GIS - implementation in Sri Lanka

**GIS applications in Hambantota district Sri Lanka
– A case study -**

**GIS in socio-economic planning
- A case study -**

Jonas Almqvist & Jenny Fergéus

Acknowledgements

Introduction

This essay is performed and compiled by Jonas Almqvist and Jenny Fergéus and based on our Minor Field Study (MFS) in Sri Lanka during June and July 1999. The Swedish international development and co-operation agency (Sida) issues scholar-ships that university students can apply for in order to carry out a minor field study abroad during two months. These scholarships aim at promoting students to seek knowledge about developing countries.

We wanted to work with some applications of Geographical Information Systems (GIS) in order to use the theories from our education in a real scenario. Ass. Prof. Petter Pilesjö at the department of Physical Geography, Lund University asked us if we would like to participate in a Sida-project regarding regional development in Sri Lanka, hereafter referred to as the Main Project. The project was to be carried out at the University of Kelaniya in Colombo. We accepted and decided to make it our final work for our Master Degree in Physical Geography.

The structure of this study

This study is divided into three separate parts, namely: **Part I**, **Part II** and **Part III**. The reason for this is that we have chosen to present our work as one single document instead of two separate studies, which would contain many similarities.

Part I is achieved by both Jonas Almqvist and Jenny Fergéus. Here we analyse the Main Project, its objectives, key actors and our objectives within the Main Project. Part I also includes a chapter discussing the use of GIS in developing countries. We present the work we conducted together at the University of Kelaniya in Sri Lanka; this is later on referred to as the Study. A summary and a general discussion ends Part I.

Part II is a case study written and performed by Jonas Almqvist regarding GIS-applications in Hambantota district. Qualitative interviews were made in Hambantota regarding the tourist potential of the district. The outcome of these interviews was visualised using network-analysis.

Part III constitutes of a case study performed and written by Jenny Fergéus in which she discusses the research of six Ph.D. students at Kelaniya University with focus on the possibilities and hindrances of using GIS in socio-economic planning.

Abstract

During the summer of 1999, we participated in a Sida-founded project regarding Regional Development in Sri Lanka (referred to as the Main Project). Our part was conducted as a Minor Field Study. The outcome is presented in three parts. The overall objective of the Main Project is to investigate if the strategies for regional development have been successful. Using GIS in the Main Project may simplify the performance. Our part of the Main Project was to implement GIS through educating the Ph.D. students participating in the Main Project. This was achieved by holding lectures and exercises. We also initiated a database with data concerning the Main Project and produced maps that visualised quantitative data concerning the Main Project. This is presented as Part I.

Part II is a case study based on interviews in Hambantota District. The objective was to examine attitudes to and the potential of tourism in the district. The results were visualized using network analyses. Since tourism is an expanding sector of Sri Lankan economy impacting regional development, tourism is of interest for the Main Project.

Part III focus on the possibilities and hindrances to use GIS in socio-economic planning. This is achieved by using the Ph.D. students' researches as examples. The reason for this is that the Ph.D. students will perform much of the research within the Main Project. Furthermore this case study looks into the attitudes towards GIS among the Ph.D. students.

Key words; GIS, Sri Lanka, MFS, Regional Development, Sida, tourism, socio-economic planning

Sammanfattning

Detta är ett examensarbete i tre delar. Del I behandlar GIS-implementation i Sri Lanka, i Del II visas GIS-applikationer rörande turism i Hambantota, ett av 25 distrikt i Sri Lanka. Del III anlyserar användning av GIS i socioekonomisk planering med utgångspunkt från fem doktorander i Sri Lanka. Arbetet utfördes huvudsakligen inom ramarna för ett Minor Field Study (MFS) finansierat av svenska Sida.

Syftet med del I var att introducera GIS i ett projekt rörande regional utveckling, med fokus på distrikten Gampaha och Hambantota. Projektet drivs i samarbete mellan Sida och Kelaniya Universitet i Sri Lanka. Genom föreläsningar och övningar introducerades GIS för doktorander knutna till projektet. Vi initierade en databas och producerade kartor som visualiserade kvantitativa data rörande projektet.

Under de två månaderna vi vistades i Sri Lanka genomfördes även två fallstudier (del II och del III). I Del II genomfördes intervjuer i syfte att undersöka potential och inställning till turism i Hambantota. En metod kallad nätverksanalys användes för att visualisera resultatet av intervjuerna. I Del III undersöks möjligheten att använda GIS i socioekonomisk planering. Arbetet omfattar fallstudier av sex doktoranders arbeten, knutna till huvudprojektet på Sri Lanka.

Nyckelord; GIS, Sri Lanka, MFS, Sida

Part I

GIS – implementation in Sri Lanka
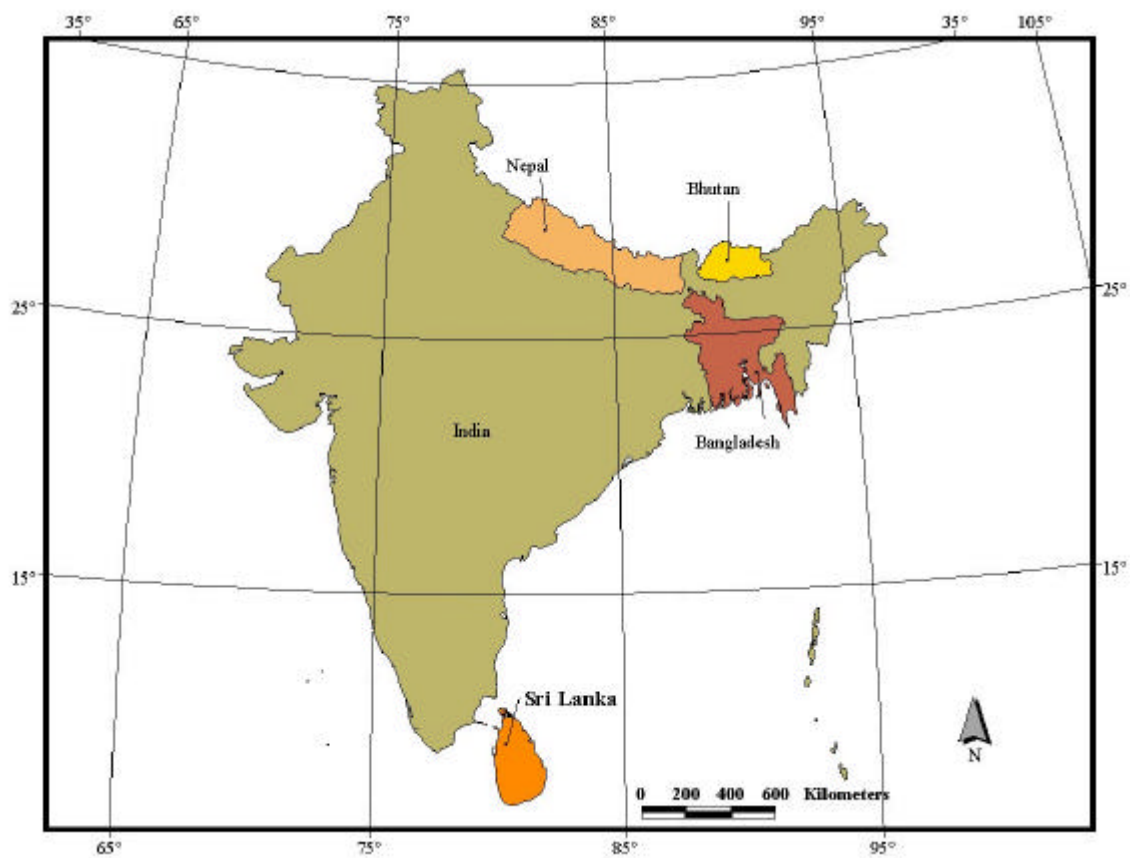
By Jonas Almqvist & Jenny Fergéus

Table of contents Part I

1. Introduction

The overall objective of our study is to introduce GIS to the Main Project. Prof. Karunanayake and Prof. Dangalle at Kelaniya University in Sri Lanka states that the Main Project will focus on relevant aspects in the overall context of regional development in Sri Lanka based on case studies of two contrasting regions regarding the level of development. By integrating GIS into the project a tool for data analyses will be provided. Furthermore GIS can help illustrate and visualise different aspect of the socio-economic inequalities between regions, and thereby simplify the performance of the Main Project.

The definitions of GIS vary depending on what type of task you want to perform with your GIS. In general a simple description is; computerised systems in which information are related to its geographical position. Christiansen (1998) gives a more detailed definition:

Definition

A GIS is a system, consisting of hardware, software, data, procedures and a proper organisational context, which compiles, stores, manipulates, analyses, models and visualise geographical data, to solve management problems.

As the definition points out, the term GIS refers in a wide sense to an entire organisational set-up which include not only the technology, but also the data and the organisational framework, such as staff and management procedures (Christiansen 1998). But it is also important to keep in mind that the term GIS is sometimes used in a narrower sense to refer to the technology components, such as the hardware and software used.

From a conceptual point of view GIS can be explained in different models. The HSDU-model refers to four "system components" of GIS, i.e. Hardware, Software, Data and User (Christiansen 1998). Alternatively it is possible to look at GIS from a flow perspective and divide it into four "process components" namely data Input, data Management, data Analysis and data Presentation. This model is often referred to as the IMAP-model (Christiansen 1998).

In defining GIS it is important to examine the terms *information* and *data* mentioned above. There are two types of geographical data; spatial and non-spatial. The former are objects, e.g.

cities, lakes and roads that can be symbolised with points, polygons or lines. These objects have an exact geographic position on the earth's surface. Using these three forms (points, polygons and lines), digital maps are created, maps that are the most essential ingredients in a GIS. The non-spatial data is information that is connected with the spatial data, e.g. ownership of a building, depth of a lake or width of a road. This type of data is often called attribute data (Pilesjö 2000).

1.1 Chapter overview

Chapter 2 gives a short description of Sri Lanka, displaying the country from a number of aspects. The purpose with the chapter is to give the reader some basic background information about the country in order to comprehend the conditions of the Main Project as well as the Study.

In chapter 3 the Main Project and its detailed objectives is described along with its key actors. In this chapter we also present our purpose in detail and our role within the framework of the Main Project. A description of the two districts Hambantota and Gampaha is also included in order to display the regional differences.

Chapter 4 discusses in general terms the possibilities and constraints of using GIS in developing countries. The factors we address are technology, infrastructure, data and human resources.

Chapter 5 describes our work at the University of Kelaniya. Here we address the exercises and lectures we held in Sri Lanka and reflect upon their result.

In chapter 6 we examine and evaluate the statistical data used in the Main Project and our study.

Part I is concluded in chapter 7, with a general discussion about the Main Project and our Study.

2. Sri Lanka

The republic of Sri Lanka (until 1970 called Ceylon) is a small tear shaped island situated in the Indian Ocean, between the 6:th and 10:th north parallel, 35 km south of India. Sri Lanka covers an area of 65.610 km^2 (which can be compared to Sweden's 449.964 km²) and has a population of approximately 18.4 million inhabitants. Sri Lanka is divided into 9 provinces, which constitutes of a number of districts; in all there are 25 districts in Sri Lanka, see Figure 1. Each district contains a number of divisions, for Hambantota divisions see Figure 2. The capital Colombo is situated in the Colombo District, Western Province, which also is the most densely populated province in Sri Lanka. The official language is Sinhala and since 1987 also Tamil. English is spoken by approximately 10% of the population. The currency is called Rupee and in July 1999 one Rupee was approximately 0.12 SEK.
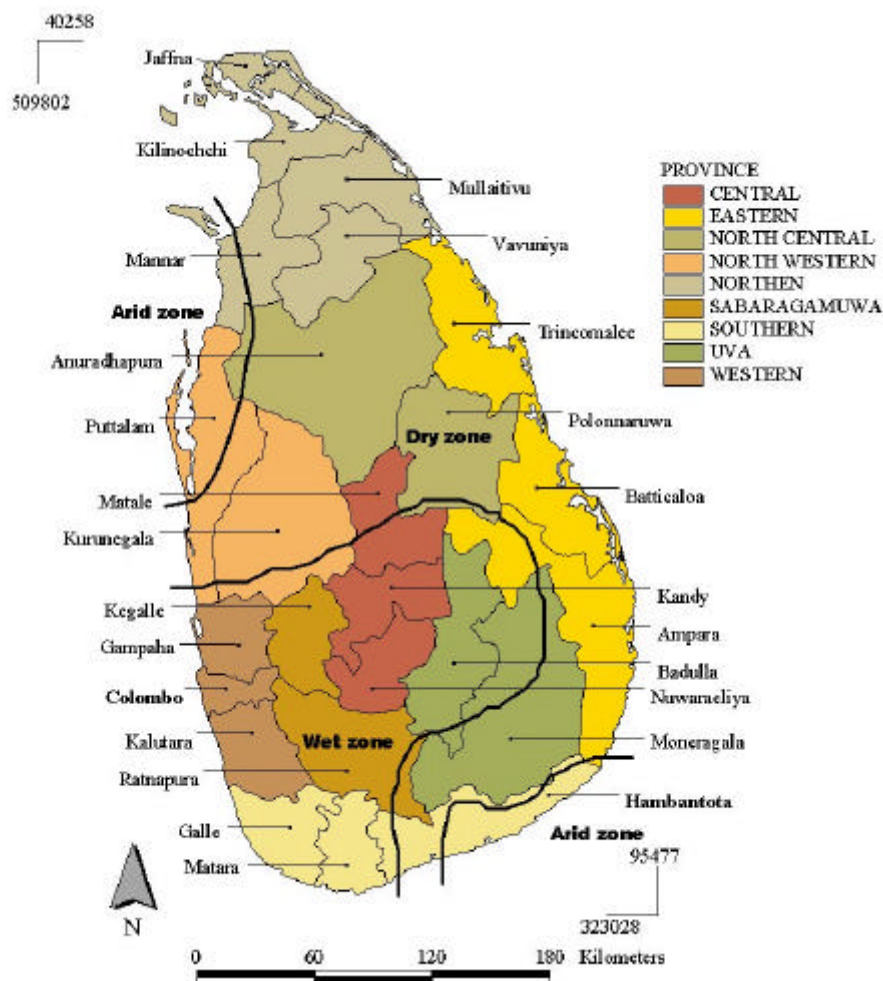

Figure 1. *Map showing the nine provinces and twenty-five districts in Sri Lanka. Climate zones after Yapa (1999). Local co-ordinate system.*

2.1 Colonial history

The country has a long colonial history and was colonised by the Portuguese (1505-1658), the Dutch (1658-1795) and the British (1796-1948) before it became independent from the United Kingdom in 1948. The British who ruled the country for almost one and a half-century enforced new legislation, a banking system and expanded the existing infrastructure. Vast plantations of tea and rubber were constructed in the north. All this had a heavy impact on the Sri Lankan economy and society, some still viable today. The colonial interest in Sri Lanka was primarily based on the country's geographical position. Sri Lanka was not only a strategic port by which one could control the Indian Ocean but it was also a waypoint in the trade with India and China. It was only the British that took interest in the whole island. The Portuguese and the Dutch were contented with settlements along the coastal areas in the south-west (Farmer 1993).

The transition to independence went smoothly and Sri Lanka adopted a pro western stance before the country declared its neutrality in 1956, but remained within the commonwealth (Farmer 1993, Lindberg 2000). A civil conflict between the Sinhalese government and Tamil separatists fighting for an independent Tamil state in the North and East escalated into civil war in 1983 and is still unresolved. The conflict is primarily concentrated to the northern and eastern parts of the country. Farmer (1993) states that the conflict dates back to 1957 when Sinhala was made national language and a wave of Buddhist revivalism swept the country. The conflict is complicated and since it does not affect this study it will not be further discuss here.

2.2 Demography and Ethnology

There are two major ethnic groups in Sri Lanka, the Sinhala and the Tamil. Of the total population the Sinhala constitutes 70 % and the Tamil 20 %. Most Sinhalese are buddhists were as most of the Tamils are hindus. There is also some muslim (7 %) and christian (3%) groups in Sri Lanka. The Tamil population is normally distinguishes into two groups, Sri Lankan Tamils and Indian Tamils. The former migrated from southern India in ancient days and the latter were "imported" by the British as labour force for the tea and rubber plantations in the north. The Tamil separatists mentioned earlier (see section 2.1) are mainly Indian Tamils.

There is also a small native tribe in Sri Lanka called Vedda, which live in the central parts of the country.

Sri Lanka has a long history of ambitious welfare politic, which has resulted in high quality of life indicators compared to other developing countries. The United Nations Development Agency (UNDP) issues a human development index (HDI), which include factors like life expectancy, literacy rate, education and gross domestic product (GDP). In this index Sri Lanka is ranked among the countries with *medium human development* and received a value of 0,716 in 1995 (Sweden revived the value 0,936). The HDI value of Sri Lanka is well above the average value of all developing countries which was 0,4478 in 1995 (UNDP 2000). Some key figures from Sida and the Swedish foreign department and the World Bank, regarding development in the country are presented in Table 1.

