POLITICAL ASPECTS OF GEOGRAPHICAL INFORMATION TECHNOLOGIES WITH EXAMPLES FROM IMPERIAL AND POST-INDEPENDENCE INDIA

by

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Abstract

Increasingly, digital geographical information technologies such as remote sensing and geographical information systems are being employed around the world to assist in resource management and sustainable development initiatives. It is often argued that better information will lead to better decisions. Until recently, however, relatively little attention has been paid to the political aspects of these technologies. The goal of this research is to examine some of the political dimensions of digital geographical information technologies in order to allow better assessment of their increasing use. Although the conclusions and recommendations are applicable to many regions of the world where these technologies are being introduced, this research derives most of its examples from India.

Since at least the early days of British imperialism, decisions regarding land use in India have been informed by various types of information, including cartographic ones. In this thesis it is argued that this information was neither neutral nor objective but rather formed political and ideological statements concerning social relations with the landscape. These statements were reflected both in the nature of the data which were collected and in the ways in which these data were presented. By examining the historical evolution of geographical information technologies in British India and attendant social and environmental impacts, the stage is set for critical speculation on the possible impacts resulting from the introduction of digital geographical information technologies such as remote sensing and geographical information systems.

This research draws heavily from the work of historian of cartography Brian Harley. Harley was interested in examining the social and political aspects of maps and cartography and his work was influenced by Michel Foucault and Jacques Derrida, among others. Harley's work is extended to include consideration of the ways in which human-environment relationships are reflected and altered by geographic information

technologies. This discussion of possible political and environment implications is influenced by recent literature in the areas of political ecology and the history of cartography.

It is concluded that although there are many obstacles including unequal access to the technology, unequal access to information, and issues of control over information creation, which may reinforce and intensify existing social and political inequities, there is cause for some cautious optimism about the potential beneficial outcomes of the use of these technologies. In certain circumstances, digital geographical information technologies have the potential to place more control of the cartographic process in the hands of localized agencies. By focusing upon the issue of control over geographical information creation, some of the decentralizing tendencies in the use of increasingly affordable geographical information technologies may be realized. It is argued, though, that locally beneficial results will only be achieved if these technologies can be used in a participatory decision-making environment.

Recommendations arising from this research include the following.

- GIS and remote sensing practitioners need to become more critically engaged.
- International development agencies need to be cognizant of the political aspects of geographical information technologies when setting policy and managing development projects.
- Curricula should be developed to foster critical engagement by practitioners.
- Practitioners should be encouraged to assume more activist roles.
- The appropriateness of geographical information technologies in specific contexts must always be considered.
- Low cost, yet effective, software and hardware that can be locally supported need to be developed.

There are many challenges and opportunities which arise from this work. The beneficial (however defined) use of geographical information technologies will require close attention to the issues raised here.

Acknowledgments

Looking back over a few years of research, I find that there are a large number of people who have assisted me in various ways and are deserving of recognition. First, there is my thesis committee: Bruce Mitchell (advisor), Douglas J. Dudycha (advisor), B. Hyma, Norman Ball, and Matthew Edney (University of Southern Maine); in the Faculty of Environmental Studies, University of Waterloo: Lynn Finch, Drew Knight, Geoff Wall, Philip J. Howarth, Gordon Nelson, Barry Warner; in Mapping, Analysis and Design, Faculty of Environmental Studies, University of Waterloo: Marko Dumancic, Lynne Elliot, Joe Piwowar, Mary Ruehlicke; in the Department of Geography, University of Madras: A. Ramesh, S. Subbiah, N. Sivagnanum, T. Vasantha Kumaran, A. Rajmohan, K. Rajendran; in the Department of Computer Science, University of Madras: K. Sundaram, S. Kuppuraj; of the Madras-Waterloo Linkage Project: Andrew Barker, Martin Bunch, David Wood; at the India Office Library and Records, British Library: Andrew Cook. On a more personal level, deep appreciation is expressed to my parents, Ann and David Dudley. Special thanks are reserved for my friend and colleague, Jeanne Maurer. Finally, a large measure of gratitude is reserved for my wife and dear friend, Judy Walker.

Sincere apologies to anyone I have inadvertently omitted.

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For Judy

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Now when I was a little chap I had a passion for maps. I would look for hours at South America, or Africa, or Australia, and lose myself in all the glories of exploration. At the time there were many blank spaces on the earth, and when I saw one that looked particularly inviting on a map (but they all look that) I would put my finger on it and say, 'When I grow up I will go there.'

Joseph Conrad, *Heart of Darkness* (1902)

The attitude one ought to adopt in coming to a land full of novel conditions is that of a learner, and not of the advisor or critic; it is only when one has learnt something of the peculiar surroundings of his subject that he should attempt to suggest anything, and this he will, if wise, do very cautiously, feeling how very much there is for him still to learn, how much that he will never be able to learn.

J. A. Voelcker, Report on the Improvement of Indian Agriculture (1893, p. 12)

But nothing in India is identifiable, the mere asking of a question causes it to disappear or to merge in something else.

E. M. Forster, *Passage to India* (Chapter VIII)

And what is an isobar? An isobar is an imaginary line connecting places of equal pressure on a map. All lines on a map, we must acknowledge, are imaginary; they are ideas of order imposed on the sloshing flood of time and space. Lines on a map are talismanic and represent the magical thinking of quantitative and rational people.

Janet Turner Hospital, *Isobars* (1991, p. 33).

It's up to you, who are directly involved with what goes on in geography, faced with all the conflicts of power which traverse it, to confront them and construct the instruments which will enable you to fight on that terrain.

Michel Foucault, Questions on Geography (1980, p. 65)

CHAPTER ONE - INTRODUCTION

From a very early age, I have been fascinated by maps and it is this fascination which has led to my choice of academic pursuits. Throughout my academic studies within the discipline of geography, specifically human geography, I have continually found myself exploring the use and nature of maps and other forms of geographical representations, particularly those embodied by digital information technologies such as geographical information systems and satellite remote sensing.

The research described in this thesis commenced in the fall of 1991. At that time I was presented with an opportunity to become involved with Madras-Waterloo Linkage Programme, a multi-year collaborative project funded mainly by the Canadian International Development Agency, along with the University of Waterloo and the University of Madras, India. This project involved a variety of collaborative research efforts, as well as the establishment of a geographical information systems and remote sensing laboratory at the University of Madras. It also provided opportunities for a number of graduate students (Masters & Ph.D.) to pursue research topics. Because of my interest in the application of geographical information system and remote sensing technologies, particularly in the ways in which these technologies can benefit local populations, I became involved in the project.

The first field visit to south India was in January 1993 and was based primarily in the Department of Geography, University of Madras. The initial research proposal around which this field visit was structured was entitled "An Examination of Rural Landscape Change in Southern India Using Geographical Information Systems and Remote Sensing". A key concept that was to be investigated was the notion of wastelands, a land classification category that has a long history in India. At that point, I had never visited a "developing" country and, thus, everything I knew about the region was primarily from reviewing academic literature.

It was during this trip that I came to realize my initial proposal was quite inadequate. If I had to identify the key moment that was responsible for me essentially abandoning the proposal, it would be during a visit to the home village of one of the University of Madras professors. We had gone on a walk beyond the village (which was located within a possible study area). We stopped to observe a farmer at work and to chat with him. He was working on his fields and the irrigation micro-engineering he was demonstrating was so impressive that I quickly came to the conclusion that there was nothing I would be able to tell someone like this about the condition of the landscape, no matter how long my field visit might be.

At the University of Madras, I also came to realize that accessibility to even basic cartographic information would be even more problematic than I had originally envisioned. Most of the work on measuring landscape change (*e.g.*, from the landscape ecology and the remote sensing literature) emphasized the need for good quality information and data, both historical and contemporary. I was finding it difficult to even obtain up-to-date topographic maps for potential study areas. Either the information did not exist, or if it did it was not accessible, or if it was accessible it was of such poor quality that it might as well not have existed.

After three months in India, I returned to the University of Waterloo and set about to reassess the research approach. At that time, I had been reading in a number of theme areas. These included the work of Piers Blaikie and Harold Brookfield, in particular *Land Degradation and Society* (Blaikie and Brookfield 1987), that had in some ways informed the original proposal. Their work emphasized the need to consider the political aspects of land degradation, development, and underdevelopment. Similarly important had been the work of Indian ecologist Vandana Shiva, especially her book *Staying Alive: Women, Ecology, and Development* (Shiva 1989). In this book, Shiva presented a compelling argument that the current state of land degradation (*i.e.*, wastelands) had its roots in British imperial practices, and these practices were being perpetuated by the current government and corporate sectors. This led me to additional reading on British imperialism as it related to India. One author of particular influence was Edward Said. Said's *Orientalism* (Said 1978) struck me as having a remarkable geographical sensibility (this is even more evident in his later book, *Culture and Imperialism* (Said 1993)). Said argued that there was a whole cultural apparatus established through the colonial/imperial period through which something called the "Orient" was defined, viewed, and subjugated.

It was viewed as something different than the "Occident". Once these labels were applied, a particular way of acting was invoked. This involved literature, painting, music, anthropological studies. It was becoming clear to me that cartography had had a role to play in this, particularly with respect to India.

I recall reading Brian Harley's articles "Maps, Knowledge and Power" (Harley 1988b), "Deconstructing the Map" (1989), and "Cartography, Ethics and Social Theory" (1990) and realizing, as I was reading them, that my entire perspective on the nature of maps and mapping was changing. Harley was most influenced by iconology, rooted primarily in art history (Erwin Panofsky), deconstructionism (particularly the work of Jacques Derrida), and the sociology of knowledge (mainly the work of Michel Foucault). Harley challenged cartographers, geographers, and anyone else who made or used maps, to consider the social and political aspects of their production, the power relationships involved, the "silences" of the maps, and their role in imperial expansion. For my purposes, it is the aspects that Harley derived from Foucault that were most compelling. Foucault was saying new things about the nature of knowledge and its relationship to power. As well, additional work was being carried out in the history of cartography that drew upon Harley's ideas.

Finally, I was also reading more about the interaction between society and technology. Ursula Franklin, as part of her 1989 Massey Lecture entitled *The Real World of Technology*, viewed technology as a system involving "organization, procedures, symbols, new words, equations, and, most of all, a mindset" (Franklin 1990, p. 12). Technology is not simply the sum of the artifacts. I was becoming more and more concerned about the relationship between society and technology because of my role in introducing digital geographical information technologies (the establishment of the GIS / remote sensing laboratory at the University of Madras) into a developing country. Langdon Winner's book *The Whale and the Reactor* (Winner 1986) was probably most influential. According to Langdon Winner (1986, p. 19),

> No idea is more provocative in controversies about technology and society than the notion that technical things have political qualities. At issue is the claim that the machines, structures, and systems of modern material culture can be accurately judged not only for their contributions to efficiency and productivity and their positive and negative environmental

> side effects, but also for the ways in which they can embody specific forms of power and authority.

This is not simply the notion that the social or economic context of technology must be considered, nor is it a form of naive technological determinism (*e.g.*, maps *cause* environmental degradation or social injustice). Instead, of concern are what Winner (p. 22) calls *inherently political technologies* which are human-made systems that appear to require or to be strongly compatible with particular kinds of political relationships. The question of whether maps and other geographical information technologies can be characterized in such a way became an important consideration in this research. The phrase geographical information technologies, which will be used throughout this thesis, includes what Harley and Woodward (eds., 1987, p. *xvi*) defined as maps, namely "graphic representations that facilitate spatial understanding of things, concepts, conditions, processes, or events in the human world." It also embodies the methods and tools, whether analog or digital, for collecting, manipulating, storing, analyzing, and disseminating these graphic representations, as well as non-graphic representations, such as geographically referenced digital databases.

This, and other literature, led to a substantial reshaping of the research. Rather than discard the original proposal completely, it was reformulated to investigate a specific mapping programme, namely the then recently completed National Wastelands Mapping Programme (which Shiva had criticized in *Staying Alive*), including some of the historical aspects to which she had drawn attention. With this new approach, I then returned to India in January, 1994 with an initial two week stop in London to spend time at the British Library's India Office Collections, and another two weeks at the Asian Institute of Technology, Bangkok. In London, I was truly encouraged by the amount of information which was available, and by the assistance of Dr. Andrew Cook, Map Archivist at the India Office Library. If only I could obtain a similar amount of quality information while in India, I would be well on my way.

I certainly had the opportunity to meet with many members of the mapping and remote sensing community while in India, particularly in connection with the geographical information system / remote sensing laboratory at University of Madras. However, even with these various contacts, some of whom were quite high up in the Indian government, obtaining reliable information was a difficult, at times very frustrating, task. In short, the main conclusion which came out of the second field season was that it was far easier to obtain cartographic information about India from outside the country. However, it was clear that geographical information was viewed as a valuable commodity within the country, and that digital geographical information technologies such as remote sensing and geographical information systems were going to have greater and greater roles in a wide range of planning and development efforts.

This resulted in yet another reconsideration of the research. Rather than focus upon a specific programme, such as the National Wastelands Mapping Programme (about which I felt I didn't have enough information or background to carry out a lengthy critique), I would instead consider more generally the political nature of geographical information, as exemplified in the south Asian context, with emphasis upon its role in human-environment relationships and how digital geographical information technologies might have different inherent political biases from non-digital ones. The results of this research are presented here.

Because of the way in which this research has evolved, the questions asked and the conclusions drawn are most relevant to geographers, GIS and remote sensing practitioners, those involved in international development work, and those who work with non-governmental organizations operating in developing countries. In other words, it is most relevant to those individuals with similar interests to my own. This thesis has been written with this audience in mind.

The remainder of the dissertation is organized as follows. First, the methodological approach to the thesis is discussed in Chapter Two. Drawing upon recent work in the history of cartography, most notably that of Brian Harley, Chapter Three outlines a critical perspective of geographical information technologies. Harley was influenced by the work of scholars such as Jacques Derrida and Michel Foucault in examining the underlying power of maps and their role as political tools.

Historically, the use of various geographical information technologies was instrumental in the "success" of imperialism and it is argued that in many parts of the world, including India, imperialism induced substantial changes in both physical and social landscapes. Using Harley's work as a starting point, historical examples of the introduction of geographical information technologies, particularly topographic and trigonometric surveying and mapping, are presented in Chapter Four. This discussion examines the status of pre-imperial geographical information in India and some consequences of the imperial application of new geographical information technologies.

While influential in shaping current discussions about the social and political aspects of cartography, Harley's work does not explicitly address the role of cartography in shaping human-environment relations. As a means by which to extend Harley's approach, in Chapter Five recent work from the area of political ecology is introduced and shown to be complementary to Harley's own work are discussed. As well, political implications of the use of digital geographical information technologies are considered. The perspective introduced earlier in the thesis is extended to consider more recent developments in geographical information technologies and their potential impact on both social and human-environment relations. It is argued that, in many ways, contemporary land information practices in India continue to demonstrate their imperial legacy, although the introduction of digital technologies has given rise to some additional considerations. Finally, Chapter Six provides a summary, conclusions, recommendations and implications of the research.

CHAPTER TWO - METHODOLOGICAL APPROACH

The broad question which this thesis seeks to answer is what are the impacts of the introduction of new geographic information technologies? The methodology employed for this research is interpretive, as opposed to scientific or experimental, in nature. The methodological process for the thesis is as follows:

- Outline critical perspective based upon recent work from the history of cartography.
- Examine historical examples of topographic and trigonometric surveying and mapping.
- Reassess critical perspective to account for human-environment relations and for recent developments in digital geographical information technologies.
- Examine wasteland surveying and mapping in imperial and post-independence India.
- Discuss prospects for the use of digital geographical information technologies for sustainable development.

That the introduction of a new technology for information handling, or the modification of an existing one, can have substantial impacts upon the organization of a society is not a new idea. For example, in *Empire and Communications*, Harold Innis (1950, p. 7) described the significance of different types of communication media. Innis argued that the effective governance of large areas depends to a very important extent on the efficiency of communication. This can be examined by distinguishing between media which emphasize time and those which emphasize space. Long lasting, durable media like stone, clay, and parchment would be examples of the former, whereas more easily transportable media like papyrus and paper are examples of the latter. Media which emphasize time are more suitable for decentralized and hierarchical types of administration and those which emphasize space are more suitable for centralized, non-hierarchical forms of governance. Innis provided an example whereby the introduction of media emphasizing space displaced those emphasizing time giving rise to a large administrative empire. The conquest of Egypt by the Roman Empire was particularly important to the expansion of the Empire because of the new access provided to large quantities of papyrus, formerly unavailable to the Romans. The adoption of papyrus, more easily transportable and reproducible than media such as stone, clay or parchment, allowed for the extension of administrative power of the Roman Empire across a greater expanse of space.

These ideas can be extended to more recent history with respect to communication through electronic or digital media (Gillespie and Robins 1989). These media are ones with great emphasis upon space, by which communication can take place virtually instantaneously over vast expanses of distance. The introduction of electronic communication (*e.g.*, telegraph, telephone, satellite transmission) has profoundly altered the way in which governance and administration can take place (see, for example, Headrick 1988; Gandy 1989; Poster 1990; Lyon 1993).

