for this area of concentration include, but are not limited to:

- Introduction to earth system science
- Signal processing and microwave remote sensing
- Applied computer science
- RSC remote sensing – selected chapters
- Remote sensing of agriculture and vegetation
- Acquisition and analysis of photogrammetric data
- Geodetic Seminar
- ...

Table 3 shows an example of a possible combination of modules for the area of concentration systems of geospatial engineering for land, water, and forestry management.

Table 3: Sample degree chart for a four-semester master’s program – **area of concentration systems of geospatial engineering for land, water, and forestry management.**

Semester	Modules						CP/ Exams
	Land Management Sciences		Geospatial Engineering Sciences		Professional Development, Sustainability, Policy, Governance, and Research Sciences		
1.	Land Management 5 CP	Real Estate Economics 5 CP	PRL + IPL - Introduction to Photogrammetry, Remote Sensing and Digital Image Processing 5 CP	Geodesy (for Land Management) 5 CP	International Professional Practice in Land Management and Geospatial Science 5 CP	Spatial Planning and Policies 5 CP	30/6
2.	Property Rights and Land Tenure Systems 5 CP	Land Administration and Land Information Systems 5 CP	Geoinformatics for Land Management 5 CP	Decision Support Systems 5 CP	Scientific Paper Writing - Theory and Practice 5 CP	Land Management International - Theory and Practice 5 CP	30/6
3. (Mobility Window)	Introduction to Earth System Science 5 CP	Signal Processing and Microwave Remote Sensing 5 CP	Applied computer science 5 CP	RSC remote sensing – selected chapters 5 CP	International Land Rights 5 CP	Spatial Planning and Policies 5 CP	30/6
4.	Master Thesis 30 CP						30/1
Key	Orange = Required Modules Blue = Area of Concentration Grey = General Electives Green = Master Thesis						

Area of Concentration 3 (*Systems of Planning, Policy, and Governance*)

The third area of concentration trains expertise on governance, organizational behavior, and policy analysis of land-related problems to formulate and communicate contextual and socio-politically sensitive policies to address challenges in the use of land and natural resources in urban and rural areas. Graduates of this area of concentration can integrate land policies with other public sector policies to address sustainable development issues. The elective modules that qualify a student for this area of concentration include:

- Land management and land policy
- Spatial planning and policies
- Aspects of Sustainable Urbanism
- Sustainable Water Resources Management
- Seminar Advanced Real Estate Management
- Multi-level governance
- Energy Transformation
- Geodetic Seminar
- ...

Figure 4 shows an example of a possible combination of modules for the area of concentration systems of planning, policy, and governance.

Table 3: Sample degree chart for a four-semester master’s program – **area of concentration systems of planning, policy, and governance.**

Semester	Modules						CP/ Exams
	Land Management Sciences		Geospatial Engineering Sciences		Professional Development, Sustainability, Policy, Governance, and Research Sciences		
1.	Land Management 5 CP	Real Estate Economics 5 CP	PRL + IPL - Introduction to Photogrammetry, Remote Sensing, and Digital Image Processing 5 CP	Geodesy (for Land Management) 5 CP	International Professional Practice in Land Management and Geospatial Science 5 CP	Spatial Planning and Policies 5 CP	30/6
2.	Property Rights and Land Tenure Systems 5 CP	Land Administration and Land Information Systems 5 CP	Geoinformatics for Land Management 5 CP	Decision Support Systems 5 CP	Scientific Paper Writing - Theory and Practice 5 CP	Land Management International - Theory and Practice 5 CP	30/6
3. (Mobility Window)	Land Management and Land Policy 6 CP	Spatial Planning and Policies 5 CP	Sustainable Water Resource Management 3 CP	Seminar Advanced Real Estate Management 6 CP	Applied computer science 5 CP	Signal Processing and Microwave Remote Sensing 5 CP	30/6
4.	Master Thesis 30 CP						30/1
Key	Orange = Required Modules Blue = Area of Concentration Grey = General Electives Green = Master Thesis						

Key competencies

Students have the opportunity to develop and expand extra-curricular competencies that they consider important for their future professional development. Such skills are essential for starting a career and societal engagement, in addition to sound specialist skills from the LMGS program. The following general elective modules help students to acquire extra-curricular and interdisciplinary skills beyond their specialist knowledge in land management and geospatial science.