Table 1. *Figures for Sri Lanka during the nineteen nineties (World Bank 2000,UD 1998).*

Figures for Sri Lanka	1990	1997	1998
Life expectancy (years)	71	73	73
Fertility rate (births per woman)	3	2	2
Infant mortality rate (per 1000 live births)	19	17	16
Population growth (% / year)	2.4	1.3	1.3
Total aid per capita (US$)	43	18	26
GNP per capita (US$)	470	700	810

Table 1 points out that the population growth has declined partly due to a reduction in fertility rate and in spite less infant mortality. At the same time the Gross National Product (GNP), has increased. The shift in aid per capita can possibly be explained with policy shifts among the donor countries. But although high ranks in literacy, life expectancy and low infant mortality, Sri Lanka has one of the highest levels of alcoholism, suicide and child abuse in the world (Catterson et Linddahl 1997).

2.3 Economy and Politics

Since independence mainly two parties have alter at power, The United National Party (UNP) and the Sri Lanka Freedom Party (SLFP). The former can be described as conservative, while the latter is more leftwing. In 1977 there was a shift in the political system. The single chamber that was introduced when Sri Lanka became a republic in 1972 was replaced with a constitution giving the president wide executive powers (Farmer 1993). After independence Sri Lanka chose to pursue an inward looking plan-economy that eventually led to a less competitive economy on the world market (Farmer 1993, Lindberg 2000).

In 1977 the government began a reform towards a market economy with assistance from the World Bank and IMF (International Monetary Fund). Private ownership and free competition accompanied with less governmental interference would boost the economy (Sida 2000). The results were considered good, with a reduced budget and trade deficit. The reforms have however led to cuts in social welfare and to widen the income gap (Farmer 1993).

Agriculture remains the primary source of income for Sri Lanka's predominantly rural population. Revenues from agricultural exports also contribute significantly to the country's export revenues. Although mineral wealth is sparse, Sri Lanka has a considerable potential for hydropower. The incidence of poverty has been reduced over the past four decades and Sri Lanka has the potential to match the economic performance of the newly industrialising (NIC) East Asian countries (yet one out of five households in Sri Lanka subsist below the poverty line). One major problem is the high unemployment amongst Sri Lankan youth. Of all unemployed 75 % are between 15 and 29 years of age, although the majority has a high level of education. Another big obstacle to Sri Lanka's future development is the unresolved civil conflict. Sri Lanka has a great tourist potential, which has been severely damaged from time to time by the civil war. Although tourists and the tourist sector are not specific targets for the Tamil suicide bombers, the terror has discouraged many tourists. Foreign tourism is primarily concentrated to the west and south-west. There are few all-year-round suitable beach areas and the narrow shelves[1] are exposed to erosion and powerful currents.

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[1] A gently sloping submarine plain forming a border to a continent, stretching from the coast to the point where the seaward slope inclines markedly to the ocean floor (Clark 1998).

2.4 Climate

The average temperature is about 30? C in the whole country except for the mountainous interior, which holds an average temperature of approximately 18? C. Annually the temperature varies between 28 to 32 degrees Celsius and the variation between day and night is a mere 4 degrees. There is a larger variation in precipitation during the year, the south-western part and the central highlands receive most while some parts in the Northeast and Southeast can be considered arid (less than 500 mm/year). The humidity is high all year round in the Southwest and during the monsoon the relative humidity reaches 90% and above (for climate zones see Figure 1).

During the beginning of summer the inter tropical convergence zone (ITCZ) moves north and sets off the summer monsoon, which brings heavy rains to the west and south-west and also to the central highland from May until October. The eastern parts experience rain shadow[2] during this period. The winter monsoon is associated with relatively dry and cool weather and persists from December until March. The winter monsoon is weaker in strength and the winds are irregular during this period. Precipitation from the winter monsoon falls on the north-eastern part of the country as well as the eastern part of the mountains. The northern and southern parts of the country have no hills to intercept the monsoon and are thus considered dry regions.

2.5 Geomorphology

Sri Lanka consists of a mountainous interior and a central highland surrounded by broad coastal plains (Stamp 1952). Up to 90% of the mountain rock consists of gneiss and shale originated from Precambrian time. There are few natural resources, like coal or oil but some valuable minerals exist (e.g. graphite) and are used by the domestic industry. Sri Lanka is also known for its rich deposits of gemstones, sapphires and rubies. The island has many but short rivers that origin from the central highlands often through series of waterfalls. Sri Lanka has narrow continental shelves, and waves and currents subject the coastlines to heavy erosion.

3. The Main Project

Since the lack of balanced growth between and within regions has been evident this is an area where it is possible to enable better policymaking and implementation through research. The overall purpose and aim of the Main Project is therefore to examine and evaluate the regional development strategies and related issues on development in Gampaha and Hambantota districts (a short description of the two districts follows in section 3.5). This will be done on a comparative basis, to identify specific problems concerning regional imbalances and devise viable future strategies for more harmonious and balanced growth of the regions (Karunanayake & Dangalle 2000).

3.1 Background

"National development is a main priority to achieve in most Third World countries"
(Karunanayake & Närman 2000)

Karunanayake and Närman (2000) also states that although Third World countries try to adopt themselves to different rules and advice set by donor agencies and advisors the gap between North and South is widening. The longstanding disputes regarding the actual meaning of development causes a dilemma when trying to create balanced regional growth. Some institutions like the World Bank and IMF argue that economic growth is a goal in itself and is defining development. They argue that the "trickle down effect"[3] eventually will eradicate regional imbalance. Others argue that one must not forget the social dimension when comparing development between countries on a national and regional scale (O'Hare 1996, Karunanayake & Närman 2000).

Development and regional imbalance within the country have been an important issue for many developing countries during the last two decades. Sri Lanka is still affected by these problems despite the attention paid to them. The development strategies in most provinces in Sri Lanka uses a multi-dimensional approach, aiming at, as Karunanayake and Dangalle (1999) puts it;
"Promoting welfare and improving living conditions of the people as well as sustaining economic growth by harnessing the local resource potential".

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[2] The region on the lee side of a mountain where the precipitation is noticeably less than on the windward side is said to be in rain shadow.

Many development strategies have failed to achieve the desired goals stated above. One reason for this is that it is mainly the public sector that initiates and implements this type of strategies, which in turn has led to heavy politicisation and bureaucratisation. Another aspect is the initiatives taken by the private sector, which tend to concentrate on more developed areas within the country (Karunanayake & Dangalle 1999).

The core-periphery concept can be used to some extent in trying to explain socio-economic inequality. In this model the core is defined as an area where relatively high socio-economic development prevails. The periphery is the area outside the core with low economic activity and poor quality of life indicators (O'Hare et Barrett 1996). Such institutes as the World Bank and IMF allege that inefficient savings and investments cause the lack of economic development in the periphery.

3.2 Objectives of the Main Project

The detailed objectives of the Main Project described below are based on material and information gathered and given to us by Prof. Karunanayake, Prof. Dangalle and Ass. Prof. Närman. It is feasible that these objectives may change over time in order to adapt to external circumstances, financial or political that may affect the Main Project.

The objectives of the Main Project are:

?? To conduct a comprehensive field survey based on interviews in order to collect data and information related to development issues in the districts.

?? To develop a database for the districts. This database will contain socio-economic data connected to their geographical position.

?? To provide graduate and undergraduate students with field experiences.

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[3] Less advantaged areas and societies will benefit from the surplus of more developed regions.

?? Strengthen academic capabilities of the departments involved.

?? Develop graduate and undergraduate courses in Regional Development as combined programmes of the Department of Geography, Economics & Mass Communication.

?? To exchange views with relevant parties concerned with development planning in the districts.

?? To design comprehensive regional development strategies for use by the public/private sectors and NGO:s (Non-Governmental Organisations).

The Main Project embraces the development of GIS capacity at the University of Kelaniya. This will be done in co-operation with Lund University.

3.3 Objectives of our part within the Main Project

Within the overall objective of Part I (introducing GIS to the Main Project) one specific part of our objective was to supply knowledge concerning the possibilities to use GIS to simplify the performance of the Main Project. Introducing GIS to the Ph.D. students and thereby giving them the opportunity to use GIS in their research primarily achieve this. By educating the Ph.D. students in the techniques of map production they will be able to create necessary maps for their own projects as well as for the Main Project. They will also be able to develop graduate and undergraduate courses, which is one objective of the Main Project (see section 3.2).

A second objective was to produce maps over the socio-economic situation in Sri Lanka at different levels of resolution. Prof. Karunanayake and Prof. Dangalle suspected that the previously performed regional development initiatives and strategies had not been able to make any larger impact in the aim to solve the socio-economical differences – neither between the districts nor within the districts. Our goal for producing the maps was to investigate whether or not this hypothesis could be supported. In this case it is also of great importance to remember that the results will never be better than the input data. Therefore samples of the socio-

economic data were investigated in order to find out which methods for data collection and preparation that had been used.

Our objectives within the Main Project was therefore to...

?? Introduce GIS to the Main Project

?? Conduct exercises and lectures in GIS for the Ph.D. students involved in the Main Project and educate them in the technique of map production

?? Produce maps for the Main Project and investigate the background data used in the Main Project

By using GIS all data can be kept and accessed in digital form and when desired presented on a paper map or on a computer. In a GIS different kinds of data, such as geographical, topological[4] and attribute data can be stored together, this is one of the advantages of GIS. Using the GIS database all relevant information can be stored in one single place, and at the same time the data can easily be distributed to other actors in the society that is interested in the subject. In this way communication between and within official departments and universities can be improved with the use of GIS (Pilesjö 2000).

One of the major advantages by keeping the data in a digital form is that continuous updating and additional manipulation of the data can easily be conducted. Within the Main Project comparisons at different spatial levels and time scales will be performed. One example is to compare different regions to find out how the socio-economic situation differs, another example is to see whether a measure taken in one area had led to any results over time.

3.4 Management of the Main Project

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[4] Topology gives information regarding spatial relationships in a dataset, i.e if one object is *adjacent*, *connected* or *within* another object.

The Main Project has several key role actors who all are responsible for different parts of the Main Project. Firstly there is Sida, who has the overall formal responsibility. They apply a passive management, which means they are steering the Main Project financially but do not interfere during the performance of the Main Project. On the next level are professor Karunanayake and professor Dangalle at the University of Kelaniya. They have the total responsibility over the Main Project, administratively as well as operationally. Ass. Prof. Närman from the University of Gothenburg is responsible for and co-ordinates the Swedish input in the Main Project. Ass. Prof. Pilesjö from the University of Lund co-ordinates and has total responsibility of the GIS-input in the Main Project. In Table 2 the different actors are listed in hierarchical order.

There are also six Ph.D. students at the University of Kelaniya, who will conduct different parts of the Main Project with their research theses. In general they discuss topics regarding poverty and regional development. Their specific theses go into; fishery, tourism, agriculture, and land use, poverty, energy and women's studies. Their research will give a further understanding of the issues that is connected with these areas.

Table 2. *Key role actors of the Main Project in hierarchical order.*

Sida	Is steering the Main Project financially, but take no active part of its conduction.
Prof. Karunanayake & Prof. Dangalle	Have the total responsibility of the Main Project.
Ass. Prof. Närman & Ass. Prof. Pilesjö	Co-ordinate the input from Swedish Universities.
Sri Lankan Ph.D. students	Conduct specific parts of the Main Project.
Swedish Ph.D. and MFS students	Conduct specific parts of the Main Project.
Almqvist & Fergéus	Supply the Main Project with specific information regarding GIS and map production.
External consultants	Supply the Main Project with general information regarding statistics, map boundaries, etc.

3.5 Gampaha and Hambantota districts

Both the Gampaha and Hambantota District have been identified for accelerated development within the framework of regional development. The Gampaha District, once part of the Colombo District has very high development indicators, on a national level. In comparison Gampaha is ranked first in Sri Lankan HDI while Hambantota is ranked eleventh out of seventeen districts[5]. When comparing monthly income Gampaha is ranked second after Colombo while Hambantota is ranked last (Karunanayake & Närman 2000). Using the framework stated in section 3.1 by O'Hare and Barrett (1996) Gampaha could be considered as the core and Hambantota as the periphery. Table 3 lists nine socio-economic indicators to further display thier distribution.

Table 3. *Distribution of socio-economic indicators over Hambantota and Gampaha districts (O'Hare et Barrett 1996). The districts are displayed in* Figure1.

Distribution of socio-economic indicators	Hambantota	Gampaha
1. Mean income per month (Rupees)	726	980
2. Workers in agriculture (%)	61	14
3. Households with access to electricity (%)	13	34
4. Life expectancy at birth (years)	75	74
5. Infant mortality rate (per 1000 live birth)	12	18
6. Households with no sanitation (%)	11	12
7. Households with piped water (%)	16	11
8. Literacy 10 years and over (%)	76	89
9. Female with no schooling (%)	20	6
Aggregated ranking	13.3	6.2

It should be noted that the figures in table 4 are not from the same year. Row 1 (1986), row 2 (1981), row 4 (1982), row 5 (1985), row 3,6,8 and 9 (1987).

Table 3 gives a characterisation of the two districts. The high figures for Hambantota regarding workers in the agricultural sector (61 %) are not due to more suitable conditions for agriculture. The reason is instead a lower level of development compared to Gampaha. These differences are also displayed in row 1, 3, 9 and 8. In contrast, Hambantota has better figures in life expectancy and infant mortality. One explanation for this could be that Gampaha is densely populated and diseases spread more easily in such areas.

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[5] Eight districts in the north and east are excluded due to lack of data, caused by the civil conflict.

O´Hare and Barrett (1996) have determined the level of development among the districts of Sri Lanka. By giving 14 different variables[6] equal weighting, an overall aggregate expression of development can be obtained by averaging the ranked scores of the 14 variables for each district. Employing this method where low scores register high development status, Gampaha is the second most developed district (barely beaten by Colombo) with an average score of 6.2 (Colombo has 5.9). Hambantota has 13.3, which places it amongst the least developed districts in Sri Lanka. As a comparison Kurunegala district has the highest scores, 16.0.

3.5.1 Gampaha District

Gampaha is located in the Western province of Sri Lanka just north of Colombo district. It spans over 1400 km^2 and its population exceeds 1.8 million, which makes it one of the most densely populated areas in Sri Lanka. Gampaha is experiencing rapid population growth and urbanisation. The district is being one of the in-migration areas in Sri Lanka, which create many new problems due to population pressure on land, infrastructure, public utilities etc.

Gampaha is situated in the wet-zone, and heavy rains result in good farming conditions. About 2/3 of the labour force are engaged in the service sector, mainly in tourism. The district displays a wide variation in terms of socio-economic conditions. The most visible character is the spatial inequality of development. The western part of the district is more urbanised and industrialised than the eastern part, which is peripheral to the mainstream of development. Gampaha District is also experiencing a rapid change of land use patterns, leading to declining environmental conditions. Therefore it is crucial to have a proper regional planning for this area.

One "Free trade zone[7]" has been established in the district to promote foreign and domestic trade and investments (Farmer 1993). Good infrastructure and the closeness to Colombo contribute to make this district relatively rich. Poverty and unemployment in the district is despite high development indicators-above average, much because of the vast in migration to the district.

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[6] We have chosen to display the nine, from our point of view most interesting indicators.
[7] A free trade zone is areas were companies within are relived from taxation.

3.5.2 Hambantota district

Hambantota is one of three districts in the southern province, it covers an area of 2550 km^2 which makes it the twelfth biggest district, and has a population of just over 600 000. The district is divided into eleven divisions, which is illustrated in Figure 2. Although the population is more concentrated in the wetter western and northern parts of the district, the level of urbanisation is low.
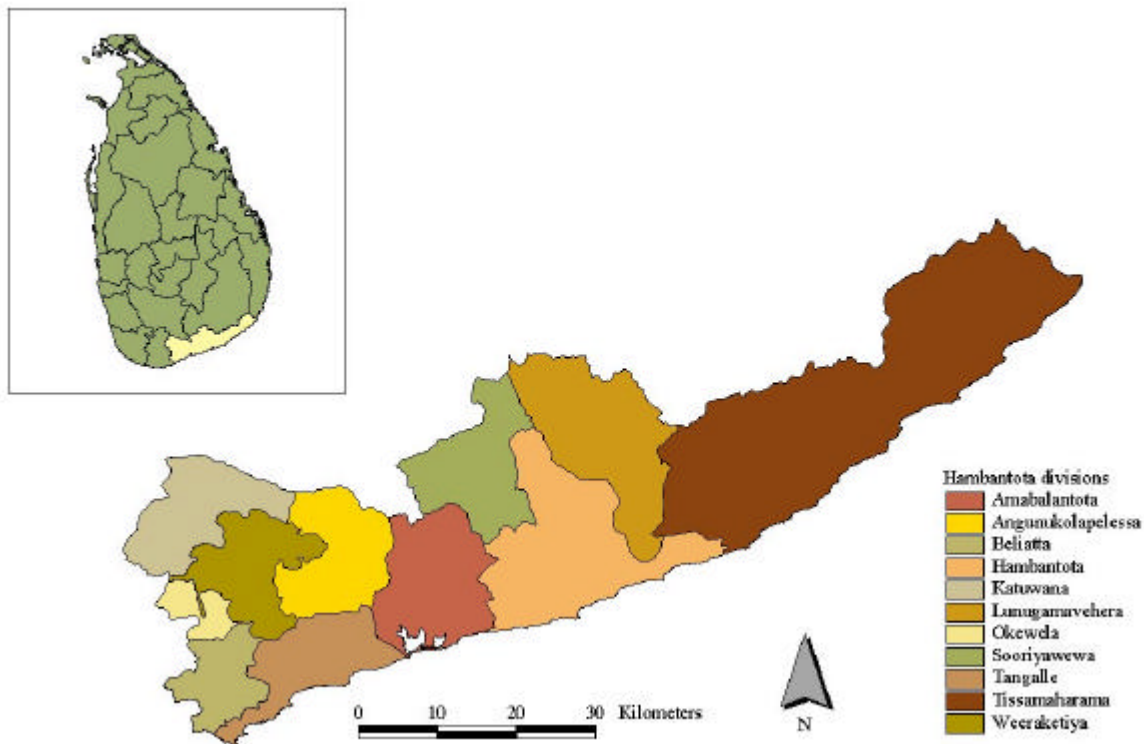
Figure 2. *Divisions in Hambantota district, southern province.*

Semiarid climate prevails although the total annual rainfall varies between 1000 – 1500 mm. A marked reduction of rainfall is evident as one passes from the northern to the southern part of the district.

