GEOGRAPHIC INFORMATION E-TRAINING INITIATIVES FOR NATIONAL SPATIAL DATA INFRASTRUCTURES

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Abstract. National and regional geographic datasets with derivative spatial analysis techniques are often crucial for decision-making in sustainable development for both developing and developed countries. The needs in the spatial data and respective training are demonstrated in this article by the two very diverse examples of Papua New Guinea and the Republic of Lithuania national spatial data infrastructures.

Handling and efficient use of geographic data requires rather specific skills. However, the existing curricula are inconsistent and hardly match even the basic needs of geographic information managers in state institutions and municipalities. The main objective of the proposed geographic information e-training system is to develop and provide the modularised Spatial Information Infrastructure courses intended for on-line based learning. This mainly will target employees of civil service and private business in Lithuania and the European Union. The proposed curriculum is a set of modular courses adding up to 1,5-year part-time studies in the field of Geographic Information Science and Geographic Information Infrastructure. Main advantage of on-line-based training is increasing accessibility in terms of both geographic location and time.

Keywords: e-training, geographic education, geographic information, sustainable development, GIS, geographic information infrastructure.

1. Introduction

Sustainable development is described as complex range of objectives, activities, and human-kind behaviours with respect to the environment that should be consistent with the aims of meeting the needs of the present and predicted future (Campagna 2006). This notion can be applied to both technological and social issues that deal with human activities that must not overload the capacity of the biosphere to absorb their impacts.

The most sustainable development decisions are inherently multidisciplinary and have to take into consideration economic, social and environmental phenomena and processes. In addition, this complicated decision-making system requires understanding spatial or geographic relations among physical and social objects and phenomena.

The term *geographic (spatial) information* refers to any information, which contains a locator component, such as geographic co-ordinates and addresses. It is used in many applications, ranging from a simple location of places to optimisation of itineraries, finding out spatial patterns and relationships, planning and performing other complex tasks. Geographic information is particularly important for regional development. It is claimed that about 80 % of decisions for development purposes are (or ought to be) spatially based (Mennecke 1997). It is often stated that an insufficient use of available geographic information, due to eg low skills of decision-makers in an application field, is the major cause of failure of development projects that bear spatial components. However, until a very recent time a big part of geographic data needed for decision-making appeared to be unavailable, inconsistent or incompatible with other datasets. That also hindered the development of geographic education strategies. Now it is high time to elaborate such a strategy at the national level in order to catch up with the needs of the geographic information infrastructure for countries that have no such strategy yet. There is a general shortage of trained manpower even in the developed countries.

The following examples demonstrate the importance of spatial information in decision-making for developed and developing nations and for different groups of users.

The FEMA (Federal Emergency Management Agency), in USA has been using GIS for quite a while (since 1992), but during Hurricane Catherine, FEMA failed to use this technology to organise adequate response to the disaster. However, at the same time volunteers successfully used Google Map to help in the rescue and recovery efforts (Schutzberg and Francica 2005).

Global warming is heating the Arctic at a rapid pace. Are there any winner in Canada's Arctic? Temporal analysis of the satellite images and spatial modelling show that probably in the next 50 years the Northwest Passage finally clears enough to be a viable shipping route; a whole range of trade opportunities will come with it. So will resources, as fossil-fuel deposits, in the ocean floor become more accessible?

Papua New Guinea (PNG) faces an awkward structural transition in its economy. The migration of farming communities to the urban areas in search of employment or better lives has exacerbated urban squatting problems as squatter settlements are considered breeding grounds for most urban crimes. Settlements spring up haphazardly without proper planning and often lack basic services such as electricity, water, schools, clinics and the like. GIS is used to incorporate settlements into the formal urban framework by properly sub-dividing

and servicing them so that they can become a recognised part of the PNG National Capital District in Port Moresby. It is a slow process and may be applied to other cities as well.

In the South Pacific, nations increasingly challenged by the pressures to integrate with the global economy are embracing tourism as a vehicle for social and economic development. One of the sample studies conducted in this area is "GIS as a Planning Support Tool for Community Integrated Tourism Development: A Pilot Study for Fiji Islands and the South Pacific", which worked in partnership with the Ministry of Tourism and Transport. The aim is for Fiji to develop a database and examine its applicability for wider implementation both in Fiji and for government and other development agencies throughout the South Pacific region.

If completed, the $24 billion Three Gorges Dam on the Yangtze River will be the largest hydroelectric dam in the world. China has decided to launch the project – then to solve the problems along the way. GIS and Remote Sensing help explore the positive and negative implications of creating the largest dam in the world. The spatial tools are used to address the spatial concepts associated with the consequences of the project: flood control and water storage, power generation, population relocation, and the loss of cultural artifacts.

Officials push the plans of building the oil pipeline along Baikal coast. Baikal is located in a tectonically active zone. The route of the proposed pipeline construction is passing through the region which is seismically active and prone to tectonic activities such as earthquakes. There is an alternative route of oil pipeline that is ecologically friendly but slightly expensive. Multispectral satellite imagery is used to assess the state of the geological status and demonstrate the seismic danger and vulnerabilities along the pipeline route.

