UNIVERSITY OF HELSINKI

FACULTY OF SCIENCE

GAP ANALYSIS AND TRAINING NEEDS ASSESSMENT FOR GIERI TRAINING OF TRAINERS PROGRAMME IN GEOINFORMATICS, 2016-2017

Report prepared by

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1. Introduction

An assessment of gaps and training needs for the GIERI Training of Trainers programme in Geoinformatics was conducted in November-December 2015. The assessment was done by distributing questionnaire forms to the four Eritrean Higher Education Institutes (HEIs) involved in the GIERI project: College of Arts and Sciences (CASS) in Adi Keyh, Eritrean Institute of Technology (EIT) in Mai Nefhi, Hamelmalo Agricultural College (HAC) in Hamelmalo/Keren, and College of Marine Science and Technology (COMSAT) in Massawa.

In this assessment, the objective was to identify to which extent Geoinformatics is currently applied in teaching and research in Eritrean Higher Education Institutes, what are the possible application areas in Geoinformatics, and to identify gaps in Geoinformatics teaching and research which the GIERI ToT programme could address. This assessment also gives important input to the design of Training of Trainers programme in Geoinformatics.

In the first part of this assessment, personal information and self-assessment of the respondents' skills in computing and Geoinformatics, training preferences and research interests were collected. Expectations towards the GIERI project and the ToT programme was also collected but the results are not included in this report.

The second part deals with each organization's capacity (current situation, desired situation and identified gaps) in Geoinformatics teaching and research.

In the third part, the most relevant teaching topics for the ToT Programme at organizational level were identified.

2. Results, Part I – Personal Information

2.1 Background of the Respondents

A total of 31 respondents answered the assessment, which can be considered an excellent result. The respondents were also equally distributed among the four targeted HEIs (figure 1, left). The only exception was COMSAT, from which only three filled forms were received, but considering COMSAT being the smallest of the colleges it can still be considered a representative sample.

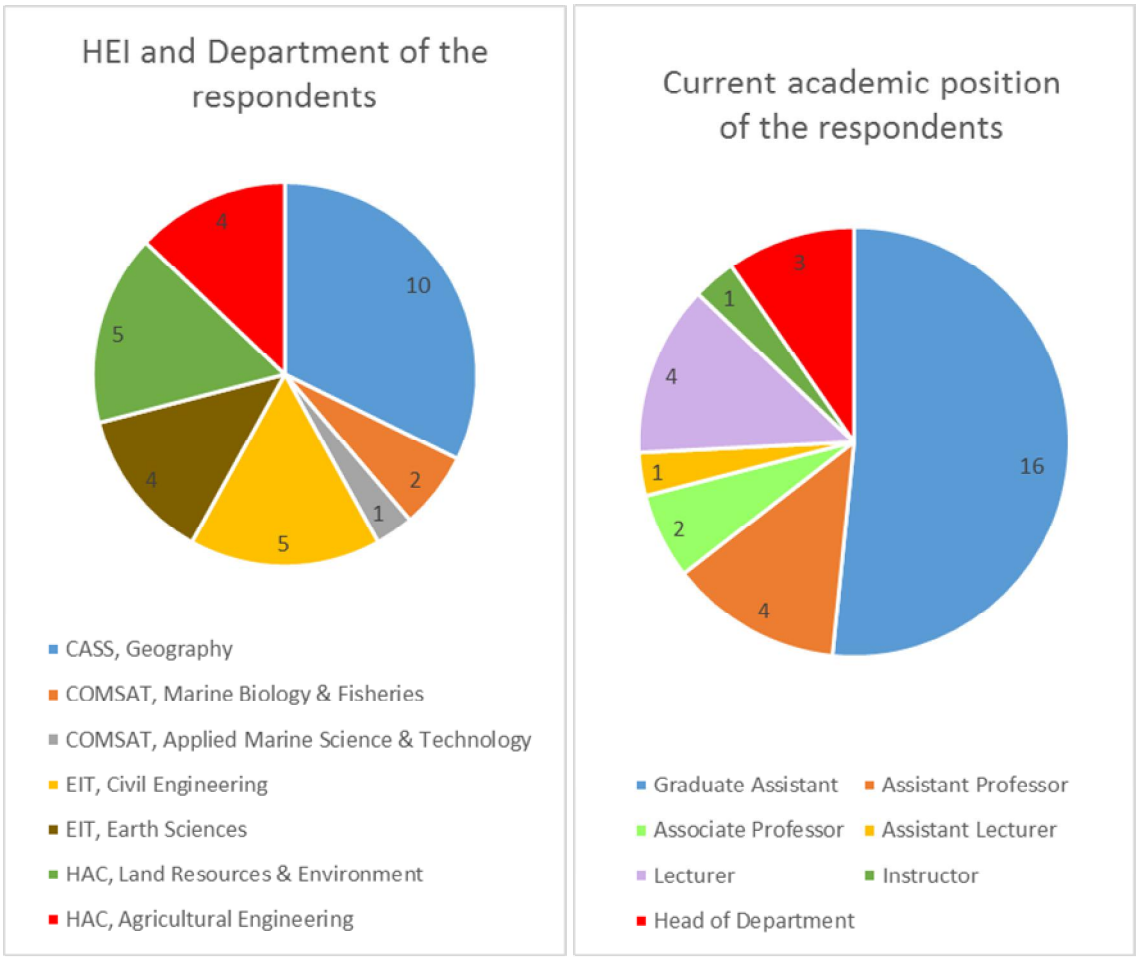


Figure 1. HEI & Department and current academic position of the respondents.

Roughly half of the respondents were junior staff (graduate assistants) and the other half consisted of senior staff members (figure 1, right). The same conclusion can be drawn from the age distribution (figure 2, left). Gender balance was strongly skewed towards males; only two females (both senior staff) responded in the assessment (figure 2, right). This, however, reflects the gender balance of staff members in Eritrean HEIs.

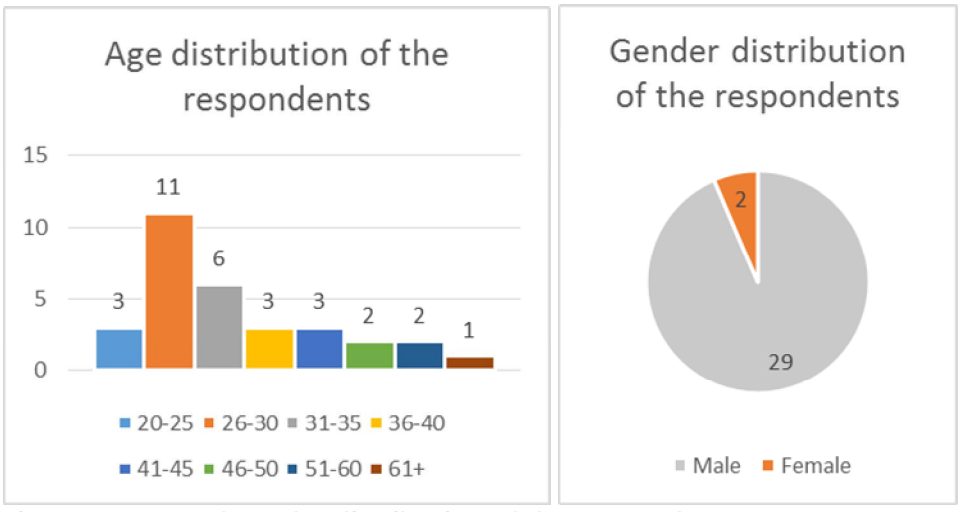


Figure 2. Age and gender distribution of the respondents.