Hambantota is not as densely populated as the Gampaha District and population growth is a modest 1 %, and the district is also subjected to out-migration. The levels of poverty are high in comparison to Gampaha district. Due to various reasons, both spatial and economic,

Hambantota represents one of the least developed areas in Sri Lanka. Hambantota has not attracted so much attention earlier in terms of both private and governmental sector investments.

Hambantota has not attracted as much tourism as the other two districts in the southern province (Matara and Galle). There are few suitable beaches due to rapid ocean currents and also logistical problems due to lack of sufficient infrastructure. Although the capital Colombo is only 300 km away it takes 7 hours by car. Hambantota has on the other hand a potential of becoming a tourist resort. The potential consists of that Hambantota can offer a variety of things, from wildlife to cultural and colonial sites and ruins (more about the tourist situation of Hambantota in Part II).

4. GIS in developing countries

In most western countries including Australia, New Zealand and Japan, GIS has been used for a long period of time. These countries have a wealth of means available for controlling, analysing and planning their environment and GIS is one tool among many to accomplish this. The situation in developing countries is somewhat very different, they have generally less means and resources for managing their affairs. Many problems in developing countries can be linked to land related issues such as agriculture, presence or absence of natural resources and effects of land use changes. GIS has the potential to help these countries understand how to make resources available and how they best can be used. Why GIS only can be considered as a potential in this context points out that there are some constraints and hindrances in implementing the technique (Burrough 1992).

4.1 Possibilities and hindrances of GIS in developing countries.

Since our study is a part of a project regarding regional development we will focus on possibilities and constraints of GIS regarding regional planning. This chapter will address these issues in general and in some aspect issues that are specific for Sri Lanka.

4.1.1 Technology

Problems of this kind have not so much to do with computer hardware. Instead it is more of a software problem, with royalties, licences and copyrights. The software itself is often designed for western societies and standards. It may not fully meet the need of other cultures. To re-design programs and software is likely to be regarded as commercially unattractive by the big companies. National and international agencies and foundations may take upon themselves to get this type of development going (Burrough 1992).

We believe that it is not only a matter of understanding the program you are currently working with. In a long-term perspective it is also important understand the operations performed by the software. If even more "user friendly" programs were to be developed for use in countries

that are beginning to build their GIS-capacity, we believe that this could lead to a situation where GIS in developing countries would be considered as "low-tech" by the developed world. We therefore believe that what developing countries primarily need is sufficient training, not more users friendly software.

4.1.2 Infrastructure

Electronic systems of all kind require a stable supply of power and a dry and clean environment. A stable power supply and clean facilities can be found in major cities, but are less common in rural areas. In Sri Lanka where high relative humidity persists all year, air-condition is a necessity. The power supply in Sri Lanka cannot be considered stable. During our time at the University of Kelaniya we experienced repeatedly blackouts and the situation is similar in the rest of the country. There is some technical equipment designed to give some relief during blackouts. Technical developments have also resulted in more robust and powerful portable computers that can be used during harsh conditions, for example during fieldwork in rural areas.

4.1.3 Data

In order to get a functional GIS one must have spatial and non-spatial data. Data collected from remote sensing (satellite images and aerial photographs) can give information about the physical environment and land cover/land use. Transformation of paper maps into digital form involves some kind of scanning or manual digitalisation. Both methods have their pros and cons. Socio-economic data that are used in regional planning can often only be obtained from census and statistical data. This type of data is often collected through field surveys, which consumes both time and money. The ongoing conflict in the northern and eastern parts has resulted in missing data for these two provinces. Teeffelen et al (1992) argue that it is also vital to collect data on a regular basis, since socio-economic features change far more rapidly than physical features. This is however not always true. The meteorological situation can change over an hour. Other physical features such as vegetation change rapidly when exposed to

forest-fire, lumber cutting etc. This confirms the importance of regular data collection regardless whether it is socio-economic or physical features.

To analyse the paper data is time consuming and one might lose or misinterpret the geographical extent of a certain attribute. This is one of the advantages with GIS, spatial analyses are done swiftly and accurate providing of course that the input data and the map used are accurate.

4.1.4 Human resources

Sufficiently skilled staff is vital for the success of any GIS project. According to Teeffelen et al (1992) there was a shortage of people with GIS knowledge in the industrialised world and an even greater shortage in developing countries. The situation today is somewhat different, at least in the industrialised world.

One can argue about the best way to train personnel and staff in GIS. An expensive way is to send a number of people to a university or training centre abroad. Burrough (1992) sees a risk in this. The people might not return to their country, and, if they return they might be absorbed by the private sector, which often can offer a higher salary. Burrough (1992) argues that training should take place within the country (e.g. training for sri lankans by sri lankans in Sri Lanka) in order to secure a long-term perspective. The need for external expertise will however remain for some time.

When discussing training it is important to keep in mind that it is possible for a group of people to obtain sufficient "button knowledge" (i.e. handle commands of the software in question) within a few weeks of a external GIS course. GIS is however much more than this and to obtain full insight in the "world of GIS" is a process that takes more than a few weeks (Teeffelen et al 1992).

5. Performance of the Study

In this chapter we will go trough our preparations in Sweden and our activities in Sri Lanka with focus on our work at Kelaniya University.

5.1 Preparing the Study in Sweden

The planning of our MFS started in the beginning of May 1999 in Sweden with the formulation of our part of the Main Project. The aim was to focus on the possibilities to implement GIS in a developing country. There had been a request from the University of Kelaniya concerning the use of GIS in the Main Project. Since the Study was, as mentioned above, a component of a greater project, it was important to try to find out as much as possible about the Main Project. We had some e-mail contact with Professor Karunanayake and one of the Sri Lankan Ph.D. students. In this way we received three of the Ph.D. students preliminary project plans concerning - fishery, energy and tourism. This led to certain understanding about the structure in their work and what methods they used. It also gave us an opportunity to seek information about the Ph.D. students' subjects in order to get prepared to co-operate with them, although it was not clear how far the Ph.D. students had proceeded in their research. Since it was not possible to discuss the Main Project further with the involved actors before the journey to Sri Lanka, the planning was kept quite general.

Since one objective of the Study was to educate the Ph.D. students in GIS, exercises were prepared for them. The exercises were one part of a GIS course for the Ph.D. students. The other part was theoretical lectures held by Ass. Prof. Pilesjö, Lund University. The purpose of our exercises was to give the Ph.D. students some basic knowledge of how to handle a GIS program, in this case ArcView by Environmental Systems Research Institute (ESRI). We tried to connect our exercises as much as possible to Ass. Prof. Pilesjö´s lectures so that the theory presented in the lectures would be followed by some hands-on practise.

5.1.1 The Sida Sandö course

In order to learn more about development issues in third world countries, a four-day course for MFS students were arranged by Sida at their training centre in Sandö, Sweden. The purpose of this course was to get prepared for the MFS. It handled questions like development, cultural differences and some guidelines on how to approach any problems that might occur. The course also included some specific information about Sri Lanka. This gave us an opportunity to learn about their culture and religion, which is important when working together with people for a long time. Another component of the Sida Sandö course was literature studies, which was quite useful since Sida has a lot of literature about related projects. Since GIS is still unusual in third world countries, we had some problems finding information useful to our Study. Therefore we concentrated mainly on studying general experiences of working in developing countries, trying to find out useful work methods and what issues that usually causes problems. There were also a lot of fruitful discussions among the participating students about MFS and related issues. The MFS course gave us an opportunity to think through our Study and discuss possible problems with other people, mainly with the other MFS students. A great part of the information given at the MFS course was however quite obvious and we think it could have been a higher level on the information.

5.2 GIS course for the Ph.D. students

During our first week in Sri Lanka we held a three-day course concerning GIS for the Ph.D. students together with Ass. Prof. Pilesjö. The structure of the course was that Ass. Prof. Pilesjö held three lectures regarding the basics of GIS. The purpose was to give an introduction and general overview of the subject. After every lecture we held between two and four exercises that related to the lecture. The program we used was ArcView and the main reason for this was that the University of Kelaniya already used ESRI modules for their map production and the maps they buy from the Survey Department are delivered in ArcInfo or ArcView format. ArcView is also widely spread and its many extensions along with that it allows many different kinds of operations makes it suitable for both advanced users as well as beginners. The exercises were basic and in a "step by step" format since none of the Ph.D.

students had been working with ArcView before. We held eight scheduled exercises and some additional exercises, i.e. in-depth versions of the first ones.

During this time it was decided that the Ph.D. Students would spend a week in Lund, Sweden in the beginning of September 1999. They would then continue to Gothenburg, were they would spend an additional three-month working with development issues at the University there. A new GIS course/workshop would give them further training and knowledge in GIS.

Exploring ArcView was the title of the first exercise. Here the Ph.D. students would get familiarised with the program using a revised version of the exercises in the ArcView manual. The exercises that followed mainly dealt with data input and layout. Among one of the last exercises the Ph.D. students visualised their work by printing some of the maps they had produced. The course also included one lecture concerning GPS with one following exercise, where the Ph.D. students should learn how to use a GPS to capture co-ordinates and transfer them into ArcView and display them on a map.

GIS was to different degrees part of all the Ph.D. students' projects, which they were already working with. It was therefore important to quickly introduce the Ph.D. students to GIS and teach them how to use GIS in a way that would suit their purposes. We tried to structure the course so that the Ph.D. students after the course should be able to work with the program, ArcView, and also know how to search for the needed knowledge by themselves. This was crucial since we knew that the Ph.D. students would have very small opportunities to receive help after our GIS course. It was therefore very important not only to educate them, but also to give them an opportunity to independently develop their skills.

To simplify further training with ArcView for the Ph.D. students, a manual concerning basic map production was made. The purpose of the manual was to make it possible to use it as a complement to the ordinary ArcView manual and to help the Ph.D. students to produce maps for the Main Project. This manual basically followed the steps in the ArcView manual but also included some useful advises and the most frequent questions the Ph.D. students had.

The Ph.D. students appreciated the GIS course and since they expressed a desire for further learning, additional exercises (as mentioned previously) were held at a later stage. We also held a couple of GIS lectures for the Master of Science students at the Department of Geography at the University of Kelaniya.

5.2.1 Reflections on the GIS course for Ph.D. students

It is somewhat difficult to measure results of a learning process. It depends of course on how detailed aims one set up, how many people that are involved and how one structure and evaluates lectures and exercises. Since it was not suitable to perform any kind of examination or test of the Ph.D. students' acquired knowledge, we used a questionnaire in an attempt to evaluate the GIS course and the lectures held by Ass. Prof. Petter Pilesjö. The questionnaire consisted of eight qualitative questions, (see appendix B) in which the Ph.D. students were asked both to give their view on the lectures and exercises, and also to reflect upon the use of GIS in their own projects. We thought that open questions would give more information than quantitative questions, considering that there were only six Ph.D. students. Even though the answers were kept confidentiality is likely that severe criticism would not surface. The reason is quite simple, since it was a small intimate group, the answers were not anonymous[8] and we (Almqvist and Fergéus) had a personal relation to everyone in this group.

According to the answers given, the general opinion among the Ph.D. Students was that the lectures and exercises had given them a basic knowledge about GIS and ArcView. From our point of view we can say that the Ph.D. students now have the knowledge to produce their own maps, in this meaning the GIS course was successful. On the other hand, a major purpose with the course was to give the Ph.D. students the necessary knowledge to use GIS in their projects, which is not possible to evaluate until their projects have been carried out.

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[8] We (Almqvist and Fergéus) were the only ones that read the answers (total anonymity was not achieved since we wanted to include questions regarding the Ph.D. students individual projects).

During our time at Kelaniya University we encountered some cultural differences, which we from the beginning did not expect to be so important as they actually were. We were aware that the Ph.D. students were used to authoritarian teachers and that they probably would hesitate to ask us questions if there was something they did not fully understand. We partly managed to encourage them to ask us questions. We were also surprised how very focused the Ph.D. students were on facts and how unused they were of questioning and discussing the facts that their teachers taught them. It was of great importance that they learned how to work independently with GIS since there would be almost no opportunities for them to get support after we had finished our studies at the University.

5.3 Producing maps

One of the main objectives of the Main Project is to find out about the spatial pattern of the development. One of the most effective ways to conduct such a survey is to produce maps displaying the actual information. This will give a general overview showing different spatial patterns and can also be used for selecting further study areas. Therefore the production of such maps became one of the main tasks for the Study.

The raw geographical data for the maps was received in ArcView format from the Survey General Office, which is Sri Lanka's official department for land survey. The first thing we had to do was to clean up the maps, for example correct nodes[9], merging polygons[10] and delete loose ends of arcs[11]. There were some problems with the Hambantota map that could not be solved either in ArcView or ArcInfo. It was corrupt and we were not able to mend it. The data were built up by a vast number of lines instead of polygons. First we tried to convert these lines into polygons in ArcView but the program did not support such operations. We also tried to merge these lines in ArcInfo, but there were some lines missing. In addition the computer did not have enough capacity to handle the large amount of lines and nodes. Therefore we had to return the data to the Survey General Office for correction and re-production of the missing parts. This took about three weeks and caused a delay.

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[9] A line starts and ends with a node.
[10] A polygon is a geometric feature.
[11] A number of arcs make up a polygon.

The map-making process took a lot of time due to various problems including electricity failures, hardware and software problems. There were three computers available in the GIS centre, which we shared with Mr Senarathna (an employee, instructed to help us) and the Ph.D. students. One of the computers had a system error, which caused random computer hang-ups. Two of the computers only had demo versions of ArcView that expired after 30 days. This meant that most of the time we could only use one computer.

All the statistical, i.e. attribute data, for the maps was received in paper form, mostly as annual reports from various departments[12]. Prof. Karunanayake and Prof. Dangalle chose the data, which we then used for the maps. The intention was that Mr Senarathna would type in the tabular data, but due to various misunderstandings we typed in most of the data. The tabular data typed by Mr Senarathna had to be supervised and edited.

5.3.1 Reflections on the map production

Both Prof. Karunanayake and Prof. Dangalle were satisfied with the maps and found some unexpected figures. For instance the infant mortality was increasing in some of the districts in spite of the efforts made to change this tendency. This information would of course be possible to find out without GIS by comparing statistical data. But it would be very time-consuming and not as easy to demonstrate the fact for other people. As a conclusion we cannot only draw attention to the fact that it is possible to use GIS in socio-economic planning. It is also an excellent method to make information accessible for other people.

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[12] Most of the attribute data came from the Department of Census and Statistics, other sources were the Central Bank of Sri Lanka and the Ministry of Policy Planning and Implementation.

6. Evaluation of the statistical data

When producing the maps with socio-economic data from the Department of Census and Statistics we came across some uncertainties concerning the data. There were remarkable differences between districts in ways that seemed difficult to explain. One example is the statistics on Infant Mortality, where there seems to be higher infant mortality within the districts that had the best equipped hospitals.

A map is never better than the basic data used for the production of it. This made it important to find out the background of the data used; for example how it was collected, processed and evaluated. To find the answers to this we contacted the Department of Census and Statistics. An interview was conducted with Mr. Sangarapillai, the additional Director of the department.

The Department of Census and Statistics collects data on a yearly basis that they process and analyse. There are basically two different kinds of data, administrative data and service data. Birth and death rates, marriages and school dropouts are examples of administrative data while building material in homes and number of cattle is examples of service data.

The administrative data is in general received from the Government and their departments and institutions like schools and hospitals. The Department of Census and Statistics issues questionnaires to the district administrators that they fill in and return. All the districts get the same questionnaires, which make it possible to compare the different districts. The Department of Census and Statistics also educate the district administrators and give them advice concerning the questionnaires and how to handle them. At the Governmental departments the Department of Census and Statistics have their own staff members.