Around the world, national Geographic Information Infrastructure projects have been developed to meet the needs of national data users. These projects have many things in common but at the same time they are adapted to specifics of particular nations (Groot and McLaughlin 2000).

The goal of this paper is to demonstrate the significance of geographic information education for sustainable development and to introduce e-training solutions for geographic information managers and users in order to meet the needs of national geographic information infrastructures. Case studies in developing and developed countries demonstrate the significance of GIS.

2. Significance of geographic education for sustainable development

The demand for well-trained geographic information managers and professionals of Geographic Information Systems (GIS) remains high worldwide (Sponberg *et al.* 2006; ITC Study guide… 2002; UNIGIS… 2005; NCGIA… 2000; University of Idaho… 2004; The University of Huddersfield… 2004; The University of Buffalo… 2004; Zentrum… 2004; Corso… 2004; Mestrado… 2004). The US Dept of Labor identified geographic information system technology as "one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology" (Richardson 2004). Job opportunities are growing and diversifying as geospatial technologies prove their value in ever more areas. The article noted that the estimated US $5 billion worldwide geospatial market will expand to US $30 billion by 2005; and, that over 140 000 organisations worldwide currently use GIS – and mostly governmental agencies.
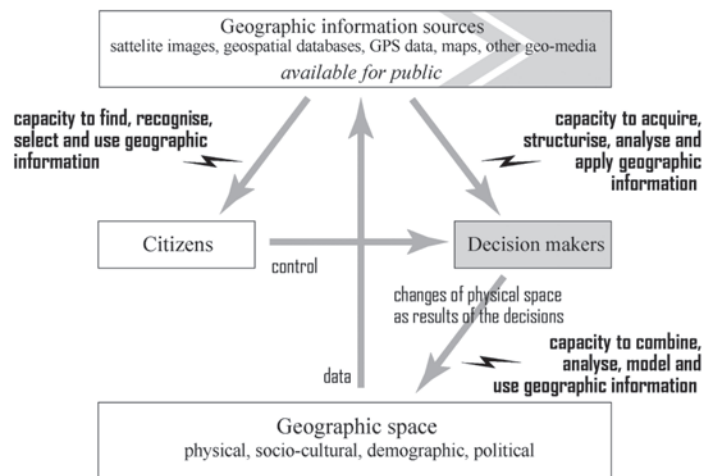
Fig. 1. Geographic information in decision-making

GIS applications continue to expand into such areas as natural resource management, strategic planning, mineral exploration, transport planning, telecommunications, land use planning, business, criminal justice, and domestic and international security. Internationally, developments in land reform, resource development, environmental management, and infrastructure development will employ an increasing number of GIS-trained application specialists (Sponberg *et al.* 2006; Zavadskas *et al.* 2003, 2004a, 2004b; Turskis *et al.* 2006).

One of the promising ways to support a country or region is in the education of their people. This is true both for developed and developing nations. New and appropriate GIS training programs are needed for different groups of users – policy makers, decision takers, technocrats, educators, and public.

We can see two major roles of geographic information training (that includes not only GIS, but also other Geo-Information disciplines, such as Cartography, Remote Sensing (RS), Geodesy and Surveying, Navigational Positional Systems, Web Mapping etc) that can be crucial for sustainable development of territories and resources.

The first role is spatial analysis for decision-making that can obviously become a useful tool for optimisation of good government decisions and for sustainable resource management.

The second role is spatial analysis for control over decision-making. As never before, citizens have direct access to information that can be used to observe the results of planning and development decisions made by government. As soon as geographic information is made public, it is sought by national, regional and/or global geographic information infrastructure mechanism, and governments or individuals will not be able to hide or distort it (Fig 1).

3. The role of GIS and related training for sustainable management in Papua New Guinea

Geographic Information Systems are increasingly used from corporate organisations to educational institutions, universities down to individuals to analyse data, process information or display and disseminate results to answer various spatial and aspatial questions. GIS is also used as a planning tool that can be readily implemented in any area of application. The widespread acceptance and use of GIS crosses many geographic borders and societies. Increasingly, the community at large, who are important stakeholders and custodians in resource management and development, are involved to participate, hence the emergence of participatory GIS (PPGIS) in recent years. The scale and rate of the introduction of GIS, its acceptance and implementation varies between countries. However, there is a surge of its use in the developing countries, but the majority of the users lack prerequisite background knowledge in GIS principles and applications. The implications from lack of proper GIS background cannot be overemphasised and here we take a case of Papua New Guinea (PNG).