2.2 Computing skills of the respondents

In order to better understand the technical know-how of the respondents, the respondents were asked to make a self-assessment of their skills in both common computing skills (spreadsheet computing, working with databases, and programming) and skills related to geoinformatics. When analyzing the results, two things are important to keep in mind:

1. The respondents consisted of both junior and senior staff members, making it obvious that the senior staff, in general being more educated and having more work experience, have better computing skills than the junior staff. Thus, the results give an overview of the skill levels of the respondents as one group. The Training of Trainers programme is mostly targeted for the junior staff members, not for senior staff. The results below show personal skill assessment, which is different from the skills present at the organizational level.
2. Self-assessments are always subjective. The actual skill levels might vary considerably in reality, which might not reflect in the results. What one understands as "analysis of remote sensing data" or "working with databases" might also be different from one respondent to another. Difference between "passable" and "satisfactory", for example, are subtle and subjective as well.

Despite these inherent limitations, some general conclusions can be made. Staff members of the four HEIs are most skilled in spreadsheet computation and databases, as well as field data collection with GPS/GNSS. Mixed results can be found from the processing and analysis of remote sensing and GIS data. Weakest skills can be found in programming and geodesy & coordinate systems.

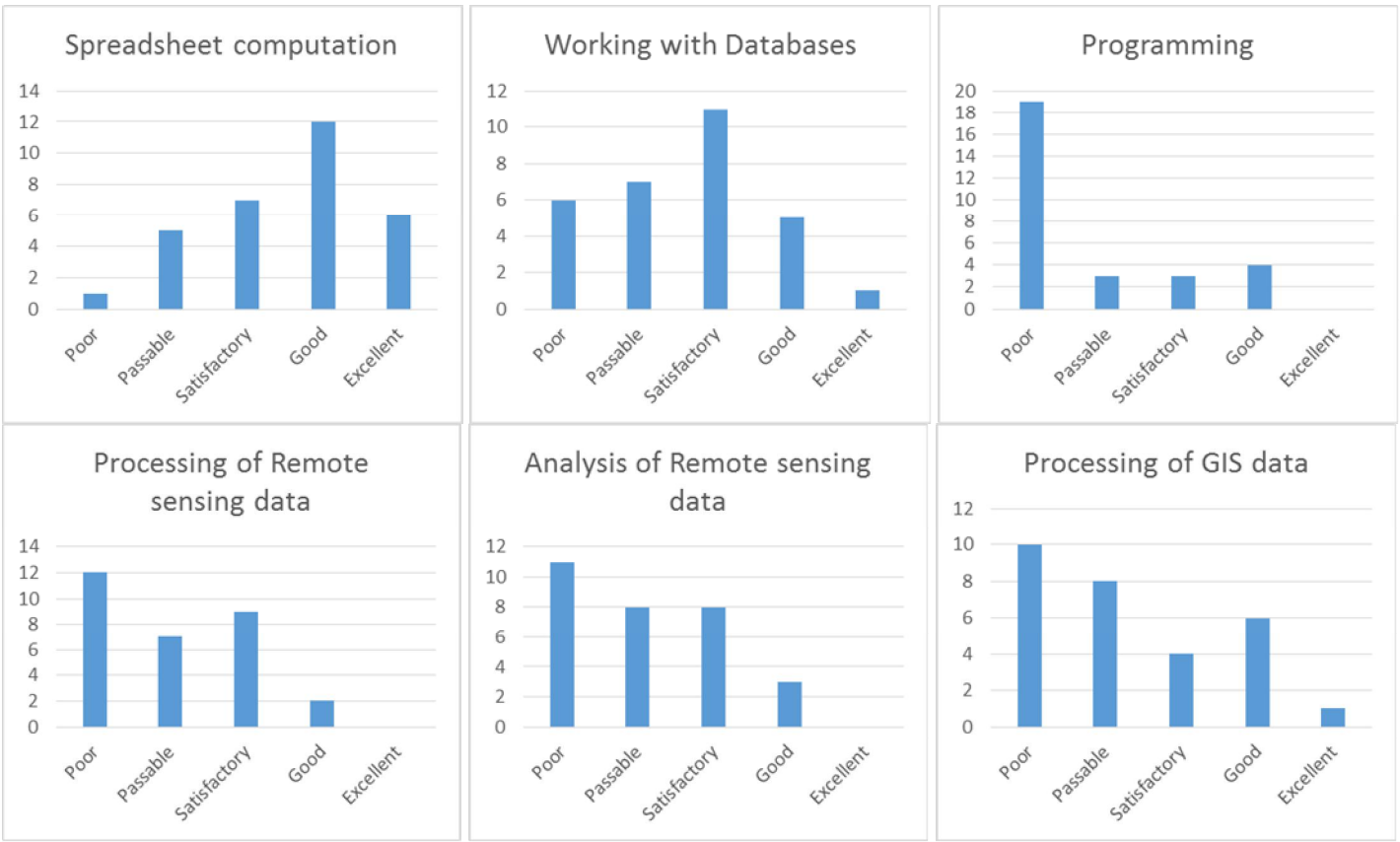


Figure 3. Results of the self-assessment of computing skills.

Three-fourths of the respondents have used a GIS software before (figure 4), either in training, teaching, or research. ArcGIS/ArcView was the most popular software used, but also five other software got mentioned. One of them, QGIS, is free open-source, while the others are proprierty software. Idrisi and Erdas are inherently remote sensing software, while the other four are GIS software.

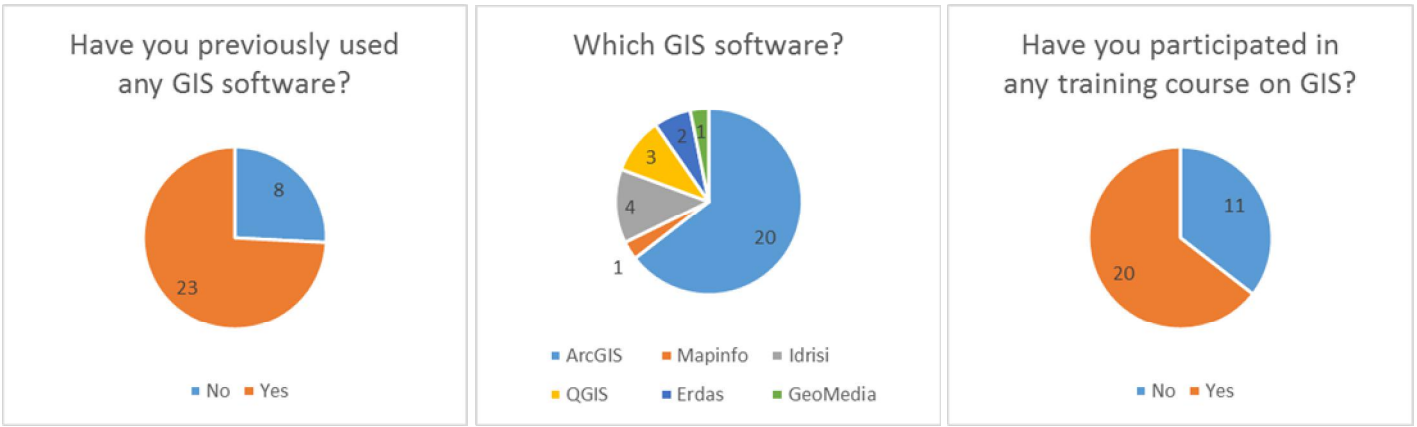


Figure 4. Results of previous GIS use.

Further, 55 % of the respondents had received some formal training in GIS before (figure 4). The respondents were also asked to give details of the courses (Appendix 1: text box 1). As one can quickly see, the training received by the respondents is quite heterogenous. The training courses can be divided into three groups:

training given in Eritrean HEIs, training given in other governmental institutions in Eritrea, and training given abroad.

2.3 Training preferences of the respondents

For the sake of choosing the best teaching method, the respondents were asked to rate the importance of different training formats. This is important to know before-hand, as the culture of teaching and learning is different from one country to another.