In a similar vein, sociologist Anthony Giddens offers the following perspective on the relationship between the state and information resources. Giddens distinguishes between *allocative resources*, which are those involved in the dominion of human beings over the material world, and *authoritative resources* which are involved in dominion over the social world itself (1981, p. 4). In Giddens' theory of structuration, power is regarded as generated in and through the reproduction of structures of domination (1981, p. 4). The storage capacity of the state is fundamental in the generation of power through the extension of time-space distanciation (*i.e.*, the way in which social systems are embedded in time and space) (1981, pp. 4-5), and the storage of authoritative resources forms the basis of the *surveillance* activities of the state, always an undergirding medium of state power (1981, p. 5). Surveillance, as Giddens defines it, involves two connected phenomena: the accumulation of information (*i.e.*, symbolic materials) relevant to state control of the conduct of its subject population or subordinates, and the direct supervision of that conduct by supervisors within any collectivity (1981, p. 5, 169). Giddens (1985, p. 5) views heightened surveillance by the state as one of the key factors associated with modernity and the rise of the nation-state[1] and, indeed, the administrative power generated by the nation-state could not exist without the information base that is the means of its reflexive self-regulation (1985, p. 180).

[1] The other three factors or "institutional clusterings" being capitalistic enterprise, industrial production, and the consolidation of centralized control of the means of violence (Giddens 1985, p. 5).

What is relatively new in this research is the explicit consideration of the role of geographical information technologies both as allocative resources, and, more importantly, as authoritative resources. This will be done primarily through an examination of how developments in these technologies can have substantial effects on the organization of societies, and upon human-environment relations. As a means to approach such issues, the research seeks to adopt a critical perspective from which the possible impacts of the introduction of geographical information technologies can be assessed.

What is meant by "a critical perspective"? Such a perspective will draw upon recent work in critical social theory and poststructuralism, at least as reinterpreted by geographers, cartographers, and historians of cartography (see, for example, Gregory 1994; Delano Smith 1996; Edney 1996; Jacob 1996). This perspective, which works from the premise that geographical knowledge is socially constructed in nature, largely rejects the empiricist claims of positivism, claims which are largely still adhered to by most contemporary GIS and remote sensing practitioners (Taylor and Johnston 1995, p. 56). However, the intention in this thesis is not one of simply abstract speculation. As a result of this investigation, I still want to be able to suggest actions which might be undertaken. As such, this perspective will emphasize the *political* aspects of geographical information technologies.

In this thesis, the term *political* refers to the "authoritative allocation of values", distinct from any formal structure of government (Caporaso and Levine 1992, p. 16)[1]. By emphasizing *authority*, the term political describes a distinctive way of making decisions about producing and distributing resources (as opposed to economics, which emphasizes voluntary exchange). In this research it will be argued that geographical information collected and controlled by the state or other authority often forms a primary means by which control over the access to and the utilization of particular land resources and territory is established and maintained. This is in addition to, or in place of, the threat of military or other forceful response. The political power inherent in this information is

[1] Caporaso and Levine (1992) also examine the conceptualization of politics relating to anything which is in the public sphere (p. 11), but this use of the term is not employed in this research.

considerable. Understanding how the introduction of new geographical information technologies might alter political relationships within a society is essential to gaining an understanding of how a state or other authority functions with respect to land resources and to the populace that has a vested interest in these resources.

In order to demonstrate concretely the shifts in political power that can accompany the introduction of new geographical information technologies, this research will draw upon examples relating to India from the late 1700s to the present. Specific reference will be made to the use of surveying and mapping technologies in imperial and post-independence India. There are a number of justifications for the selection of this geographic context. First, as will be discussed more fully in Chapter Four, the introduction and use of surveying and mapping, essentially European technologies which had minimal cultural precedent in south Asia, played a significant role in the domination of India by imperial powers. Bryant (1992, p. 23) notes that an appreciation of the historical dimensions of conflict over access to land resources is essential to an understanding of contemporary struggles. When the historical context of India is considered, arguably the most significant factor that has shaped the landscape and one whose effects continue to be evident to the present day was the period of European, especially British, imperial expansion, particularly from the late eighteenth century until the mid-twentieth century (Crosby 1986; Tucker 1988; Guha and Gadgil 1989; Shiva 1989; Gadgil and Guha 1992). Second, because of intense population pressures on the natural environment in contemporary India, the introduction of better geographic information handling capabilities is often promoted as an important component in any sustainable development strategy. However, in promoting such technologically-based approaches, the underlying assumptions and political biases of information technologies are rarely considered. These inherent assumptions and biases may, in fact, be incompatible with many objectives of sustainable development and may be influenced strongly by the imperial legacy of the land information technologies that have preceded them.

The time period examined by the thesis can be roughly divided into two parts: historical (late 1700's to roughly 1947) and contemporary (post-1947 but with emphasis upon the 1980's and 1990's). The decision to split the account in this manner is based upon a number of both conceptual and practical considerations. First, 1947, the year of Indian independence, represents a major watershed in the history of India with the change from imperial rule to nationhood. One can speculate that the objectives of geographical information programmes of an independent government should be different than those of an imperial administration[1]. Therefore, it makes sense to divide the account into two distinct time periods. Yet, in the thesis, the attention provided to the immediate post-Independence period is fairly limited. This is because the focus of the research is on the impact of the *introduction* of *new* geographical information technologies. Broadly speaking, the mapping technologies in place in the years immediately following Independence were essentially the same as those which had been introduced near the beginning of the twentieth century (or earlier, in some instances). It is only with the recent introduction of digital technologies that a fundamental change in way of doing surveying and mapping has taken place, a change analogous to Thomas Kuhn's (1970) concept of a paradigm shift or Foucault's concept of a discourse (see Chapter Three; Phillip 1985, pp. 68 - 69)[2].

The source material for analysis of the historical period was obtained largely from published accounts found in North American university libraries and archival material reviewed in January, 1994 at the India Office Records and Library, British Library, London. As administrators, the British kept substantial records and accounts of their activities, and the historical literature on the British period in India is considerable. Much of this information is readily accessible, either in London, in North America, or in widely distributed published form. The most important of these works are the four volume (1945 - 1968) *Historical Records of the Survey of India* by R. H. Phillimore, the 1878 *A Memoir on the Indian Surveys* by Clements Markham (chief of the Geographical Department of the India Office), C. E. D. Black's 1891 *A Memoir on the Indian Surveys, 1875-1890*, the *Report of the Indian Survey Committee, 1904 - 1905*, and various annual reports from the Survey of India.

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[1] This is not meant to suggest that surveying, cartography, and imperial policy were static throughout the imperial period.
[2] See Rabinow (1984, p. 26) for a discussion on the parallels between Foucault's and Kuhn's work.

For the contemporary period, much of the technology is still in its infancy, and it is often not yet possible to obtain a clear understanding of the impacts. The question of impacts will be addressed with more emphasis upon the characteristics of the technologies, rather than their application, although where possible, contemporary applications will be discussed. The availability of material for the contemporary period differs somewhat from the historical period in India. Often, many restrictions exist on contemporary information accessibility and the manner of record keeping is often inaccurate and incomplete. For the contemporary period, some of the material was obtained from published sources. In addition, a series of interviews and discussions were conducted with individuals involved in the implementation of geographical information technologies (see Appendix I for a list of individuals consulted). Attendance at a two-day national workshop on Application of Remote Sensing and GIS in Decentralised Planning, Decision Making and Monitoring (February 22-23, 1993) at the National Remote Sensing Agency facilities, Hyderabad, India, also provided an opportunity to meet and talk with both practitioners and users of digital geographical information technologies in India. Finally, the author was involved personally in a project to institute a GIS / Remote Sensing Laboratory at the Department of Geography, University of Madras and was able to come to appreciate some of the issues which arise when trying to implement these technologies in a developing country.

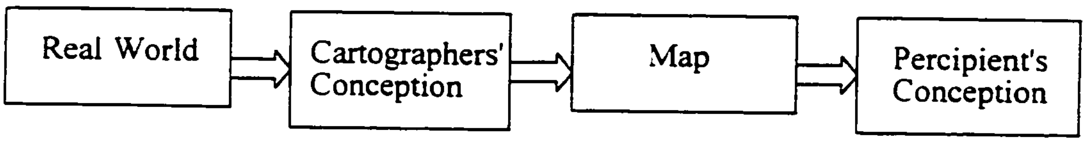
At this point, some limitations concerning the research should be identified. First, as with all research projects, limited time and limited funding pose constraints. This means that the amount of time that could be spent in London, in India, and in North America at various libraries was less than would have been preferred, and that the number and types of people who could be identified, contacted, and interviewed were limited. Second, library and archival resources in India are often poorly maintained and rather disorganized which prevents easy access to useful material. Sometimes there are also restrictions on access to certain collections. Third, with regard to the examination of historical accounts of the introduction of geographical information technologies, the source material for the late eighteenth and early nineteenth centuries is generally more complete than for the late nineteenth and early twentieth centuries. The reason for this is that during the earlier period, it was required that administrative records be sent to the East India Company offices in London. As administrative responsibilities shifted to India in the latter half of the nineteenth century, there was often less need for records to be forwarded to London. Subsequently, many of these records have either been lost or destroyed due to factors such as poor maintenance or climatic conditions, or are much less accessible than records maintained in London or elsewhere outside India. Fourth, in post-Independence India, maps and other forms of geographical information are often regarded as militarily sensitive material and access for foreign civilians is either quite difficult or not allowed at all. It was this limitation which initially prompted this study into the *political* aspects of geographical information. Finally, documentary sources are limited to English language material (either originally written in English or translated from another language). This is not as serious a limitation as might be the case in some other countries because the primary language of administration in India is still English. However, there is likely some relevant material that could not be identified and examined due to this limitation[1].

It is believed, however, that these limitations do not substantially detract from the main goal of the research which is to assess political aspects of the introduction of geographical information technologies. Although it would be desirable to have obtained much more detailed information regarding contemporary geographical information technology practices in India, the difficulties faced in acquiring such information lend support to the need to examine the issues of authority which accompany the introduction and use of these technologies. Development of a critical perspective concerning these technologies will hopefully provide a means by which others may be able to assess the impacts of these technologies.

[1] Further considerations relating to ethnocentrism and related issues of "Westerners" doing research in "Third World" contexts are discussed by McGee (1991) and Sidaway (1992).

CHAPTER THREE - CRITICAL PERSPECTIVES ON GEOGRAPHICAL INFORMATION TECHNOLOGIES

Through the 1970s and 1980s, a dominant conceptual model of the mapping process was one derived from research in electrical engineering and based upon communication theory (Guelke, ed. 1977; Board 1981, ed. 1984). This cartographic communication model focused upon the processes by which map information was encoded and ordered by the mapmaker, transmitted, received, and finally decoded by the map user (Figure 1). The model diverted attention away from data gathering and mapmaking activities and focused upon the transmission process, thereby downplaying issues of data accuracy and precision and of representation (Pickles 1992; Woodward 1992, p. 52). By diverting attention away from the mapmaking process, this model is inadequate for handling the political dimensions of geographical information. Consequently, questions of authority, representation, and power cannot be readily addressed.



Source: Robinson and Petchenik 1977, p. 99

Figure 1. A Diagram of the Cartographic Communication System with Emphasis Upon the Conceptual Aspects

To gain an understanding of how maps, and by extension other types of geographical information technologies, facilitate political power, the work of cartographic historian J. Brian Harley is important, in particular, research conducted toward the final years of his life[1]. The basis for Harley's work on the political aspects of cartography, which is the aspect of his research most relevant to the present discussion, can be found in three main papers: "Maps, Knowledge, and Power" (1988b), "Deconstructing the Map" (1989), and "Cartography, Ethics and Social Theory" (1990). Harley wished to read maps as 'texts' - as socially constructed forms of knowledge (1988b, p. 277). His stated aims were "to

[1] J. Brian Harley died in December 1991.

explore the discourse of maps in the context of political power" (1988b. p. 278). "to search for the social forces that have structured cartography and to locate the presence of power - and its effects - in all map knowledge" (1989. p. 2). and "to contribute to a theoretical framework within which a social history of cartography as a set of practices might be written" (1990. p. 1). To achieve these aims. Harley drew on a number of perspectives. These included, initially, iconology and the meaning of signs following the work of art historian Erwin Panofsky, and later deconstruction after the French literary critic Jacques Derrida and the work of French philosopher Michel Foucault into the sociology of knowledge.

In "Maps, Knowledge, and Power", Harley (1988b, p. 279) looked at cartography from the point of view of Erwin Panofsky's (1939) formulation of iconography in which the "deeper" symbolic meaning of maps can be explored. According to Panofsky (p. 3), iconography is the branch of the history of art concerned with the subject matter of works of art as opposed to their form. Iconographic study seeks to understand the meaning in a work of art by setting it in its historical context and analysing the ideas implicated in its imagery (Cosgrove and Daniels 1988, p. 2). Panofsky distinguished between a narrow form of iconography which involves the identification of conventional representational symbolism within art (*e.g.*, a lamb signifying Christ), and a deeper, interpretive version which he labeled *iconology*. Iconology,

> ... excavated what Panofsky called the 'intrinsic meaning' of a work of art 'by ascertaining those underlying principles which reveal the basic attitude of nation, a period, a class, a religious or philosophical persuasion - unconsciously qualified by one personality and condensed into one work'. (Cosgrove and Daniels 1988, p. 2)

Harley argued for the application of iconology to the study of cartographic materials.

> For maps, iconology can be used to identify not only a 'surface' or literal level of meaning but also a 'deeper' level, usually associated with the symbolic dimension in the act of sending or receiving a message. A map can carry in its image such symbolism as may be associated with the particular area, geographical feature, city, or place which it represents. It is often on this symbolic level that political power is most effectively reproduced, communicated, and experienced through maps. (Harley 1988b, p. 279)

Commenting further on maps as images, Harley (1988b, p. 278) stated that,

> Maps are never value-free images; except in the narrowest Euclidean sense they are not in themselves either true or false. Both in the selectivity of their content and in their signs and styles of representation maps are a way of conceiving, articulating, and structuring the human world which is biased towards, promoted by, and exerts influence upon particular sets of social relations. By accepting such premises it becomes easier to see how appropriate they are to manipulation by the powerful in society.

The distinctions of class and power are engineered, reified and legitimated in the map by means of cartographic signs (1989, p. 7). Harley (1988b, p. 282) also suggested that it was the graphic nature of the map that gave its imperial users an arbitrary power, a form of power that could be easily divorced from its social responsibilities and its exercise. Gilmartin (1984, p. 40) claimed that iconology is a well-established method of analysis in art history which can be applied in the field of cartography. She demonstrated its applicability in an analysis of sixteenth century cartographic representation of the southern hemisphere and concludes that it can allow for a greater understanding of the relationship between maps and society than the cartographic communication model.

Starting with "Deconstructing the Map" and continuing with "Cartography, Ethics and Social Theory", Harley started to move away from iconology and came to view maps as a kind of language or literature (*i.e.*, as texts). As he suggested in "Maps, Knowledge, and Power", by treating cartography as a literature, questions concerning the readership of maps, carto-literacy, conditions of authorship, aspects of secrecy and censorship, and political statements made by maps can be asked (1988b, p. 278), and the tools of literary criticism can be employed. In this task, Harley was most influenced by French literary critic Jacques Derrida whose concept of deconstructionism provides a means by which to analyse the underlying bases of knowledge as presented in texts and other representational forms (*e.g.*, visual art, architecture, cartography). By accepting that a map can be treated as a text, the underlying bases of the knowledge presented by the map can be examined by deconstruction. This can allow us to "read between the lines of the map" (Harley 1990, p. 3) and uncover the political assumptions of cartographic "facts". This demands a closer and deeper reading of the cartographic text than has been the general practice in either cartography or the history of cartography (Harley 1989, p. 8). Such a reading has also been suggested by Pickles (1992).

Belyea (1992) has argued that Harley's reading of deconstructionism was in some instances mistaken and that he did not take deconstructionism to its more radical conclusions (e.g., that maps, as texts, can only refer to other texts and not to some external "reality"). She commented that Harley accepted a fundamentally conservative definition of the map as a representation of reality which another commentator claimed is essentially positivistic in nature (Baldwin 1989). Helgerson (1989, p. 101) offered another perspective on this:

> What interests will be served by the deconstruction of the map? We may hope and even believe that they will be the interests of liberation and equality. But since such happy consequences have been the proclaimed goal - sometimes realized, more often not - of scientific positivism, it seems at least unlikely that positivism's unmasker will have any better success.

However, by asking such questions, by deconstructing Harley's motives, in many ways serves to endorse his conclusions by accepting his methods (Baldwin 1989, p. 90).