'GIS' was a buzzword in PNG in the late 1980s and early 1990s as it entered the various institutions and government departments. It was considered a novel technology and left only to the experts to use and preach to others. Increasingly, it is gaining popularity as it penetrates into offices, schools and even homes. The outcome of such popularity with GIS would be reflected in the decisions taken by GIS consumers. Those decisions can only be as good as the quality of the data used and the competent knowledge of the GIS operator. Errors caused by data, software or the operator can also occur but there are ways to check, control, minimise or eliminate them. If decisions are to be based on GIS products such as graphs, tables and maps, it is important for the GIS operator to be conversant with the corresponding functionalities of GIS for respective outputs. Moreover, it is equally important for the user of such GIS (geo-information) products to be literate in GIS and map reading affinity to correctly decode and interpret the results to take appropriate actions. Currently, general GIS literacy is an area that is lacking in PNG. A general awareness and education on GIS and map reading would be valuable as information technology is increasingly becoming popular and affecting the decisions of the society. In other words, PNG is increasingly trying to catch up with the rest of the world in information technology.

Recently a paper was published on population increase and land use change in the Morobe Province of PNG between 1975 and 2000 using GIS (Ningal *et al*. 2008). This study is an example of how GIS can be used to assess and quantify land use changes, planning and resource management. Similar studies can be undertaken with specific objectives where students and others can be trained to leverage the tools available in GIS to answer real questions in PNG.

The objective of the land use change study was undertaken to test if there is a positive correlation between land use change and population increase. Land use change is generally taken as a proxy for population growth in many studies. Previous study by McAlphine and others disproved this trend for PNG on a national scale (McAlpine *et al.* 2001). Since there is a huge cultural diversity and significant topographic differences in PNG, a case study on the Morobe province was undertaken to get an insight at a local (province level) scale.

Colour topographic maps of 1975 were used as the starting point of land use state in the Morobe Province. This baseline is chosen to coincide with the dates of the topographic maps which were mapped from 1975. The country also attained independence in the same year and large scale land use appeared to be minimal, hence a suitable baseline date for accounting land use changes in PNG.

The graphics represented on the 1975 topographic maps can be categorised into two main classes; man-made and natural features. Man-made features are such as roads, villages, towns, schools, aid posts, airfields, and plantations, while natural features are like rivers, mountains, forests, contours, lakes, coastline etc. Land use classes identified from the legend of the topographic maps were forests, urban plantations, grassland, cultivation, and water. These land use classes were captured and stored as 1975 land use in the GIS. Their areas were calculated and other related data were also incorporated into the 1975 land use data set.

Since there is no land use map available for 1990 such as the 1975 topographic maps to collect the land use data, the 1990 satellite remote sensing image over Morobe was used to collect land use data for 1990. This is done by using the 1975 land use data and identifying changes in the 1990 satellite image. Other data from Agriculture Dept and Forest Authority were used to confirm the boundaries and types of land use changes for 1990. The same procedure was followed to collect the land use data for 2000. After these steps are completed, the land use data for 1975, 1990 and 2000 are collected, updated and stored in GIS for processing, analysing and producing results for reporting.

Once data are collected and stored in a GIS, numerous processing and analyses are possible. The type of processing and analyses are dependent on the expected result. The results will provide answers to questions posed in the study aiming to satisfy certain objective(s). Our objective was to assess and report the land use change in the Morobe province between 1975 and 2000. The GIS analysis tries to answer questions like:

- Which land use change occurred most/least between 1975 and 2000?
- What is the rate of change between 1975 and 1990 compared to 1990 and 2000?
- Which district(s) in Morobe experienced the most land use change and how much?
- What is the dominant soil type in the agricultural land use change in Morobe province?
- Which district experienced the highest population growth but little change is agricultural land use?
- Which district experienced the least population growth but a significant land use change?
- What climatic and environmental conditions are prevalent in the area with most agricultural changes?
- Is there a correlation between population growth and land use change and if so, by how much?

Such questions and more can be asked to derive answers from GIS. GIS operators who are familiar with the system can construct the right questions to get the desired answers. In this study, various GIS operations were performed to answer the above questions.

The results showed that between 1975 and 2000 there was a significant increase in population and also a marked change in land use. Forest areas were cleared for cultivation while other forest areas were cleared for logging purposes. Some of the logged areas later were

converted to cultivation. It also showed that people tend to stay close to an access to transport systems such as roads, airstrips or wharves. The general picture shows that with a population increase, there were also accompanying land use changes, mainly in agriculture.

To use such a study result in PNG to make decisions or take actions, it is important that the person(s) involved in the planning and decision-making or those who are stakeholders be familiar with GIS products and their uses. They should be able to have a general understanding of the data used, the main GIS processes and the outcomes. They should also be able to pose questions on the GIS results instead of taking them as a correct information because there are always associated sources of errors. Only informed and trained GIS and map users can be able to discern and ask pertinent questions for clarifications, confirmations or validations regarding any GIS product.

The study concluded that in the absence of improved soil fertility management, an improved farming system and increased crop production, the current trend of clearing forests for cultivation will continue. This implies that without planning, the resources would be depleted quickly with increasing population growth. This is where GIS can be used by decision makers such as planners, agriculturalists, lands officers, community liaison officers, resource owners etc to make policies and plan for a sustainable use of the resources at their disposal.

