THE ROLE OF SPATIAL INFORMATION IN NATURAL RESOURCE MANAGEMENT

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ABSTRACT

This century's rapid expansion in technology, population and economic activities has also featured the rapid and unsustainable exploitation and depletion of resources. Already half the world's population lives within 60km of the coastline. A third of the coastline is at high risk of degradation by human activity. In many countries fresh water availability is approaching crisis point; 1.3 billion people do not have access to clean water. It is estimated that 5 million people die annually from water borne diseases. Fish stocks are three-quarters (3/4) of what they were once; water available today is 60% of the 1970s levels, as is forest coverage.

The last 30 years have witnessed a growing understanding that the earth cannot sustain current levels of pollution and utilisation of natural resources. A need for their management has arisen. This is only possible through a continuous effort to survey and monitor the quantitative and qualitative characteristics of the environmental conditions.

Spatial information is best discussed in the context of Geomatics. Geomatics refers to the integrated approach of measurement, analysis, management, storage and display of the descriptions and location spatial data. These data come from many sources, including earth-orbiting satellites; air and sea-borne sensors and ground-based instruments. They are processed and manipulated with state-of-the-art information technology. Geomatics finds application in many disciplines, including but not limited to *environmental studies, planning, engineering, navigation, geology and geophysics, oceanography and land information management*. It is thus fundamental to the management of natural resources**.**

This paper proposes to discuss the current concerns on natural resources depletion and the potential role of spatial information in alleviating this. Greater interest will be paid to *GIS and Remote sensing* as Geomatics techniques with the possibilities of guiding sustainable resource exploitation and management.

1. INTRODUCTION

The current surge of interest in environmental information springs from the convergence of three profound world-wide trends: environmental awareness, liberation of public affairs, and information technology. Degradation of environmental resources (air, water, soil and biodiversity) has mobilised public opinion. This is because these resources intimately and directly affect the quality of our lives (E.g. 'El Nino' 1997 and 'La Nina' 1998). As a result the public demands to be better informed on the state of the environment. In turn, governments and industries need spatial information in order to manage and utilise the environmental resources in a sustainable manner.

The past two decades have witnessed dramatic advances in Information Technology. Spatial data processing has advanced to the point where it matches the applications challenges presented by the natural resource management. In addition, the Internet, Geomatics, and Telecommunications are rapidly changing the way natural resources are being managed and protected. These have provided more accurate and up-to-date information about resources; further the information is readily available to would be users.

2. DEFINING RESOURCES

A natural resource may be defined as a supply of raw materials that are furnished by nature, and bring a country, person, and etc. wealth. Natural resources are subdivided into non-renewable and renewable .The former are substances which have evolved over geological periods of time and therefore effectively cannot be replaced. These include substances such as metal ores, coal, oil, and natural gas. Renewable resources are those which are capable of regenerating themselves continually from input. These include animals, plants, soil, rain, wind, and tidal energy. *Solar energy is not renewable but may be regarded as infinite.*

These definitions make a complex picture. Renewable resources are only self-generating if they are allowed to be so. Over-exploitation effectively converts some renewable resources into non-renewable resources. For example, globally soil is being lost at a rate much faster than it can be replaced; species extinctions are of course final. Such destruction represents a loss both of resource income and capital *(Cooper and Palmer, 1992).*

3. TRADITIONAL APPROACH TO NATURAL RESOURCE MANAGEMENT AND ITS SHORTCOMINGS

Natural resource management involves manipulation of the resource to preserve or supply products on a sustained basis *(Knight and Bates, 1995).* It revolves around, but is not limited to the manipulation and analysis of many different types of spatial data. Spatial data is that which has physical dimensions and geographic location. Traditionally most of this data is stored in separate and unrelated databases. This makes its use in decision making complicated as spatial relationships are interpreted through visual observation of several different resources maps, unrelated in terms of scale and projection. The limiting factor in decision making is not the amount of data available to resource managers; rather it is the ability to mentally organise and compare these large quantities of information. This can be frustrating, time consuming and expensive. Many hours of manual processing are often necessary to get the data into suitable format. Consequently, managers may find themselves in a difficult position in which they cannot use all of the available information but are still required to provide solutions.

4. GEOGRAPHIC INFORMATION SYSTEMS

A Geographic Information System (GIS) is a computer based information system that has a capability of handling all kinds of spatially referenced land-related data at all mapping scales in support of decision making. It enables the input, management, manipulation, analysis, modeling, output, and dissemination of spatially referenced land-related data *(Mulaku, 2001).* Its multifunctional capability makes it a powerful tool.

4.1 GIS in Natural Resource Management

GIS is a vital tool in natural resources management. The various aspects of resource management it supports include storage and retrieval of data, interpretation and analysis of the resource data, and development of the Resource Management Plans (RMP's). Resource use alternatives are formulated, and the GIS is used to evaluate each in terms of environmental impact, economic implications, acreage, and potential use conflict. One important function of GIS is to assist in recognising underlying patterns in data. These patterns may be areas of forestland suitable for timber harvest or potential shifts in population distribution. GIS simulations can be used to understand the direct and indirect effects of human activities over long periods of time and over large areas.