There is no problem to receive the administrative data. It does however often take long time, up to a couple of years until they receive it and thereafter process it. When they do receive the data, they begin with the processing of the provincial data and then continue with the district data. Since the Department of Statistics and Census have to publish the data in their yearly report, Statistical Abstract, they often have to estimate the data – especially the district data. The consequence is that the Department of Census and Statistics have to publish estimations in their yearly report, Statistical Abstract. The estimations are often based on the provincial data

until the district data is processed. Therefore the latest presentation is always the most correct. An example of this is that the statistics on infant mortality for 1989 presented in Statistical Abstract from 1997 are more correct than the same figures presented in Statistical Abstract from 1993. This difference is presented in Figure 3.
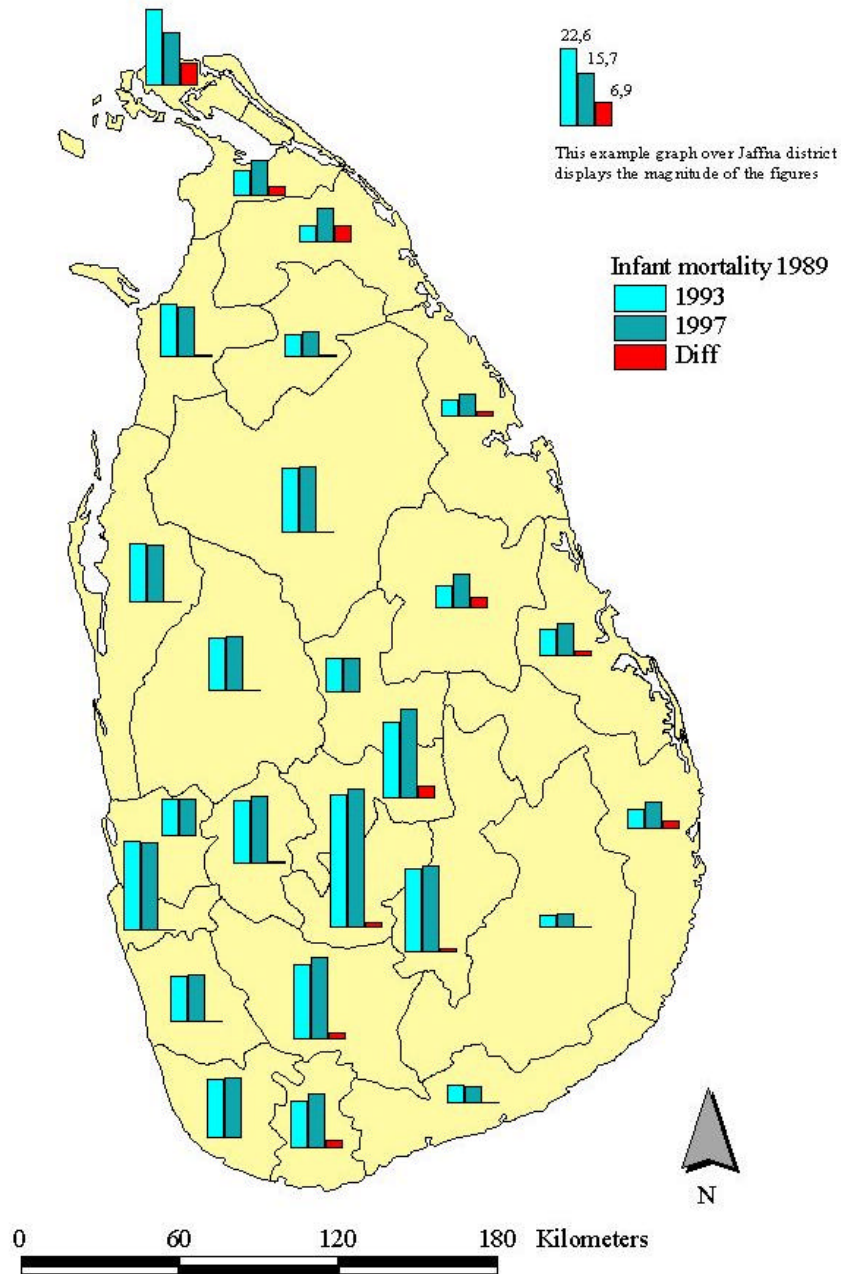

Figure 3. *The map shows the statistical data of the infant mortality for 1989 presented in Statistical Abstract 1993 and Statistical Abstract 1997. The red graph (Diff) shows the differences between these data.*

Service data is more difficult to receive than the administrative data since it is collected through field interviews. The response rate for the service data is between 85-90% and the sample basis is less than 1% of the population. The Department tries to minimise the drop out rate by trying repeatedly to get hold of people who might not be at home the first time they are conducted. It is also difficult to get accurate data from the northern and eastern districts because of the problems there.

Every tenth year they perform a census to evaluate the statistics. However, this was not possible 1991 when there should have been one, mainly because of the regional problems in the north and east. Therefore the last census was performed 1981 and the next one is planned to 2001.

From the census of 1981 the accuracy for birth data was 97% and 95% for mortality data when evaluated. The main reason for the higher uncertainty regarding the mortality figures is that it is not necessary with a "deceased certificate" for a funeral. To start school it is necessary to have a "birth certificate". The uncertainty is generally greater in the rural areas, as well as in the north-east. The overall standard error for the statistics handled by the Department is less than 5%.

Another interesting fact that came up during the interview is that even though the overall data for the country is correct, there are spatial errors. The administrative data is registered in the place of occurrence. This means that if a person living in one district seeks medical treatment in another district and dies there, the death is registered where the hospital is located and not where the person were resident. This is the answer to the paradox with the infant mortality and well-equipped hospitals mentioned previously.

7. Discussion and Conclusions

The implementation of GIS to the Main Project cannot be considered finalised. Instead it should be seen as an ongoing process as illustrated in Figure 4. Therefore it is important to have a strategy with defined goals, a realistic time schedule and follow-up. As illustrated in Figure 4 the third step (Follow-up) should initialise improved planning resulting in improved performance and so forth.
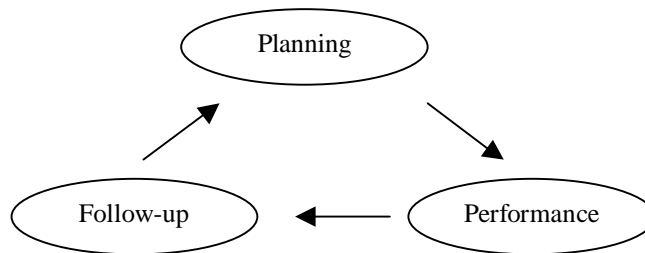
Figure 4. *The process for the implementation of GIS in the Main Project.*

The Ph.D. students have acquired theoretical and practical knowledge in GIS and they are introduced to the subject. However, they need to obtain more thorough understanding to be able to use GIS in an independent and continuous way in the Main Project. And therefore it is important to have an implementation strategy as shown in Figure 4, which consider the Ph.D. students' need of further training. Otherwise they may end up with only "button knowledge" as mentioned in section 4.1.4.

It is obvious that it is hard to fluently handle a GIS program and to fully comprehend all mechanisms of a GIS after only one month of lectures and exercises. It is important to let the implementation find its own pace. It takes time to get accustomed to computers in general. And it is without a doubt easier to learn how to master a GIS program if you are an experienced computer user to start with.

By introducing the Ph.D. students to GIS, they can pas on their knowledge though courses to others and thereby spreading and increasing the GIS capability at the university. This development could, on a regular basis be given a boost by additional lectures and exercises held by GIS experts either in Sri Lanka or Sweden.

We have previously discussed both the advantages and the constraints of GIS, now it is time to reflect upon the question: Will the Main Project benefit by the use of GIS?

From Sida's point of view the GIS implementation is part of a technology transfer, introducing a new technology might promote development and reduce the technology gap between North and South. The individual research projects' attitude towards GIS and reasons for wanting the technology may differ. Pilesjö (2000) writes that "it is often regarded as high status to have many and advanced computers". Teeffelen et al. (1992) addresses the aspect of "lab-envy" which means that purchases are made on the basis "only the best is good enough". We feel that this is a universal problem, not concentrated to developing countries. There are of course many good reasons for wanting to use GIS and other computerised technologies. Some of these we have mentioned before, see section 3.3 and chapter 4.

We think that the Main Project will benefit by the use of GIS and that the technique has a role in feature development of the project. How big this role can be depends on future implementation strategies and the willingness to find long-term solutions for education and technology issues.

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Appendix A

Word list, acronyms and abbreviations

GIS   Geographical information systems, for definition see *Introduction Part I.*

Sida   Swedish international development and cooperation agency.

ITCZ   intertropical convergence zone: The boundary zone separating the northeast trade winds of the Northern Hemisphere from the southeast trade winds of the Southern Hemisphere.

MFS   Minor Field Study, Sida issues scholarships witch students can apply for in order to carry out a field study abroad during at least two months. By doing this Sida hopes to promote students to seek knowledge about developing countries.

NGO   Non Governmental Organisations. A collective term for all non-profit organizations working with aid that are institutionally separated from the state apparatus (Lindber 2000).

Infant mortality rate The probability of dying between birth and exactly one year of age expressed per 1,000 live births.

Total fertility rate   The number of children that would be born per woman if she were to live to the end of her child-bearing years and bear children at each age in accordance with prevailing agespecific fertility rates.

GNP   Gross national product. The value of the final output of goods and services produced by the residents of an economy plus net primary income from non resident sources.

Appendix B

Questionnaire

*This is a small questionnaire regarding GIS. One part of our study in Sri Lanka is to examine how GIS can be implemented in socio-economic planning and development. Therefore we would appreciate if You would answer these questions. The purpose of this questionnaire is to evaluate the lectures and the exercises in order to get an overall idea of how GIS best can be implemented. The answers will **only** be used by us. Your answers will help us complete our study.*

<div align="center">

Kindly

Jonas & Jenny

</div>

...

1. What are Your impressions of the GIS lectures held by Ass. Prof. Petter Pilesjö?
    For example; difficulty level, amount of time etc.

2. What are Your impressions of the GIS exercises held by Jonas Almqvist and Jenny Fergéus?
    For example; difficulty level, amount of time, connection to the GIS lectures etc.

3. What is Your general impression of GIS?

4. Give a short description of Your project

5. Do You think it is possible to use GIS in Your own project and if so in what way?

6. What would You like to learn more about concerning GIS?

7. What are Your expectations regarding the GIS course in Sweden this September (1999)?

8. Is there anything else You would like to add?

Thank you for your time.

Appendix C

Lunds Universitets Naturgeografiska institution. Seminarieuppsatser. Uppsatserna finns tillgängliga på Naturgeografiska institutionens bibliotek, Sölvegatan 13, 223 62 LUND.

The reports are available at the Geo-Library, Department of Physical Geography, University of Lund, Sölvegatan 13, S-223 62 Lund, Sweden.

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Part II

GIS applications in Hambantota district

- A case study -

By Jonas Almqvist

Table of contents Part II

1. Objectives of Part II

The objective of this case study is to visualise how GIS can be used in science concerning socio-economic factors, and go over the tourist potential of Hambantota district. Tourism is an expanding sector in Sri Lanka, impacting regional development in the country, and hence of interest for the Main Project. The work was performed in two steps. Firstly a number of interviews in Hambantota town were conducted. The purpose was to collect the interviewees' experiences, opinions and attitudes towards possibilities and problems regarding tourism in Hambantota. In the interview material I found a vision/scenario describing Hambantota as the centre in a new tourist region in the south of Sri Lanka. One part in this scenario consisted of the idea that tourists, individually or in groups would travel around in the Southern Province visiting various sights of interest (the scenario is explained more thoroughly in section 2.1). On the basis of this scenario I moved on to select and transform geographical data that I could use to visualise the following scenario using network analysis[13];

By having Hambantota town as a starting point GIS could be used to find out how far away an "imagined tourist" would get in a given time range with different means of transportation.

Visualising this scenario shows a method that can be used when planning infrastructure investments or when investigating accessibility to various sights.

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[13] A method to find and analyse the optimal route using calculations based on geographical distances and theoretical speed values (Olsson 1999).

2. Methodology

In Part I (see Introduction) we addressed the spatial and non-spatial data forms and we argued that all spatial data has a geographical position on the earth's surface. The spatial data can either be *discrete* or *continuous*. When an object is clearly defined in it's surroundings the data is said to be *discrete*, i.e. roads, houses and so forth. Temperature on the other hand is an example of *continuous* data, it varies gradually and no clearly defined boundaries exist. The non-spatial data can be either *quantitative* or *qualitative*. Numerical data and scalable statistics are considered to be quantitative. One or many people's opinions or feelings towards a certain phenomena are an example of qualitative data. This type of data is often collected through interviews or discussions and the purpose is thus to attain a thorough understanding of the different aspects of the phenomena rather than measuring the magnitude and prevalence of it.

GIS has primarily been used in natural science projects and not so much in social science. Pilesjö (2000) stresses the importance of "a comprehensive view" in order to fully understand "what is happening around us". To use both a technical and a social approach in a project could lead to a more thorough understanding of the investigated features.

In order to find out more about the potential and attitudes towards tourism in Hambantota eleven interviews with hotel owners and personal, the Vice Chairman at the chamber of commerce and a Police Inspector at the local police station were performed (for list over the interviewees see Table 1). Since the objective was to perform a survey from their (the interviewees) perspective, and since the questions mainly dealt with tourism potential and the future of Hambantota tourism development, the choice fell on using open questions (for questionnaire see appendix A). Some of the questions used were, on purpose, quite vague. The questions were used more in order to get a discussion going than to receive a word for word answer. Since it was not obvious in what direction the answers would go, the questions were used as notes, guiding the conversation from one subject to another. During the interviews notes were taken since the word for word answers were not as important as to grasp the "big picture". The sample basis was set to select three large first class hotels, three middle class hotels and an equal number of guesthouses and hostels. Interviews with the Vice Chairman at the Hambantota Chamber of Commerce, a police inspector and a café in Hambantota town

were also arranged. The reason for choosing mainly hotels and guesthouses was that they would be more informed and used to thinking about issues regarding tourism.

The selection of establishments was subjective since the purpose was not to generalise the outcome of the interviews. I simply walked around in Hambantota and visited the hotels and guesthouses that I came across. In some cases the owner was not in and the staff could not answer any of the questions due to various reasons, these are explained in section 3.1. It was also obvious that the same type of questions could not be asked to both executives and the staff. In general a lot more information was collected when speaking to people in executive positions. They were obviously more familiar with the subject and spoke English more or less fluently. This does not mean that the interviews made with the staff was useless, of course it was interesting to get their views on the future.

A list of the interviewees is presented in Table 1. As evident from Table 1, the sample basis was not fulfilled. One reason for this is that there are only two first class hotels in Hambantota. Another was that the interviewing process was more time consuming than expected.

Table 1. *List over the interviewees in and around Hambantota town.*

Name of establishment	First class	Middle class	Guest house	Other
Café in central Hambantota				X
Chamber of Commerce Hambantota				X
Hambantota Rest house		X		
Hazims Guesthouse			X	
Joy Guesthouse & restaurant			X	
Lake View Guesthouse & restaurant			X	
Sea Spray Hotel		X		
Sunshine Guesthouse			X	
The Oasis Hotel	X			
The Peacock Hotel	X			
A Police Inspector in Hambantota				X

The persons interviewed in Table 1 above were as follows; the owner of the *café*, Vice Chairman Mr Mahen Senanayake at the *Chamber of Commerce*, the manager of *Hambantota Rest house*, the owner at *Hamzims Guesthouse*, the owner of *Joy guesthouse*, the manager of the *Lake view Guesthouse*, the owner Mr Dinnyson Edirisuriya of the *Sea Spray Hotel*, an

employee at the *Sunshine guesthouse*, the managing director of the *Oasis Hotel*, an employee at the *Peacock Hotel*, and Inspector of police Mr D.S. Karunanayake at the *police station*.

2.1 Outcome of the interviews

The intention was to try to achieve a relaxed discussion, were the interviewees would do most of the talking. I tried to avoid leading questions, and attempted to keep expressions and questions as simple as possible if the respondent's English level was low. It came as no surprise that it was easier to interview and maintain a dialogue with persons who could speak English fluently. To gain the interviewees trust was also important. Despite the attempts I was sometimes met with suspicion, partly since failing to explain the intentions with the interviews. Explaining who you are, where your come from and your purpose with the interview are fundamental factors when doing field interviews (Neuman 1994). I had a letter of recommendation[14] with me, but it was useless were it was needed the most; interviewing people whit limited knowledge in English. In a case were the interviewed person only speak a little English, he/she certainly can't read English. Another factor for the mistrust is that there is a stiff competition amongst the establishments. I was often asked not to give a word for word recollection of what a person had said, and also not to reefer answers directly to the one how had said it. An example of this was when involved in a discussion the interviewed person could say -"don't tell anyone that I said this..." and so forth. Finally it was obvious that executives had more knowledge about the tourist situation in Hambantota than would an employee. An employee might also hesitate to "speak his or her heart" in fear that the boss might disapprove of their answers. Again this behaviour can be explained by that I was not completely successful in convincing some of the interviewees that their specific answers would not be connected to their person.