Returning to the issue of training GIS operators, consumers etc. with vested interest in GIS in PNG, there is a clear need for a sustained and long-term plan. Currently, the PNG University of Technology (UNITECH) in Lae, Morobe province, is the only educational facility where courses in GIS and related GeoInformation topics are taught. The full course spans 4 years for a Bachelor degree in Cartography and 3 years for Diploma in GeoInformation. The number of graduates with GIS competencies from the Unitech is inadequate to meet the country's need. Those who are introduced to GIS in the workplace have to understudy other experienced GIS operators through in-house training, attend short GIS courses or use manuals and other resources. The very nature of GIS requires fundamental technical and theoretical understanding and knowledge for its effective use. Lack of understanding in the proper use of GIS in the work places where GIS products are used to base decisions upon can be seriously affected if errors are introduced and propagated without control. Erroneous GIS products could lead to nasty implications such as expensive litigations, accidents and even loss of lives. Therefore a proper training plan for GIS ranging from students to middle-management professionals, policy/planning/decision makers and politicians should be designed and delivered. It turns out that many who claim to know GIS in fact do not sufficiently understand GIS to take advantage of the full range of capabilities and functions available in GIS to optimize and streamline routine procedures. Installations of GIS at workplaces are aimed at lowering overhead costs and to improve production, however, persistent low productivity could imply lack of training; hence the maximum potential of GIS remains underutilised.

The significance of GIS and the need for training was recognised around the time GIS was introduced in PNG and much have been said and written hitherto. A concrete training plan for different levels such as from students to politicians as pointed out earlier is yet to be attained. Departments, statutory organisations and others send their employees abroad to attend GIS course which are usually expensive. Many attempts have been made to conduct in-country trainings such as short courses. These courses tend to vary in their themes, contents, duration

and generally simple and broad in scope. The attendants gain basic GIS operation skills but barely sufficient to undertake advanced GIS tasks. Increasingly the members of PNG GIS user-group is growing and links are now forged with other GIS organisations in the Pacific region, for example, SOPAC. SOPAC is Pacific Islands Applied Geoscience Commission based in Suva and concerns with providing products and services on community lifeline, community risk and, oceans and island (SOPAC… 2007). Recently SOPAC provided some training on GIS and GPS in PNG for various GIS users. The University of PNG (UPNG), through the efforts of UNDP, EU and Conservation International has set up a GIS and Remote Sensing Centre in Port Moresby within the Biology Dept in the School of Natural and Physical Sciences. GIS and Remote Sensing courses are taught in UPNG since 2003 for its students but taylor-made courses would be offered to outsiders in the near future.

What emerges in PNG is a lack of a comprehensive plan for GIS education and training to be designed and implemented with financial and policy support from the national government. Instead, there is disparate and piecemeal approach to GIS education leaving the growing number of GIS operators and users to fend for themselves. Apart from UNITECH and UPNG, other training courses are not sustainable. The GIS user group formed by GIS users from various government departments and other institutions is a positive effort to discuss problems, update each other and share common problems. This effort can only be sustained and enhanced if the government realises the role of GIS and its significance in the development of PNG.

Although the number of GIS users hooked up to the Internet and e-mail systems are increasing, most networks face various constraints. Such limitations are in the form of low bandwidth, expensive airtime rates from Internet providers resulting in limited use, or simply being denied the access by the top management for reasons such as misuse of the system, leading to a low productivity. In such cases where access to the Internet are restricted, GIS operators who are usually in the lower production line are denied the opportunity to quickly surf the Internet and find answers to questions from online GIS forums, Google, contacting universities, institutions or a host of other sources to find solutions to GIS problems. This bottleneck can only be improved with a political will and long-term policy from the national government.

Furthermore, in spite of the continued attempts by National Mapping Bureau (NMB), the National Mapping Agency (NMA) of PNG to convert analogue maps into digital versions, the mammoth task is ongoing but at a slower pace. The digital products are not readily available for public consumption and there appears to be a technical problem in its dissemination – both on- and offline. National Spatial Data Infrastructure (NSDI), Spatial Data Infrastructure (SDI), Geospatial Data Infrastructure (GDI) or other synonyms that refers to producing, storing and distributing spatial data via a clearinghouse is yet to be fully established. Foundation data such as topographic data layers are necessary to overlay framework and thematic layers. Foundation data layers like control points, contours, rivers, road alignments etc. come under the mandate of the NMA that is responsible for its production, storage and dissemination. In the absence of the foundation data layers, GIS users resort to various means of capturing these datasets by themselves, thereby creating redundant and duplicate copies of data for in-house

consumption that are at most, incompatible with datasets from other GIS organisations. Time, effort and cost can be saved if the National Mapping Agency could be the sole producer and supplier of basic foundation data across PNG. The use of a common data set from NMB that is accessible to GIS operators and consumers would eliminate questions related to discrepancies caused by differences in source data. Questions and queries can be directed to NMB which is mandated to produce and supply the foundation data. NMB as a credible source of these data sets, consumers will have confidence, thereby its use become popular.