By using the database integration capabilities of GIS, Planners and Resource Managers gain a better understanding of the complex interrelationship between physical, biological, cultural, economical, and demographic considerations around a specific resource. Access to this information and its understanding makes it essential in making sound resource-use decisions. This ensures balanced management and use of the resources.

GIS is increasingly replacing the traditional methods because it is faster, cost efficient and accurate. GIS analyses are hence becoming routine in a significant number of field offices.

4.2 Examples of GIS Application in Natural Resource Management

GIS applications are diverse and include water quality monitoring, modeling narcotic crop sites, waste site assessment, analysing effects of carbon dioxide etc.

Some analyses relative to forest are overlaying forested areas and logging areas to see what percentage of forest area is in danger of degradation. Adding data on protected areas or biodiversity hot spots allows one to see how these areas fit in the picture. Egregious problems, such as protected areas being included in logging concessions can also be detected.

One notable example is the detection of illegal oil and gas drainage from public lands by wells on private lands. GIS reduces the process of drainage detection from several days done manually to a few hours *(Onsrud and Cook, 1990).*

5. REMOTE SENSING

Remote Sensing is the science and art of obtaining information about an object, area, or phenomenon. This is done through the analysis of data acquired by a device that is not in contact with the object, area, or phenomenon under investigation. Remote sensing now includes photography, radar, lasers, and sonar and thus provides information with unique and valuable characteristics.

When remote sensing was first envisaged and activated in the 1960's it was viewed as the science of obtaining the image of an object in space. The image had a number of uses that were primarily concerned with identification, area estimation etc. The number of usable images was limited by technical processing limitations, resolutions problem and cloud cover.

5.1 Remote Sensing in Natural Resource Management

Remote sensing provides an opportunity to view or analyse natural resources in inaccessible areas. It can be generated in accurate unbiased form; acquired at minimal costs at a known point in real-time; geographically referenced; prepared in useful and storable format; and produced in volumes never attainable before.

Aerial photography has been used for a long time by resource managers to assess the direction and magnitude of changes in important natural resource parameters. Simple aerial photographic techniques have been used to establish baselines for comparative environmental analysis, develop an awareness of subtle long term environmental effects, identify indicators of environmental change, and provide a new source of data for environmental planning and management.

5.2 Exaples of Applications of Remote Sensing in Natural Resource Management

There are many uses of remote sensing in natural resource management; one ambitious scheme is the monitoring of food production on essentially a global basis *(Johannsen, Sanders, 1982).*

Meaden and Kapetsky, 1991, note that from the perspective of aquaculture and inland fisheries, remote sensing is especially significant in optimising fish production. This is done in a variety of locations many of which are in areas which are remote or poorly mapped, and for which the real time digitised data emanating from remote sensing sensors will prove absolutely invaluable.

Remote sensing information, collected through RADARSAT data, contributes to the mapping and monitoring of surface water resources in Canada.

Remote sensing has many useful applications in agriculture. It is used to assess crop type classification, crop condition assessment, and crop yield estimation and to map soil characteristics and soil management practices. Radar data collected by satellite are also useful to monitor drought or flooding events that can severely impact crop productivity.

This information is valuable to decision makers and analysts within government agencies, grain marketing bodies, agricultural retailers, and insurance companies.

6. INTEGRATION OF GIS AND REMOTE SENSING

GIS and Remote Sensing have a degree of mutuality; GIS provides a means for increasing the utility of remote sensed data. New information can be regularly updated. GIS makes it possible to improve the interpretation and analysis of remote sensed images. This is achieved by combining reference data from special sources. A GIS, integrated with image processing capabilities is a powerful tool for computer assisted resource mapping.

Today, it's probably more accurate to describe the remote sensor data as "ancillary" since the GIS can contain a great many data layers, only one or a few of which are derived from remote sensing. Remote sensing is able to capture a wide range of images through the use of more varied sensors and increase effectiveness in data extraction. This has enabled the two disciplines to complement each other, broadening their raison d'être *(Meaden and Kapetsky, 1991).*

7. CONCLUSION

Even though obstacles remain to their full deployment, Geomatics technologies now being developed and demonstrated suggest natural resource applications that were not believed possible using traditional techniques. As we progress towards the long talked about notion of integrated natural resources management, some parallel continuums along which the technology manifests are:

- The technology helps create integrated views of databases that span the levels of map scale, detail and use. This helps in understanding the earth's ecology.
- The technology meets the need for information presentation tools, as the pendulum swings towards community place based management.
- The emergence of shared data infrastructure and accelerated information delivery, e.g. Internet data ordering.
- Significant advances in data acquisition technology.
- Rapid improvement in data storage, retrieval and analysis.

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BIOGRAPHICAL NOTES

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