From the graphs at figure 5 it is clear that interactivity in teaching is highly valued: both between instructor and students, and between students themselves. Working together as a group at the same speed (in practical lab exercises) was considered slightly more important than working independently at own speed. According to experience, the former method works best when all students are at the same starting level, usually on basic level courses. The latter method works better when the students have more heterogenous background in their skill level, and in more advanced level courses, when students are more condifent with the software and methodology. This allows more skilled students to proceed faster and not get frustrated on the less skilled people slowing down the teaching, and also gives more time for the instructor to give hands-on assistance to the ones who need it.

Lastly, problem-solving on your own (e.g. in practical lab exercises) was seen as somewhat more important than following step-by-step instructions. Both methods have their pros and cons – one can learn more by solving problems on your own, but this method can be quite laborous for beginners and thus require more personal assistance time from the instructors. Following step-by-step instructions, however, can be more ideal way of learning in situations when teaching a larger group of beginners, or when the course materials are used for self-learning without the assistance of an instructor.

Figure 5. Training preferences of the respondents.

2.4 Research interests of the respondents

More than a half of the respondents were not involved in academic research projects (figure 6, left). Those who answered positively were mostly senior staff, while the junior staff were more involved in teaching duties. The research carried out by the respondents was also very diverse and highly relevant, as can be seen from the answers in Appendix 1: text box 2.

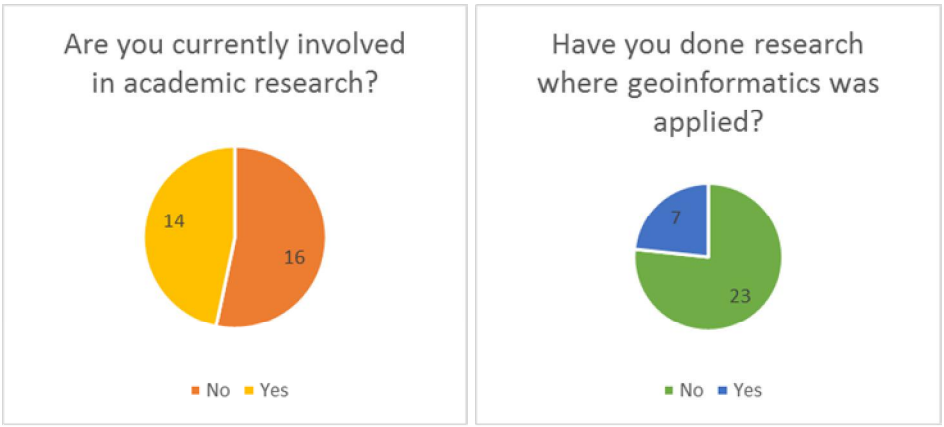


Figure 6. Respondent's involvement in academic research in general, and in research where geoinformatics is applied.

Currently geoinformatics is hardly used in research according to the respondents feedback (figure 6, right and Appendix 1, text box 3). The notable exception is Hamelmalo Agricultural College, where geoinformatics is applied in soil, accessability and hydrology studies.

However, when looking at the personal interests, research ambitions and potential application areas of geoinformatics in research (Appendix 1, text box 4), it is quickly confirmed that there is so much unleashed potential where geoinformatics could fit in and add value. There is no doubt about the huge demand for geoinformatics not only as a research tool or method, but as a science itself, in all four HEIs. This is a very promising sign for the ToT programme as well, since research projects are included in the programme.

3. Results, Part II – Organizational Information

3.1 Current situation of Geoinformatics at organizational level

The second part of the assessment looks at the geoinformatics research and teaching capacity at the organizational level. First, the respondents were asked to describe the current situation (baseline) in their organization in three open-ended questions.

The first question dealt with the current situation in geoinformatics teaching and research. Detailed answers can be read from Appendix 1, text box 5. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering: In teaching: applied in a limited way in surveying and photogrammetry course. Not used in research.
- EIT, Dept. of Earth Sciences: In teaching: A course of GIS and Remote Sensing (4th year) and photogeology course (2nd year). Not used in research.
- HAC, Dept. of Land Resources & Environment and Dept. of Agricultural Engineering: In teaching: Remote Sensing & GIS taught in introductory courses (3 credits each). In research geoinformatics is being used only for preparing maps and to some extent in spatial analysis in senior research projects.
- CASS, Dept. of Geography: In teaching: Surveying & cartography (2nd year), Aerial photo interpretation & Remote Sensing (3rd year), Introduction to GIS (4th year), Map use & interpretation (4th year). However, teaching focuses too much on theory and practical exercises are very limited, lab assistance inadequate. Not used in research except for graduating students who apply geoinformatics to prepare their project work.
- COMSAT, Dept. of Marine Biology & Fisheries: In teaching, one course in GIS for undergraduates: "Introduction to GIS and Remote Sensing". In research, not much is done using geoinformatics.

In the second question, respondents were asked to give details of the actual skills, knowledge and abilities of staff in geoinformatics. Detailed answers can be read from Appendix 1, text box 6. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering: Staff skills are limited.
- EIT, Dept. of Earth Sciences: One expat staff member has a MSc in Remote Sensing and GIS.
- HAC, Dept. of Land Resources & Environment: One staff member has MSc in GIS, teaches and assists in research, however the skill and knowledge of other staff is poor and needs upgrading. The

curriculum of the department should also be reviewed such as that of agronomy so that their students take RS and GIS courses.

- HAC, Dept. of Agricultural Engineering: Staff capacity low, many even don't understand its usefulness for agricultural sciences.
- CASS, Dept. of Geography: The younger teacher assistants have same introductory knowledge. Teaching is highly dependent on two expatriate teachers.
- COMSAT, Dept. of Marine Biology & Fisheries and Dept. of Applied Marine Science & Technology: No skilled person in our staff, teaching given by outsiders.

In the third question, respondents were asked about geoinformatics resources and their accessibility in their organization. Detailed answers can be read from Appendix 1, text box 7. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering: Some surveying equipment (e.g. levels, theodolite) are available. Inadequate and unskilled human resources. Accessibility not an issue.
- EIT, Dept. of Earth Sciences: Demonstration version of GIS software (ArcGIS?) available. Apart from one expat, inadequate and unskilled human resources. Accessibility not an issue.
- HAC, Dept. of Land Resources and Environment: No Geoinformatics lab, but few computers equipped with software like ArcView, Idrisi. Students have access to those in practical courses. One GIS expert available for teaching and assistance. Accessibility not an issue.
- HAC, Dept. of Agricultural Engineering: Few individuals have geoinformatics software in their PCs but not at organizational level so far. Inadequate and unskilled human resources. Accessibility not an issue.
- CASS, Dept. of Geography: GIS lab exists, but hardware is seriously outdated. ArcGIS software, satellite image prints, printer, stereoscope and a GPS receiver are available. Apart from two expats, inadequate and unskilled human resources. Accessibility not an issue.
- COMSAT, Dept. of Marine Biology & Fisheries: Software available in some computers, some data exists. No human resources. Accessibility not an issue.

3.2 Desired situation of Geoinformatics at organizational level

Now that the baseline of Geoinformatics teaching and research in the four HEIs has been established, it is time to look at the future objectives and possibilities. Respondents were asked to put aside all difficulties and shortcomings, and elaborate potential uses and application areas of geoinformatics in their organization's teaching and research activities, when all necessary resources would be available. Detailed answers to this question can be read from Appendix 1, text box 8. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering: Geoinformatics should be introduced in the undergraduate studies of Civil Engineering to be efficiently implemented in teaching and research activities. Geoinformatics is essential for surveying, urban planning, highway alignment, hydrology, geotechnical engineering, etc.
- EIT, Dept. of Earth Sciences: The department of Earth Sciences will have Eritreans teaching Geoinformatics and more courses will be included. GIS will be used more efficiently in research, e.g. in geological mapping and exploration. Spatial data and experiences will be shared with colleagues from CASS.
- HAC, Dept. of Land Resources & Environment: In department of Land Resources and Environment, geoinformatics will be applied in teaching and research of numerous disciplines: forest monitoring and inventory, analysis of crop water requirements, crop monitoring, precision farming, soil mapping,

drought and natural hazard forecasting, land change analysis, land capability/suitability assessment, land resource management.