The final perspective that Brian Harley adopted is that of the sociology of knowledge, drawing heavily from the work of the French philosopher Michel Foucault[1]. One of Foucault's primary concerns, and the one of interest here, is the historical bases of power relationships. As Philip (1985, p. 67) notes,

> [Foucault's] primary objective is to provide a critique of the way modern societies control and discipline their populations by sanctioning the knowledge-claims and practices of the human sciences: medicine, psychiatry, psychology, criminology, sociology, and so on. The sciences of man [*sic*] have, he argues, subverted the classical order of political rule based on sovereignty and rights, and have instituted a new regime of power exercised through disciplinary mechanisms and the stipulation of norms for human behaviour.

[1] See Harris (1991) for a discussion of Foucault's impact upon the discipline of geography.

Foucault's primary unit of analysis is the discourse which is best understood as a system of possibility for knowledge (Philip 1985, pp. 68-69).

> [Foucault's] method is to ask what rules permit certain statements to be made: what rules order these statements: what rules permit us to identify some statements as true and some as false: what rules allow the construction of a map, model or classificatory system: what rules allow us to identify certain individuals as authors: and what rules are revealed when an object of discourse is modified or transformed .... (Philip 1985, p. 69)

By adopting this approach, substantially different questions arise compared to those that have typically been asked in the study of cartography. Maps are not judged in terms of their accuracy and their comprehensiveness (*i.e.*, the truth of the map), but rather in terms of how they function in particular social and historical contexts (*i.e.*, on what basis is the truth of the map asserted). What rules allow maps to function as they do, and what happens when the nature of mapmaking changes?

Harley (1989, pp. 3-5), following Rouse's (1987) interpretation of Foucault, identified two distinctive sets of rules which have guided Western cartography since the seventeenth century. These are the rules governing the technical production of maps (the "scientific" rules), and the rules governing the cultural production of maps (including considerations of ethnicity, politics, religion, or social class). The latter, Harley argued, have a substantial influence upon the former. For Harley (1989, p. 2), the task was to search for the social forces that structured cartography, and to locate the presence of power - and its effects - in all map knowledge.

On the nature of power and its relation to forms of knowledge, Foucault (1977, p. 27) offers insightful analysis:

> We should admit ... that power produces knowledge (and not simply by encouraging it because it serves power or by applying it because it is useful); that power and knowledge directly imply one another: that there is no power relation without the correlative constitution of a field of knowledge, nor any knowledge that does not presuppose and constitute at the same time power relations.

In other words, notions of power cannot be considered independently of the knowledge that allows power to exist; nor can knowledge be thought of as existing independently of power relations. The nature of this power/knowledge relationship with respect to various types of geographical information will be a primary consideration in this research (see also Harley and Zandvliet 1992).

Also related to the discourses surrounding cartographic information are what Harley (1988a) identified as the *silences of maps*, be they intentional or unintentional. These silences can be contributed by many agents in the mapmaking process, through the stages of data gathering to those of compilation, editing, drafting, printing, and publication (*i.e.*, according to the scientific rules). However, rather than dealing with silences which can be attributed to geographical ignorance or to technical limitations, he focused upon *political* silences (p. 57) (*i.e.*, the cultural rules). In Harley's view, what is absent from maps (their silences) is as much a proper field for inquiry as that which is present (their utterances) (p. 58).

Brian Harley's work has inspired a number of other researchers to look at the social dimensions of mapping and provide critical responses[1]. Wood (1993) argued that Harley confused mapping (an innate cognitive ability in *Homo Sapiens*) with mapmaking (an "unusual function of specifiable social circumstances arising only within certain social structures" (p. 50)). Maps, Wood argued, are systems of signs and for this reason they are able to work in communication situations. A sign is defined as "a transmission, or construct, by which one organism affects the behaviour of another, in a communication situation." (p. 51) In a communication situation,

> The goal, then, is not to send a message, but to bring about a change in another, and it is the situation calling for this change that calls for the map. This situation is necessarily ... social. Evidently it is also ... political. (p. 52, italics original)

Wood argued that Harley did not understand that it was the social situation that called for the map (the map also could change the social situation).

[1] See, for example, Dahl (ed. 1989) for a collection of responses to "Deconstructing the Map".

> The map exists only in its inscription ... [and] it is the inscriptive property of the artifactual map that permits it to serve the interests of the power elites who control the mapmaking process (as well as those who would contest them). (p. 53)

Another criticism comes from Rundstrom (1991). While applauding Harley's effort, Rundstrom is critical of its inability to account for indigenous mapping and of its emphasis on 'text' over process. Rundstrom's conception of a process cartography situates the map artifact within the mapmaking process and places the entire mapmaking process within the context of intracultural and intercultural dialogues (p. 6). Similarly, Edney (1989) argued that all mapmaking activities, not just those of the cartographer or map compiler, require critical assessment. Edney was concerned about how much of the structuring and symbolization of cartographic information is done prior to map compilation, particularly by explorers and surveyors.

The next chapter will provide a discussion of a number of examples of the mapmaking process in imperial India with attention to the communication situation that gave rise to particular maps. The main question that will be asked is what do these map artifacts, and the processes which led to their creation, tell us about the political context in which they were created?

CHAPTER FOUR - GEOGRAPHICAL INFORMATION TECHNOLOGIES IN BRITISH INDIA: AN HISTORICAL PERSPECTIVE

In the previous chapter, issues concerning the political nature of geographical information, derived mainly from recent research in the history of cartography, were introduced. In this chapter, using the ideas discussed above, some historical aspects of the use of geographical information technologies in imperial India are identified. First, the state of pre-imperial geographical information is examined, with particular reference to the social, cultural, and political bases of this information. This brief discussion is followed by a more extensive exploration of British topographic and trigonometric surveys and the role which they played in establishing and maintaining imperial control over India. In doing so, this chapter establishes the historic context of geographical information technologies and their role in expanding British interests in India.

Pre-Imperial Cartographic Activities

It is difficult to assess, with any degree of certainty, the exact status of Indian geographic knowledge prior to European contact. The English-language research material on pre-European south Asian geographical information is relatively sparse. Until Volume Two, Book One of the *History of Cartography* (Harley and Woodward 1992a), non-Western cartography had been rather neglected in the history of cartography[1] and when it was previously considered, it was almost always against Western criteria (Harley and Woodward 1992b, p. *xx*). Joseph E. Schwartzberg's (1992a, 1992b) contribution to the *History of Cartography* is the most thorough examination of pre-European south Asian cartography, and much of the discussion in this section is based upon this work. Other notable work has been provided by Susan Gole (1988, 1989, 1990) whose reproductions

[1] For example, Lister (1970, p. 105) states rather emphatically, "Of native Indian cartography there is little one can say beyond the fact that it is negligible. What there was of it was purely symbolic and was based on the Buddhist [*sic*] view of cosmography."

of and commentaries on early Indian maps provide some of the most readily accessible examples of cartography of this period.

There is almost no extant cartographic or cosmographic production of a distinctly Indian stamp that can be unequivocally assigned to any date earlier than the thirteenth century, A.D. (Schwartzberg 1992a, p. 295), although archeological evidence suggests that settlement plans probably existed in ancient India. Gole (1990, p. 99) makes the observation that even if no maps or plans with accurate measurements and scale have been found, it should not be assumed that Indians did not know how to conceptualize in a cartographic manner. Certainly they had the mathematical skills, given India's contributions to astronomy and geometry (Schwartzberg 1992a, p. 295).

The present scarcity of early Indian cartographic materials may be the result of many factors. First, the hot, humid, monsoon climate which affects much of the Indian subcontinent would not have been conducive to the preservation of paper, cloth, palm leaf or other organic materials which might have been used for record keeping and many of the materials may have simply been destroyed (Schwartzberg 1992a, p. 327). Many of the maps that do still exist are concerned with religious themes (not only Hinduism but Buddhism and Jainism as well) (Schwartzberg 1992a, p. 329). In light of this, another speculation on the paucity of terrestrial mapping in pre-European India is provided by Schwartzberg (1992a, p. 329):

> The dominant and ultimate concern of all three faiths [Hinduism, Buddhism, and Jainism] has little to do with a single lifetime on earth. The span of a single terrestrial existence is, after all, an infinitesimal moment in the vast and endless cycle of time. ....
>
> In short, then, to those of a religious bent - which for many centuries probably included most learned persons - so mundane a task as preparing a seemingly accurate map of the finite terrestrial earth or a small segment of it could not have appeared particularly important.

Further,

> In seeking to explain why India did not develop mapping more vigorously than it did, we finally revert to the propensity of a cosmically attuned

> society to attach relatively little importance to the mundane concerns to which most terrestrial maps relate. (1992a, p. 330)

Another factor of which to be cognizant is that access to the formal cartographic information which did exist would not have been uniform.

> Until recently, rates of literacy in India were remarkably low. Apart from the traditionally learned priestly castes of Brahmans, there were few social groups among whom learning was especially advanced. Before Islamicization, in fact, higher learning was virtually a monopoly of the Brahmans, though even among that group literacy was far from universal. Thus the portion of the total population that might have been called on to prepare maps - at least maps deemed of consequence for other than narrow, short-term utilitarian purposes - was relatively small, and the total corpus of maps produced would have been commensurately limited. (1992a, p. 328)

A further, but related reason for the scarcity of premodern Indian maps is suggested:

> In the Indian tradition of higher Brahmanical learning, which has persisted for millennia, rote memorization plays an important role. Memory training may begin by age eight or even earlier. The oral tradition, in which one learns directly from the mouth of one's guru, places great emphasis on mastery of the spoken - not the written - word, including for certain texts the proper rhythmic incantation and accent of each memorized *sloka* (verse). It has little need for visual imagery. Conceivably, the relative unimportance of graphic aide-mémoires, such as characterize primary education in so many cultures, even those of preliterate societies, is tied in with the relative scarcity of premodern Indian maps.
>
> Mastery of the Vedas and other sacred texts was a key to the power of the Brahmans. The recitation of particular texts was essential for the performance of the numerous sacrificial rites and other ceremonies from which many - but by no means a majority - of that caste derived their livelihood. There was a vested interest, therefore, in keeping certain branches of learning secret; for what was written down could be learned independently of a master. (1992a, pp. 329-330)

Schwartzberg is very liberal in his definition of what constitutes a map, including both cosmographic and cartographic forms of representation. If the discussion is restricted to terrestrial mapping, the extent of mapping activity in pre-European south Asia appears even more limited. Based on the existing evidence. the production of topographic[1] maps did not occur evenly throughout pre- or early colonial India but rather seems to have been concentrated in a relatively few areas (*e.g.*, Jaipur. Maharashtra, Rajasthan. Gujarat, Kashmir) and was largely absent from others (*e.g.*. areas south of Maharashtra. eastern parts of the subcontinent such as Bangladesh) (Schwartzberg 1992b. pp. 400-401). Also. no existing map predates the seventeenth century.

Even with the recent work of Schwartzberg and of Gole which presents a corpus of surviving pre-European south Asian maps much larger than previously thought to exist. the role of maps in traditional India was not comparable to their importance in Europe at corresponding periods (Schwartzberg 1992a, p. 327), nor in India after European settlement. Thus, as we shall see shortly, the introduction of topographic and other forms of "scientific" mapping by Europeans introduced a substantially new way of representing the Indian landscape[2].

There was not a specific *discipline* of cartography in pre-imperial India (or in other early societies). Those who made maps and similar artifacts did so as an adjunct to other activities. There was an incredible gulf between the privileged high castes (generally Brahmin) who would have been responsible for the maintenance of scholarly and religious knowledge, and the recently arrived Europeans. The gulf between the general indigenous population and the new arrivals would have been even larger. Thus, we see an enormous gap between the nature of geographical information between the indigenous people of India and the European powers that later came to India. The important point for this discussion is that, culturally, geographical information in pre-imperial south Asia was fundamentally different from the cartographic and other means of organizing geographical information that Europeans brought with them to the region.

[1] Schwartzberg (1992b, p. 400) considers topographic maps as encompassing "... a wide variety of maps of land areas more inclusive than a single city, town, fort, garden, or other relatively small locality."

[2] Callicott and Ames (eds. 1989) provide an overview of concepts of nature in Asian traditions of thought including Hinduism and Buddhism.

Imperialism and Geographical Information

Geography (like cartography) has always been a thoroughly practical and deeply politicized discourse, and it continues to be marked by its origins (Gregory 1994, p. 8). Human geography grew, as a discipline, in conjunction with European imperialism, and was a fundamental factor in the "success" of imperialism (Hudson 1977; see also Smith 1994; Godlewska and Smith, eds. 1994). It is interesting that, until fairly recently, the relationships between geography and imperialism seem to have attracted little historical attention, particularly where the British empire is concerned (Driver 1992, p. 26), even though, as Mackenzie (1990, p. 1) noted,

> Geography is a discipline with strongly imperial antecedents. The growth of geographical societies, the emergence and institutionalisation of the discipline, and its move towards a distinctly nationalist and economic bent were all inspired by empire.

Driver (1992, p. 26) offered one possible explanation for this lack of critical self-examination:

> It is as if the writings of our predecessors were so saturated with colonial and imperial themes that to problematise their role is to challenge the very status of the modern discipline.

In examining the relationship between geography and imperialism, a useful concept is *Orientalism* which Said (1978) introduced and defined in a number of interdependent ways. The first refers to the academic study of the Orient. Anyone who studies the Orient is an Orientalist and what he or she does is Orientalism (p. 2). His second definition reads as follows:

> Orientalism is a style of thought based upon an ontological and epistemological distinction made between "the Orient" and (most of the time) "the Occident." Thus a very large mass of writers, among whom are poets, novelists, philosophers, political theorists, economists, and imperial administrators, have accepted the basic distinction between East and West as the starting point for elaborate theories, epics, novels, social descriptions, and political accounts concerning the Orient, its people, customs, "mind", destiny, and so on. (pp. 2-3).

Said's third meaning of Orientalism, which is more historically and materially defined than the other two, is:

> Taking the late eighteenth century as a very roughly defined starting point Orientalism can be discussed and analyzed as the corporate institution for dealing with the Orient - dealing with it by making statements about it, authorizing views of it, describing it, by teaching it, settling it, ruling over it: in short, Orientalism as a Western style for dominating, restructuring, and having authority over the Orient. (p. 3)

Said contended that,

> ... without examining Orientalism as a discourse [in philosopher Michel Foucault's sense of the word] one cannot possibly understand the enormously systematic discipline by which European culture was able to manage - and even produce - the Orient politically, sociologically, militarily, ideologically, scientifically, and imaginatively during the post-Enlightenment period. (p. 3)

One of the ways in which the discourse of Orientalism and imperialism can be examined is through the representational tools that were employed (see Figures 2 and 3).

> ... that Orientalism makes sense at all depends more on the West than on the Orient, and this sense is directly indebted to various Western techniques of representation that make the Orient visible, clear, "there" in discourse about it. And these representations rely upon institutions, traditions, conventions, agreed-upon codes of understanding for their effects, not upon a distant and amorphous Orient. (p. 22)

Although many accounts of the imperial period discuss military and economic factors, considerably less attention has been given to the cartographic tools which allowed the military and economic ambitions to be realized[1]. Yet, as Harley (1988b, p. 282) suggested,

> As much as guns and warships, maps have been the weapons of imperialism. Insofar as maps were used in colonial promotion, and lands

[1] Accounts by Headrick (1980, 1988, 1991), who has discussed the role of naval, botanical, armament, irrigation, transportation and communication technologies in the rise of empire, and Bayly (1993) who has examined the nature of intelligence information in the functioning of empire (not just British) in south Asia, do provide significant insights into how non-instrumental "information technologies", such as botanical gardens, museums, and spy networks, were crucial in the expansion and maintenance of empire.