In general the interviews pointed in the same direction. In Hambantota the domestic tourism dominates during summer and spring. When autumn and winter comes the number of foreign tourists increase. The average tourist, both foreign and domestic, usually stays between one and three days. Among the most popular sites is the festival in Kataragama, (the division east of Hambantota) a religious event for both Hindus and Buddhists. This festival also attracts a

large number of pilgrims although they often stay in Kataragama town or at the festival site. Many tourists visit the Yala National Park, which is the biggest in Sri Lanka. There is also a bird sanctuary in Bundala (east of Hambantota) that attract some tourists. The flow of foreign tourists depend upon the situation in Sir Lanka, periods of violence directly affect the tourist sector. Although Hambantota is as far from the north one can come, tourists and tourist companies' fright "easily".

Many visitors to Yala come with package tours from the capital Colombo, they have a planned route and pre-planned meals and hotel reservation. They often stay at the Peacock Hotel or the Oasis Hotel. The foreign backpacker tourists often choose hotel/guest house on site and usually stay longer than three days. The establishment often offer to arrange various tours, i.e. safaris to Yala, to backpackers. Most establishments use different prices for different tourists. Foreigners pay more than do local and domestic tourists. The simple explanation is that tourist from abroad have more money.

The bigger hotels get some tax relief during the first five years. They can also buy television sets and other equipment tax-free. There are little or no co-operation among the hotels and guesthouses in Hambantota. There are no Hotel-Chains in Hambantota and consequently one hotel only recommend another if they are fully booked. This behaviour is of course the same in the rest of the world and not unique for Hambantota district.

There is a general but modest optimism regarding future tourism in Hambantota. Almost every interviewee thought that Hambantota town and district would benefit from more tourists, both domestic and foreign. This is not too surprising given that almost all of the persons interviewed worked in the tourist industry. There are some concerns regarding increasing prostitution and drug problems. But since Hambantota can't offer as many suitable beaches as Gampaha district (this is of course a disadvantage when trying to attract "sun-tourists"), the general opinion amongst the establishments is that these problems can be avoided. The general opinion amongst the interviewed is that foreign tourists are responsible for causing the above mentioned problems.

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[14] Prof Karunanayake at the University of Kelaniya issued this letter.

In order to be more attractive as a tourist resort Hambantota needs to develop its infrastructure within the district as well as the connection to the capital and the Hill Country[15] (north of the southern province). Today it takes between six and seven hours to drive from Colombo city to Hambantota town. The power supply also needs to be improved, many hotels have diesel generators to modify the effects of frequent blackouts.

The government has talked about building a super highway between Colombo and the southern district. There are also some plans to build an airport and a commercial harbour in the south. Today the railroad from the capital Colombo ends in Matara district (west of Hambantota). If this infrastructure were built, it would be a boost for the region, some of the interviewees' say that its just empty promises, but Mr Dinnyson Edirisuriya, owner of the Sea Spray hotel says:

"The fact that the government is beginning to talk and discuss such infrastructure investments is a good start, even if it might take a few decades for it to be built"

Two interviews presented a vision of Hambantota as a southern tourist centre. The interview at the Oasis Hotel, just outside Hambantota town, and the interview with Mr Mahen Senanayake, Vice Chairman at the Hambantota Chamber of Commerce. They point to the fact that Hambantota is unique in many aspects. The climate varies from arid to dry to wet (see Part I, figure 2 for climate definition). Sri Lankas biggest National Park, Yala is situated in the southern province. There is also a large bird sanctuary in Bundala and another sanctuary in Wirawila. The southern province can also display a large number of ruins from all colonial periods (see part I for the colonial time period). Other unique natural features are the Hot Springs[16] at Madunagala, various caves, waterfalls and a blowhole[17] along the coast at Hummanaya. In Figure 1a sight map is presented.

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[15] The central highland around Kandy is often referred to as the Hill Country.
[16] Hot, sulphuric water springs out from the ground.
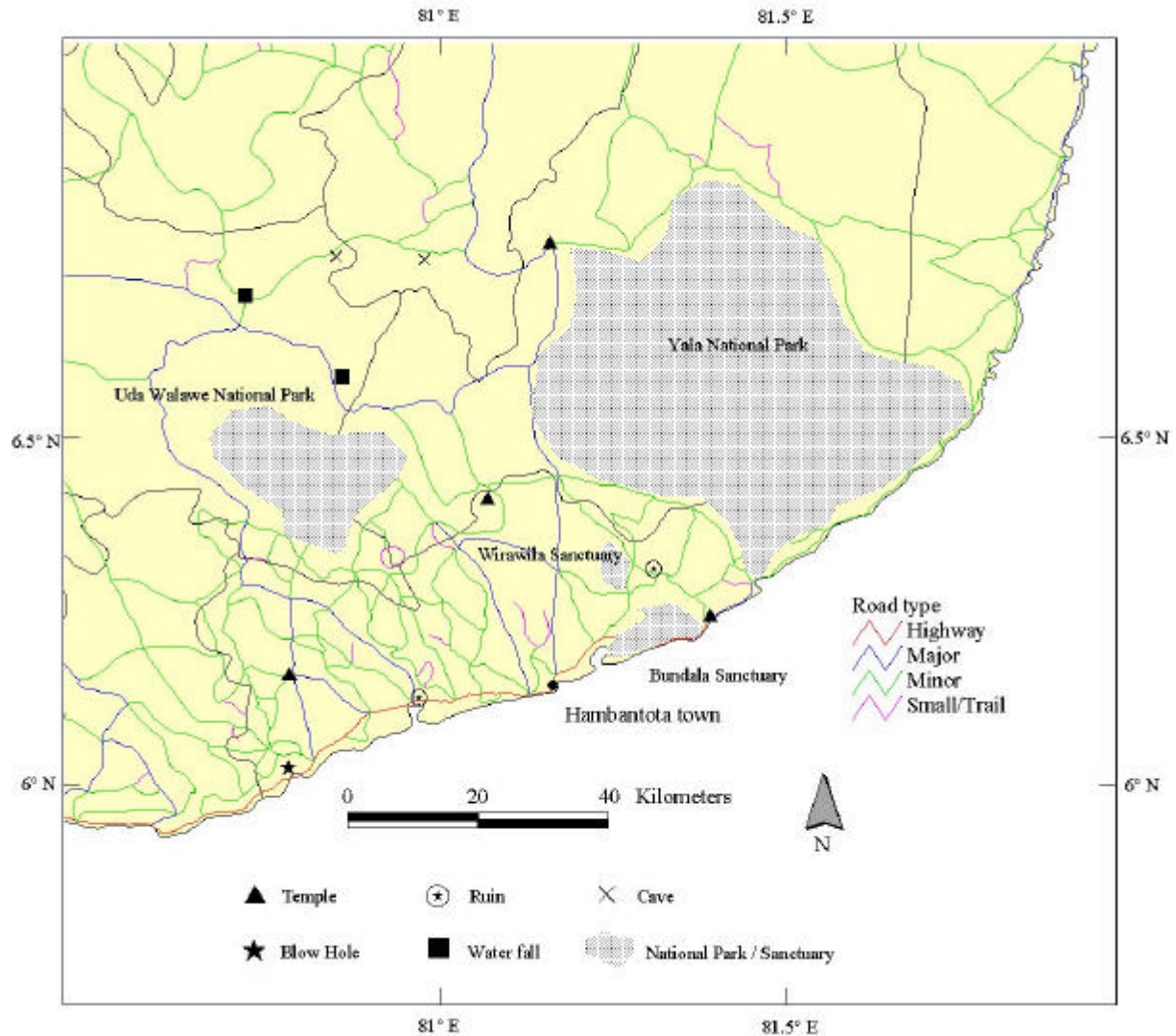[17] A sort of cave along the coast where ocean water cascades up into the air.

Figure 1. *A selection of various sights in and around Hambantota district. The geographical positions of the sights and parks are approximate (co-ordinates in Latitude/Longitude).*

A thing that Hambantota and the lager part of the southern province lack are beaches that is suitable for swimming. In Part I we mentioned the narrow continental shelves of Sri Lanka. There are some small beaches in the southwest but these are subjected to heavy erosion. In addition rapid currents make the water unsafe for swimming most time of the year. Of the southern coast there are corral reefs, but they are also "out of reach" for snorkelling.

This has lead to thoughts about focusing on "alternative tourism". A cultural, historical and natural tourism where variety is the key word. According to the interviews, foreign tourists in other parts of Sri Lanka, especially in Gampaha district are only interested in the six S´s; sun, sand, snorkel, spirits, sex, and smoke. It is this kind of tourism Hambantota wants to avoid,

according to the two interviews mentioned previously. Mr Mahen Senanayake at the Chamber of commerce stresses the need to document all of the things worth seeing in and around Hambantota. With a simple map and clear directions hotel and guesthouses could organise trips or rent out motorcycles and bicycles for tourists how wish to explore Hambantota district and the rest of the southern province on their own. Building a golf course and organising fishing trips is other examples thatwould attract tourists. In this way local people would also have the opportunity to earn money from tourists, when tourists visit local markets and shops. With the infrastructure investments in an airport and a superhighway from/to Colombo together with putting the railway though Hambantota the accessibility will be dramatically increased. If all this fall into place Hambantota could become a new tourist centre with "endless" possibilities according to Mr Mahen Senanayake.

3. Data and data transformation

Additional data has been added to the database that was built in the Study (see Part I). Today (February 2001) the database consists of digital maps at different resolution and over different parts of Sri Lanka. These maps contain different features such as land use, roads, province, district and division boundaries. Along with the maps a number of quantitative attributes are stored, giving information on road type, employment statistics in the different districts and so forth.

For the analysis I wanted to perform I needed a road layer that covered the southern part of Sri Lanka. Furthermore I wanted the road data to be "denser" (i.e. more roads) in Hambantota district since the focus was set to this district. The optimal data would apart from the above-mentioned factors also contain information regarding speed limits and road classifications. It was also preferable with a road layer that was up to date i.e. not showing road conditions as they were ten or twenty years ago. Finally the road data had to have topology[18], which is a necessity when performing network operations.

All of the road datasets in the database lacked one or many of the criteria mentioned above. One road layer over Hambantota districts that had topology and was quite detailed (over 7000 line segments) contained no other information than the segments length. Other datasets contained roads that were classified but lacked topology. It was obvious that no matter which road data that were used, it would not be able to reflect the reality. Achieving "real conditions" would require extensive fieldwork (collecting or measuring speed values and updating existing maps) and it would be time consuming. Realising this, I decided to "expand" one of the layers in the database that met most of the criteria mentioned above. This road data had topology and the roads were classified. It did not contain speed limits and only the biggest roads were present in Hambantota district, it was also not possible to determine how up to date the data was.

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[18] Topology explains spatial relationships in a non-geometrical term. Examples are geographical information regarding content and adjectives.

I started to add roads subjectively to dense the road network in and around Hambantota district. I then classified the road segments to increase the diversity of the road network into four different groups, namely:

- ?? Highway
- ?? Major
- ?? Minor
- ?? Small/Trail

The classifications of the roads depend on both traffic intensity and size. Is in this case the class *Highway* represents roads with the most traffic, but the *Major* road class can be of equal size. A *Major* road is though always bigger than a *Minor* road, which in turn is bigger than a *Small/Trail* road. The resulting road network is displayed in Figure 2.
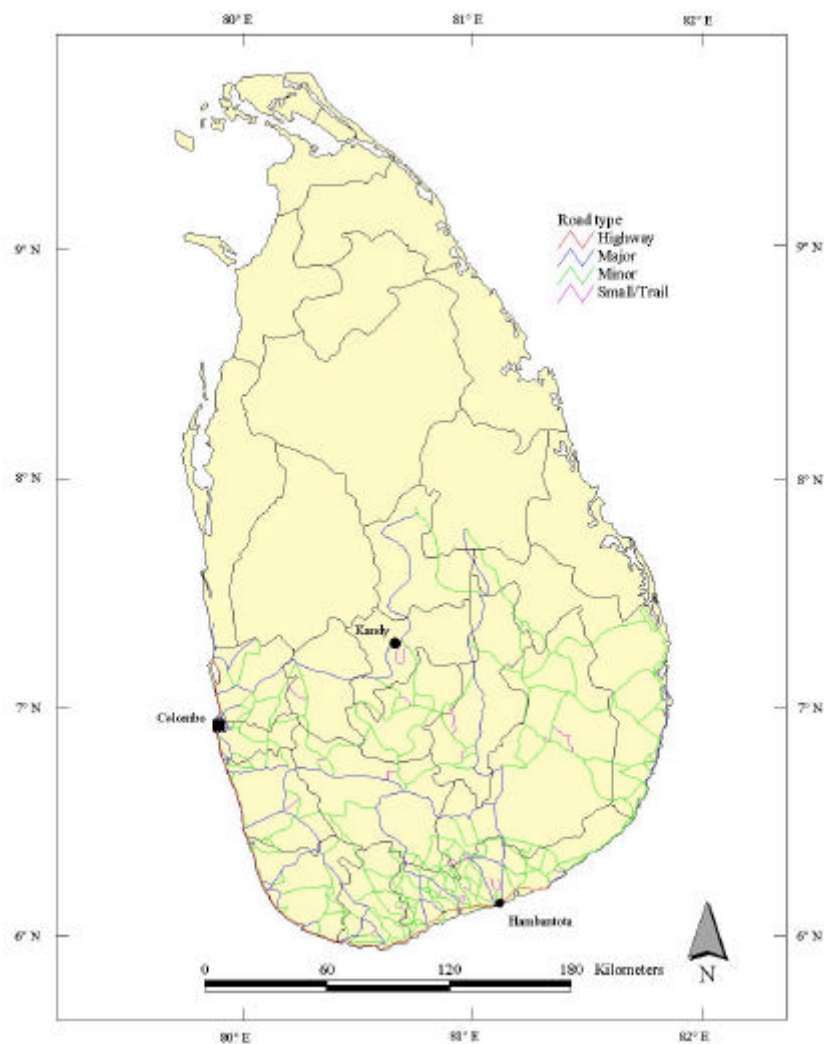
Figure 2. *Resulting road network over the Southern part of Sri Lanka. Co-ordinates in Latitude/Longitude.*
The classification was used to calculate different cost fields for the roads. A cost field gives information about the cost (in this case minutes) for travelling a single line segment. Three different cost fields (all fields were set to display cost in minutes) were calculated to symbolise travel with different types of vehicles. Car, vespa/motorcycle and bicycle were used. The cost fields were calculated with equation 1.

$$S \ ? \ D / T \tag{1}$$

D is the distance in kilometres (the length of a single line segment). T is the time (in hours) it takes to travel a line segment. By dividing these two terms the Speed (S) in km/h is received. In order to get some real values and not only estimations the time was measured when travelling on the Highway in a minibus from Colombo city to Hambantota town. It took 6.5 hours and the distance in kilometres was received from the digitised map (I had digitised the actual costal road between Colombo and Hambantota, so the factor D should be more or less correct). Dividing the distance 230 km with the time 6.5 h, the resulting mean travelling speed was ? 35 km/h. With the use of this mean value it was possible to calculate the other line segments by rearranging equation 1 into equation 2.

$$T = D / S \tag{2}$$

The mean speed value had to be adjusted to suit the different types of vehicles. The values chosen are presented in Table 2.

Table 2. *The mean speed in km/h displayed by the different type of vehicle.*

Vehicle type	Road type			
	Highway	Major	Minor	Small/trail
Car	35	38	30	5
Vespa/Motorcycle	30	33	30	10
Bicycle	10	13	12	5

The values in Table 2 are an attempt to imitate real conditions based on my limited experience of the traffic situation in Hambantota. In my opinion it is often faster to travel on the Major roads because the traffic is less dens, simplifying overtaking.

Equation 3 below is an example of how the cost fields were calculated. D is the length in meters of a single road segment, divided by 1000 to return the length in kilometres. This is in turn divided by the speed (S) in km/h and then multiplied with 60 to return the time (cost) in minutes.

$$((D / 1000) / S \; ? \; 60) \hspace{4cm} (3)$$

It should again be stressed that the speed figures that has been used are *mean values* and that the estimations are made subjectively. It was also assumed that the speed was equal in both directions. It is possible to set different speed values for different directions, but for this operation to be meaningful you need more detailed information regarding the road in question.