- HAC, Dept. of Agricultural Engineering: Geoinformatics teaching will be improved and increased and research related to geoinformatics enhanced. Students and staff will be encouraged to apply acquired skills in geoinformatics in their senior research projects using the facilities available. Geoinformatics would have essential impact on the development of agricultural science and it would be a helpful tool in collecting agricultural data.
- CASS, Dept. of Geography: The potential is huge, provided the resources are available. Both staff and students will use it in various research and class assignments. Practical knowledge of tools, techniques and software empowers the students to improve understanding in decision making. In order to effectively implement geoinformatics in teaching, the curriculum has to be revised and upgraded in different departments in order to incorporate basic principles of geoinformatics in their courses. These departments have to also devise a mechanism by which their senior students have to incorporate geoinformatics in their research methods while doing their senior research projects as their partial fulfillment of their BA degrees. There are plenty of potential uses of GIS, first and foremost at teaching level to train students. In research, potential application areas are, for example, study of the natural and urban environment and its resources, and management and planning of these resources.

3.3 Identified gaps at organizational level

The analysis of the desired situation also involves the identification of factors that could contribute to improving the current situation. The difference (gap) between the current and the desired situations will help identify the training needs. Respondents were asked to identify these organizational gaps.

One noteworthy concern that was raised and shared by every respondent was the availability and speed of internet facilities, which was not considered adequate in any of the HEIs. Although every college has some kind of internet connection, it is shared by the whole campus making it notoriously slow and unreliable. Since the GIERI project has no means to improve this situation, the original plan to include on-line courses through distance education must unfortunately be forgotten. We can only hope the situation will gradually improve, since internet is so essential for modern geoinformatics in many ways: as a source of data, information and up-to-date software, access to on-line training materials and manuals, networking and communication with other GIS users, on-line technical support through various GIS and Remote Sensing user communities, and so on.

Detailed answers to the identified gaps can be read from Appendix 1, text box 9. Overall it can be said that the identified gaps are almost similar in every HEI. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering: Lack of (surveying) equipment, geoinformatics not included in the curriculum, lack of practical exercises.
- EIT, Dept. of Earth Sciences: Lack of skilled staff, hardware and software.
- HAC, Dept. of Land Resources & Environment: Lack of skilled personnel, software, hardware, data such as up-to-date and accurate satellite imagery, electricity.
- HAC, Dept. of Agricultural Engineering: No access to up-to-date information, lack of well-trained human resources, lack of necessary facilities (software, hardware, rooms, electricity), lack of financial support and financial bureaucracy. Lack of understanding of the importance of GIS & RS at organizational level.

- CASS, Dept. of Geography: The most stressing shortage is in qualified GIS experts in our teaching and lab technician staff. This shows in lack of any assistance in terms of hardware and software. In addition, hardware (computers and accessories, data collection tools, ground surveying instruments), software and data are outdated - complete renovation of the lab is essential.
- COMSAT, Dept. of Marine Biology & Fisheries: The fact that the software we have in the lab (ArcGIS) is proprietary software, not open-source, makes some of the interested staff and students to concentrate less on the software.
- COMSAT, Dept. of Applied Marine Science & Technology: Trained human resources are hardly available, hardware and software not up-to-date.

3.4 Outsourcing of Geoinformatics resources

One common way to overcome the shortage of skilled manpower in teaching is to hire experts from outside to give teaching. The respondents were asked if their organization has used this possibility. The results can be summarized per HEI as follows:

- EIT, Dept. of Civil Engineering, HAC, Dept. of Land Resources & Environment, HAC, Dept. of Agricultural Engineering and COMSAT, Dept. of Applied Marine Science & Technology: No.
- EIT, Dept. of Earth Sciences: We have approached Dept. of Water Resources and mining & exploration companies to provide us spatial data and copy of software.
- CASS, Dept. of Geography: In the past, the Department (while under University of Asmara) had a collaborative agreement with Univ. of Bern. At present, CASS is actively working towards establishing linkage with government institutions which use geoinformatics. In the absence of qualified teachers in GIS, CASS has sought and got experts from the President's Office Mapping unit, and Water Resource Department of the Ministry of Land, Water & Environment.
- COMSAT, Dept. of Marine Biology & Fisheries: GIS experts are hired to teach from Ministry of Land, Water and Environment, Division of Land, from President's Office Mapping Unit, and from abroad.

3.5 Other issues

Respondents were given a chance to express any other issues in their mind about the GIERI project. Some of these concerns can be read in Appendix 1, Text box 10.

4. Results, Part III – Identification of most relevant teaching topics at organizational level

Finally, the third part of the Gap Analysis and Training Needs Assessment looked at the most relevant topics that should be covered in the Training of Trainers programme of GIERI project. These should be based on each organization's knowledge gaps as identified previously, not on individual needs.

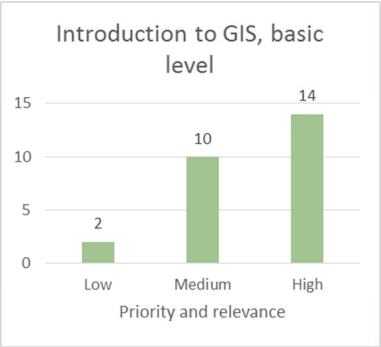
Respondents were asked to rate the importance of 14 pre-selected, tentative topics. These topics roughly cover the same content as the geoinformatics teaching given to undergraduate (BSc and MSc) students at Department of Geosciences and Geography, University of Helsinki. Each topic was also given a difficulty level

(Basic/Intermediate/Advanced). At this stage, the topics were kept quite general, so that respondents could elaborate on organizational-level specific needs related to the topics. One should also keep in mind that the topics are not the same as courses – some topics are even overlapping – but it is possible to deal with two or three topics in one course when kept in a general level.

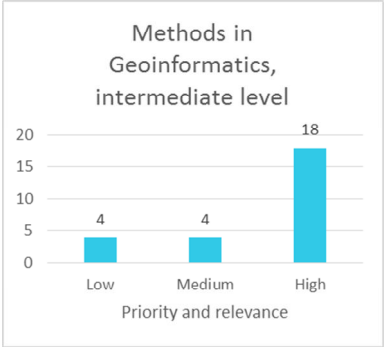
Some of the respondents saw the need of geoinformatics teaching so great that they valued each topic being highly relevant and high priority. This might be true, but it makes prioritizing the courses difficult, as the resources available for GIERI are not enough to cover each and every topic. Nevertheless, with 27 respondents, it is possible to draw some general conclusions on which topics are absolutely crucial and which are less crucial at this stage.

When looking at the results of current situation in geoinformatics teaching at the different HEIs (chapter 3.1), one can see that introductory-level courses on GIS and Remote Sensing are given in all HEIs except Dept. of Civil Engineering at EIT. Cartography, map use and interpretation is also taught in CASS. This is an important result of the training needs assessment – one can reasonably assume that majority of the junior staff, i.e. Graduate Assistants and junior teaching staff, have been to at least one of these courses, and knows the basic concepts of GIS and Remote Sensing. However, this does not mean that introductory-level courses in GIS and Remote Sensing should not be included in the ToT curriculum. It is only after the introductory courses that the instructor(s) can really establish the current skill level of each student. The software to be used in the course (QGIS) is also new to most of the students, so it is good to familiarize oneself with the software before going into more advanced topics. On the other hand, topics already familiar to the students can be skipped and more emphasis can be given to unfamiliar topics.

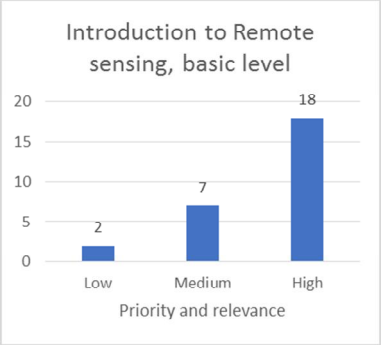
Below are the results of the identification of most relevant teaching topics, and specific needs identified by the respondents.