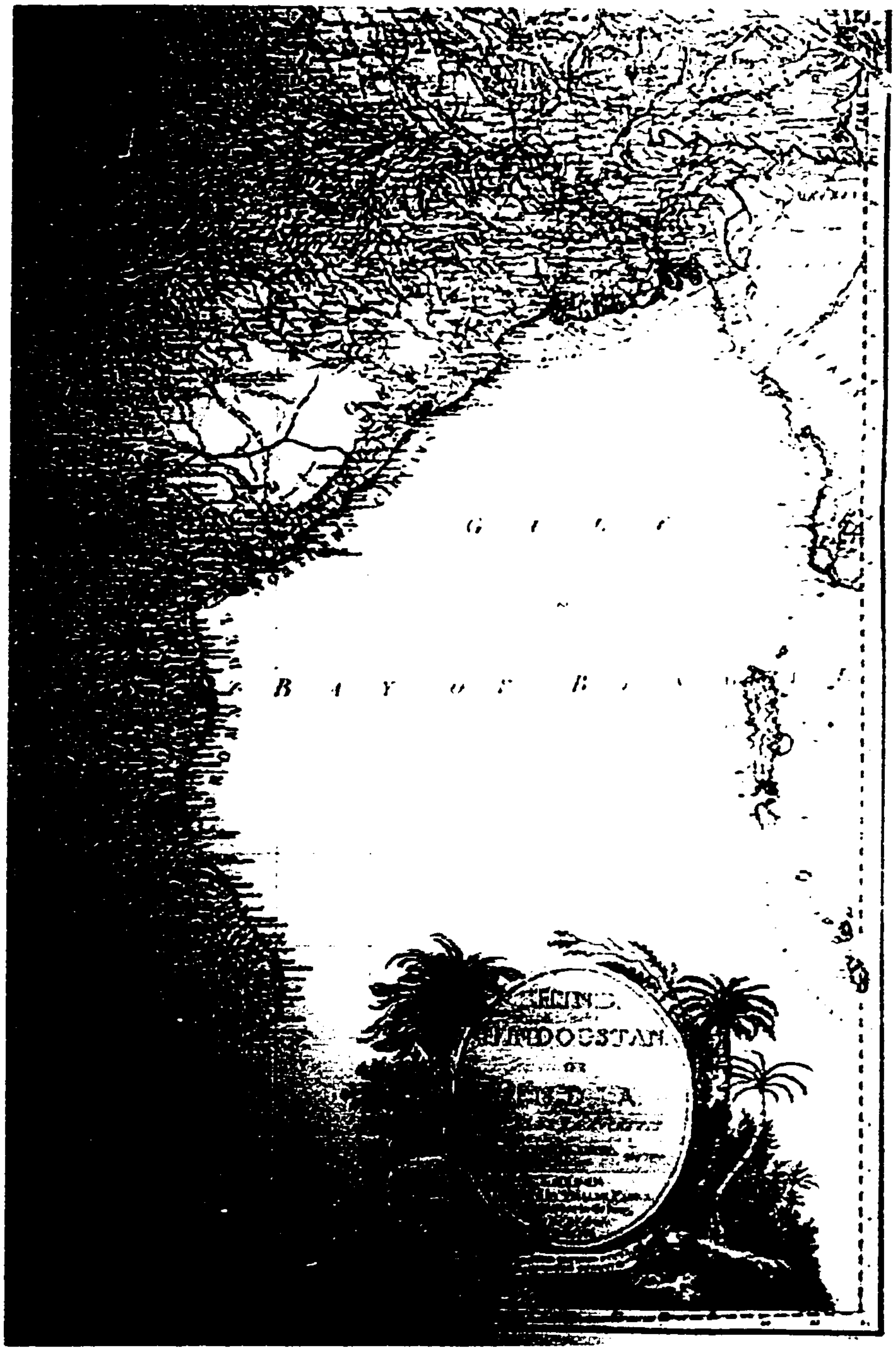
> claimed on paper before they were effectively occupied, maps anticipated empire. Surveyors marched alongside soldiers, initially mapping for reconnaissance, then for general information, and eventually as a tool of pacification, civilization, and exploitation in the defined colonies. But there is more to this than the drawing of boundaries for the practical political or military containment of subject populations. Maps were used to legitimise the reality of conquest and empire. They helped create myths which would assist in the maintenance of the territorial status quo. As communicators of an imperial message, they have been used as an aggressive complement to the rhetoric of speeches, newspapers, and written texts, or to the histories and popular songs extolling the virtues of empire.

The two maps shown in Figures 2 and 3 illustrate the imaginative Orientalist expressions their creators wanted to convey. This is particularly evident in the cartouche elements. In Figure 2, a 1788 map by De La Rochette, published by William Faden (London) shows some of the *exotic* (to the European viewers) flora and fauna associated with India. The geographical information itself is derived from Rennell's 1782 *Map of Hindoostan* (Gole 1980). More striking in its Orientalist imagery is Figure 3, published by Homann Hiers, a German map-making firm, in 1733. Suggestions of riches (the elephant tusks on the ground), foreign cultures, and strange animals dominate the map, with the geographical information, in many ways, taking a secondary roll.

One of the predominant practices of imperialism and colonialism was the establishment of boundaries, often of an almost exclusively cartographic origin (see, for example, Johnson's (1976) examination of the U.S. Rectangular Land Survey in the American mid-west). However, the social and ecological impact of this process is an aspect that, in the context of imperialism, has not received the attention it deserves, considering the pervasiveness of boundaries[1].

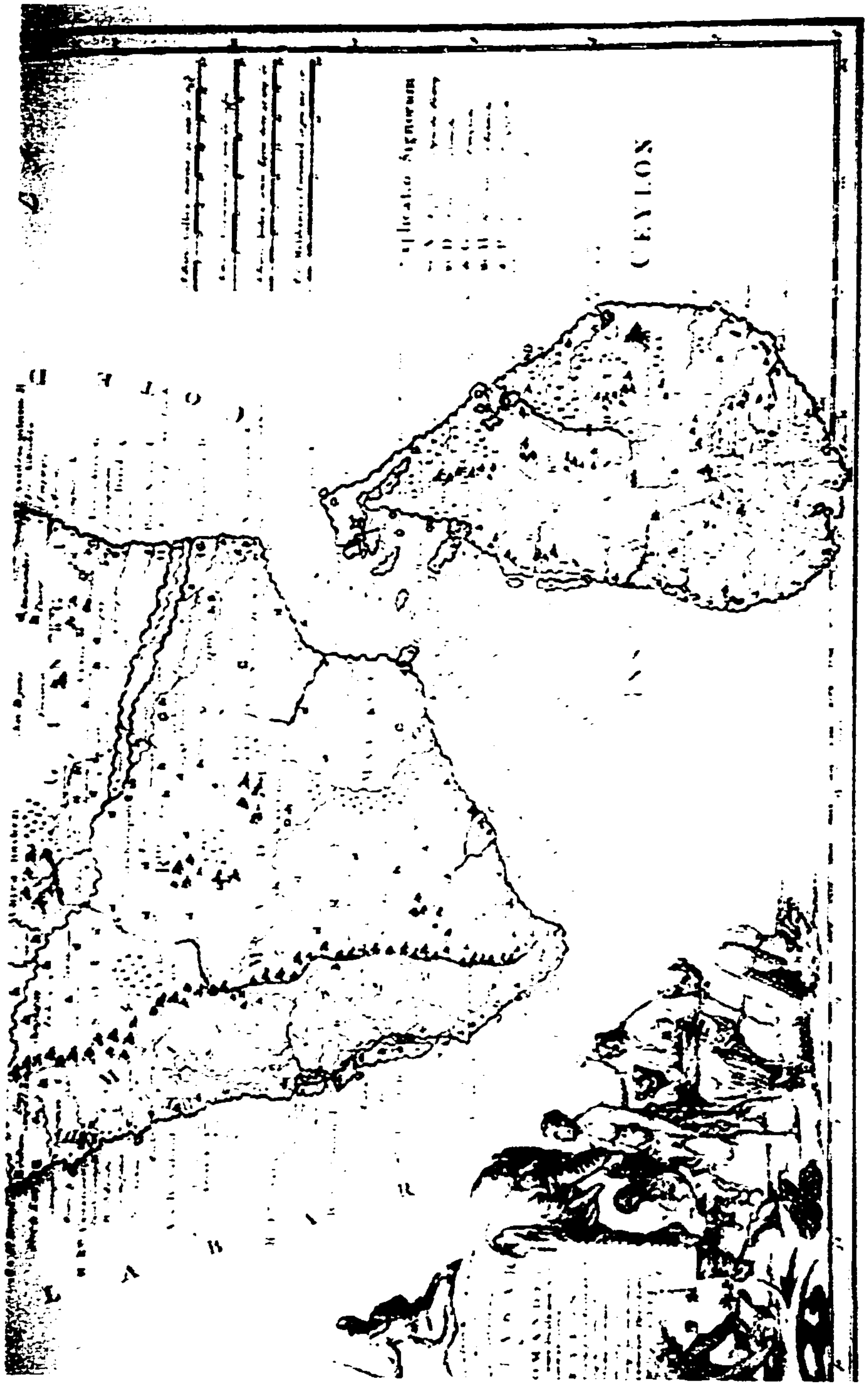
> Given the great expansion in the land-control ambition of the European empires during the colonial period it is surprising that scholars who have explored the symbolism of boundary-making have tended to neglect the influence of forest and land boundaries on the pre-colonial patterns of social life in forest, pasture or arable land. (Grove 1990, p. 19)

[1] A recent exception to this statement is Brealey (1995) who has analysed how maps helped dispossess the Nuxalk and Ts'ilhqot'in First Nations in British Columbia.



Source: Gole 1980, Map 49. Original Size: 52 x 68 cm

Figure 2. Early Map: Hind, Hindoostan or India



Source: Gole 1980, Map 32. Original Size: 48 x 54.5 cm

Figure 3. Early Map: Malabar & Coromandel

Meinig (1986, p. 232) discusses the relationship between imperial powers and indigenous peoples as mediated through imposed cartographic boundaries.

> The very lines on the map exhibited this imperial power and process because they had been imposed on the continent [North America] with little reference to indigenous peoples, and indeed in many places with little reference to the land itself. The invaders parceled the continent among themselves in designs reflective of their own complex rivalries and relative power, ...

This sentiment is echoed by Harley (1989, p. 14),

> In colonial North America, for example, it was easy for Europeans to draw lines across the territories of Indian nations without sensing the reality of their political reality. The map allowed them to say, "This is mine; these are the boundaries".

Connection can also be identified between the use of cartographic technologies and the rise and global spread of capitalistic modes of production. Harvey (1990, p. 424), for example, noted that cartography, in the transition from feudalism to capitalism, involved a "refinement of spatial measurement and representation according to clearly defined mathematical principles."[1] As Sheppard (1995, p. 6) argued,

> ... the technologies developed by geographers, cartographers, and surveyors not only solved problems but made possible the transforming of space from a complex cultural category into a precise, universal, and objective metric which was highly functional to the development of trade, the cataloging of resources, and the definition of property ownership.

In *Culture and Imperialism*, Said (1993, p. 78) made the following statement regarding the role of the geographical representation of imperial expansion:

> Underlying social space are territories, lands, geographical domains, the actual geographical underpinnings of the imperial, and also the cultural contest. To think about distant places, to colonize them, to populate or depopulate them: all of this occurs on, about, or because of land. The actual geographical possession of land is what empire in the final analysis is all about. At the moment when a coincidence occurs between real control and power, the idea of what a given place was (could be, might

[1] A similar refinement of temporal measurement was also fundamental in the rise of capitalism.

> become), and an actual place - at that moment the struggle for empire is launched. This coincidence is the logic both for Westerners taking possession of land and, during decolonization, for resisting natives reclaiming it. Imperialism and the culture associated with it affirm both the primacy of geography and an ideology about control of territory. The geographical sense makes projections - imaginative, cartographic, military, economic, historical, or in a general sense cultural. It also makes possible the construction of various kinds of knowledge, all of them in one way or another dependent upon the perceived character and destiny of a particular geography.

There was an intimate relationship between European imperial expansion and the rise of scientific inquiry in the nineteenth century. In south Asia the Great Trigonometrical Survey (discussed in the next section) was the principal scientific endeavour sponsored by the East India Company (Edney 1990, p. 10). Other activities included the founding of the Asiatic Society in 1784 which soon become the focal point of all scientific activities in India (Kumar 1990, p. 59). In England, the Geological Society of London was created in 1807 (Kumar 1990, p. 57, Stafford 1990, p. 69) and the Royal Geographical Society in 1830 (Stafford 1990, p. 77). Kumar (1990) notes that the rise and patronage of the natural sciences in India by the East India Company was closely related to the economic benefits which the scientific activities were expected to accrue. This will be examined in more detail later in this chapter with reference to trigonometric and forest surveys. However, an example, quoted here at length, is informative as to the type of scientific inquiry conducted in conjunction with the surveys. This example is from a report by Charles Black (1876, pp. 4 - 5) describing the resurvey of a southern portion of the Great Trigonometrical Survey, originally surveyed by William Lambton.

> The party under Major Branfill completed the revision of the southern portion of the Great Arc, about five-sixths of which had already been revised at the commencement of the present year, the last operations having terminated in 1871. The remaining gap was about 108 miles in length, and by its revision the last of the old links in all the chains of triangles, which might have been objected to as weak and faulty, have now been made strong and put on par with the best modern triangulation. Search was made for one of Lambton's old stations, in a group of red sand hills, and eventually it was discovered that this must have moved 1,060 yards to the E.S.E., being the direction of the prevailing winds in the locality, and at the rate of 17 yards per annum. This affords a very accurate measurement of the rate of progress of this remarkable sand-wave, which all efforts to arrest have hitherto proved unsuccessful. Mr. Bond, one of the Assistant Surveyors, had the good fortune to catch a

> couple of the wild folk who inhabit the hill jungles of the Western Ghats, and occasionally came to the villages with honey, wax, and sandalwood, to exchange for cloth, rice, tobacco, and betelnut. On examination they each proved to be 4 feet 6 1/2 inches high, and, generally speaking, of a low type. After completing the triangulation, Major Branfill proceeded to reconnaitre the Straits of Manaar, with a view to connect, if possible, the triangulation of India and Ceylon. ....

The paragraph continues describing more of the details of the survey.

This passage is indicative of the empiricist approach which guided the British presence in imperial India. All things -- agriculture, forests, animals, minerals, people (*e.g.*, "the wild folk") -- could be subject to scientific investigation. All things could be treated as objects appropriate for study. A survey of the indigenous population could be treated in the same manner as a survey of the terrain. So-called *tribals* could be measured and categorized as could sand hills. The ease with which the commentator of the previous passage moves from describing the revision of the trigonometric survey to describing the capture and study of a "couple of the wild folk" to again describing the revision of the survey is striking.

In the remainder of this chapter, a number of examples of surveying and mapping activities from British India will be examined. The focus will be upon exploring the role that mapping played in imperial acquisition and control of India by Britain and upon demonstrating some of the political aspects of cartography in this particular setting.

Geographical and Trigonometric Surveying and Mapping

The British East India Company was first formed as a commercial trading enterprise in 1600, but it was not until the middle of the eighteenth century, with the collapse of the Mughal empire, that the British had much impact within the Indian subcontinent (see Appendix II for a chronology of selected historic events). Following the Battle of Plassey in 1757, as their influence extended inland from the great Presidency towns (Calcutta, Madras, and Bombay), geographical knowledge of the subcontinent became more important for the British, especially for the movement of troops (Phillimore 1968, p. *xiii*;

Heaney 1968, 1957). The surveying activities themselves played an important role in the expansion of British imperialism in India. Often the surveyor was one of the first Europeans to enter a district (Edney 1990, p. 236).

> The surveyor is at the forefront of territorial consolidation, protected by his own squad of soldiers. He not only records the topography of conquered provinces; he records the features of the economic environment in addition to the physical world, locating potential quarries, agricultural areas, and so on. Moreover he records placenames, translating or transliterating them from the original native languages, or even ascribing wholly new foreign names. (Edney 1990, p. 7)

Indeed, one can consider that the very act of surveying,

> ... constitutes the reassertion by one party of its control and ownership of the territory of another party. (p. 269)

An example of this was the not uncommon use by the surveyors of flags as signals for distant sighting, an act that proved particularly provocative to the local people (Edney 1990 p. 264).