To sum it up, attention must be paid to train the consumers of geo-information products to enable and equip them to use the outputs from GIS for the intended purposes. Approximately 85 % of the people in PNG live in rural areas and depend on Subsistence agriculture. About 97 % of the land is owned and controlled by local ethnic groups. It still remains an enormous challenge for any form of planning, be they development of infrastructure, registration of customary land, inventory of natural resources, mineral/oil explorations or other, GIS is becoming an important and useful tool to deploy. This calls for a timely and effective training in GIS and map reading to support informed decision making by the respective decision makers and implementers. Planned use of resources can be sustained and the used GIS has a specific and unique role in countries like PNG, where there is much social, cultural and physical diversity.

The first step would be for the NMB to make foundation data of PNG easily accessible to consumers at affordable prices. GIS users can easily overlay their thematic data layers for various processes. To sustain NMB's spatial data production, storage, maintenance and dissemination, long term National Government support in the form of policy and funding would be a direct impetus to such implementation to reach fruition. In turn, NMB can upgrade its employees through training and update its data sets through timely revisions. Without the support from the National government, the current situation is likely to remain for some time.

4. Lithuanian Geographic Information Infrastructure and geographic education

The Lithuanian Geographic Information Infrastructure (LGII) is now in the process of implementation (Beconyte *et al.* 2007). This program, begun in early 2004, has been designed to provide a national geographic data clearinghouse that is the repository of consistent interoperable spatial data and services (Feasibility 2004; Framework 2004). The implementation, support and management of this national geographic information infrastructure is reliant upon highly skilled geographic information professionals. These professionals will become responsible for, not only the maintenance of the central geographic metadata catalogue and distributed geographic databases, but also for the efficient management of each LGII data/services provider (node). The training and education of geographic information managers, analysts and technicians is possible because of the availability of rich and up-to-date geographic datasets through this infrastructure program. Therefore the Lithuanian Geographic Information Infrastructure project is inseparable from the national geographic education strategy. At the same time, in the private sector, managers stand to gain from the positive impacts of geospatial solutions that will allow them to maximise returns on investment within their organisation through LGII. The need for this capacity is no longer limited to specialised do-

mains, as in the past, but encompasses the economy of the nation as a whole. The importance of geographic knowledge to the development of an informed society is generally not open to debate any more.

In order to increase a broader awareness, understanding and more efficient use of geographic information among Lithuanians, a framework of long- and short-term educational activities should be developed, focusing upon the following target groups:

1) Decision-makers and politicians (basically awareness-raising, fitting the needs, tasks and time restraints of this target group).

2) Specialists who are using geographic information including public servants (focused education in form of high school teaching and in-service training, specific seminars and workshops).

3) GIS professionals (continue developing courses in new technologies, software and their updates).

4) Students involved in non-geographic educational schemes (introduction of geographic information in the curricula, educational portal or specialised applications for understanding geographic information technologies and principles of management).

5) Citizens (promotion of geographic information services).

The current level of awareness and skills in geographic information-related subjects like geodesy, cartography, GIS and their applications is not very high in Lithuania. On the other hand, such skills are better gained through a practical experience. The knowledge accumulated by specialists working in geographic information infrastructure is most important. However, it should be complemented with specific purpose-oriented courses. The in-service training system for those already active in their professional careers should be considered a high priority in Lithuania, like it is in many other European countries (Bennell Pearce 2003; Kozma Polonyi 2004).

There are a few approaches that can be taken to conduct professional GIS training for decision-makers and decision-takers, technological personal and educators. A traditional way is continuous skill and knowledge retraining through short on-the-job courses or/and external courses and workshops conducted by educational institutions or consultants. However, the sustainability in maintenance of the training system can be achieved through the creation of a national GIS e-training system. The developers of Lithuanian spatial data infrastructure choose the latter approach. It assumes creation of a centralized Geo-Information Science course repository that is on-line and accessible for all groups of users and that is maintained and updated on a regular basis. Such a repository includes a series of geomatics courses designed for different levels of education, applications and themes. Government contractors (eg university faculties) can run these courses on a regular basis and, at the same time, the contents of these courses are open to Lithuanian users.

There are different ways to support the sustainability of such a system and stimulate interest of users to take these courses. Some of these are:

• To enforce vocational training of public servants by the statute of the governmental institutions.

• To finance training from the State budget.

• To grant postgraduate certificates/diplomas or/and degrees from recognizable institutions for course's or program's completed.

- To actively promote the benefits of geo-spatial technology and the significance and usefulness of geographic data.

5. Lithuanian proposed curriculum and basic contents

The proposed Geographic Information Infrastructure (GII) training curriculum, for the above-mentioned e-training centre, consists of 13 courses. Every course is worth 10 ECTS, and a final thesis is worth 30 ECTS (Fig. 2). The curriculum is designed in such a way that some courses are mandatory, some are electives. The total number of credits for the program is 120 ECTS. The thesis is defended in-class, in a similar way that theses are defended throughout universities in other European countries. The trainees will have an opportunity to choose their study tempo, as well as their learning methods. Prerequisites for this program are: (1) completion of at least a Bachelor's degree (or equivalent – at least three years university studies) in any discipline and (2) proficiency with the Windows operating system and the World Wide Web.