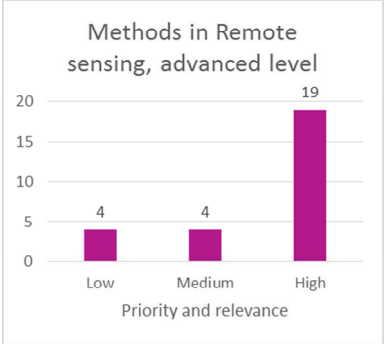
Specific needs: *Agricultural & engineering applications, models, map drawings, images, creating views, spatial query and analysis. GIS concepts, data models, data input and editing, analysis methods.*



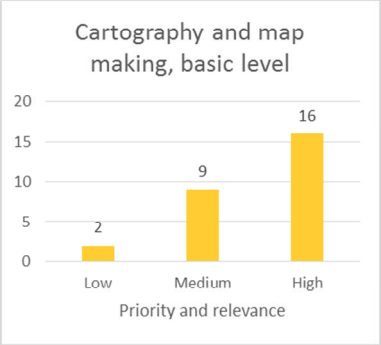
Specific needs: *Methods of spatial data analysis*



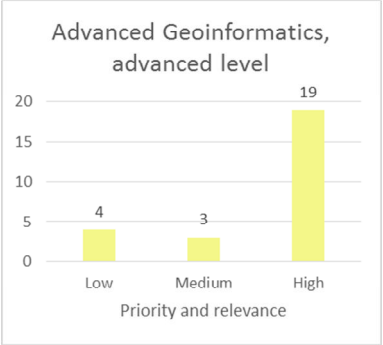
Specific needs: *Agricultural & engineering applications, land use studies, image interpretation, population concentration, data acquisition, satellites & sensors*



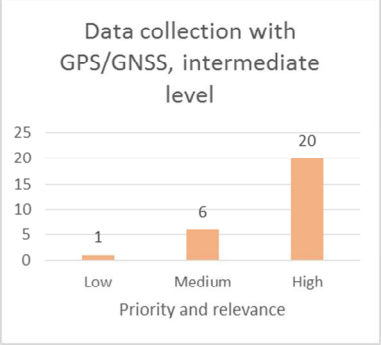
Specific needs: *Image processing, aerial photo interpretation and triangulation, image enhancement*



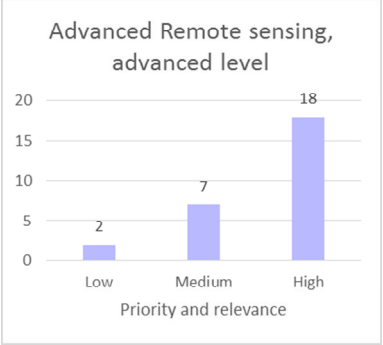
Specific needs: *Small & large-scale map making, mapping techniques, map scales and projections, coordinate systems*



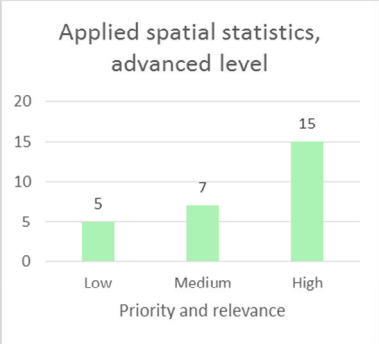
Specific needs: *Network analysis, topological analysis of complex features*



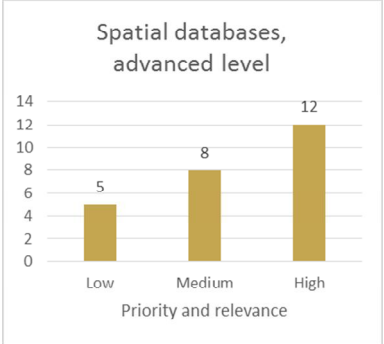
Specific needs: *Agricultural sector, water and resources sector, use of GPS data in GIS analysis, GPS applications, GPS signals and measurements, how GPS works, geodetic aspects of GPS.*



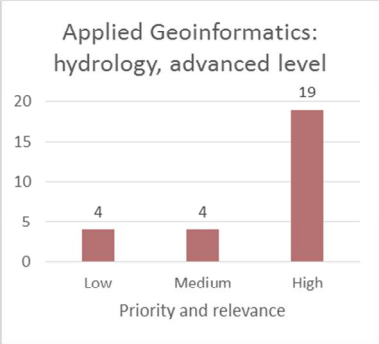
Specific needs: *Image processing and analysis of different image sources for environmental monitoring & security, photogrammetry, application of RS data*



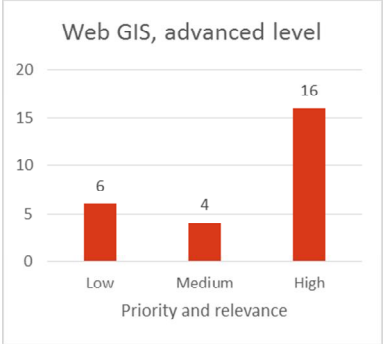
Specific needs: *Descriptive statistics, sampling, statistical analysis*



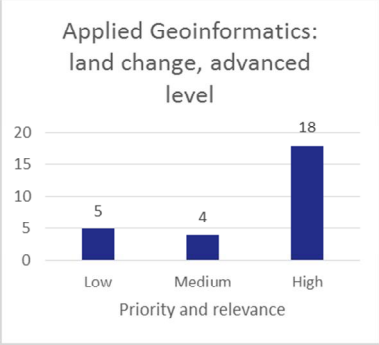
Specific needs: -



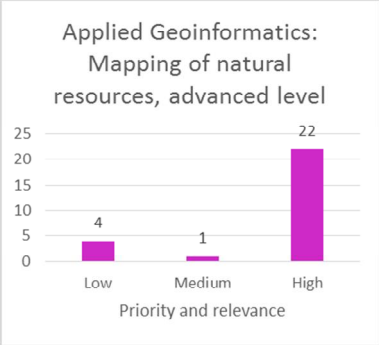
Specific needs: *Groundwater and surface water hydrology, surface runoff modeling and analysis*



Specific needs: *Web GIS applications, network infrastructure (internet, www, intranet), google earth*



Specific needs: *Environmental degradation, soil erosion, desertification, land use modeling & analysis, environmental monitoring*



Specific needs: *Availability & spatial distribution of natural resources*

The results of this exercise can be summarized as follows:

The top five topics were:

1. Applied Geoinformatics: Mapping of natural resources
2. Data collection with GPS/GNSS
3. Applied Geoinformatics: Hydrology
4. Methods in Remote Sensing
5. Advanced Geoinformatics

The topics with lowest priority were:

1. Spatial databases
2. Applied spatial statistics
3. Web GIS

5. Conclusion

The results of this assessment, first of its kind ever conducted in Eritrea, will be used to design the Training of Trainers Programme in Geoinformatics, which will be the model for up-coming Masters Degree Programme in Geoinformatics at Adi-Keih College of Arts and Social Sciences. The baseline of geoinformatics training and research in Eritrean HEIs has now been established. This assessment can be also used as a tool to measure progress achieved to the targeted outcomes of GIERI project.

As can be seen in the current situation analysis of the four HEIs, the geoinformatics training given in them consists of very few individual courses, and their position in the curriculum of individual disciplines could be strenghtened and improved considerably. There is no point in introducing geoinformatics as a discipline and a degree programme in every HEI, but with careful planning of resources, and with the new skills and knowledge the trainees of the ToT programme will acquire, much more can be benefited from geoinformatics than simple map-making. This is why the whole idea of the Geoinformatics Master's Programme at CASS is to train staff members of different HEIs, not only geographers. In this way, maximum benefit for the Eritrean society as a whole can be achieved from the programme.