- EuroTeQ Collider – Theme 2023-2025: Enhance Connections for Sustainable Futures,
- Intercultural science communication and ethics in science
- Politics for rocket scientist: an introduction to political science for non-political scientists
- What shall I do? Ethics for engineers
- Geodetic Seminar

Beyond the curriculum, there are also seminars on the topics of intercultural awareness and culture in a university context (orientation week at the beginning of the semester) and writing techniques for the master's thesis (prior to the 4th semester). In addition, the Chair of Land Management also organizes an annual team-bonding event in the winter semester in a selected city of Germany, which is aimed at training intercultural awareness and teamwork among students. Besides this, students can also become part of one of the many outstanding, extracurricular activities organized by student teams. For example, students can volunteer for TU eMpower Africa e.V (TUMA) – a student-led volunteer initiative that analyze, realize and sustain the development potential of various communities and regions in Africa by using research results, which have been obtained by its members during their theses and student projects at Technical University of Munich. These activities are supported by the Chair of Land Management by supervising study projects and thesis that are used by TUMA to implement various sustainability projects in Africa.

Mobility Window

The third semester also offers an excellent opportunity for mobility options, as shown in Table 1. It is possible to spend one semester with one of the collaborating partners, such as Renmin University in Beijing/China, Diponegoro University in Semarang/Indonesia, JM Lyon3 in Lyon/France, or KNUST in Kumasi/Ghana. Students are informed about mobility options during their welcome session in the first semester and are encouraged to utilize the opportunity. Support is given to the students in deciding which universities and courses to study in the partner universities abroad to facilitate smooth recognition of credits earned abroad. Funding for such international semesters needs to be acquired.

Master Thesis

The master's thesis sums up the graduates' abilities to recognize a land management-related issue and analyze, evaluate, and synthesize it, using the methods and tools acquired through the program to formulate an innovative solution specifically suited for their selected context or case study. Before writing their master's thesis, students acquire interdisciplinary research skills through group work and the elective module scientific paper writing – theory and practice. The students also develop multidisciplinary research skills through participation in the geodetic seminar, which will be offered to the LMGS students as a free elective as part of measures to integrate well with the rest of the geodesy professional profile. Guided by a supervisor, the geodetic seminar trains the skills to research literature on a given geodetic topic, prepare and present it to an audience, and discuss it publicly. The students also demonstrate their acquired research skills through a colloquium in which they are required to give a presentation on their final thesis.

The Master thesis can be completed outside the School of Engineering and Design or outside TUM in a defined framework and in collaboration with a qualified examiner of TUM – this type of

arrangement is possible to allow students to gain practical industry experience while writing their thesis with a company.

7 Organization and Coordination

The LMGS program is administratively located at TUM ED. Most elective modules as well as the master's thesis are offered by the teaching staff of TUM ED. The TUM School of Life Sciences and the TUM School of Social Sciences and Technology provide additional modules for this program. For administrative aspects of study organization, some responsibilities lie with the TUM Center for Study and Teaching (TUM CST) and its administrative units, while others are handled by the units of TUM ED (see the following overview):

- Student Advising: Student Advising and Information Services (TUM CST)
Email: studium@tum.de
Phone: +49 (0)89 289 22245
Provides information and advising for prospective and current students (via hotline/service desk)
- Departmental Student Advising: Walter Dachaga (M.Sc.)
Email: info.lmgs@ed.tum.de
Phone: +49 (0)89 289 25789
- Academic Programs Office: School of Engineering and Design
Study and Teaching
email: studyandteaching@ed.tum.de
- Study Abroad Advising/Internationalization:
TUM Global & Alumni Office
Email: internationalcenter@tum.de
TUM ED:
Saskia Ammon
Email: saskia.ammon@tum.de
Phone.: +49 (0)89 / 289 15021
Room: MW 2011

S. Ammon primarily assists students who are planning or undertaking an ERASMUS study stay or a Double Degree program at a partner university of TUM. The responsibility for the ERASMUS internship program and a study stay through TUMexchange lies with the Global and Alumni Office of TUM.

- Gender Equality Officer TUM ED: Dr. Annette Spengler
Email: annette.spengler@tum.de
Tel.: +49 (0)89) 289 27102
- Advising – Barrier-Free Education: TUM-wide: Service Office for Disabled and Chronically Ill Students (TUM CST),
Email: Handicap@zv.tum.de
Phone: +49 (0)89 289 22737

TUM ED:
Dr. Ingrid Mayershofer

Email: ingrid.mayershofer@tum.de

Phone: +49 (0)89 / 289 15020

- Admissions and Enrollment: Admissions and Enrollment (TUM CST)
Email: studium@tum.de
Phone: +49 (0)89 289 22245
Admissions, enrollment, Student Card, leaves of absence, student fees payment, withdrawal
- Aptitude Assessment (EV): TUM-wide: Admissions and Enrollment (TUM CST)
Email: studium@tum.de
Phone: +49 (0)89 289 22245
Departmental:
Aptitude Assessment Commission,
Email: info.lmgs@ed.tum.de
- Semester Fees and Scholarships: Fees and Scholarships (TUM CST),
Email: beitragsmanagement@zv.tum.de
- Examination Office: Graduation Office and Academic Records (TUM CST), Campus Munich
Graduation documents, notifications of examination results, preliminary degree certificates
- Departmental Examination Office: School of Engineering and Design, Department Aerospace and Geodesy,
Daniel Hartenstein. M.A.
Isabella Canchila Acuña, M.A.
examination.asg@ed.tum.de
- Quality Management: TUM CST – Quality Management
<https://www.tum.de/studium/tumcst/teams-cst/>