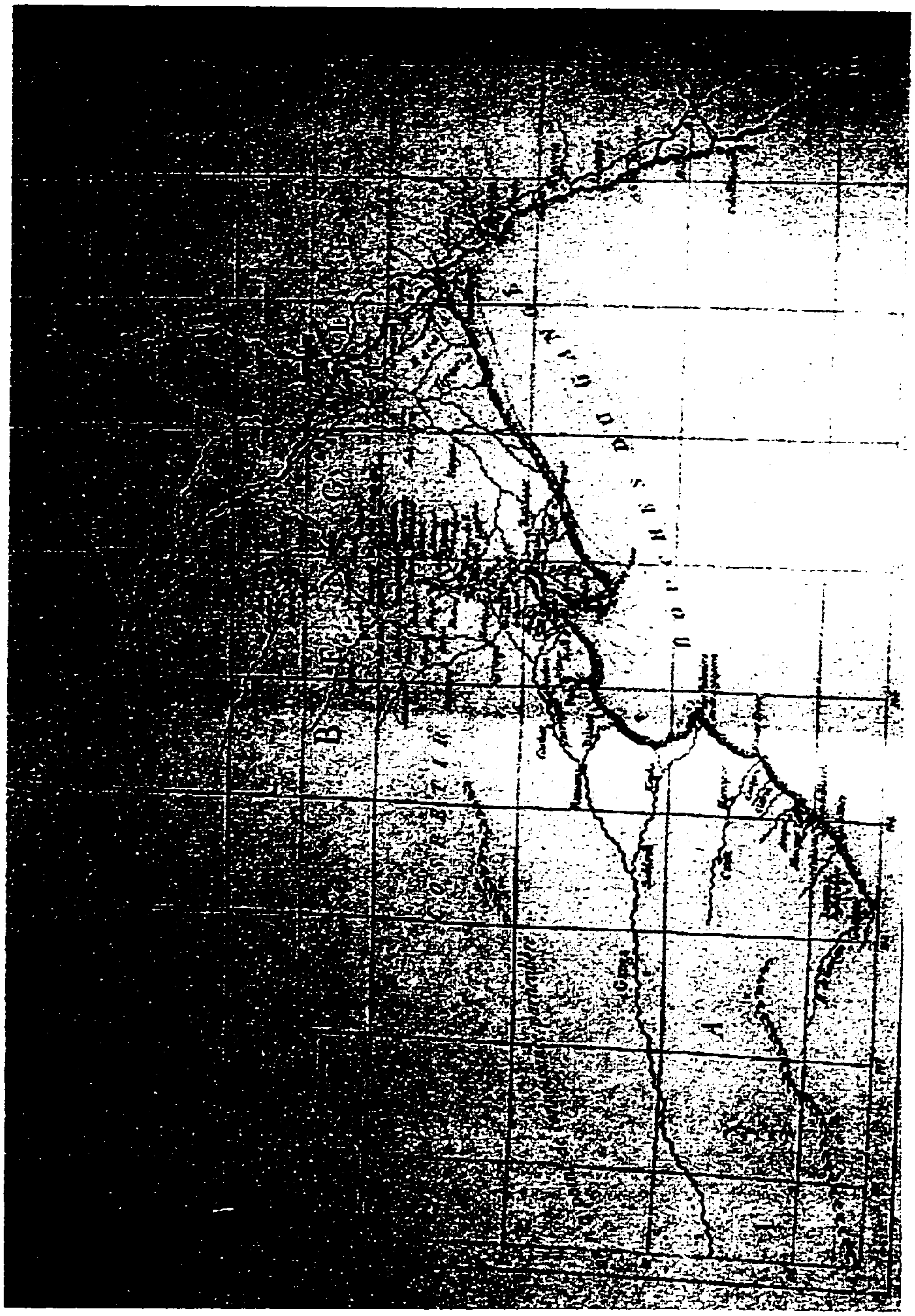
Geographical surveys were one means by which the British would proclaim sovereignty over newly acquired lands. For example, James Rennell's survey of Bengal (1765-1771) was commissioned immediately after the East India Company took responsibility for the governance of that territory (Edney 1993a, p. 62). Similarly, in the south, Colin Mackenzie's survey of Mysore (1799-1808) followed shortly after the Company's defeat of Tipu Sultan at Seringapatam in May 1799.

Prior to Rennell's survey, most European mapping of India was based upon the accounts of explorers, reports from Jesuit missionaries as with French geographer Jean Baptiste Bourguinon d'Anville's 1752 map (Phillimore 1945, p. 1), or military route surveys (reconnaissance surveys made during troop movements) (Figures 4 and 5). d'Anville was the official cartographer for the French East India Company. d'Anville took great pains to verify his knowledge (Gole 1980) and was one of the few geographers who preferred to leave areas of the map blank rather than fill in detail for which he had no reliable knowledge (Phillimore 1945). As such, it is argued by Gole (1980) that his maps show the exact knowledge of India in Europe at that time. Another perspective on this, though, is that the map shows the extent of European penetration into the subcontinent. The coastal areas and navigable waterways were the lands initially visited by the Europeans (in this case, mainly Jesuit missionaries). The blank areas on the map are those areas which Europeans did not (yet) control, did not have power/knowledge over. Certainly there were indigenous people living there, in addition to native flora and fauna. The landscape was not empty, as implied by this map. The empty spaces within the graticule are waiting to be filled in with a European construction of India.

Figure 5 is a typical example of a map from military route survey, conducted as part of troop movements through the country. This particular map is from a survey conducted in Oudh, in the present-day state of Uttar Pradesh, in April and May 1799. The map shows details of administrative and strategic importance, including the locations and Anglicized names of settlements and river courses. Such a map demonstrates control (or controllability) of the territory.

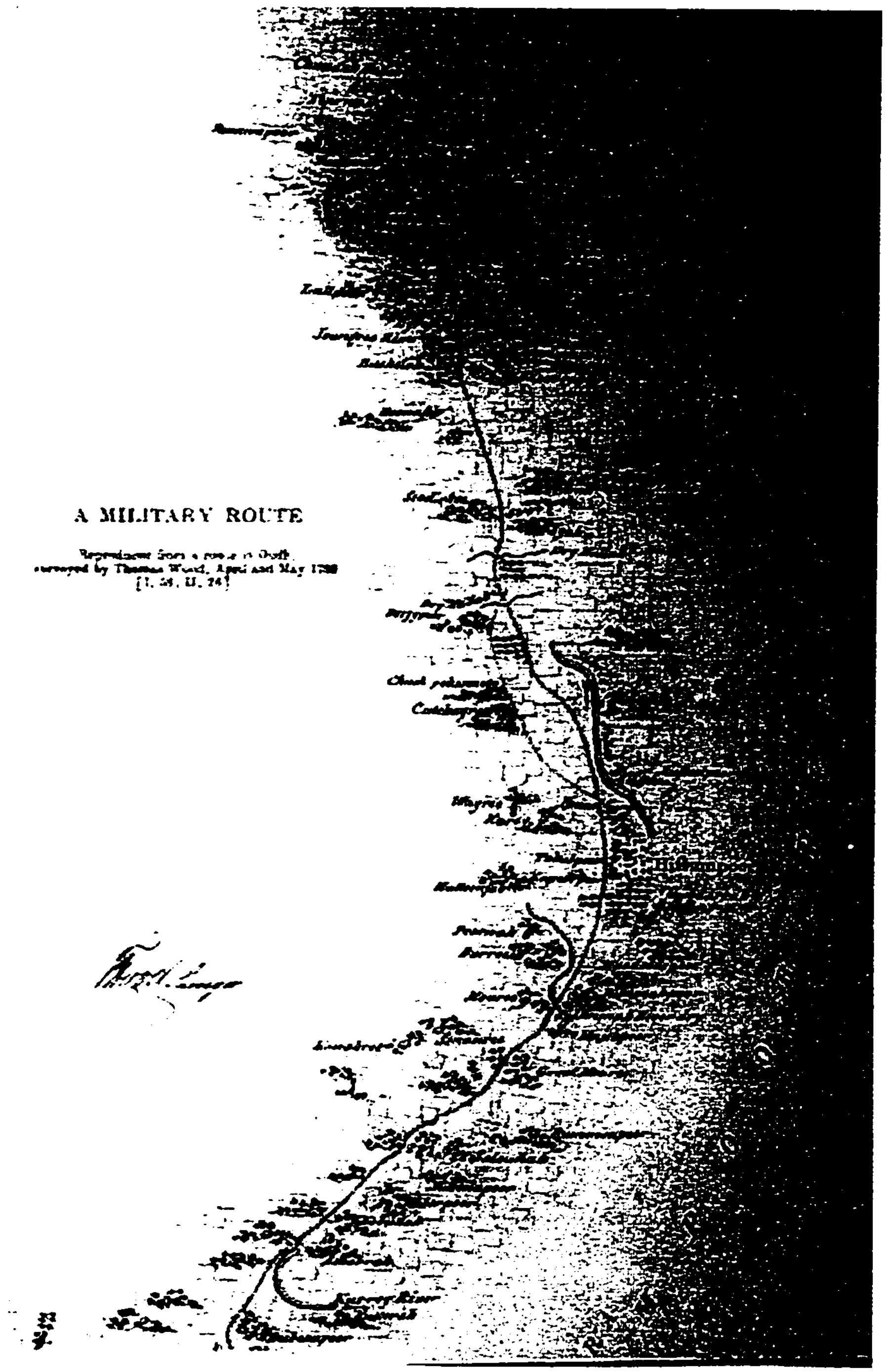
Rennell's survey of Bengal (Figure 6), which was based on route traverses, was the first survey and mapping activity for the East India Company which can be described as systematic (*i.e.*, designed explicitly as a land survey and not simply as an accompaniment to other Company activities). The stated purpose of this survey was to produce an accurate plan of the productive land in the territory although, in terms of the information actually collected, Rennell went beyond this mandate by documenting natural resources, economic activities, and socio-cultural characteristics (Edney 1993a, p. 62).

Colin Mackenzie's survey of Mysore at the scale of one inch to the mile also went beyond the mere collection of military or geographical information and aimed to produce a comprehensive statistical account of the entire state (Berthon and Robinson 1991, p. 136). His survey team included two European surveyors, as well as another assistant in charge of botany, mineralogy and natural history. The team also included some young native-born graduates from the Madras surveying school. Mackenzie's survey was also the first topographic survey to be based upon a proper triangulation (Edney 1990, p. 40). This followed earlier efforts by the Madras Astronomer, Michael Topping (who founded the Madras Observatory in 1792 and the Madras surveying school in 1794), and his



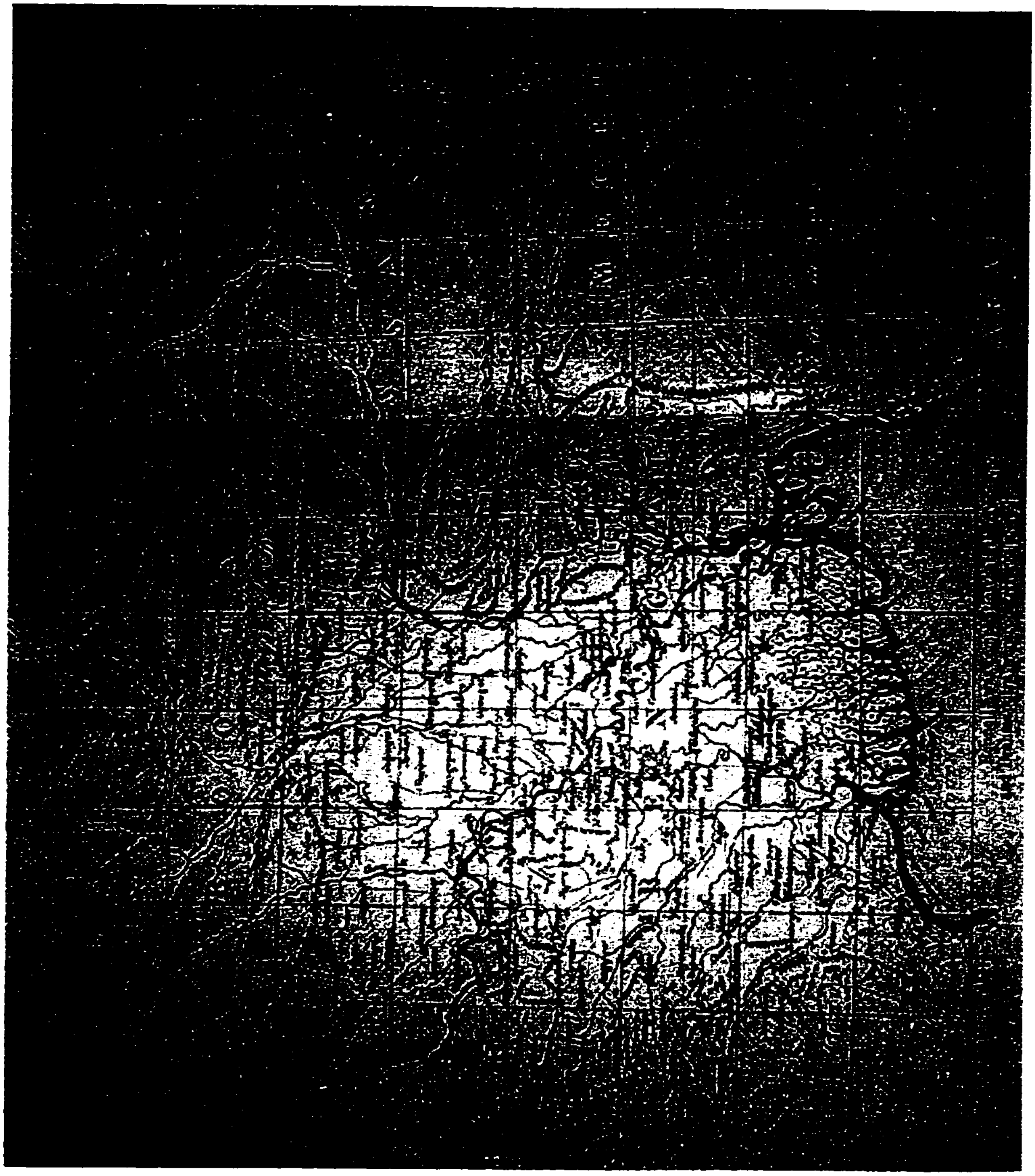
Source: Phillimore 1945, Plate 13.

Figure 4. Detail from Jean Baptiste Bourguinon d'Anville's 1752 Carte de l'Inde



Source: Phillimore 1945, Plate 5.

Figure 5. Example of a Military Route Survey



Source: Phillimore 1945, Plate 12.

Figure 6. Part of James Rennell's Survey of Bengal

assistant, John Goldingham, for achieving trigonometric control for surveys which were carried out in the Madras Presidency along the Coromandel Coast between 1788 and 1794 (Edney 1990, p. 39).

The Surveyor General's office was part of the military establishment and at this time, maps were considered to have great strategic value. As Phillimore (1950, p. *xv*) has stated,

> Geographical information was of such great value that it had to be kept secret from all possible adversaries, and even the art of survey was not to be taught except to the Company's own trusted servants. ... The district officer was expected to work without a map.

This view applied particularly to any maps that might be of military value (specifically with regards to other European powers such as France), especially large to medium scale maps. Prior to the 1820's, such maps were not to be published and the number of manuscript copies was to be kept to a minimum (Edney 1991a, p. 60). As the Company consolidated its position in India and the war with France concluded (1814), the Company relaxed its prohibition somewhat of the publication of medium scale maps, although many restrictions still remained. The requirements of utility began to override those of security (Edney 1991a, p. 62). However, as will be seen in Chapter Five, military security has remained a prominent feature of the Indian cartographic establishment to the present day.

By the end of the eighteenth century, survey departments were established in each of the three presidencies (Calcutta 1767, Bombay 1792, Madras 1810) (Agarwal 1989, p. 27). In 1815, the Company's Court of Directors abolished the departments in Madras and Bombay (deputies and office establishments continued to operate until the early 1830's) and established the Office of the Surveyor General of India in Calcutta (Edney 1990, p. 62). Colin Mackenzie, who at the time had been the Surveyor General of Madras since 1810, was named Surveyor General. The role of the new Surveyor General office was not to conduct or oversee the actual surveys but rather to collect surveys conducted by others, reduce this information to a uniform scale, and produce large-scale provincial maps along with a "General Map of India" (Edney 1991a, p. 61). The disarray of the map office made this task difficult and largely unworkable which led Mackenzie to recommend the creation of an "atlas" which would be a collection of map sheets along regular sheet-lines which would form a complete topographic image of India.

The *Atlas of India* , the most important topographic mapping series during the nineteenth century in India, was begun in 1823 with the last new sheets appearing in 1906 (Edney 1991a, p. 59). As described by Markham (1878, p. 406),

> The Indian Atlas was designed to occupy 177 sheets, 40 inches by 27, and the globular projection and scale (4 miles to the inch), originally proposed by Mr. Aaron Arrowsmith, were adopted. The scheme embraces the region from Karachi to Singapore, and includes Ceylon. From 1825 Mr. Walker combined the various documents sent home by the surveyors in India, prepared the sheets for publication, engraved them on copper, and issued them to the Surveyor General in India and to the London Agent. (Markham 1878, p. 406)

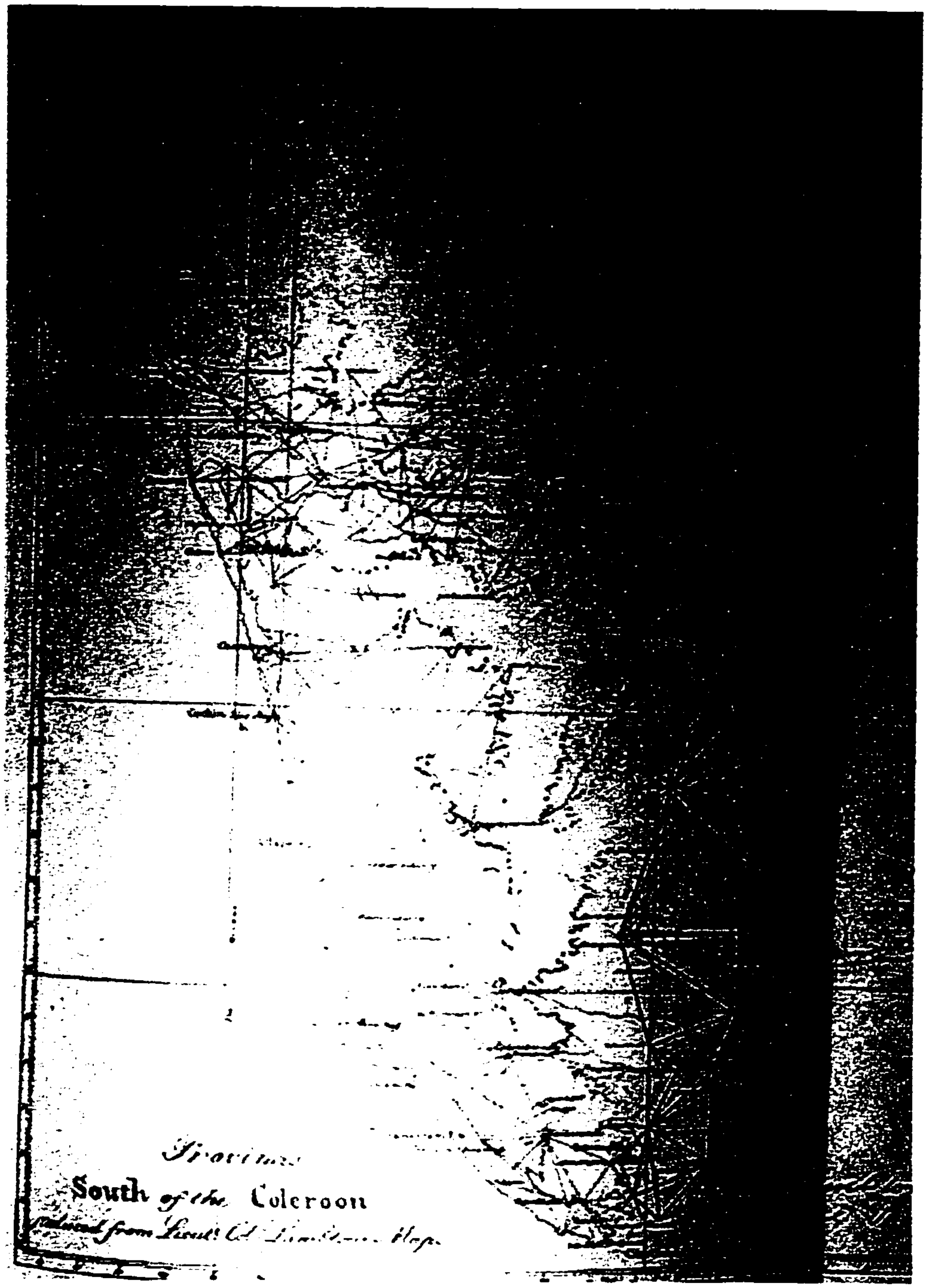
A total of 79 full-sized and 280 quarter-sized copper-engraved sheets was produced at a scale of four miles to the inch. Initially all production was carried out in London, based upon information sent from India. As the East India Company had insufficient expertise to produce the *Atlas* entirely on its own, production was contracted to commercial cartographers (Edney 1991a, p. 60). Edney (1991a; 1990) has documented the development of this series.