The second important note one can make of current Geoinformatics teaching is that it focuses too much on theoretical content, and not enough emphasis is put on practical exercises and assistance. This message will be taken seriously in planning of the curriculum. In geoinformatics teaching at University of Helsinki, the situation is the reverse – more emphasis is put on practical content than theoretical. According to feedback from Finnish students and learning results, putting more emphasis on practical lab exercises and project work is a more powerful method of learning. Geoinformatics is both art and science – one needs to know the theoretical and scientific background, of course, but if one doesn't know how to apply this in practice, the teaching has had no real value.

Considering current human resources in geoinformatics, there is a big gap in demand and supply. Most of the very few existing teaching staff in geoinformatics are expatriates, or experts hired from outside. The almost total lack of available and skilled Eritrean geoinformatics experts has forced the HEIs to choose this path. Hardware, software and data are quite easy to purchase when funds are available, but skilled human resources are the most valuable asset any HEI can possess, since it takes years of training, hard work and motivation to train an expert on this field, and to convince and motivate the experts to stay working in the HEI.

Geoinformatics in general is used and perceived rather as a techical tool than a scientific discipline itself. In other words, there is so much unleashed potential that geoinformatics could give to strenghten teaching and research in all four HEIs.

Lastly, it can be said that the results confirmed the dire need for geoinformatics training and research in Eritrean Higher Education Institutes. The respondent's positive feedback on the GIERI project and genuine eagerness to learn the art and science of geoinformatics was confirmed. The findings also stressed the importance of geoinformatics to Eritrean society and economic development.

APPENDIX 1. Detailed Answers to Open-Ended Questions

Text Box 1. List of previous GIS / RS training courses taken by the respondents

- *Remote sensing and image interpretation*, EIT, Dept. of Earth Sciences. Three respondents took this course.
- *Training on Erdas Imagine* by dept. of Water resources, experts from Switzerland. But we didn't benefit from the training as we didn't manage to get neither the software nor remote sensing data.
- *Photogeology*
- *GIS Application course* in 2003, Asmara University
- *Introduction to RS and its applications*, *GIS and its applications*, HAC, 2009.
- *Introduction to GIS*, Anseba Regional Administration, Division of Land and Agriculture.
- *Introduction to ArcGIS I & II, Building Geodatabase I & II, Working with Spatial Analyst*, National Statistics Office, given by ESRI experts in 2006.
- *Mobile mapping with ArcPad and GPS, fundamentals of ERDAS Imagine*, National statistics office, ERDAS
- *Application of GIS & RS for environmental monitoring using QGIS*, given by MESA at Ministry of Land, Water & Environment, 2015. Three respondents took this course.
- *Introductory course in GIS*, Louisiana State University, 2000 and *6-month training in GIS* at Asmara, 2008.
- *GIS training* in Stockholm, Sweden, 1997, *Application of GIS in Hydrology*, Israeli universities in 2003, *GIS in developing world*, Bern University / Asmara University, 2003
- *Post-graduate diploma programme for 10 months*, Indian Institute of Remote Sensing, 2004
- *Remote Sensing and GIS Applications for Mapping and Monitoring of Natural Resources*, RSAC-UP, Dept. of Science and Technology, Govt. of India
- *ArcView 3.3 training*, Nakfa House, Einstein Institute of Computer, 2008.
- *Post-graduate diploma in Remote Sensing and GIS*, Jamia Millia Islamia, New Delhi, 2004-2005
- *Introducton to GIS*, CASS, 2009/2010
- *Introduction to GIS and Remote Sensing*, COMSAT, 2010-2011

Text Box 2. Current academic research projects

- EIT, Earth Sciences*: Geological study "Petrography, geochemistry and geochronology of granitoid rocks in Dekemhare area"*
- HAC, Land Resources & Environment*: "Effect of supplementary irrigation and nitrogen levels and oil physicochemical properties & yield of sorghum", "Effect of eucalyptus trees on other species"*
- HAC, Land Resources & Environment*: "Long-term effect of fertilizers and manure on the properties of soils", "Soil survey and capability classification"*
- HAC, Land Resources & Environment*: "Watershed development project, soil erosion observation, meteorological observation"*
- HAC, Land Resources & Environment*: "Baseline survey and environmental impact assessment of Hamelmalo and Habero Sub-Zobas, country program strategy and baseline survey"*
- HAC, Agricultural Engineering: *"Groundwater inventory"*
- CASS, Geography*: "Shift from mobile pastoralism to crop & livestock farming: consequences on household economy and ecology".*
- CASS, Geography*: "GIS analysis, environmental studies, urbanization, cultural, migration studies"*
- CASS, Geography*: "Economic & social impacts of land degragation in and around Adi-Keih". "Land related disputes in Southern Eritrea".* Abstracts submitted to NCHE for approval.
- CASS, Geography*: "Geographical analysis of urban fringing in Asmara, work ethic and agricultural output of rural highland peasants of Eritrea, land degradation".*
- CASS, Geography*: "Correlation of social indicators and environmental degradation"*
- CASS, Geography*: (1) "Urban vulnerability to poverty in Eritrea: Causes, coping strategies and mitigation efforts", (2) "Understanding the realities of gender gap in Eritrea: College influences on the gap".* Research proposals submitted to Eritrean Research Fund.
- COMSAT, Marine Biology & Fisheries*: "Monitoring of coral reef ecosystem around Massawa and Durghella Island".*
- COMSAT, Marine Biology & Fisheries*: "Coral reef monitoring, gill net selectivity of mullet, stock assessment of sharks".*

Text Box 3. Past and current research projects where geoinformatics was applied

- EIT, Earth Sciences: "*Application of Remote Sensing techniques in the identification of gold-bearing gossans from non-gold-bearing gossans*". Research project with Univ. of Texas, 1997-98.
- HAC, Land Resources & Environment: "*Status and distribution of macronutrients in soils of Hamelmalo area, Eritrea"*
- HAC, Land Resources & Environment: "*Modelling relative physical accessibility of populated places of healthcare facilities in Eritrea".*
- HAC, Agricultural Engineering: "*Hydrological inventory of Meseb-Gash river basin*".
- CASS, Geography: "*Map reading and interpretation, migration studies*"
- COMSAT, Marine Biology & Fisheries: "*Using GPS as a tool to record position of study sites*."

Text Box 4. Personal interests, research ambitions and ideas where geoinformatics could be applied as a tool or research method in your field of expertise

- EIT, Civil Engineering: *Environmental engineering, water resources*
- EIT, Civil Engineering: *Ground water studies using remote sensing* (two respondents)
- EIT, Civil Engineering: *Photogrammetry surveying, water, environment*
- EIT, Earth Sciences: *Hydrogeology, Web GIS*
- EIT, Earth Sciences: *Geophysical/Hydrological data analysis & processing, geological mapping of inaccessible areas*
- EIT, Earth Sciences: *Spatial data analysis and visualization*
- EIT, Earth Sciences: *Geology*
- HAC, Land Resources & Environment: *Agricultural research (Soil fertility mapping, crop monitoring..), environmental monitoring, forestry management, characterization of water pollutants applying GIS*
- HAC, Land Resources & Environment: *Soil survey and pedology, land capability/suitability analysis, map making, land valuation, land use planning, land use change analysis*
- HAC, Land Resources & Environment: *Assessment of soil loss, crop water requirements, ground water recharge estimation, assessment of crop stress due to water, insects, diseases etc.*
- HAC, Land Resources & Environment: *Mapping, spatial data analysis in agricultural science*
- HAC, Land Resources & Environment: *Digital image processing and analysis, topology of road and river networks, land capability / suitability analysis, watershed delineation and modeling, modeling degraded lands, land cover change, climate change*
- HAC, Agricultural Engineering: *Watershed modelling*
- CASS, Geography: *Analysing land use / land cover system in Eritrean highlands*
- CASS, Geography: *Use of field surveys and RS data in identifying, evaluating, assessing and mapping areas affected by gully & sheet erosion*.
- CASS, Geography: *Using GIS: Population studies, land form analysis, hydrology. Using RS: land use analysis, population studies.*
- CASS, Geography: *GIS data collection, processing & applications, aerial photo interpretation & processing, mapping techniques, modelling, environmental management, agricultural development, land use, poverty reduction*
- CASS, Geography: *Using time-series data, change analysis of land use patterns, impact of land degradation*
- CASS, Geography: *Land use management, environmental monitoring, geo-cultural landscape research*
- CASS, Geography: *Studying quality of life and its consequence on environment*
- CASS, Geography: *GIS applications in human geography*
- CASS, Geography: *geodatabase development, geoprocessing services, geostatistical analysis, application of GIS in urban planning and land use change*.
- COMSAT, Marine Biology & Fisheries: *Studying coral reefs with remote sensing: site selection, monitoring environmental parameters, georeferencing old maps, measurement of temperature, salinity and current with remote sensing*
- COMSAT, Applied Marine Science & Technology: *spatial distribution of marine organisms and their conservation, flood risk mapping of coastal towns and mitigation measures, mapping of marine resources (e.g. fisheries, underwater minerals), locating fish habitats according to their species and economical values for sustainable harvest and conservation*