The training curriculum that will be developed in GII to is described below (Fig. 4). Obligatory courses (for trainees who are seeking a Master's degree) are:

- GII-01 "Fundamentals of geographic information systems",
- GII-05 "GII application areas and case studies",
- GII-06 "Spatial information infrastructures advanced course",
- GII-07 "Advanced database management",
- GII-11 "Web programming by mark-up languages for GII".
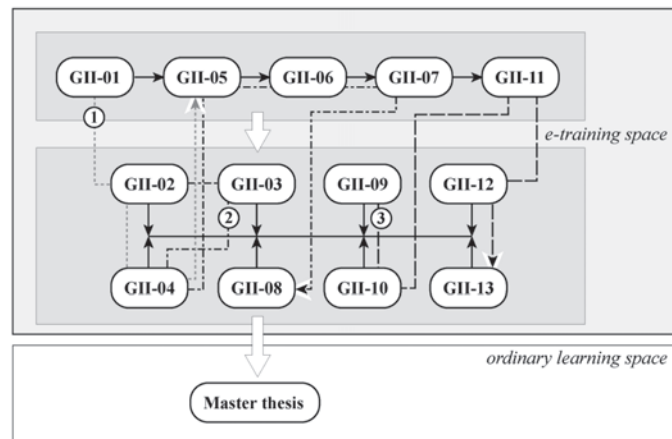
Fig. 2. Curriculum structure

Optional courses (trainees will choose 4 from 8) are:
- GII-02 "Geodesy and cartography for GIS",
- GII-03 "Spatial analysis, modeling and simulation",
- GII-04 "Spatial information infrastructures",
- GII-08 "GIS on the Internet", + "Web portals for GII",
- GII-09 "GII standards, specifications and metadata",
- GII-10 "GIS Application development",
- GII-12 "Object-oriented web programming for GII",
- GII-13 "Script-based web programming for GII".

Every course in this programme includes theoretical material (multimedia lectures) and practical exercises (tutorials and lab assignments). All material will be available on-line. Theoretical material includes required readings that contain an introduction to course, lecture notes (ppt, pdf, doc) and interactive (avi, ppt with voice, flash) formats, lists of references and recommended readings, theoretical self-assessment exercises, tests and quizzes, and midterm and final examinations. Theoretical supplementary material is also provided in the form of slide presentations, audio and video lectures, seminars, pod-casts, and FAQs. Synchronised and unsynchronised tools for on-line interactions among learners and/or instructors, such as on-line chat and forum rooms, will bring elements of communication into the delivery of the program. Laboratory exercises should also be available on-line. These include tutorial and multimedia demonstrations and lab assignments that utilise localised sets of geo-data. On-line access to GIS and RS software will also be implemented.

6. Implementation of Lithuanian E-training programme

High-technology subjects, such as GIS, remote sensing and GPS, require special, high-technology approaches to facilitate effective teaching and learning. In GIS-related training skills are important, as well as theoretical knowledge. Skills often determine a student's employability and promotional opportunities in the workplace.

One of the key attributes of e-learning is the flexibility that it offers employees – they can learn at home and/or in the office on their own time and/or their employer's time. Technically, geo-information science learning can be viewed as a learning portal (The University of Toronto 2007; Malaspina University College 2007). Students are receiving educational services from an institutional learning portal (eg WebCT, Blackboard, Moodle, etc.). Software and data access are provided by the educational institution's GIS server (eg using a remote terminal, drive sharing, DBMS servers, Web servers, Web Map servers, and/or FTP servers). Third-party learning portals (eg ESRI Virtual Campus) can also be used to supplement learning (eg software skills).

The most challenging technological task is to provide free access to GIS software for student use. A number of ways can be used to tackle this problem. The most flexible way is to provide stand-alone software for installation on each student's computer. This option limits the use of shareware and evaluation and allows only limited functionality of the software. More advanced courses may require access to a more functional commercial software. This requires a special agreement with software providers and the software usually needs to be purchased. To reduce software costs for students, software can be run on a remote terminal

and users can have access from their desktop computers by using a standard internet browser (Fig. 3).

These learning and technological approaches can be used for GIS e-learning in Lithuania.

Recently, the Lithuanian GIS curriculum has undergone a few changes. The first stage in developing the national GIS e-training program involved the preparation of nine comprehensive GIS training courses. These were designed and prepared for delivery to the Republic of Lithuania's civil service. More than 200 civil servants are scheduled to receive training in GIS and its application in the state's spatial data infrastructure program. This training program is funded jointly by the European Union and the Republic of Lithuania.