4. Analysis and results

This analysis is based on the speed values in Table 2. By manipulating the travelling time the resulting maps show how far the tourist can travel in 30, 60, 120 and 240 minutes using different types of transportation. In section 3 I described how the cost fields were calculated, when the computer program performs the analysis these cost fields are added together as the program moves along the segments one by one. Figure 3 below displays a possible travelling situation for car. According to Figure 3 a tourist travelling by car could reach all of the sights in the map. It would take a tourist approximately 3 hours to reach a waterfall if having Hambantota town as a starting point. Returning to Hambantota will then take an additional 3 hours (assuming equal speed in both directions).
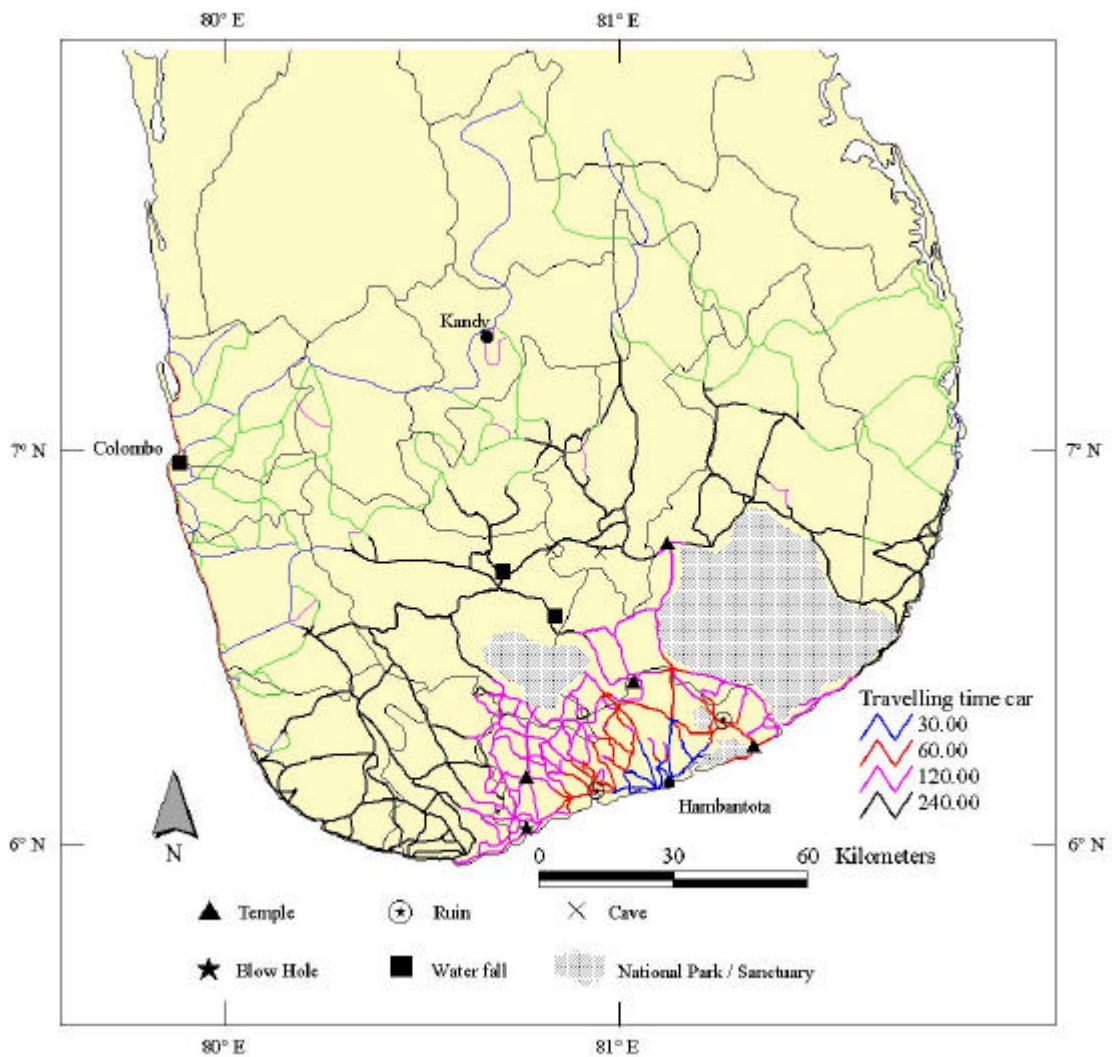

Figure 3. *Travelling time for Car, displayed together with some points of interest (POI). The geographical positions of the sights and parks are approximate (co-ordinates in Latitude/Longitude).*

This method can be used to show and identify roads and areas where infrastructure investments would give maximum increase in accessibility. As an example, examining Figure 3 one can see that if a want tourist to visit a sight or facility that is situated on or close to a small road the travelling time is severely increased. The speed value for driving a car on a small road is, in this case, 5 km/h. Rebuilding this road so that it could be classified as Minor would increase the speed value to 30 km/h and thereby dramatically increase the accessibility.

In Figure 4 the same analysis is performed, but this time for motorcycle. Compared to Figure 2 the tourist still reaches all sights but at slight higher time cost. Using a motorcycle this analysis shows that the tourist reduces the time cost on smaller roads and the accessibility is thereby increased. I believe this can be valid in reality.
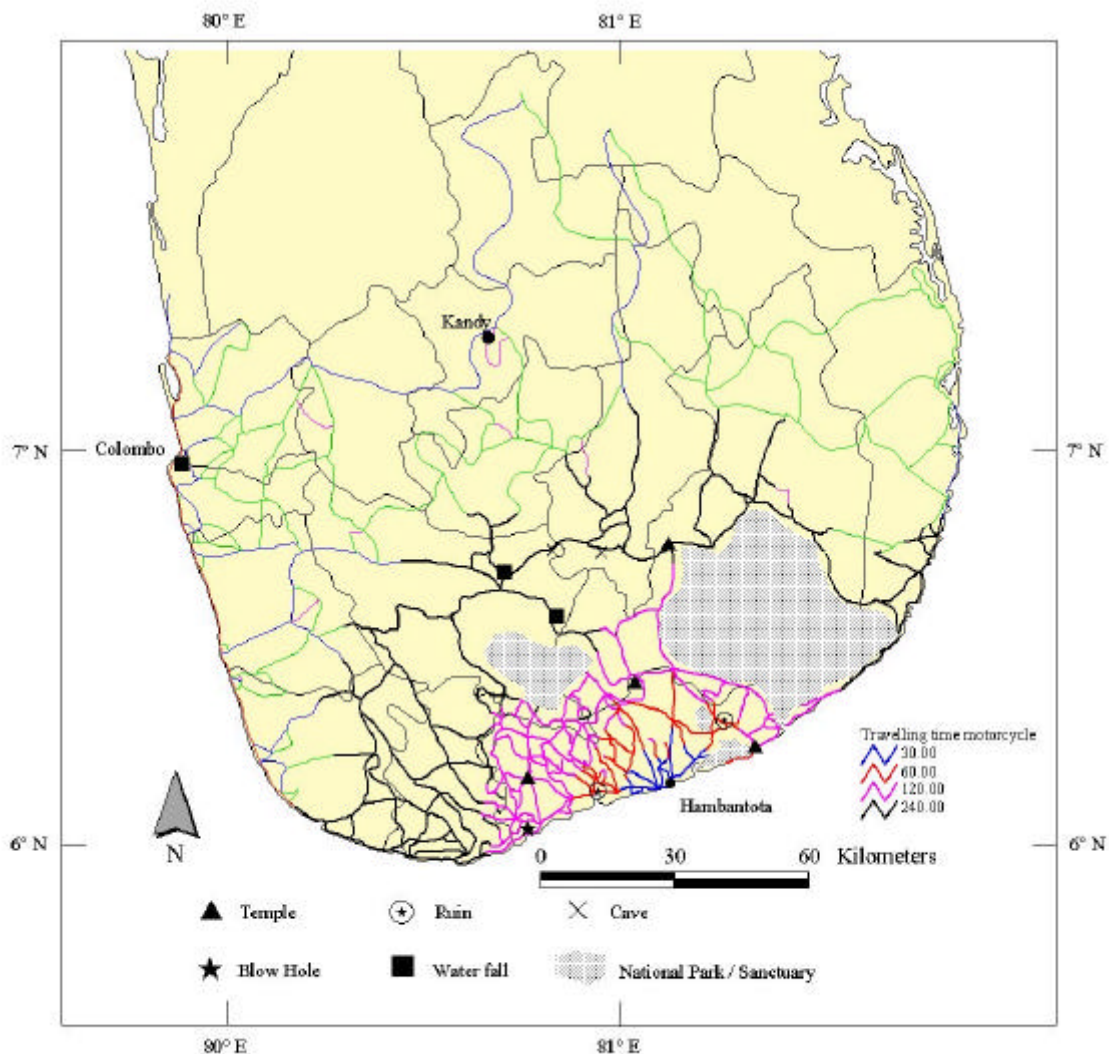

Figure 4. *Travelling time for Motorcycle, displayed together with some points of interest (POI). The geographical positions of the sights and parks are approximate (co-ordinates in Latitude/Longitude).*

The same theory can be applied when analysing the situation for travelling with bicycle. But this situation is somewhat different. Because of the low mean speed values (compared with car and motorcycle) the travelling cost increases very fast. This method is consequently more useful when the data consists of a dens road network over a "small" area and not like in this case half a county. Figure 5 below displays the travelling time for bicycle (note the different time interval). Figure 5 illustrates the abovementioned problem.
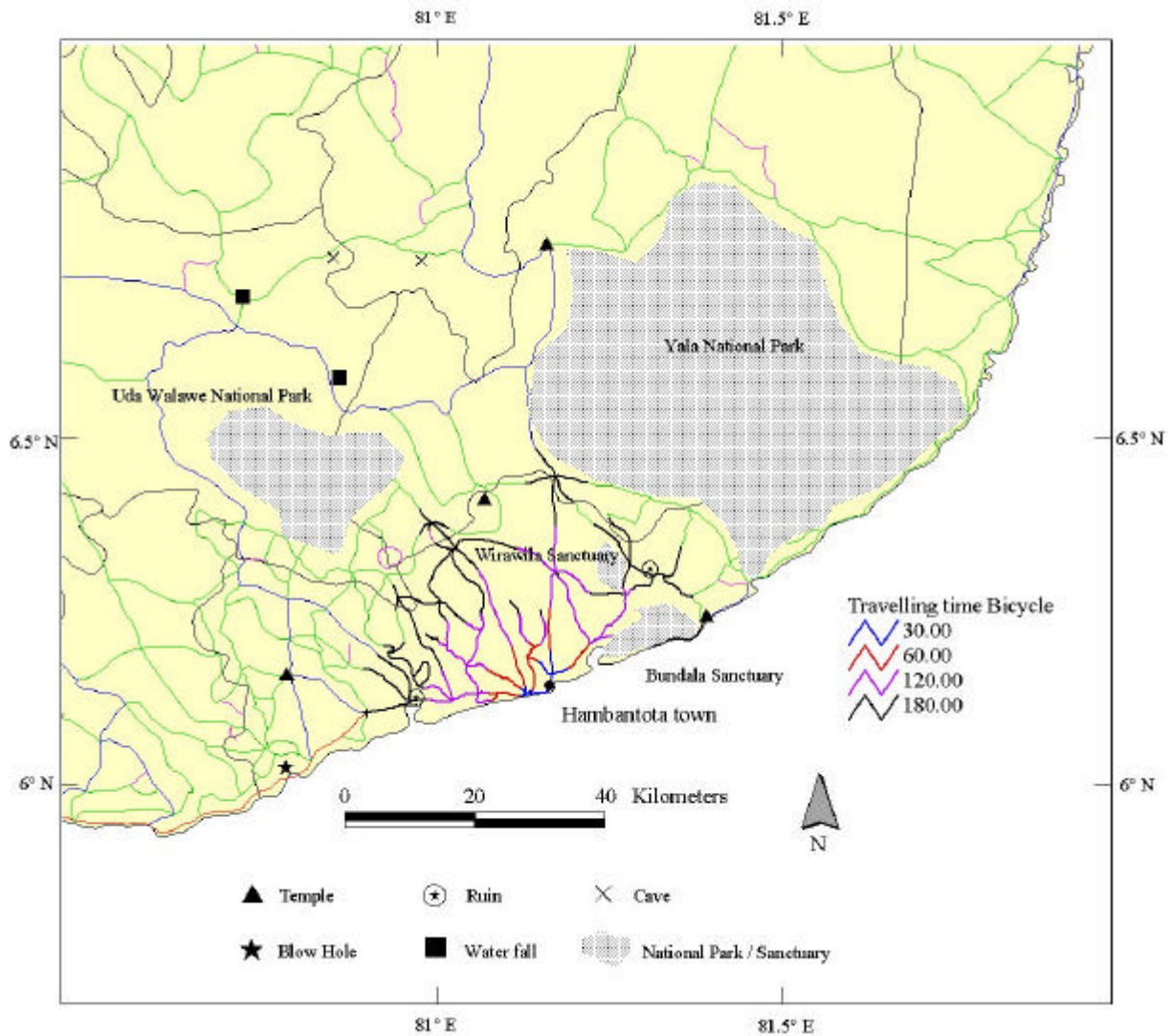

Figure 5. *Travelling time in minutes for Bicycle displayed together with some points of interest (POI). The geographical positions of the sights and parks are approximate (co-ordinates in Latitude/Longitude).*

5. Discussion and conclusions

Regarding the form and performance of the interviews made in Hambantota during June 1999 some things could have been done in a better way. I was not completely successful in explaining the purpose of my case study to the interviewees. Involving an interpreter would have helped in overcoming the language problem, but it could at the same time make the interviewees feel more exposed. The interpreter might also unintentionally manipulate the answers instead of giving a word for word recollection and this would bias the interview. The outcome regarding *attitudes* towards tourism was of course biased, due to the sample basis (almost all of the interviewees are in the tourist industry).

Despite the encountered problems during the interviews the outcome were satisfying. It gave an insight in the present tourist situation as well as their thoughts regarding the feature. In the present situation (June 1999) tourism doesn't generate much income to the local people in the district. Many foreign tourists that visits places in and around Hambantota come with package tours (usually from Colombo), everything is paid in advance, preordered meals and accommodation. The foreign backpackers are, on the other hand, in general keen to explore on their own but in return they can be classified as low spending tourists. In the two first class hotels the Oasis and the Peacock the majority of the staff come from other districts than Hambantota. The hotels seek personnel with "tourist education" or people with experience of the business. Today (July 1999) there is no such education in Hambantota. This means that the big hotels don't offer many openings for unemployed in the district. In addition the guesthouses are often family owned and don't employ persons outside the family. There is also a stiff competition amongst the establishments in Hambantota. And those how can afford it only advertise and promote their own hotel. It might be a good idea to promote the region (i.e. Hambantota district) instead of individual establishments. I think this strategy would attract a lager number of tourists and generate more income not only to hotels but also to local people. The Hotels and Guesthouses would still compete but not until the tourist reaches the region.

By visualising the scenario in section 2.1 I have shown a method that can be of use when analysing road directions and accessibility. This method can also be applied when dealing with any type of data that is in a network, may it be water pipes or electricity cables. In an analysis, quantitative data is usually used but qualitative data can constitute the base for deciding what

quantitative data that should be used. In studies regarding regional development one may have a mixture of both qualitative and quantitative data that needs to be visualised. As argued in Part I (section 7) having "button knowledge" is not sufficient for operating a GIS and that it is important to understand the operations performed by the computer. Another important factor is to understand the data that one wants to analyse. Understanding that different data have different characteristic makes it possible to, for instance, avoid generalisation of qualitative data. Using the method I have used in this case study could hopefully lead to a more thorough understanding of many research projects.

Through cooperation on a partnership level between donor agencies, such as Sida, and governments, universities or institutions, resources can be made available that facilitates a GIS implementation. A successful implementation can generate "profit" which can manifest itself in many ways;

- ?? Introducing new technologies into an institution might result in a new way of thinking, which could lead to new approaches to traditional research.

- ?? Increased communication between departments in a university can lead to a more efficient handling of research projects and hence save time.

One risk is that GIS results are accepted without criticism, meaning that decisions are made based on the visually "good looking" output when the input data might be of poor quality. Used in an incorrect manner, GIS can actually oversimplify a phenomenon and important information can thereby be lost. The use of GIS can when used in the right way provide better information on which better decisions can be made.

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Appendix A

Questionnaire

1. Hotel name, owner, room rate, season, personnel?

2. What kinds of tourist are coming and how long do they stay, what do they see? Touts? Guides?

3. What can Hambantota offer, what makes Hambantota special to tourists?

4. Does the government help, lower taxes etc?

5. Please describe your tax situation.

6. Are you organised in any way, helping each other, any form of cooperation?

7. The government's plans to build a super highway, airport and harbour; promises or reality?

8. What do you think is necessary for more tourists to come to Hambantota, infrastructure etc?

9. How do you see the future, both for your hotel and for Hambantota? Focusing on foringe tourism?

10. Can you see any problems with tourism (prostitution, drugs, etc.) how can one minimize these problems?

11. Do you think local people also will gain from an increase in tourism?

Part III

GIS in socio-economic planning

- A case study -

By Jenny Fergéus

Table of contents Part III

1. Introduction

The Main Project includes the development of the GIS capacity at the University of Kelaniya as described in Part I (Chapter 3.2). A central motive for this is to be able to employ GIS in the socio-economic planning. Six Ph.D. students at the University of Kelaniya associated to the Main Project will conduct much of the socio-economic research within the Main Project. Therefore it is of great importance to coach the Ph.D. students in these skills. One of the objectives of Part I was to train the Ph.D. students in GIS by holding lectures and exercises (see Part I, Chapter 5.2). This gave them basic technical knowledge about GIS, but it is vital that the Ph.D. students also use GIS in socio-economic research to fully be able to put GIS in a wider context and develop an understanding for GIS in socio-economic planning. Technical skills are not enough since without a comprehensive view it is quite easy to use the technique in an incorrect way. Theoretical lectures and exercises in computer laboratories can give the Ph.D. student basic knowledge, but to fully understand the possibilities and hindrances they need a lot of training on real cases. A method to develop an understanding is if the Ph.D. students can use GIS in their own research.