Text Box 5. CURRENT SITUATION: To what extent is Geoinformatics currently used in teaching and research in your organization? Please give details on disciplines, programmes and courses.

- EIT, Civil Engineering: *No separate program, we use GIS in surveying (in a limited way)*
- EIT, Civil Engineering: *Civil engineering software, programming using C (map-making, geodesy, coordinate systems not taught in undergrad studies)*
- EIT, Civil Engineering: *GIS is not currently used in teaching and research in Dept. of Civil Engineering*
- EIT, Civil Engineering: *Course related to Geoinformatics is surveying in areal surveying & photogrammetry*
- EIT, Earth Sciences: *A course of GIS and Remote Sensing (4th year) and photogeology course (2nd year)*
- HAC, Land Resources & Environment: *Geoinformatics teaching is given in our department and Dept. of Agricultural Engineering, but application in research activities is limited except in soil mapping*
- HAC, Land Resources & Environment: *Courses in GIS & RS are taught, but practical application is at lower level like basic map making*
- HAC, Land Resources & Environment: *Courses in GIS & RS. Used in map-making (land use maps) and basic spatial analysis.*
- HAC, Land Resources & Environment: *RS & GIS given as introductory courses (3 cr each) in Dept. of LRE and AE, however for research it is being used only for preparing locational maps and to some extent in spatial analysis in MSc and PhD research.*
- HAC, Agricultural Engineering*: It is in a rudimentary stage and offered in a fragmented way. Application of GIS & RS courses for Agricultural engineering students, used for senior research projects, knowledge of GIS & RS of staff is very much limited*
- HAC, Agricultural Engineering: *It's in small extent on undergraduate classes such as Remote Sensing and GIS*
- CASS, Geography: *Introductory course on GIS & RS (3 cr each) offered to geography undergraduate students. Graduating students use this knowledge to prepare their project work.*
- CASS, Geography: *In research, application of Geoinformatics is at a very infant stage. Teaching in courses: Surveying & cartography (2nd year), aerial photo interpretation & remote sensing (3rd year), Introduction to GIS (4th year), Map use & interpretation (4th year)*
- CASS, Geography: *Courses offered concentrate more on theoretical than practical content. Lab assistance in courses not adequate.*
- CASS, Geography: *Not enough practical sessions, students get only lecture notes and throw them away after exams. Skill-based courses, such as surveying and cartography, map use interpretation) are also taught theoretically. Geoinformatics research is currently non-existent. In field trips, some instructors show GPS and other surveying instruments to their students.*
- CASS, Geography: *Teaching in Geoinformatics is totally theoretical in nature, practical aspects are totally missing at undergraduate level.*
- CASS, Geography: *As such Geoinformatics is used very little in teaching and research in CASS*.
- COMSAT, Marine Biology & Fisheries: *One course in GIS for undergraduates: "Introduction to GIS and Remote Sensing". In research, not much is done using Geoinformatics*.

Text Box 6. CURRENT SITUATION: Give details of the actual skills, knowledge and abilities of staff in your organization regarding Geoinformatics teaching and research

- EIT, Civil Engineering: *Our department does not have any knowledge about Geoinformatics*
- EIT, Civil Engineering: *As the related courses are given for two semesters with limited lab courses I can say the staff skills are also limited*
- EIT, Earth Sciences: *One expat staff member has a MSc in Remote Sensing and GIS*
- HAC, Land Resources & Environment: *Only one staff member in the college is skilled in GIS teaching and research assistance. Most of us have only basic knowhow in this field.* (Four respondents)
- HAC, Land Resources & Environment: *One staff member has MSc in GIS, tries to teach and assist in research, however the skill and knowledge of staff is poor and needs upgrading. The curriculum of the department should also be reviewed such as that of agronomy so that their students take RS and GIS courses*.
- HAC, Agricultural Engineering: *Low capacity*
- HAC, Agricultural Engineering: *Very low, many even don't understand its usefulness for agricultural sciences*.
- CASS, Geography: *No highly qualified instructors in GIS, application of GIS in teaching and research is limited*
- CASS, Geography: *The younger teacher assistants have same introductory knowledge. Two of our senior staff have also a good grasp of geoinformatics.*
- CASS, Geography: *Teaching is highly dependent on expatriate teaching staff, who focus on theoretical parts but lack practical skills to teach students*.
- CASS, Geography: *We have skilled staff, but a proper set up of a well-equipped lab is not in place.*
- CASS, Geography: *The actual talent and ability of geoinformatics applicability among the staff is less, as we all treat GIS as a largely technical issue.*
- CASS, Geography: *Very primitive understanding*.
- CASS, Geography: *The knowledge and skills can improve in a very short span of time among the staff. In CASS, emphasis is given to theoretical part rather than practical part. This is a high time to start this training programme.*
- CASS, Geography: *The geoinformatics related courses are held by expat instructors. To be honest, the courses were made to be held by them because the college was left with no other option.*
- COMSAT, Marine Biology & Fisheries*: We don't have a skilled person in our staff. The course is always given by outsiders.*
- COMSAT, Applied Marine Science & Technology*: There is shortage of skilled permanent staff. GIS course given at dept. Of Marine Biology & Fisheries. I*

Text Box 7. CURRENT SITUATION: What kind of Geoinformatics resources (human / hardware / software / data) your organization currently possesses? Can staff and students equally access those resources?

- EIT, Civil Engineering*: Only geology Dept uses GIS, Dept of Civil Engineering has none*
- EIT, Civil Engineering*: All the surveying instruments in my organization are mostly out of use, students and staff access them equally*
- EIT, Civil Engineering*: For the surveying courses, only some materials are available like levels, theodolite. Everyone can equally access them*
- EIT, Earth Sciences*: One staff member has experience in GIS, we use a demonstration version of the software (ArcGIS?)*
- HAC, Land Resources & Environment*: No GIS/RS lab, but few computers equipped with ArcView, Idrisi. Students have access to those in practical courses. (Five respondents)*
- HAC, Agricultural Engineering*: GIS Expert in Dept of LR&E. Very few software (Idrisi in computer lab, ArcGIS 9.3 in some PCs)*
- HAC, Agricultural Engineering*: Nil. Few individuals have GIS/RS software in their PCs but not at organizational level so far.*
- CASS, Geography*: GIS lab equipped with computers and ArcGIS 10.3 software. All students taking a course on GIS have equal access to the GIS lab.*
- CASS, Geography*: Not adequate, lack of skilled staff and know-how; hardware, software and data are not satisfactory. Both staff & students have equal access to these resources.*
- CASS, Geography*: The computers in the existing GIS lab are loaded with outdated GIS software. Mostly 4th year degree students have access to the available GIS resources.*
- CASS, Geography*: The staff is practically unskilled, GIS lab has outdated hardware and ArcGIS software. The resources are accessible to all.*
- CASS, Geography*: There is no shortage of hardware but great shortage in skilled human resources and software.*
- CASS, Geography*: In CASS, we have a big GIS lab full of furniture with few working computers. Our lab has HTC computers with 1 GB RAM, printer, stereoscope and 1 Garmin GPS receiver. Furthermore, we have a collection of satellite images prepared by UMEE. Currently we are using ArcGIS 10 desktop in our lab. Regarding accessibility of these resources I may say they are available for everyone in the college who is willing to use them.*
- COMSAT, Marine Biology & Fisheries*: Our collage doesn't have almost any GIS/RS software, teachers from outside bring their own software to teach our students. But once installed, the software is equally accessible by the students or staff members who are interested.*
- COMSAT, Applied Marine Science & Technology*: COMSAT currently possess software and data. Everyone can access but use is limited by lack of expertise.*