Three courses – "Elements of geographic information systems", "Management of geographic information", and "Geodesy and cartography for geographic information infrastructure" – are currently being delivered to the trainees (public servants) (Projektas ... 2007). Graduates of these courses will receive a "Certificate of Completion" from a Canadian academic institution.
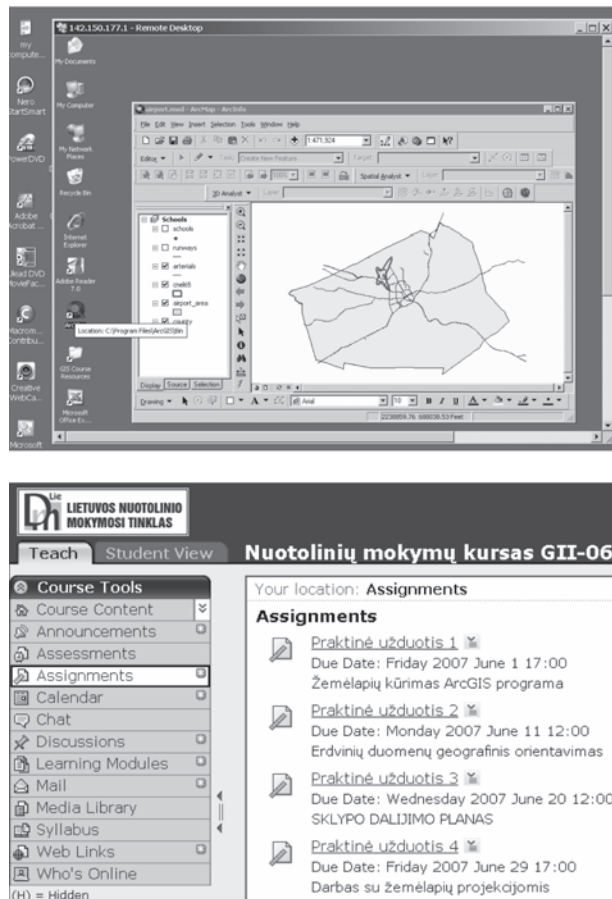
Fig. 3. Access to assignment page on the student learning portal and GIS software through a remote terminal

The methodology used to deliver the courses includes a combination of the following (Fig. 4):

- Student learning through lectures and practical materials via the web-based learning portal (on Blackboard and GIS Server), course book and assigned supplementary readings.
- Supervision of individual work is conducted by remote instructors via email correspondence and through web-based two-way forum support (on Blackboard).
- Introduction seminar, initial surveying, and final exams are conducted in class with instructors. Introduction and orientation materials are also accessible from the web-based learning portal.
- Students use GIS and other software through the remote terminal on the GIS Server. In addition, a DVD-ROM pack with light version of GIS software and lab data was provided to students for installation on their personal computers.
- Students take a mid-term exam and submit the results of assignments through the web-based learning portal (Blackboard).
- Media consultancies can also be done through the broadcasting software (eg Skype) or in face-to-face mode in a computer lab.

Trainees use the following types of educational materials in their studies:

- Most theory is introduced on-line and almost all teaching materials can be found on the learning portal and/or GIS Server. Lecture slide-presentations and course-books are also supplemented with recommended readings from textbooks and Web resources.
- Students carry out practical work based on on-line tutorials and assignment instructions. The instructions and spatial data can be found on the learning portal and/or GIS Server. Students upload results of assignments through the learning portal. There are three types of assignments in the courses (other than readings): (1) tutorials (not all of them require submission), (2) instructor-assessed and graded assignments/papers/projects, and (3) ESRI Virtual Campus courses completed via the Internet. Lab exercises are the most frequent type of assignments and are designed to assess student progress and check some of the things students have learned. Each student receives feedback on each assignment and the instructor can assess the progress of every student.
- In some courses, students submit individual reports. Report requirements and instructions can be accessed from the learning portal.

Classrooms	Home Work	Classrooms
1	2	3
Surveying and Initial Evaluation Orientation and Introduction	Reading Laboratory Assignments and Tutorials on GIS Server Portal Forums Chats and Announcements ESRI Campus Virtual Courses Mid-term Exam	Final Exam
Classrooms ⟹	Seminar(s) Online and/or face-to-face consultancies	

Fig. 4. Structure and sequence of the course delivery

As an example here, we are providing some descriptions of course objectives of "Management of geographic information". This course teaches strategies for successful GIS management and implementation. It examines GIS from small-scale project-based GIS initiatives, through to large-scale enterprise GIS implementations. The consistent methodology of systematic user needs assessment, requirements specification, database design, application development, implementation, and operation and maintenance are carried through all levels of GIS implementation.