This case study was conducted mainly at the University of Kelaniya in Sri Lanka during the 4/6-23/7 1999, together with the Study (see Part I) and the case study performed by Jonas Almqvist (see Part II).

2. Objectives of Part III

The overall objective of Part III (hereafter referred as the Case Study) is to show examples of how GIS can be used in socio-economic planning. This will be achieved in cooperation with the Ph.D. students, which expectantly will benefit both their research as well as the Case Study. By utilizing the Ph.D. students' research to conduct the Case Study, the Ph.D. students have to comprehend if and how they can use GIS in their own research. In some cases this is already done by the Ph.D. students, while in other cases GIS is a new phenomenon. Since both the knowledge about GIS and how far they have come with their research varies widely between the Ph.D. students, there will almost certainly be great differences in the outcomes of the detailed objectives of the Case Study between the Ph.D. students' research.

The detailed objectives of the Case Study are as follows:
1. Determine how the Ph.D. students plan to use GIS in their research
2. Evaluate the possibilities for the Ph.D. students to use GIS in their research
3. Propose improvements and demonstrate examples of how to use GIS in their research

3. Methodology

There are usually three different ways of conducting a study, as quantitative surveys, as qualitative case studies or as time series, according to Kahlon and Ghebre (1996). To make the latter method meaningful, it would be necessary to follow the development of the studied area - in this case the research of the Ph.D. students - over a longer period than the two months that this Case Study lasted. In the choice between a quantitative survey and a qualitative case study it seems most meaningful to have a qualitative approach for several reasons. According to Neuman (1994) a qualitative study is the best-suited approach to use when dealing with an explorative type of research. Qualitative research has more potentials of discovering new issues. It is a way of becoming familiar with the basic facts and developing well-grounded assumptions. Using qualitative studies also has an excellence potential to go deeper into the subject. Though, Neuman also claims it is not about which form of study that is best, but under what conditions it is performed. Since there were only six Ph.D. students, which participated very closely in the Case Study, a qualitative approach appeared as the best choice.

3.1 Interview technique

There are in general two types of questions, open and closed. Open questions means that there are no given choices for the respondent, while the closed questions has two or more options for the respondent to choose between. There are several advantages and disadvantages between the two types of question, of which some are listed in Table 1. According to Neuman it is not which sort of questions that are best, rather under what circumstances the questions are appropriate. The closed questions are often more suitable for quantitative surveys while the open questions are more appropriate for qualitative studies. In this Case Study open questions was used for several reasons. One of the main reasons was that, as stated above, the Case Study was in fact qualitative. Consequently it is logical to use open questions, which give qualitative answers instead of quantitative questions that the closed questions have to be categorized as.

Given that the Ph.D. students were only six, there would be no meaning to conduct a statistical evaluation from the answers. This means that different degrees of details in the answers would not be a problem, neither would the answers have to be coded in any particular manner. It would also be easier to avoid misunderstandings since the open questions in combination with interviews made it possible to ask further and give deeper explanations when there was any uncertainty in the questions or in the answers. This is also the main reason why the Case Study is mainly based on interviews with the Ph.D. students. Before the interviews the Ph.D. students were given a written questionnaire with some questions concerning GIS and their projects (see Appendix B, Part I). The purpose for this was to prepare the Ph.D. students for the interviews and to get an idea of the level of the Ph.D. students' skills in GIS. One have to keep in mind that the communication caused some problems, both because of cultural reasons, as stated in Part I, but also because of language difficulties.

Table 1. *Open versus closed questions (model made of Neuman, 1994, modified by Kahlon and Ghebre, 1996)*

	ADVANTAGES	DISADVANTAGES
OPEN	?? Unlimited number of answers possible ?? Unanticipated findings can be discovered ?? Respondent can qualify and clarify responses	?? Different degrees of details in answers ?? Coding responses is difficult ?? Comparisons and statistical analysis become very difficult
CLOSED	?? Easier and quicker to answer ?? Respondents are more likely to answer about sensitive topics ?? Answers are easy to code and analyse	?? Respondent with no opinion or knowledge can answer anyway ?? They force people to make choices they would not make in the real world ?? Misinterpretation can go unnoticed

4. Results and Discussion

This chapter is divided in two parts; the first part (4.1) presents the general knowledge of GIS among the Ph.D. students. This is vital to examine before considering the possibilities to use GIS in their research. The second part (4.2) concerns GIS potential in each of the Ph.D. students' individual research.

4.1 General knowledge about GIS

In this part the result of the questionnaire and the interviews with the Ph.D. students is presented and discussed. Question 4.1.1 and 4.1.3 comes from the interviews while 4.1.2 comes from the questionnaire. Note that the questions were not asked in the same order as they are presented here. There is also no internal order in the answers presented, i.e. the answer of one question presented first does not come from the same Ph.D. student as the first answer of another question. The reasons for this are that it is not the individual answers that are interesting here. Instead it is the general attitudes of the group. Another reason is to keep the answers as anonymous as possible. Please note that even if the answers are within quotes, there might have been some language adjustments to the answers. Though, the intention was to keep the answers as close to the origin as possible.

4.1.1 "What is GIS?"

The first question was asked in order to find out how familiar the Ph.D. students were with the concept GIS:

> *Q: "What is GIS?"*

> *"The meaning of GIS is Geographical Information Systems. But we can also handle other types of information, for example the distribution of malaria and the*

distribution of population is very useful for the doctors. Although the information is spatial it is possible to convert this information to economic information. I believe that geographical data can be used by anyone, not only geographers. We have learned that geography is a separate subject, but GIS has proved it is for use for everybody. Another thing is that in our country we can save a lot of time by using GIS for planning of roads, electricity, communications, etc. I think all these departments should use GIS. GIS is really helpful and we need this technique in developing countries. Another thing is that we can store and update data very easily without wasting resources. When considering all these things GIS is very helpful and needed."

"I do not have so much knowledge about GIS. This is my first experience of GIS. I believe that by GIS we can formulate data. We can digitise spatial data into non-spatial data. When we are going to do a research, like social or natural science we can use data as a tool to collect data. All sorts of data we can treat with GIS, for example houses, land use, families. The main task with GIS is to produce maps."

"GIS says what happens where. One important thing is that it can source human activities, interactions and changes and so on. And also I think GIS gives spatial information. Another thing is that with GIS maps, the information is much more understandable than just using tabular data."

"It is some sort of storing information and you can use it as a tool. You can for example cross check data. It is a good tool, but you have to master it. And you must know what to do, otherwise the information might be available but if you do not have the knowledge it is useless."

"To me GIS is the way of processing data and analysing spatial data."

"GIS is an important tool to analyse socio-economic data in development and planning process. Third world countries like Sri Lanka can use the GIS to accelerate their development projects. According to my knowledge it can display

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map data and all kinds of information in maps. However, GIS can be identified as an interesting subject."

As seen in the answers above, there are large variations in the understanding of GIS among the Ph.D. students. This was expected since the background knowledge between the Ph.D. students varies greatly, as seen in 4.1.3. The common GIS knowledge is quite basic; most of the Ph.D. students are not very familiar with GIS and the opportunities and hindrances it offers. This is important to keep in mind when discussing the possibilities for the Ph.D. students to use GIS in their studies.

4.1.2 "What is your impression of GIS?"

The purpose of this question was to get an idea about the attitudes towards GIS. It is of course crucial for the outcome of the Ph.D. students that they are motivated:

Q: " What is your impression of GIS?"

" Happy to use the GIS technology for my future studies."

"It will be a very interesting subject to learn and practise. On the other hand there is no hesitation that it is a more useful tool for many researchers to select a sample and collect data in a proper way."

" GIS is a scientific tool which can use any subjects to show spatial relationship. I am thinking about how GIS can use social science research and economic planning. Although we get the knowledge about how to use GIS, can we use this expensive material (satellite image) or can we find some alternatives?"

"It is a tool. Time spent to GIS gives good results. It is very important."

"I find GIS as a very powerful analytical tool. At the same time I am aware of its capabilities as well as its limitations."

"GIS helps in many ways to solve more complicated and complex problems involved with a large scale database. GIS can handle these large databases very easily as I need. Data arranging, analysing, updating and storing the data also will be very easy. Results can be presented in different ways, such as maps, graphs and table form by using GIS facilities. When considering all these things I believe GIS will help to accelerate the personal and national progress."

Even though the knowledge level of GIS is quite basic, as seen in 4.1.1, the attitudes towards GIS are very confident. It is often symptomatic when introduced to a new technique to focus on the possibilities without thinking about the hindrances.

A majority of the Ph.D. students sees GIS mainly as a tool, which is not optional. It would be preferable if they looked upon GIS as concept, meaning more than only the technique. It probably depends on an immatureness concerning GIS. This can lead to the use of GIS in an incorrect way. By having too much confidence in the technique the Ph.D. students might use GIS software uncritically without paying enough attention to the data used. This may result in incorrect conclusions. This is further discussed in Chapter 5.

The hierarchical structure in Sri Lanka, as well as in many other countries, often creates a one-way communication where people tend to do only what they are told to by someone higher in the hierarchy. Therefore it is pleasant to see that the Ph.D. students seem to be genuine interested in GIS. This simplifies the performance of the Case Study since it is always easier to work with motivated people.

A very crucial opinion is about the costs connected to the use of GIS, as one of the respondents mentioned. Not only is the hardware and software expensive, the material such as maps and aerial photos, and education and training are also associated with high costs.

4.1.3 "How much experience did you have of GIS before the lectures and exercises?"

Even though the questions in 4.1.1 and 4.1.2 gave some clue, it would be interesting to find out how much experience the Ph.D. students had of GIS before the GIS lectures and exercises. Depending on their background knowledge of GIS, it could give an idea of how complex GIS solutions the Ph.D. students could use in their research.

> *Q: "How much experience did you have of GIS before the lectures and exercises?"*

> *"I have heard about GIS in my courses, but I have never used it in my theses. After learning I want to use GIS. I need a good course in GIS, because if I do not use GIS in a correct way it will be a waste of time, so before I use GIS I want to get a good knowledge."*
> "Nothing."

> *"I have done an ArcInfo course for two weeks with some digitising and node correction."*

> *"I have three certificates from GIS courses, mostly for one or two weeks each. Only theoretical because we did not have time for exercises."*

> *"Nothing."*

> *"I had a little bit but not much. I had heard about GIS, but not applied GIS for any purposes. I was interested but I had not the possibilities to use it. I was told that I only need to know when it is possible to use GIS, then I can let someone else do it for me. I have been interested in map analyses for a very long time, but have not had the possibilities to use GIS."*

The Ph.D. students do not have very much GIS knowledge, especially when considering that they all want to use it in their research. On the other hand, they all have a major interest of

learning GIS, which is just as important as the knowledge. This becomes obvious when comparing the answers from 4.1.1 with the answers from 4.1.3 and in further discussion with the Ph.D. students; the correlation between the Ph.D. students background knowledge about GIS and the understanding of GIS is not as big as the correlation between the understanding of GIS and the interest for GIS. In other words, the interest for GIS seems to be more important than the background knowledge for the understanding of GIS.

4.2 The research of the Ph.D. students

Unfortunately one of the Ph.D. students left the Main Project in the beginning of the Case Study, approximately after one week, and another Ph.D. student took his place. Since the replacing Ph.D. student had not chosen any research field at the time, he was left out of this part of the Case Study. Therefore there were only five Ph.D. students to work with concerning the GIS-potential of their research. Notice though, that the replacing Ph.D. student participated in all other activities conducted, such as GIS lectures, exercises, interviews, etc.

In the following chapter, there will be a brief description of the research of each of the five remaining Ph.D. students. A deeper description of their research is presented in the Appendix. The descriptions are based on both written descriptions and interviews. There is a large variation in the material depending on how far the Ph.D. students had proceeded in their research. After the description of the research, the result of the interviews concerning the possibilities to use GIS for each of the Ph.D. students will be presented. Given that the answers are individually connected to each of the Ph.D. students and their studies there will not be any quotations presented in the following chapter. Finally there will follow a discussion including suggestions regarding the possibilities to use GIS for the Ph.D. students. In order to maintain the anonymity the Ph.D. students have gotten a letter each (from A to E).

4.2.1 Poverty in fishing communities: Specific case study of lagoon fishermen in western and southern regions in Sri Lanka

> The development projects implemented recently have lead to changes in land use pattern. These development projects create ecological changes connected to ecosystems and issues related to social, economic and environmental conditions. The strategies for development in Gampaha and Hambantota are mainly based on industrial or agricultural activities, which affect the water bodies negative with pollution and overexploitation, and this in turn, affect the fishermen. This study will investigate the effects on the fishing community. This can be evaluated by comparing time series data. The information will be extracted from satellite images, land use maps, reports of socio-economic and bio-economic conditions and changes, and field surveys.

Ph.D. student A has a very good understanding of the possibilities and hindrances to use GIS. The idea of conducting time-series investigations of the change in land use patterns and ecological decrease is good, but there could be some problems. By constructing maps over the expanded industrial and agricultural areas, analysing the water bodies affected by these activities, and comparing them to the changes in productivity for the fishermen, there are probably some connections found. It is though crucial that the data mentioned, such as satellite images and land use maps, are available. It is also possible to extract this information from written reports of earlier surveys and from official statistics with a GIS tool - under the condition that this type of data is available. But it is of great importance to remember that the reliability of old data might be poor, especially if the conditions under which the data were collected are unknown. Another problem is how the data are categorised when it might be collected under different periods and by different individuals; Do they have similar methods to evaluate the data?

Ph.D. student A also intends to use GIS to analyse the interconnection with the biological system, the social system and the economic system and how a change in one of the mentioned affects the other two. There is however some questions about how this could be done. The analysis may be difficult to do with GIS since the types of information that has to be compared

are very disparate. The risk when trying to compare such unequal information is that either the conclusions are irrelevant or too wide. The value of analyses with GIS is dependent on the fact that the technique is used in a proper way with proper data. By using deficient data the result will be useless. Otherwise one might end up comparing apples with pears. According to Eklundh (1999), it is a major problem that GIS can be used to create visually professional presentations of data with low quality.

Instead of using GIS analyses, this field study is most likely better to conduct with field studies and interviews in combination with investigating already written reports in the subject. The result, however, may preferably be presented on a map.

4.2.2 Socio-economic role of women in Hambantota District

The social role of women in Sri Lanka is vital to the family and has not changed very much during the decades, while the change of the economic role is significant. At present more than two thirds of the Sri Lankan women work outside the home in addition to their housekeeping role. Various programmes have been implemented to develop the socio-economic status of women in Hambantota District. The main purpose of this study is to collect and analyse relevant data regarding the socio-economic role of women in Katuwana village. This will be done in order to review the status of the women in Hambantota District and to identify the present socio-economic role of women in Hambantota District. Primary data will be collected by both interview and observation methods. In addition, secondary data will be gathered from published articles.

Ph.D. student B plans to conduct interviews and observations in Katuwana village to find out aspects of the women's situation such as occupational groups, age, income, family structure etc. When asking how he will use GIS in his research he answers that he would like to create maps with the data he collect. To do this he wants to learn how to digitise and he also says he needs more training on how to use the GIS programmes. He is also interested in learning about statistical methods.

The subject for the study is interesting and has a good GIS potential, but to start with; Ph.D. student B needs to widen the field area to several different villages in Hambantota district. It is not possible to draw any conclusions about the whole district by only using one village for the research. This is extra important in a country like Sri Lanka, where the diversity between the villages is enormous. It is not possible to draw any reliable conclusions about for example, fishing societies by observing an agricultural society. A suggestion is that he uses at least three dissimilar villages.

The idea of producing maps over the data collected is good and it will make it easier to analyse spatial variations in the role of women. If possible, it would be interesting to conduct a survey of how the role of the women has changed during time and compare it to the development programmes implemented in the district. The result could be presented on maps and analysed in a GIS to see if it is possible to draw any conclusions of the success of the development programmes. These are not very advanced suggestions concerning GIS, but since Ph.D. student B does not have any background knowledge about GIS, the suggestions mentioned above should be suitable.

4.2.3 Sustainability of the peasant socio-economic systems: A study of southern Sri Lanka

> The rural development strategies that have been implied have caused successful socio-economic changes at village level. Still, peasant society has rarely visible benefited in life quality. Although the peasant agriculture has undergone several institutional changes associated with rural development, the basic questions of rural poverty and economic stagnation remain a major problem affecting the majority of the people. This study aims to identify spatial patterns of socio-economic conditions and their relationship to land use and changing trends in the peasant socio-economic systems. By using written reports supplemented with field research, maps and aerial photographs, the study will result in recommendations for a sustainable rural socio-economic and environmental system.