According to Edney (1990, p. 60),

> The publication of the collected information adhered to the ideals of systematic, scientific cartography in outward form alone. The history of the British mapping of India after 1799 is that of the creation and maintenance of an *image* of system, of order, of regularity, and of science. (p. 60; emphasis added)

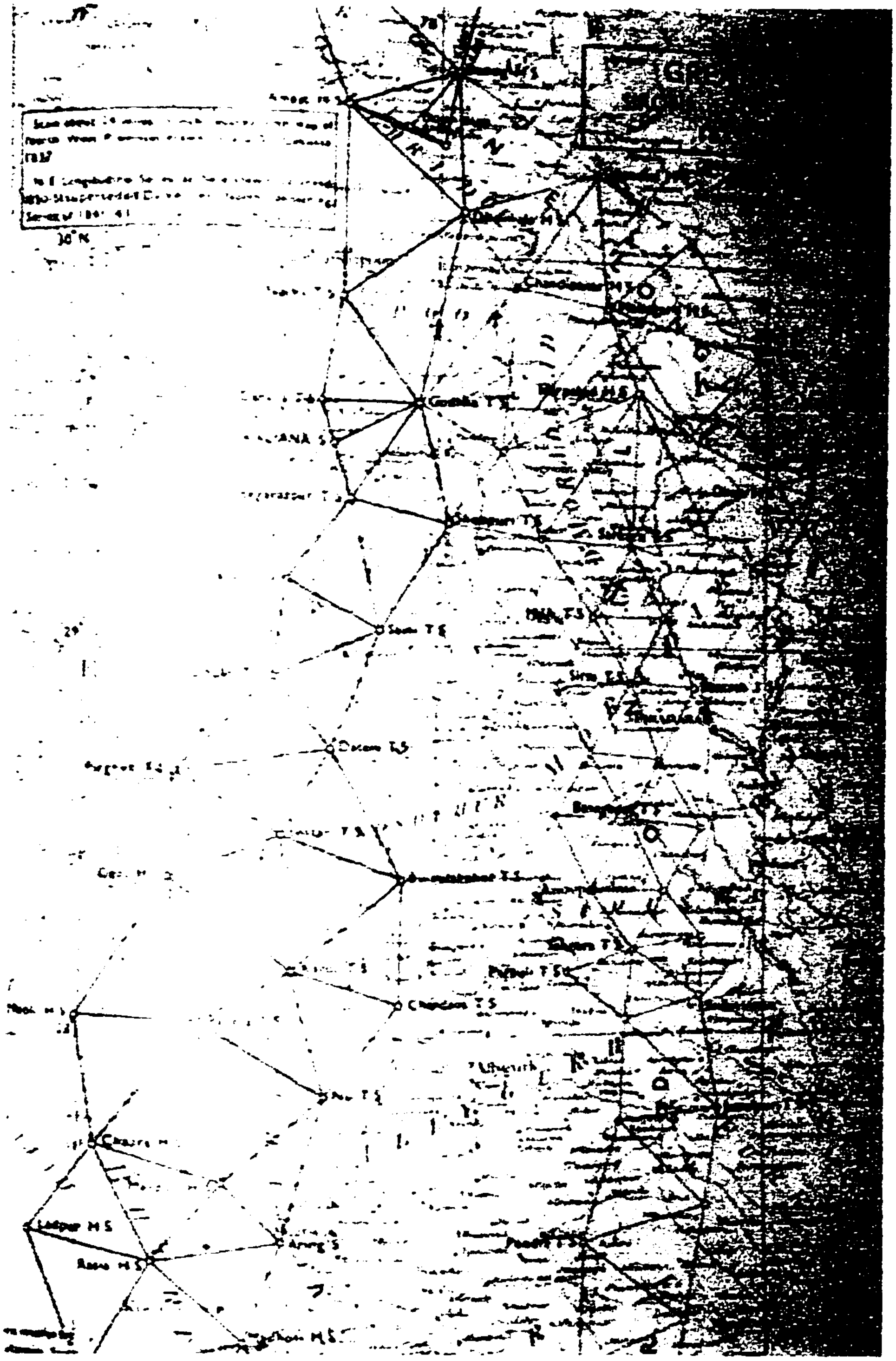
The *Atlas of India* was a means for the East India Company to construct a coherent image of India derived from the diverse information being collected in a wide variety of uncoordinated surveys. This image would be "more in tune with the great national surveys which epitomized contemporary cartographic fashion in Europe" (1991a, p. 59). The British maps of India, which presented the landscape of India as rational and uniform, were not neutral nor value-free. They depicted lands which the British did or could control and upon which the British could impose legislation in a manner and to a geographical extent impossible for previous rulers of the Indian subcontinent (1990, p. 285). Further, by promoting an *ideal* of systematic mapping, the British attempted to create "an imperial space defined by European principles which enabled them to reduce India's immense diversity to a rational and ultimately controllable structure" (1993a, p. 61).

In addition to the topographical or geographical surveying and mapping activity, trigonometric (*i.e.*, purely geodetic) surveying was also of considerable importance during the early nineteenth century. In 1802, William Lambton initiated a triangulated survey in the south of India (Figure 7). Starting in Madras with a baseline measured near Fort St. George, Lambton and his team traversed the southern portion of the subcontinent and reached the western coast in 1806 (Markham 1878, p. 67). He measured the distance from the east coast to the west coast along the 13° parallel as 360 miles, not 400 miles as the East India Company had previously believed (Berthon and Robinson 1991, p. 138). He then continued his survey starting at Cape Cormorin at the southern tip of the peninsula and moving northward along the 78° meridian. In 1817, Lord Hastings (Governor General) ordered the commencement of the Great Trigonometrical Survey, extending the work that William Lambton had started in the south to the rest of the subcontinent (Figure 8). As such, the Great Trigonometrical Survey became the only British survey intended from the outset to cover the whole of the subcontinent in a systematic manner (Edney 1990, p. 11). Lambton continued as Superintendent of the work until 1823 when he died. The survey then came under the orders of the Surveyor General of India, and George Everest, formerly Lambton's chief assistant, assumed the role of Superintendent. By the time Everest retired in 1843, he had completed the field observations and computations of the Great Arc northwards to Dehra Dun (latitude 34° 20') (Phillimore 1968, p. *xiv*).



Source: Phillimore 1950.

Figure 7. William Lambton's Triangulation



Source: Phillimore 1950.

Figure 8. Great Trigonometric Survey

The primary purpose of Lambton's triangulation, and later the Great Trigonometrical Survey, was to produce a triangulation base for detailed topographic surveys. For example, in the production of the *Atlas of India*, the intention was that the survey material sent to London was to be based on, or properly connected to, the Great Trigonometrical Survey (Phillimore 1968, p. *xiii*). Although highly labourious and quite expensive, the trigonometric surveys rarely achieved this goal. This is clearly indicated in the 1905 *Report of the Indian Survey Committee*, which offers useful insights into how surveying and mapping evolved in India throughout the nineteenth century. In 1904 the committee was sanctioned by the Secretary of State for India to assess the state of surveying and mapping activities in India, especially those undertaken by the Survey of India. The committee was charged with looking at a number of areas of the Survey's operation (Cook 1985):

- the state of the maps in each province and the measures required to bring them up to date
- methods and expense of survey
- methods of reproduction
- the organisation of the Survey

Their report indicates substantial disarray in the state of survey and mapping in India, particularly with regards to topographical mapping.

> We are not aware that any other country has ever published its topographical maps in so fragmentary a condition. (Indian Survey Committee 1905, p. 40)

The reasons for this state of affairs were numerous:

> ... the topographical mapping of the country has never been carried out on any definite system, the maps being the result partly of early reconnaissances, partly of direct topographical surveys, partly of compilations from the surveys made by revenue or, in later days, by cadastral parties. The want of system (which has been imposed on the Survey Department by the varying requirements of different parts of the country,) has led to an immense amount of patchwork, and renders it difficult now to give a connected account of the topographical work accomplished. (p. 5)

The situation was particularly bad in the Madras Presidency:

> In Madras there are practically no Survey of India maps other than the 1/4" sheets of the Atlas of India which are based on material provided by very old surveys, and though well executed, are now out of date. (p. 40)

An exception to this statement was Mysore which was surveyed in 1880's with a 1" map published.

The Committee considered the separation of the trigonometrical, topographical, and revenue surveys in the period 1843-1861 as a "fatal step" in the demise of systematic topographical mapping.

> What was done, under the system of separation, on the other hand, was that the trigonometrical branch, being left independent, confined itself solely to geodetic objects; the revenue survey, being left independent, confined itself solely to the large scale survey of cultural patches; and topographers, also independent, were scattered over the country doing separate bits of surveying of their own, and when they did encounter any areas which had been surveyed by revenue parties, those revenue surveys were found either to be obsolete and useless, or a patchwork small-scale map was compiled, half of which had been surveyed ten years before. (Indian Survey Committee 1905, p. 40)

This demise was largely attributable to George Everest, whose emphasis as Surveyor General upon the scientific work, especially the Great Trigonometrical Survey, caused the progress of the geographical delineation of the country to languish (Indian Survey Committee 1905, p. 7). Everest had concentrated all his efforts on the trigonometrical survey, firmly refusing to initiate any new topographical surveys and, when Andrew Waugh took over as Surveyor General in 1843 upon Everest's retirement, only one topographic survey (that of the Nizam of Hyderabad's dominions) was in progress (Phillimore 1968, p. 3). Waugh followed Everest's lead in emphasizing the work of the Great Trigonometrical Survey. As Phillimore (p. 319) commented,

> Except as possible material for the Atlas of India, neither Everest nor Waugh were at all interested in maps of Bombay and Madras. Manuscript maps of all Madras districts had been supplied before 1830 and there were also maps on the 16-mile scale. In 1822 Arrowsmith had published his quarter-inch *Atlas of the South Peninsula* in 18 sheets but since the

> abolition of the post of Deputy Surveyor General at Madras, responsibility for maps had rested with the Chief Engineer who was in no position to undertake further compilation.

As indicated earlier, a primary objective of the Great Trigonometric Survey was to provide a triangulation base for detailed topographic surveys (an objective which was rarely achieved). A second objective of the trigonometric surveys was to provide information about the size and the shape of the Earth independent of any mapping (Edney 1990, p. 40; Berthon and Robinson 1991, pp. 137-140). Indeed, as noted earlier, the trigonometrical surveys were the principal scientific institutions promoted by the East India Company (Edney 1990, p. 10). Through these two objectives, however, the Great Trigonometrical Survey presents a paradox (Edney 1990, p. 262). At the time of the survey's inception, the East India Company's key criterion in collecting information was utility for purposes of governance. Yet,

> At the fundamental level of the need for information for the administration of India, a triangulation of India was not necessary. More importantly, the Great Trigonometrical Survey was prosecuted with fervor when other scientific and far more cost efficient activities (such as the detailed topographic surveys) were cut back in the name of economy. (p. 262)

Edney (1990, p. 262) suggests that this paradox can be resolved by considering the Great Trigonometrical Survey as "a symbolic reaffirmation of the conquest of India, as a new symbol of European Empire." The Great Trigonometrical Survey created an imperial vision of space based upon what the British saw as an advanced, scientific and ordered structure which brought the whole sub-continent into a single system (p. 271). The Company's servants believed the rational, precise, and uniform nature of their geographical knowledge to be the direct opposite to that of the Indian natives whose geographical knowledge the British perceived as being irrational, imprecise, and mystical (p. 236). The imposition of the triangular grid of the trigonometric survey upon the landscape created *the image* of a homogenous territory which could be administered and governed as a single entity. Local uniqueness was to be dissolved through the act of mapping. In fact, the Court of Directors of the East India Company, responding to suggestions that the *Atlas of India* (begun in 1823) be compiled in India where the surveyors might appreciate the uniqueness of place, insisted that the *Atlas* be produced in

London because the Great Trigonometrical Survey "established a uniformity that overrode the unique circumstances of each detailed survey" (Edney 1990, p. 285).

Following the 1905 Report of the Indian Survey Committee, substantial changes were enacted in the Survey of India, the predominant organization responsible for survey and mapping in India. The committee was highly critical of the lack of system in the Survey's activities. It recommended standardization of the map production process and that within twenty-five years the one-inch (1:63,360) scale map of India should be completely updated (Cook 1985; Agarwal 1989). It also recommended that small scale map series should be published on "degree sheet" lines to be tied in to the proposed uniform International Map of the World at the scale of 1:1,000,000 developed at the International Geographical Congresses of the 1890's (held in Bern 1891; London 1895; Berlin 1899) (Cook 1987). This involved accepting the true longitude of Madras as 80° 14' 54" East of Greenwich which was a difference of 2' 27" 18 longitude from the value that had been used for topographical mapping up to that time. This resulted in a gap of over 4 kilometers at Madras between the eastern edge of old topographic sheets and adjacent new sheets. In addition, revenue (cadastral) surveying was no longer to be conducted by the Survey of India but was to become responsibility of the provinces (where this was not already the case).

The process of standardization did not progress as quickly as the committee had envisaged. World War I saw the energies of the Survey of India diverted to the war effort with the organization being responsible for surveying and mapping as far west as 40° East (Mesopotamia). In addition, many of the staff were called away to duty and in the years immediately following the war much training was required for new staff (Wheeler 1955).

The years following World War I also saw the Survey of India involved in experiments concerning the use of aerial photography for peace-time surveys (terrestrial photography had been first tried by the Survey in 1899). One early working paper (Lewis and Salmond 1920, p. 17) concluded that:

> It would appear then that there is nothing to be gained by adopting the air method for normal 1 inch surveys in the plains of India.

This conclusion did not dissuade further experimentation with aerial techniques (Beazley 1927; Norman 1929). In 1927 the Indian Air Survey Committee was formed, in 1928 a Wild Phototheodolite was purchased, and in 1933 Chapter 12 (provisional), "Photogrammetric Survey (Air Survey)", of the Survey of India Handbook of Topography was published[1].

The years leading up to World War II saw the curtailment of civilian mapping programmes and their mobilization for military purposes (Wheeler 1955). By 1940 the Survey of India was responsible for production of quarter-inch (1:253,440) map sheets for an area bounded by 40° North, 48° East, the natural frontier of the Himalayas, the eastern boundaries of Assam and Burma, and the Indian Ocean coast (Cook 1987). Following the Cairo Survey Conference in 1940, the western boundary extended to 40° East to relieve European war pressure on military survey units to the west. As the war progressed, the Survey of India's responsibilities shifted eastward and by 1943 it was producing maps covering Persia (east of 60° East), Afghanistan, India, Burma, Siam, Indo-China, western and southern China, Malaya and Sumatra. Production included "certain 'fake' documents [which] were printed in Map Publications Office in Calcutta, for anti-Japanese espionage purposes" (Wheeler 1955, p. 2). In 1945 the South East Asia Command took over mapping responsibility for areas east of India, although the Survey of India was still relied upon for printing facilities (Cook 1987).