TUM ED:

- Vice Dean Academic and Student Affairs: Prof. Dipl. Arch. ETH Mark Michaeli
Email: vicedean_study_teaching@ed.tum.de
- Academic Program Director: Prof. Dr. Christoph Holst
Email: christoph.holst@tum.de
- Quality management: Brit Krieger
Email: qualitymanagement@ed.tum.de
- QM circles: Dimitri Franz
Email: dimitri.franz@tum.de
- Evaluations Email: evaluationen@ed.tum.de
- Module management Arno Buchner
Email: modulverwaltung@ed.tum.de

8 Enhancement Measures

This section highlights the changes that were made to the LMGS program to align it with student needs and contemporary trends in the land management profession. Key changes are adopting a continuous admission approach, making one elective module a required module for professional development, offering geodetic seminar to students, adopting external expert recommendations to focus on training students to become specialized generalists in land management and geospatial sciences, enhancing the flexibility of the program structure, and expanding the modules offered in the three areas of concentration of the program to foster integration and existing inter-departmental collaborations. These changes are necessary for the sustainability of the program in accordance with professional expectations while satisfying the needs and aspirations of students.

Continuous Admission Approach for the LMGS Program.

A major strength of the LMGS program is the focus on internationalization. However, the international character of the program also poses visa challenges for prospective students of the LMGS program, which led to only 7 out of 33 admissions in 2021 and 8 out of 36 admissions in 2022 enrolling in the program. To address this, the continuous admissions policy was introduced, whereby students who meet the eligibility requirements and do not require an aptitude test are immediately issued with an admissions letter. The remaining applications are assessed as soon as there are a sufficient number of completed applications. This way, students can receive their admission letters on time and have ample time to process their visas to take up their study places.

Training Specialized Generalists in Land Management and Geospatial Science

In an extended quality management circle meeting last year, there was an expert recommendation to train students as generalists by cutting back on deep topics and focusing on teaching students to have an overview. Accordingly, a meeting was held with all lecturers and module coordinators in the LMGS program to discuss module contents and proposed adaptations to be made to suit the qualification profile of the LMGS program. That aside, the modules in the first and second semesters of the LMGS program are foundational courses that are meant to bring all students of diverse backgrounds up to level on Land Management and Geospatial Sciences. The impacts of this measure will be based on subsequent feedback from the students.

Flexibility of the Program Structure and Areas of Concentration

When the program was established, the original intention of the areas of concentration was to allow students the flexibility to combine different elective modules to tailor their qualification profile according to their interests, and to provide the flexibility to choose an area of concentration that was intended to be complementary rather than exclusive. However, this has meant that students have not previously been able to choose modules outside of their area of concentration, thus not enabling the desired flexibility and resulting in longer study periods than intended, where students have not been able to complete the entire area of concentration in one semester. To address this issue, the following changes have been incorporated:

- (i) Students must still select one out of three areas of concentration in the third semester of the program.
- (ii) The total credits to be earned in the third semester (areas of concentration) of the program should sum up to at least 30 CP.

- (iii) To be qualified for their selected area of concentration, the student must complete at least 20 CP from the cluster of elective modules that are offered in their selected area of concentration. The remaining 10 CP can be fulfilled by selecting elective modules in other areas of concentration or general electives catalogue.

Required modules for professional development and research skills

In general, students are guided by the course coordinator in selecting their areas of concentration and a combination of elective modules to suit the expected qualification profile of the LMGS program. Students are informed in their welcome session about the structure of the program, and a special session in the second semester is organized to meet students and discuss expertise development and selection of areas of concentration to guarantee those expertises. In addition, the elective module “International Professional Practice in Land Management and Geospatial Science” will be changed to a required module with the aim of exposing students to land management practice in different country contexts and enabling students to tailor their expertise to evolving roles in land management. The module descriptions of “International Professional Practice in Land Management and Geospatial Science” will be expanded to include elements of professional ethics, professional career planning, and expertise development. The module “Geodetic Seminar” will be offered to the LMGS students to foster integration with other students within the Geodesy Professional Profile while developing their independent research and communication skills.

Impacts of Enhancement Measures

The above changes have resulted in an increase in the number of first-year students who enrolled in the 2023/24 winter semester (from 8 in the previous year to currently 20 students). These changes have also enabled 4 students to complete the program last year, and the changes are expected to facilitate flexibility in the program and enable students to complete the program within the standard duration. Overall, the LMGS program remains a leading program, equipping graduates with the necessary skills and expertise to address contemporary land and natural resource issues.