Students develop skills in GIS project planning, design, management and documentation. They improve their ability to independently acquire, evaluate, and implement new GIS-based skills and understanding and to put these into a context of effective GIS use. The course gives a student an insight into GIS implementation, both in theory and in practice. Upon a successful completion of the course material, the student should be able to:

- write a simple proposal document;
- plan for a GIS project by determining scope, schedule, budget and resources;
- identify GIS project risks and potential mitigations;
- understand the interplay between scope, schedule, cost, resources and quality;
- manage an existing project by controlling risk and change;
- monitor and describe the progress of an existing GIS project;
- describe datasets and data-flows within an organisation;
- be able to create simple UML Class Diagrams to describe basic data structures;
- understand the nature and sources of error in a GIS project;
- be able to determine and describe the sensitivity of a GIS model to changes in input values.

7. Conclusions

Development of a national Geographic Information Infrastructure is not sustainable without properly-trained geographic information managers. Geographic information training is necessary both for decision-making and for control over the decision-making process. Demand for skilled GII managers is constantly growing and training of such professionals is a complex and lengthy process. GII managers need integral skills and the latest knowledge in different geographic information fields, such as geography/cartography, informatics and management.

Strategies how to carry out geographic information training in different countries depend on many factors, such as the level of country development and their GII, availability of recourses and specifics of national training systems.

Thus in PNG, most of on-job trainings are funded by external aids organization such as Australian Aids etc. Main forms of GIS trainings are short courses that are carried out in-country or abroad. Usually these are very expensive and sporadic activities. Long term National Government implementation of GII training strategy is not the first priority in PNG due to lack of human resources in governmental and educational institutions.

The online approach of national GII training is chosen in the Republic of Lithuania that has more resourse after entering the EU. The level of geographic information training in

Lithuania is still insufficient, due to the absence of a universal training strategy, narrow orientation, dependency on particular technologies, etc.

None of the existing academic Lithuanian curricula could be easily adopted to meet the needs of the state's spatial infrastructure. Hence, it is imperative to prepare and implement the proposed curriculum and start GIS training. The 13 courses for in-service training curriculum are orientated to the needs of Lithuanian Geographic Information Infrastructure and is a major, first step to improve the situation. Meanwhile, implementation of certificate courses for the GII programme has started with in-service training of 227 public servants from ministries, municipalities and other government agencies. The courses will be re-used to enable a full postgraduate program for e-training in Lithuania to be established. The first run of these modules enables an improvement in the structure and content of geo-data – something that is most important for building an effective learning environment.

The concept of using on-line modules has several advantages compared to the traditional university courses:

- Possible extension of the modules over a longer time span for full-time employees;
- Flexibility to choose only appropriate parts for students who are already professionally active;
- Modules can easily be adapted to fit specific training environments (eg advanced geography, geodesy, environment, IT specialists, GIS users, governmental employees – planners and decision-makers).

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GEOGRAFINĖS INFORMACIJOS E. MOKYMO INICIATYVOS NACIONALINĖMS ERDVINIŲ DUOMENŲ INFRASTRUKTŪROMS

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Santrauka

 Nacionaliniai ir regioniniai duomenų duomenų rinkiniai dažnai yra labai svarbūs priimant teisingus plėtros sprendimus. Be jų neįsivaizduojama subalansuota plėtra tiek išsivysčiusiose, tiek besivystančiose šalyse. Tačiau, siekiant šiuos duomenų rinkinius efektyviai panaudoti, būtina gerai suprasti geografinės informacijos naudojimo galimybes ir išmanyti erdvinės analizės metodus. Straipsnyje analizuojami dviejų labai skirtingų šalių – Lietuvos ir Papua Naujosios Gvinėjos – nacionalinių geografinės informacijos infrastruktūrų kūrimo pavyzdžiai, atskleidžiantys erdvinių duomenų poreikį ir su jų naudojimu susijusių mokymų svarbą ir galimybes.

Geografinių duomenų tvarkymas ir efektyvus naudojimas neįmaomas be gana specifinių darbuotojų įgūdžių. Deja, daugumoje šalių egzistuojančios mokymo programos, susijusios su geografinės informacijos valdymu, yra nenuoseklios ir visiškai nepritaikytos geografinės informacijos valdytojų poreikiams valstybės ir savivaldos institucijose. Dažnai studijos nesuteikia šios srities specialistams net būtinųjų žinių. Siūlomos geografinės informacijos e. mokymo sistemos pagrindas yra atskiri kursai, orientuoti į erdvinės informacijos infrastruktūros poreikius ir kartu sudarantys nuoseklią studijų sistemą. Jie pritaikyti nuotoliniam mokymuisi darbo vietose. Tai ypač aktualu Lietuvos ir Europos Sąjungos valstybės tarnautojams, tačiau naudinga ir verslo įmonėms. Šie kursai visi kartu sudaro pusantrų metų trukmės geografinės informacijos mokslo ir geografinės informacijos infrastruktūros ir studijų programą, kurią galima įgyvendinti darbo metu. Nuotolinis mokymas labai patogus tuo, kad kursai bet kuriuo metu pasiekiami iš bet kurios vietos, todėl yra prieinami daug platesniam naudotojų ratui.

Reikšminiai žodžiai: e. mokymas, geografinis švietimas, geografinė informacija, subalansuota plėtra, GIS, geografinės informacijos infrastruktūra.

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