Mapping and Partition

So far, a number of examples have been provided to illustrate some of the ways in which authoritative power is reflected in and reinforced by the use of surveying and mapping technologies. However, the political power inherent in maps is perhaps most explicitly illustrated in the partition of British India into India, West Pakistan and East Pakistan (later Bangladesh). In early June, 1947, when it became evident that the Muslim League

[1] Different chapters of the Handbook of Topography were published in different years and revised in different editions. The first edition of Chapter 1, "General Duties, Organization and Institutions" was published in 1911.

and the Congress Party would not be able to agree upon governance of a united independent India, Viceroy Louis Mountbatten devised a plan to partition British India into the separate countries of India and Pakistan. This partition was to occur by the middle of August, 1947. On June 27, 1947, Sir Cyril Radcliffe, a renowned barrister from London, was made responsible for determining the boundary in the Punjab and in Bengal between the soon to be created countries of India and Pakistan. Radcliffe had no experience in India and it was, in fact, for this reason that he was seen to be an impartial party without prejudice towards either side (the Congress Party or the Muslim League). Radcliffe worked alone in Delhi's heat in a bungalow on the edge of Delhi's viceregal estate tracing out the boundary lines on Royal Engineers' maps which would divide eighty-million Indians. The account by Collins and Lapierre (1975, pp. 247 - 248) describes Radcliffe's work as follows:

> The remorseless demand for speed had given him no alternative but to work in the solitude of his bungalow. Cut off from any human contact with the great entities he was dividing, he was forced to visualize the impact of his work on areas that seethed with life, with only the abstractions of maps, population tables and statistics to guide him.
>
> Daily, he was compelled to slice away at an irrigation system imbedded into the surface of the Punjab like the veins in a man's hand without being able to see on the ground the effect his line would have on it. Radcliffe knew that water was life in the Punjab, yet he was unable to survey the meanderings of his line down even one of those vital concrete spillways, sluice gates and reservoirs.
>
> Never would he walk a rice paddy or study a jute field that his pencil was going to mutilate. He would not be able to visit a single one of the hundreds of villages through which his line would run, to contemplate its effect on the hapless peasants it might isolate from their fields, their wells or their roads. Not once would he be able to soften the human tragedies that his boundary was certain to produce by following its trace upon the surface of the land he was dividing. Communities would be severed from the lands they tilled, factories from their freight depots, power plants from their grids, all because of the terrible haste that the Indian leadership had imposed on Radcliffe, compelling him to demarcate, on an average, 30 miles of frontier every day of this land that he had not had time to see, and about whose economy, agriculture and, above all, people he was almost wholly ignorant.
>
> Even the meager tools that he possessed turned out to be hopelessly inadequate. It proved almost impossible to find an ordnance map large enough to serve as his master map. The details on the maps he did find

> were often inexact. The Punjab's vital five rivers, he noted, had a curious tendency to stray as much as a dozen miles from the beds assigned them by the Punjab's vaunted engineering services. The population tables which were supposed to be his primary guide were inadequate and constantly being distorted by either side to support their conflicting claims.
>
> Bengal proved the easier task. Radcliffe hesitated for a long time over Calcutta's fate. There was, he thought, much logic in Jinnah's claim to it, so there might be a unitary flow of jute from field to mill to port. In the end, however, he felt that its Hindu majority population had to overrule economic considerations. Once he had resolved that question, the rest of his work in Bengal was easier. His boundary, however, was "just a pencil line drawn on a map," with all the heartbreak that implied. Almost nowhere in that tangle of swamps, marshes and low-lying fields could he find the points of reference a boundary marker seeks, rivers or a crest line.

The human costs of following partition were enormous with estimates of 500,000 killed in the conflicts that followed (Spear 1990) and incredible movements of people.

> It is reckoned that about five and a half millions traveled each way across the new India-Pakistan border in the Punjab. In addition about 400,000 Hindus migrated from Sind and well over a million moved from East Pakistan to West Bengal. (Spear 1990, pp. 238 - 239)

Partition of the Indian subcontinent was one of the final acts of British imperialism in India and perhaps the ultimate demonstration of cartographic power. Post-Independence India was truly a cartographic creation.

Summary

In order to demonstrate the political nature of surveying and mapping, this chapter has drawn upon a number of examples from British India. By viewing these instances from the perspective introduced by Brian Harley, insights into the role of mapping technologies in imperial expansion have been provided. It was noted that the mapping technologies introduced by the Europeans, particularly the British, were significantly different than any technologies in place prior to European contact. Initially, surveying and mapping preceded imperial expansion and provided a graphical sense of control (or controllability) over the subcontinent.

Two types surveying and mapping programmes provide evidence of the role of cartographic information in imperial conquest and administration. Topographic or geographic mapping, as typified by the *Atlas of India*, allowed for the creation of images of India as a unified entity, or at least one that could be treated as though it were a single entity. The topographic map served to minimize the vast cultural differences throughout the Indian subcontinent with the use of standardized symbolization and Anglicized place names. As such, topographic mapping can be considered an example of an *Orientalist* mode of representation, following Edward Said's conception of the term. In a similar but more abstracted manner, trigonometric maps reflected an image of India as rational and controllable, through purely geometric lines, which marginalized both the human and the natural landscape. Although the Great Trigonometric Survey was undertaken for *scientific* purposes, Edney (1990) noted that its cost never justified its expected practical utility. He argued that the symbolic significance of the GTS, as a powerful visual depiction of the conquest of India, allowed it to continue.

The argument here is not that surveying and mapping were the reasons that British imperialism in India occurred. Many factors, too many to be covered within the scope of this dissertation, influenced the course of historical events throughout the period in question. However, while maps were only one of many technologies which facilitated imperial expansion and administration, it is difficult to conceive that imperial control would have been able to occur, at least to the same extent, in the absence of these mapping technologies. Maps present powerful, non-objective, images which both reflect and reinforce the *political* interests of those who control the creation of the maps. This is perhaps most powerfully demonstrated in the act of partition, by which the nation states of India and Pakistan are seen as almost purely cartographic creations. Considering maps as political tools provides insights into the means by which control over land resources can be achieved and maintained. Such insights are not simply historical curiosities but need to be considered in light of current mapping practices. The next chapter seeks to extend this exploration to take into account more recent developments in mapping technologies.

CHAPTER FIVE - A CRITICAL PERSPECTIVE ON DIGITAL GEOGRAPHICAL INFORMATION TECHNOLOGIES

Introduction

Starting from Brian Harley's work in the history of cartography and using examples from British India, some of the political aspects of geographical information technologies have been examined. However, a question still remains with respect to the applicability of Harley's approach to contemporary geographical information practices. Can contemporary geographical information technologies, such as remote sensing and geographical information systems, be treated in the same manner as more "traditional" paper-based technologies? If not, in what ways must Harley's approach be modified? This chapter will attempt to develop a critical perspective on what will be termed *digital geographical information technologies*, and their use in promoting sustainable development in developing countries.

For purposes of this thesis, there is at least one other important element missing from Harley's approach. Harley does not explicitly address environmental and ecological issues. If we are to consider the roles of mapping technologies in influencing human-environment relationships (*e.g.*, both historically, and through the use of remote sensing and geographical information systems within a programme of sustainable development), then the ways in which mapping technologies affect these human-environment relationships needs to be examined.

Fortunately, many of the questions (of authority, of differing perceptions of "truth") asked by Harley are also the concern of research in the area of political ecology. As formulated by Blaikie and Brookfield (1987), political ecology seeks to understand the political aspects of environmental change. Perhaps surprisingly though, most political ecology research has not considered the political aspects of information technologies in influencing power relationships between the state and local communities, and the subsequent affects upon human-induced environmental change. In this chapter, an attempt will be made to demonstrate the ability of political ecology to extend the critique started by Harley, and to also show the utility of critically examining the role of geographical information technologies in affecting human-environment relationships, both historical and contemporary.

Political Ecology and Geographical Information

Over at least the past decade one of the most important driving forces behind resource management policy formulation in many parts of the world has been the notion of sustainable development. Most commonly, sustainable development concerns the linkages between economic development and ecological well-being, particularly intergenerational aspects of these linkages (*e.g.*, WCED 1987). There are, of course, differing, often conflicting perspectives on what constitutes sustainable development. In developed countries, there tends to be an emphasis upon environmental issues such as climate change, biodiversity, and habitat destruction, whereas in developing nations there is often more emphasis upon enhanced economic activity (Wood 1995, pp. 7-8). As noted by Wilbanks (1994, p. 543),

> ... people in industrialized countries tend to focus on environmental management with as little negative impact on economic development as possible. ... People in developing countries, meanwhile, tend to focus on economic development with as little negative impact on the environment as possible.

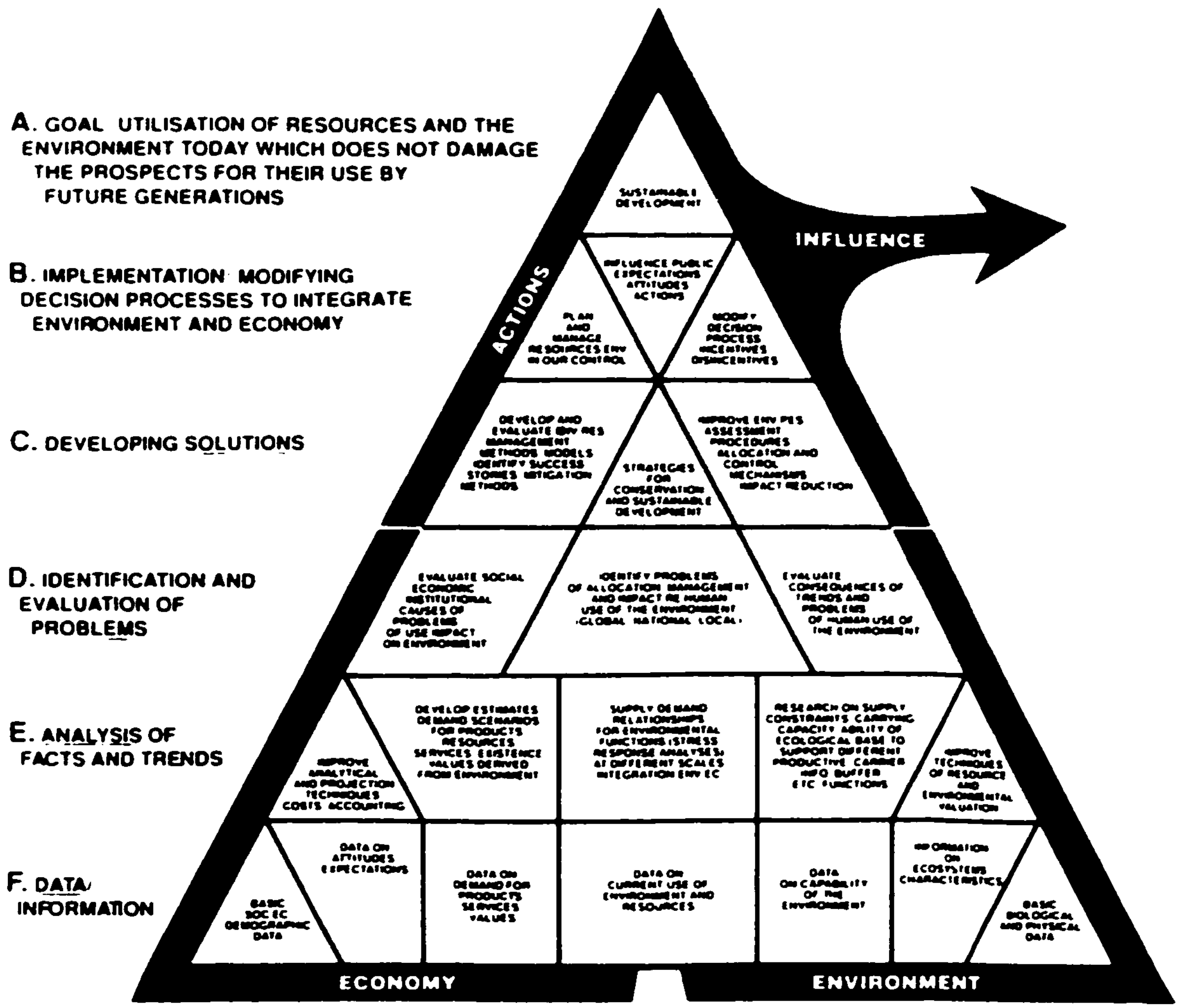
Yet, despite differences of opinion of what might constitute sustainable development, many commentators in both developed and developing nations identify the need for better information and improved information handling capabilities, including the use of technologies such as satellite remote sensing and geographical information systems (see, for example, Rao 1993; Estes *et al.* 1992). Manning (1990), in his presidential address to the Canadian Association of Geographers, outlined a structure for sustainable development initiatives. The basis of his pyramidal model (Figure 3.1), which proceeds from the bottom to the top, is that better information will lead to better decisions, making possible the management of the demands placed on the environment in a way that is consistent with the environment's long-term ability to supply these demands, while at the same time allowing for modification of the human impact upon the environment by limiting degradation (p. 293). The model is built upon knowledge of the natural environment and the human condition (p. 294). Manning argues that the use of mapped information and geographical information systems should be encouraged because of their ability to provide information quickly and effectively to decision makers.

It must be remembered that sustainable development,

> ... is a concept that is fundamentally *political*. Its realization lies in answers to such questions as who is in control, who sets agendas, who allocates resources, who mediates disputes, who sets the rules of the game. (Wilbanks 1994, p. 544, italics original)

Because human uses of natural resources and the environment are increasingly influenced by political considerations, there is a greater need to integrate both environmental and political understanding in analysis of environmental problems (Bryant 1992, p. 12). The field of *political ecology* provides a means by which political aspects of land resource utilization and degradation can be explored. Political ecology is an attempt to understand the political sources, conditions, and ramifications of environmental change (Bryant 1992, p. 13) by combining the concerns of ecology and a broadly defined political economy (Blaikie and Brookfield 1987, p. 17). Linkages are made within political ecology from the study of underdevelopment and rural poverty to environmental issues (Pickles and Watts 1992, p. 310). Political ecologists argue that in order to understand human-induced environmental changes, it is essential to address the social, cultural, political, and economic contexts within which these changes occur, in addition to the changes themselves.

Figure 9. Building Blocks Towards Sustainable Development



Source: Manning 1990, p. 294.

Political ecology builds on the long tradition of human ecological research (*e.g.*, Barrows 1923, Park 1936, Dickinson 1970, Bennett 1976 - historical overviews are provided by Young 1983 and by Smith and Reeves 1989), but is distinguished by its increased emphasis upon the (broadly defined) political factors which influence human interaction with their environments. Furthermore, a political ecology approach provides a framework for human ecologists interested in examining the interrelationships between local patterns of resource use and the larger political economy (Bassett 1988, p. 453; Bell and Roberts 1991, p. 304). Finally, a political ecology approach tends to encompass more of the physical environment than many other approaches to human ecology.

Taking a cue from the title of Blaikie and Brookfield's (1987) influential book, *Land Degradation and Society*, much of the political ecology research has been concerned with the relationship between damage to ecological systems and human activity. Central to Blaikie and Brookfield's approach are the notions that land degradation has both social causes as well as consequences, and that competing social definitions of degradation must be taken into account.

> Since degradation is a perceptual term, it must be expected that there will be a number of definitions in any situation. It is, therefore, essential that the researcher recognizes any such conflict over the use of land and, therefore the definition of degradation. Sometimes the definition is given to the researcher as the 'ruling' one or the state-supported one, in the sense that land should be used in a certain way and degradation is, therefore, defined as reduction in capability to fulfill this demand. Sometimes the researcher will wish to supply other criteria derived from her/his own political and technical viewpoint. (p. 6)

Research using political ecology approaches has been conducted in many different contexts. These include effects of development projects in east Africa (Bennett 1984), disease in Tanzania (Turshen 1984), soil erosion in developing countries (Blaikie 1985), peasant-herder conflicts in the northern Ivory Coast (Bassett 1988), life in a peasant corporate community in northwestern Mexico (Sheridan 1988), peasant agriculture in northern Portugal (Black 1990), soil and water resources in rural Zimbabwe (Bell and Roberts 1991), environmental management in China (Hershkovitz 1993), wetland conversion and gender issues (Carney 1993) and afforestation projects (Schroeder 1993) in The Gambia, and colonial deforestation in Madagascar (Jarosz 1993). Much of this work focuses upon regions formerly subjected to European colonialism or imperialism and emphasizes the marginalization of both people and the environment in these regions.