Ph.D. students C will use secondary data in first hand and supplement with field researches. This data will consist on interviews and reports over the situation for the peasants. He would like to use GIS to analyse spatial patterns of development in Hambantota district.

It might be difficult to use a GIS in order to explore how the sustainability of the peasant society has been affected by the socio-economic changes taking place, unless focusing on very specific details, for instance analysing how one specific change have affected the income for peasant families. Still, it might be complicated to isolate one specific factor. The GIS analyses should be used very carefully in this study.

There are also some hesitations in the use of aerial photographs. The risk is that it is too difficult to interpret the aerial photographs into useful data for this study. The data achieved might have a too low quality to be reliable. There will probably not be any need for the aerial photographs.

GIS is still a useful tool in this study for storing and visualizing data. When presenting the material, maps will be an excellent complement. But as described, the analyses should be used very carefully.

4.2.4 Development potential for tourism in Hambantota District

The tourist sector is a powerful growth element in the Sri Lankan economy. Today there are overcrowded tourist resorts in certain destinations. To avoid conflicts between the tourists and the locals, there is a need for additional tourist resorts. Hambantota has a good, but yet not developed potential to become a tourist resort. The objectives for this study are therefore to evaluate the existing tourism sector in Hambantota and identify suitable locations for future tourism development. To accomplish this, an inventory of existing tourist attractions plus potential attractions will be conducted. Primary data such as interviews and questionnaire surveys will be carried out. Secondary data will be collected from official institutions.

Ph.D. student D intends to build his study mainly on interviews and already written reports to find out attitudes towards tourism in Hambantota and to explore different tourist attractions within the district. In opposite to the other Ph.D. students, he has not decided yet if and how he would use GIS in his study.

This study has a very god GIS potential with several different possibilities. To start with Ph.D. student D could conduct a survey over where tourist attractions are located and then compare it with the existing infrastructure (such as roads, hotels and other facilities), population and restricted areas like national parks. In this way it would be possible to perform several different GIS analyses, for example to find where there are potential areas for tourism development and then compare it with the infrastructure to see if and how the infrastructure has to be expanded.

It is also possible to set up strategies on the tourist development depending on which conditions that are set up in the analysis. One example is if Ph.D. student D set up the conditions that a tourist resort must not be situated inside a national park, maximum three kilometres away from the sea, and within one kilometre from an existing road he can point out different areas where there is a development potential for tourism.

A more advanced analysis could be to examine how many tourists an area could handle. To do this Ph.D. student D has not only to investigate the GIS potential of the area, but also how much resources each tourist demands and compare these factors, and not forgetting to examine the attitudes towards tourists in each area. It might be more difficult to perform this, but on the other hand could this kind of analysis be really useful.

Ph.D. student D could also use maps to visualize the result of the analyses. Even if he decides not to perform any analyses, he could use a GIS system to store the data collected through interviews.

4.2.5 Coastal erosion of South West Sri Lanka

Sri Lanka has, as many other coastal countries, vast problems with coastal erosion. The impact of the coastal erosion is most intensive in the South West of Sri Lanka. This area is now densely populated with economic and infrastructure facilities concentrated to the coastal zone. The accelerating coastal erosion therefore creates considerable problems, which might lead to a total collapse of both the ecological and economical systems in the coastal zone. This study intends to determine the causes of coastal erosion by investigating the spatial and temporal variation of land loss due to coastal erosion in the South West. The overall goal is to calculate the exact amount of land loss. Maps, satellite images and aerial photographs will be compared over time in addition to secondary data collected by universities and institutions.

This study has probably the best GIS potential of the five Ph.D. students' research. Ph.D. student E has a good understanding of GIS and does not only see it as a tool. He plans to store and categorise data through time and space. After that he can label the data before analysing it. By using old and new maps he can calculate the changes, but he says he has a problem with the scale and projection between the maps. This is though something an advanced GIS can handle once he converts the maps into a digital form, which also is what he should start with. After that it will be easier to label the nonspatial data to its spatial position. Spatial relations can often be discovered visually even before any analyses are done, which might be of assistance in planning the analyses of the data. It is easy to rely only to the technique, but one should not underestimate the importance of going through the material visually before letting the GIS analysing the data.

With a GIS tool it is possible to perform complicated analyses that otherwise would be very time-consuming. Therefore I recommend that Ph.D. student E tests different existing soil loss models and evaluate them with sample areas in order to find one that seems confident for the studied area. It is of course dependent on the quality of the data used. Depending on the soil models, he might need maps such as hydrological maps, soil maps, topographical maps etc. Further on, if the quality of the data is good, it might be possible to adjust the soil loss model if it is necessary. By finding a good method for calculating the soil loss due to coastal erosion,

it is possible to predict where and of what magnitude the problems will occur in the future, which in turn will create enhanced opportunities to prevent the coastal erosion. It is also particularly useful for socio-economic planning; especially since both the population and the infrastructure facilities are growing in the coastal zones. This is a great example of how natural science and social science can integrate.

5. Conclusions

In the Case Study a written questionnaire was used, followed by face-to-face interviews. By using two different methods as well as repeating questions on different occasions, it was more likely to increase the amount of information received. When having any kind of communication, there are some factors we need to consider. An example is that we tend to hear what we want to hear and relate to post experiences, which could bias the answers. By using both written and spoken answers, this source of error would expectantly be reduced. In an attempt to decrease the problems of biased answers due to the lack of anonymity the questions were as far as possible asked in a general form. It was also clarified that individual answers would not be exposed together with the respondent's identity. Another bias was that the answers concerning GIS could be influenced by the lectures in GIS held within the Study (see Part I). To avoid this, if possible, the interviews were scheduled as late as possible after the GIS lectures and exercises, i.e. approximately one and a half month.

The overall objective of the Case Study was to demonstrate how GIS could be used in socio-economic planning. As mentioned, one of the Ph.D. students was replaced in an early stage, which lead to the consequence that it was only possible to evaluate the research of five of the Ph.D. students. By utilizing the Ph.D. students' research, possibilities and hindrances in five different studies has been examined. The fact that all the Ph.D. students had confident attitudes towards GIS simplified the performance of the Case Study. They were also very interested in learning more about GIS, which of course was a condition for a successful outcome of both their research and the Case Study. Even if the possibilities to use GIS differ between the Ph.D. students' studies, they could all use it in one way or another. They could all use GIS to visualise their data, but some of them should be careful when conducting analyses. This does not mean that they cannot do it, only that they have to be observant on both the data they use and on the result they get.

As discussed in 4.1.2, most of the Ph.D. students have their focus set on the technical part of GIS. This is nothing unexpected, since GIS is a new subject for most of the Ph.D. students. Hence, it is important to concentrate on the thoughts behind the techniques; what is the purpose with GIS? When, why and how can we use it? It is essential to have a good fundamental understanding about GIS, not only to be able to conduct relevant analyses, but

also to be able to critical valuate surveys and analyses performed by others. As seen in Chapter 4.2 the majority of the Ph.D. students plan to use that sort of information in their research. It is easy to lay to much confidence in the technique. Just because the result looks advanced, it does not mean it has to be correct. If you use nonsense data, you will get nonsense as a result. Therefore it is always important to have a critical approach.

As mentioned in 4.1.2 there are high costs connected to GIS. There are high initial costs, such as hardware and software. There are also high costs in satellite images, aerial photos, and in some cases maps are very expensive. In addition, the value of education and training is often underestimated. These investments in time and money will hopefully pay back in the long term, but they should not be underestimated in the beginning.

A risk when introducing a new technique is that beginners tend to want too much. Instead of starting with the basics, people tend to start with the most complex parts because it seems more interesting. This lack of selfcontrol may lead to a backlash; when things get too difficult it is easy to give up, blaming the technique to be too complicated. Therefore it is important that those responsible for the guidance try to keep it on a realistic level. I tried to suggest GIS solutions for the Ph.D. students that are reasonable according to their background knowledge. Another risk that in some ways are connected to the one just mentioned is when giving the technique an intrinsic value. When the technique is unnecessary do not use it.

This chapter is mainly concentrated on risks with GIS for a reason. The advantages are far greater than the disadvantages, but the latter are easy to forget when concentrating on the benefits. As seen in chapter 4.2, GIS is a superior technique when used in a correct way. Still, it is important to keep a critical thinking and always have the risks in the mind. Otherwise we might fail to do the best of a superior technique.

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Appendix – Description of the research of the Ph.D. students

Poverty in fishing communities: Specific case study of lagoon fishermen in western and southern regions in Sri Lanka

The pace of development in Sri Lanka is among the fastest of the Third World. This rapid development increase already high claims on the natural resources, resulting in exhaustion, which in turn leads to adverse impact on sustainable economic development and to degradation of ecosystems and valuable habitats. The new development projects implemented in recent past have lead to changes in land use pattern. A disadvantage of such development projects is that they create ecological changes interconnected to ecosystems and issues relating to the social, economic and environmental conditions. Changes in land use pattern can have either positive or negative effect on other groups in the community. The strategies for development that are implemented in Gampaha and Hambantota are mainly based on industrial or agricultural activities. Changes in land use for these sectors affect the water bodies, which in turn affect the fish production. The wetlands in Sri Lanka suffer without exceptions from pollutions caused by upstream industries and overexploitation of resources. These impacts have lead to stagnating income of fishermen, increased conflicts among community groups, and lack of progress in economic development are visible. The destruction of habitat and extinction of species accelerate further ecological degradation. The prime cause of the circle is imbalanced management of the natural resources in development. This study will investigate the effect of changes of lagoon productivity on the socio-economic system of the fishing community, with the following detailed objectives:

1. To identify the changes of land use due to the recent development projects in the areas using GIS tools
2. To examine the influence to the socio-economic conditions of the different groups of the community
3. To examine the use of socio-economic information for strategic planning by relevant natural resources management institutions

The effect of changes can be evaluated by comparing time series data. In practice it is difficult to get annual variation of the biophysical changes from socio-economic information by field search. Therefore three major sources of information will be used to collect information for comparison. Spatial changes will derive from the land use maps and satellite images. Information on biological changes of the water bodies and socio-economic and bio-economic conditions will be obtained from previous research reports. Additional information will be collected through case studies and compared with first two categories of results.

Socio-economic role of women in Hambantota District

Sri Lankan women play a vital role within the family as a mother, wife, sister etc. At the same time the women have a significant economic role, providing their labour for various types of economic activities, especially agriculture. Though, a few decades ago their social role was about the same as today, but their economic role was minor. At present two thirds of the Sri Lankan women are employed in governmental or nongovernmental sector. Above this, some women are self-employed. With the rapid economic changes at present, attitudes and values have changed significantly and the role of women has expanded. In the current economic crisis, a lot of women have to work outside the home, but with the implicit understanding that they are still to perform the traditional role of the housekeeper in addition to their professional responsibilities. When paying attention to development, it is therefore necessary to identify the present socio-economic role of the women.

Women in Sri Lanka have participated in productive labour from time immemorial and their dual role is not a new experience for most women, especially for women in the agricultural sector, which is still the major area of economic activity in the country. Nevertheless, women are a neglected group of the rural communities in Sri Lanka.

The present micro level empirical study will be conducted in Katuwana village in Hambantota District and the study will take the following objectives:

1. To review the status of women in Hambantota District
2. To identify the present socio-economic role of women in Hambantota District

The major purpose of the present study is to collect and analyse the relevant data regarding the socio-economic role of women in Katuwana village. Primary data will be collected by both interview and observation methods. The data will cover the aspects such as; occupational groups, age, income, family structure, housing conditions, wages etc. In addition, secondary data will be gathered from published articles.

Sustainability of the peasant socio-economic systems: A study of southern Sri Lanka

The agricultural sector serving the rural population is central to the development process of the third world countries. The rural development strategies that have been implied since the political independence in 1948 have caused successful socio-economic changes at village level. However, peasant society has rarely visible benefited in life quality. Even though the peasant agriculture has undergone several institutional changes associated with rural development, the basic questions of rural poverty and economic stagnation remain a major problem affecting the majority of the people. The peasantry comprises mainly of small-scale farmers and landless agricultural labourers and as such they have been central to many development issues. Although villages have to some extent been beneficiaries of modernization, studies have shown that the general trend in many areas is toward a decline of socio-economic life. Issues such as poverty, unemployment, malnutrition, landlessness and degradation of the natural environment are connected to the persistent underdevelopment. When the environmental conditions are unfavourable the sustainability of village ecosystems become unattainable. The focus of the research is therefore to study the sustainability of the peasant ecosystem in the southern Sri Lanka in the context of socio-economic and environmental changes. The broad objective of the study is to examine the sustainability of the village economics. The specific objectives are:

1. To identify spatial patterns of socio-economic conditions, their relationship to land use and changing trends in collected villages in southern Sri Lanka since 1948.
2. To conduct case studies of selected villages representing different agro-ecological and socio-economic characteristics in order to observe the process of change and identify the key variables in this process.
3. To develop a database for analysis of village level data, using the computer assisted devices such as GIS, where appropriate.
4. To make specific and relevant recommendations with a view to establish a sustainable rural socio-economic and environmental system.

Part III

The methodology of this will utilize both macro and micro level data. The macro level analysis will primarily employ secondary data and supplemented by primary field research. The micro level investigations will be carried out in selected villages mainly through primary data collections. Information derived from interpretation of maps and aerial photographs as well as other relevant surveys will be used.

Development potential for tourism in Hambantota District

The inception of the tourist industry in Sri Lanka dates back to the early 1960's. Since its inception, tourism sector has become a potent growth element in the Sri Lankan economy. The ongoing war in the North and East Regions has lead to a problem with overcrowded tourist resorts in certain destinations, especially during the tourist season. Such situations may lead to environmental problems or conflicts between tourists and the local community. To avoid this, additional tourist destinations have to be created where potential resources are available for tourism development.

The area selected for the present study is Hambantota District in the South of Sri Lanka. The district has a spectacular coastline of 150 kilometres. Apart from this coastline, Hambantota district is rich with a variety of tourist attractions, such as national parks, bird sanctuaries, historical and archaeological sites. Majority of these places have not yet been developed sufficiently to cater the needs of the tourists. If properly developed these attractions would definitely benefit the existing tourism sector of the country. As a general rule, tourism in Hambantota District is also concentrated along the coastline. Compared to other destinations of the South Coast Region, tourism in Hambantota District is still in an infant stage. Promoting new tourist locations or expanding facilities in the existing destinations in the Hambantota District will be a major solution to the acute problem of overcrowding in certain tourist destinations in the Wet Zone.

Main objectives of the proposed study are as follows:

1. Evaluating the existing tourism sector in Hambantota district.
   Since much of the tourist activity is seen around Tangalle and Hambantota towns, greater attention will be given to them. Linkages of tourism with the other sectors of the economy, existing infrastructure facilities for tourism, positive and negative effects of tourism, attitudes of the local people towards tourism will be analysed in detail.
2. Identification of suitable locations for future tourism development.
   To fulfil this objective, an inventory containing the so far utilised tourist attractions in Hambantota District will be prepared. In addition accessibility as well as the opportunities available for further development of tourism in these locations, attitudes

of the local people towards the development of tourism will be given due consideration.

Primary data as well as secondary data will be used in the proposed study. To collect information about the existing tourist sector, questionnaire surveys would be conducted covering the hotels and guesthouses, other tourist centres and local households. In addition personal interviews will be held with prominent people such as school principles, aurvedic doctors, Buddhist priests, etc, to collect information and their views on future tourism development. Secondary data would be collected from official institutions such as The Ceylon Tourist Board, A.G.A. office of the Hambantota District, Police Stations of Tangalle and Hambantota, and the Archaeological Department.

Coastal erosion of South West Sri Lanka

Losing land due to coastal erosion is a common phenomena found almost everywhere in the world along the coastline. Sri Lanka is losing coastal land from time immemorial. But this process has become curtail problem at present because the core section of the country are bound with the coastal zone. The impact of land loss is mostsevere in the South West coastal zone with in Sri Lanka. Available result obtained from historical data sources shows that the considerable amount of land has lost due to shore erosion process in Sri Lanka. It seems like this problem is worst in South West. Until 1960s, this was not considered as a hazard since the edge of the shoreline land was abandoned by the law as reservation area. But now the coastal zone, especially South West is highly populated, and economic and infrastructure facilities have concentrated to the coastal zone. Because of this, losing coastal land in this area creates considerable distraction to all section of activities. Economic, Social, cultural activities and the natural resources are highly deformed. This leads to collapse the core sections of many systems of the coastal Zone and the country. Sri Lanka is already experiencing severe economical, social and environmental problem caused by the coastal erosion, and these problem in return accelerate the existing erosion problem. Thismay also lead to the collapse of the entire ecological and economical systems.

Constructing a protection structures at the erosive spot without understanding related maritime forces with spatial and temporal variation of coastal erosion process is not a successful step. This study will aim to determine the causes to the coastal erosion by investigating the spatial and temporal variation of land loss due to coastal erosion at the South West coastal sector. The overall goal is to calculate the exact amount of land loss through coastal erosion. Maps, satellite images and aerial photographs will be used and compared over time as well as secondary data collected by universities and institutions.