Text Box 8. DESIRED SITUATION: What are the potential uses and application areas of Geoinformatics in your organization? With all resources available, how would you implement these in teaching and research activities in your organization?

- EIT, Civil Engineering: *Geoinformatics is essential for civil engineering (surveying, urban planning, highway alignment, hydrology, geotechnical engineering)*
- EIT, Civil Engineering: *Geoinformatics should first be introduced in the undergraduate studies of Civil Engineering to be efficiently implemented in teaching and research activities*.
- EIT, Earth Sciences: *We will have nationals who'll teach GIS and RS courses and add more GIS-related courses in the future. We will use GIS more efficiently in our future research works in geological mapping and exploration by sharing spatial data and experiences with colleagues from CASS*.
- HAC, Land Resources & Environment: *Appropriate processing & analysis of crop water requirements. Crop evapotranspiration in relation to meteorological data record in water station*
- HAC, Land Resources & Environment: *Proper assessment, processing and analysis of data on forest monitoring as forestry is given as a course in the college*.
- HAC, Land Resources & Environment: *Come with end result for detail rainfall for soil and forest map will be generated. It will be an aid / assistance in the learning process*.
- HAC, Land Resources & Environment: *Land use change analysis, land suitability and capability mapping, detailed soil characterization and mapping*
- HAC, Land Resources & Environment: *Accurate spatial data can be acquired so that all crop growth factors can be utilized, human interventions either for the benefit or against soil and water can be identified, drought and natural disasters can be forecasted and the necessary remedy preparation can be made*.
- HAC, Land Resources & Environment: *Land capability / suitability classification, use of high resolution imagery*
- HAC, Land Resources & Environment: *Forest monitoring and inventory, crop water requirement analysis, land use change analysis, land resource management, soil mapping, crop monitoring and precision farming*
- HAC, Agricultural Engineering: *Accurate, timely and spatial input for agricultural research*
- HAC, Agricultural Engineering: *It would have essential impact on the development of agricultural science as a knowledge and it would be helpful in collecting agricultural data*.
- HAC, Agricultural Engineering: *The number of training courses and practicals pertaining to GIS and RS shall be improved and increased. Enhance research works related to GIS&RS. Encourage students and staff to do senior research projects using the facilities available.*
- CASS, Geography: *Huge potential in application of Geoinformatics at CASS*
- CASS, Geography: *Study of the environment and its resources: resource identification and inventory, management and planning of natural resources*
- CASS, Geography: *High staff potential to learn geoinformatics. Land use studies, urban studies, mapping*.
- CASS, Geography: *The potential is huge, provided the resources are available. Both staff and students will use it in various research and class assignments*.
- CASS, Geography: *Senior students of CASS try to include maps of GIS output in their final year B.A. thesis and other term papers.*
- CASS, Geography: *There are plenty of potential uses of GIS, first and foremost at teaching level to train students. Practical knowledge of tools, techniques and software empowers the students to improve understanding in decision making.*
- CASS, Geography: *The prime application and use of the skills and knowledge we acquire from this training is going to greatly foster and assist the several researches my institution will deploy with geoinformatics techniques. In order to effectively implement them in teaching I suggest we have to revise and upgrade our curriculum in different departments in order to incorporate basic principles of geoinformatics in their courses, and also these departments have to devise mechanism by which their senior students have to incorporate GIS in their research methods while doing their senior research projects as their partial fulfillment of their BA degrees.*
- COMSAT, Marine Biology & Fisheries: *We are planning to install QGIS open-source software to our computer lab.*

Text Box 9. IDENTIFIED GAPS: In your view, what are most critical gaps (or missing resources) your organization faces to reach the desired situation?

- EIT, Civil Engineering: *Internet access, laboratory classes*
- EIT, Civil Engineering: *Internet facilities, laboratory instruments*
- EIT, Civil Engineering: *Geoinformatics not included in the curriculum*
- EIT, Civil Engineering: *Almost no instruments* (two respondents)
- EIT, Earth Sciences: *Skilled staff, lack of hardware and software*.
- EIT, Earth Sciences: *Skilled staff*
- HAC, Land Resources & Environment: *Skilled personnel, required software & hardware* (two respondents)
- HAC, Land Resources & Environment: *Accurate and up-to-date GIS/RS software and hardware, highly qualified experts, up-to-date and accurate satellite imagery, electricity*
- HAC, Agricultural Engineering: *No access to up-to-date information, lack of human resources, knowledge, software, hardware, financial support and financial bureaucracy* (two respondents)
- HAC, Agricultural Engineering: *Well-trained human resources, lack of necessary facilities (rooms, electricity, internet, hardware..), lack of understanding of the importance of GIS & RS at organizational level*
- CASS, Geography: *Qualified GIS instructors, shortage of software (especially RS), shortage of lab technicians*
- CASS, Geography: *Most of the infrastructure is outdated, complete renovation of hardware and software is essential*
- CASS, Geography: *The most stressing shortage is lack ow own expert in Geoinformatics. In addition, hardware, software and data are outdated.*
- CASS, Geography: *Lack of any assistance in terms of hardware, software, trained personnel*.
- CASS, Geography: *Data collection tools (such as modern Trimble GeoExplorer GPS), ground surveying instruments for vector data capture, scanners for raster data capture, up-to-date satellite images and aerial photos, up-to-date and open-source GIS-software, appropriate physical infrastructure for networks of GIS*
- CASS, Geography: *Gaps are in skilled persons who can give training and required facilities like availability of software and proper arrangement of the lab*.
- CASS, Geography: *The most critical and serious gap in CASS in general, and Geography dept. In particular is having Geoinformatics related courses with no faculty specializing in them.*
- COMSAT, Marine Biology & Fisheries: *The fact that ArcGIS is proprietary software, not open-source, make some of the interested staff and students to concentrate less on the software. But now I hope with QGIS more users will get interested.*
- COMSAT, Applied Marine Science & Technology: *Trained human resources are hardly available, hardware and software not up-to-date.*

Text Box 10. OTHER ISSUES: Anything else you would like to bring to the attention of the GIERI project coordinators?

- *In HAC, potential graduate assistants who were working as a community service were all assigned to other organizations (e.g. Land Resource dept. at Ministry of Land, Water and Environment)*
- *I believe pursuing MA degree and above is more of an exposure thing than simply taking class lectures with the familiar faces you get acquainted with. So what I expect from GIERI is a totally different learning system with instructors that we are not familiar with. I strongly believe it is in this way that we can only have the taste of the educational system found in the other side of the world. In addition since we lack the required local knowledge of the field, I suggest it will be much more effective and smooth if you can find a means by which the GIERI completely adopts the curriculum from Univ. of Helsinki. I personally value the recognition and validity of an international certificate that is going to be offered by the end of the programme. So if you can find by any means that the Univ. of Helsinki can offer the degree it can be a huge motive for the trainee.*