Although they lack theoretical coherence (Peet and Watts 1993, p. 239), one common theme throughout all these works is the relationship between local patterns of resource use and the larger national and international economy. Increasingly, there is a greater emphasis within political ecology research to take into account poststructural concerns of power, discourse, and cultural difference (Peet and Watts 1993, p. 227). These are the same concerns raised by Harley with respect to cartography and many of the influences (*e.g.*, Foucault, Derrida) are the same for both political ecologists and for those concerned with the political aspects of information technologies. Yet, in political ecology research, very little attention has been paid to the role of information and information technologies. As (Peet and Watts 1993, p. 239) observed,

> ... there is no serious attempt at treating the means by which control and access of resources or property rights are defined, negotiated, and contested ....

If sustainable development is political, then the tools which are to be utilized in achieving sustainable development need to be considered in a political light. Unfortunately, what is often absent from frameworks such as Manning's is consideration of the social construction of knowledge and information. Such a framework is essentially positivist in nature and assumes that data can be neutral and unbiased reflections of reality. As noted earlier for the context of India, geographical information technologies introduced by Europeans played an important role in imperial expansion. The current use of technologies such as remote sensing and geographical information systems has its roots in this period of imperial rule. Therefore, an important starting point is an examination of the historical aspects of geographical information technologies in order to be able to better understand their use in a contemporary context.

Extending Harley's Work to Digital Geographical Information Technologies in Developing Countries

Although Brian Harley was writing as a historian of cartography and his primary focus was upon paper-based cartographic materials, many of his ideas have particular relevance with respect to geographical information systems, remote sensing, and other digital spatial information technologies. However, the applicability of approaches, influenced by his reading of Derrida's deconstructionism and of Foucault's sociology of knowledge, needs to be reexamined in light of the fundamental differences between paper-based maps and digital geographic information.

The focus of deconstructionism is upon the underlying bases of knowledge as presented in texts and other representational forms. Rundstrom (1991) questions the usefulness of such an approach in cultural settings which are non-text based (an admittedly generalized example of these he employs are indigenous peoples of Africa, the Americas, Asia, and Australia). Such a criticism can be extended to the applicability of deconstructionism to digital mapping. Within a digital computer, the cartographic text is ephemeral. The "map" may not exist beyond the computer display and might "exist" there for only a short period of time. How does one deconstruct something which does not exist? Similarly, iconological analysis is made more difficult in the absence of stable images. Within a GIS, symbology on a digital map can be changed with a few keystrokes. Questions raised by deconstructionism surrounding the conditions of authorship can also be problematic. Often it is not clear who the author of digital information might be. For example, who is the author of remote sensing imagery? Now one might argue that there is some confusion here between the concepts of *data* and *information*, with data being the raw measurements and information being some interpretation, classification, or other *value-added* operation applied to the data. Yet, it is often not clear what the lineage of digital geographical information might have been. Often information is utilized without knowledge about the conditions under which the data were collected or what transformations the data have undergone to produce the resulting information.

Rundstrom (1991, p. 6) suggests consideration of the cultural, social, political, and technical *processes* on which all map artifacts are contingent for their political power.

This conception of a *process cartography* situates the map artifact within the mapmaking process and places the entire mapmaking process within the context of intracultural and intercultural dialogues. Although Rundstrom's criticisms refer to the deconstructionist aspects of Harley's work, the questions asked within Rundstrom's conception of a process cartography mesh well with the questions of power/knowledge raised by Harley, based upon his reading of Foucault.

One issue which needs to be considered in promoting the use of digital geographical information technologies is the assertion made by a number of authors (*e.g.*, Pickles 1991) that rather than being used as *information* technologies, the use of GIS and remote sensing by the state and other authorities forms part of a surveillance strategy employed as a means to control local resources and populations. This assertion can be explained by returning to the work of philosopher Michel Foucault (introduced in Chapter Three). One of Foucault's most influential books, *Discipline and Punish* (1977), traces the rise of the modern penal system. One of the concepts central to his study was that of Jeremy Bentham's late eighteenth century model architectural plan for a prison, the Panopticon[1]. The Panopticon (pan + optic = all seeing) was designed as a circular building to house inmates (or the insane, factory workers, school children) in individual cells with a tower in the middle where the guards or supervisors would be situated. The architectural arrangement and lighting allows supervisors to observe each of the cells without themselves being seen. The prisoner in the Panopticon is "seen, but he does not see; he is the object of information, never a subject in communication." (Foucault 1977, p. 200) The Panopticon differs fundamentally from previous forms of imprisonment and discipline in that the prisoners themselves are implicated in its successful functioning. As Foucault (p. 201) argued, the major effect of the Panopticon is:

[1] A note should be made of the connection between the ideas of utilitarian philosopher Jeremy Bentham (1748 - 1832) and the activities of the British East India Company which were the focus of Chapters Three and Four of this thesis. Bentham published his scheme for the Panopticon, a model prison, in 1791. James Mill (1773 - 1836), a follower of Bentham, published his history of British India (3 Volumes) in 1817, and in 1819 was given a post with the East India Company. David Ricardo (1772 - 1823) published *Principles of Political Economy* in 1817 (influenced by both Bentham and Mill). Ricardo's work is the classic statement of Benthamite economics. John Stuart Mill (1806 - 1873), empiricist philosopher and author of *On Liberty*, was the son of James Mill and obtained a clerkship in the East India Company (through his father's influence) in 1823 and became head of the office in 1856 (Copleston 1967).

> ... to induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power. So to arrange things that the surveillance is permanent in its effects, even if it is discontinuous in its action; that the perfection of power should tend to render its actual exercise unnecessary; that this architectural apparatus should be a machine for creating and sustaining a power relation independent of the person who exercises it; in short, that the inmates should be caught up in a power situation of which they are themselves the bearers.

Through spatial ordering, the Panopticon brings together power, control of individuals, groups, and knowledge by locating individuals in a hierarchical and efficiently visible spatial organization (Rabinow 1984, p. 19)[1]. In addition to providing an efficient means of surveillance, the Panopticon also offers a system of ***normalization*** by which is meant,

> ... a system of finely gradated and measurable intervals in which individuals can be distributed around a norm - a norm which both organizes and is the result of this controlled distribution. (Rabinow 1984, p. 20)

As Rabinow (p. 21) notes, "an essential component of technologies of normalization is the "key role they play in the systematic creation, classification, and control of 'anomalies' in the social body". This requires a vast documentary apparatus by which individuals can be categorized.

> More precise and more statistically accurate knowledge of individuals leads to finer and more encompassing criteria for normalization. This accumulation of documentation makes possible the measurement of overall phenomena, the description of groups, the characterization of collective facts, the calculation of the gaps between individuals, their distribution in a given 'population'. The power of the state to produce an increasingly totalizing web of control is intertwined with and dependent on its ability to produce an increasing specification of individuality. (Rabinow 1984, p. 22; see also Foucault 1977, p. 190)

Foucault takes the concept of the panopticon and extends it as a metaphor of surveillance in modern society. It is the diagram of a mechanism of power reduced to its ideal form: a figure of political technology that may and must be detached from any specific use (p.

[1] Edney (1997, p. 24) has noted that the analogy between map and panopticon is not perfect because maps are (largely) about land, whereas the panopticon is about people. The map's effects, as a geographic panopticon, are not *direct*.

205). Both Gandy (1989) and Poster (1990, p. 93) extend the notion of the panopticon to encompass electronic communication and computer databases as part of the technologies of power (structures of domination in Poster's language, p. 90). This superpanopticon (Poster's term) functions without walls, windows, towers, or guards but still maintains social control by means of invisible inspection and categorization (see also Lyon 1993). By extension, one can suggest that maps can be viewed as a panoptic technology as has been either proposed or alluded to by a number of authors (Harley 1989, p. 13; Pickles 1991; Edney 1993a, p. 65) and, subsequently, that digital forms of geographical information technology (*e.g.*, geographical information systems and remote sensing) have the characteristics of a superpanopticon. In other words, instead of treating maps as communication media, as has been the focus of cartographic theory throughout the 1970s and 1980s, another approach is to view them as surveillance technologies whose basic goals are to foster the technics and ideology of normalization (Pickles 1991, p. 83; 1993).

Unfortunately, largely absent from the literature concerning digital geographical information technologies has been any sort of sustained critique of the political nature of these technologies. Only recently has there been research (Pickles, ed. 1995; Sheppard and Poiker, eds. 1995) that has focused explicitly on the political implications of geographical information systems and other digital spatial technologies. Prior to these publications, critical reflection and assessment have been rare. Aangennbrug (1991, p. 101) observed that,

> The rapid development of GIS in academia, the private sector, and all levels of government has created a booster type atmosphere where critics have been scarce or dismissed as anti-progress. In the rush to join the GIS bandwagon taking stock of basic problems and defining the limits has (*sic*) been rare.

However, Aangeenbrug's own critique of geographical information systems (GIS) focused primarily upon technological limitations and largely neglected political aspects. In a more penetrating examination, geographer John Pickles (1993, p. 453) has commented on the lack of critical engagement within geography about the ethics and sociology of GIS and related technologies:

> Specifically, GIS within the discipline has been largely unconcerned with the needs of marginalized, populist, oppositional groups for access to place and time specific information, and has been much more concerned with the development of large area analyses and generalized systems of monitoring and analysis - the work of the state (federal leasing policy), the military (MX missile siting), or business (optimum transshipment points).

As with "traditional" paper-based cartography, little attention has been paid to the inherent cultural and philosophical biases contained within digital representations of space. Eric Sheppard (1993, p. 459) has argued that technologies such as geographical information systems are inherently biased towards empiricist epistemologies (as opposed to epistemologies based upon structuralism, feminism, post-modernism, etc.), are not neutral, and can fundamentally influence the intellectual directions of the discipline of geography. Lake (1993) made a similar claim with respect to the use of geographical information systems in planning. These positions echo a comment made earlier by Pickles (1991, p. 81) that,

> The reemergence of positivist epistemology and instrumental rationality through the medium of geographic information systems, artificial intelligence, and the development of the surveillant technologies of war, marketing, planning, and production poses an important challenge to the theoretical frameworks within which critical social science is effected.

Further, certain types of perceptions are better represented than others in the rational Cartesian coordinate system employed in geographical information systems (Rundstrom 1995; Sheppard 1995), and, as a result, the knowledge claims of certain social or cultural groups tend to be diminished and marginalized in top-down decision-making processes which make use of GIS technology.

As with Harley's work in the history of cartography, it is argued here that what needs to be considered in a critical manner is the political nature of digital geographical information technologies, particularly in the context of the so-called *developing* countries. Most of the technical development of GIS has taken place in North America and Europe, and most of the GIS initiatives in developing countries have been through the initiatives of aid groups (Coppock and Rhind 1991). Taylor (1991) argued that GIS are products of industrial and post-industrial society and of limited relevance to the development problems of regions in Africa, Asia, and Latin America. To expect that this technology can be simply transferred to these regions and perform functions for which they were not designed may not be wholly reasonable. Similarly, Smith (1980, p. 176) has argued that,

> ... the threat to independence in the late twentieth century from the new electronics could be greater than was colonialism itself. We are beginning to learn that de-colonization and the growth of supra-nationalism were not the termination of imperial relationships but merely the extending of a geo-political web which has been spinning since the Renaissance. The new media have the power to penetrate more deeply into a "receiving" culture than any previous manifestation of Western technology. The results could be immense havoc, an intensification of the social contradictions within developing societies today.

Various researchers (Yapa 1991; Yeh 1991; Klosterman 1995; Subaryono 1996) have discussed the appropriateness of technology such as remote sensing and GIS in developing world contexts. However, few of these authors question the appropriateness of the technology itself; they tend to examine the most appropriate configuration of the technology (*e.g.*, personal computers versus workstations) and institutional barriers to implementation. As Taylor (1991, p. 73) has argued,

> ... to understand GIS in developing nations, it is necessary to understand the challenges and context of development which is itself a constantly changing panorama. This is not primarily a technical problem.

In the mainstream geographic information system and remote sensing literature, Fox (1991, p. 69) offers one of the few critical commentaries regarding the introduction of these technologies in Asia:

> Questions on how spatial information systems will influence public participation in land-use decisions, how this technology will affect the function of offices using spatial data, and how this technology can be used to resolve conflicting social and economic issues have not been examined. Yet the tendency in most Asian countries for strong governments and weak public participation in the decision-making process does not portend well for the use of this technology in a manner that equally benefits all members of society. The political and economic interests that currently control local and regional governments will probably grow stronger and more entrenched through the availability of these systems, while ordinary citizens may be even more excluded from access to political and bureaucratic power.

> Rapid access to information on land and land ownership will affect how land is used and will open the door for possible abuses of privacy and of social and political institutions. The possible consequences of this technology need to be examined carefully in the context of the social, economic and political institutions of each Asian nation.

When examining the use of digital geographical information technologies for achieving sustainable development in developing countries, a number of important considerations need to be addressed. These include access to geographical information technology, access to geographical information, and determination of what constitutes valid information (*i.e.*, control of geographical information creation). These three issues will form the basis for the rest of the discussion.

Access to Geographical Information Technology

The first consideration in this critical assessment concerns access to the technology itself. Access to technology can be restricted in a number of ways. These can include economic, socio-cultural, or political barriers. In developing countries, where the gap between rich and poor is substantial, only those few individuals or organizations with access to substantial financial resources will be able to afford the necessary computer hardware and software and to purchase or otherwise collect the required data. Because of the complexity of spatial data structures and the volumes of data involved, powerful (and therefore more expensive) computers are generally a prerequisite. Computer-based technology also requires considerable physical infrastructure apart from the immediate hardware and software requirements. Operation of the equipment generally requires dust-free, air-conditioned environments and stable power supplies, which are often not available, particularly in rural villages. Increasingly, acquisition of information requires access to the quickly expanding "information superhighway", but in a country where even basic telephone service is still not widespread, even in urban areas, the gap between the data "haves" and "have-nots" is increasing substantially.

As well as the physical infrastructure, human infrastructure is an important consideration. When basic literacy rates are low and map literacy rates even lower, it is difficult to conceive of widespread adoption of a rather sophisticated set of computer-based spatial information tools. Further, the vast majority of the software interfaces use the English language which decreases accessibility to non-English speaking individuals. Access to geographical information technologies, and the information derived from them, will tend to be restricted to the elite within society, many of whom have been educated at Western universities and are perhaps less sensitive to local needs and conditions.

With greater utilization of geographical information technologies for decision making, it can be expected that the separation between rich and poor will widen and that those without access to the technology and the information derived from it, will be further marginalized in the decision-making process. As Weiner *et al.* (1995, p. 30) have asserted,

> The digital landscape becomes a terrain for elite planners to negotiate social differences and territorial conflict. In the process, workers, minorities, women, poor peasants, and the unemployed, become even further distanced from decision-making processes.

As with the cartographic tools used to further imperial objectives, the use of remote sensing and geographical information systems allows for decisions to be made at locations far removed from the places the decisions actually affect. The decision maker may have never visited the area being considered, never met with the people living there and, never gotten personally involved in the community. Yet the lives and livelihoods of the local population are impacted substantially based upon the lines on a map and the attributes in a database.

Yet, of the three issues identified (access to technology, access to information, and control of information creation), access to geographical information technology is probably the most easily addressed. In developing countries, computer hardware prices continue to decrease substantially, and there is often a thriving indigenous personal computer industry, at least in urban areas. Further, inexpensive or public domain software is being written, often with the needs and conditions of developing countries being taken into account (see, for example, Meijerink *et al.* 1988; Yapa 1989). However, access to technology is not, in itself, sufficient. It is access to the information derived from the application of the technology, rather than necessarily direct access to the technology, which is more important in land resource decision making.

Access to Geographical Information

It is often argued that achieving sustainable development entails securing effective citizen participation in decision making (WCED 1987, p. 65). Effective citizen participation cannot occur without greater citizen control over the information on which decisions are based. As stated in Chapter 40 ("Information for Decision-Making")[1] in *Agenda 21* from the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil, in 1992,

> 40.11. Countries, with the cooperation of international organizations, should establish supporting mechanisms to provide local communities and resource users with the information and know-how they need to manage their environment and resources sustainably, applying traditional and indigenous knowledge and approaches when appropriate. This is particularly relevant for rural and urban populations and indigenous, women's and youth groups.

Access to geographical information is important in facilitating citizen participation. Benmouffok (1993, p. 5) argued that it is impossible to have sustainable and equitable development without free access to reliable and accurate information. While completely *free* access is perhaps unrealistic, certainly low cost, publicly available information is an important precursor to effective citizen participation. Technologies such as satellite remote sensing and global positioning systems allow for collection of data much more rapidly and over far larger areas (globally in some instances) than was ever possible in the past. Dissemination of these data via satellite telecommunications can be almost instantaneous and be oblivious to international borders. Integration of these data within a geographical information system allows for manipulation, analyses, and cartographic

[1] The complete text of Chapter 40 is provided in Appendix III.

output in ways difficult, if not impossible, with paper-based cartography, and in a much more timely manner.

If we look specifically at India, the Indian remote sensing programme has become one of the more technically sophisticated programmes in the world today and the most advanced of the so-called developing countries (with the possible exception of China). The year 1965 saw both the establishment of the Indian Institute of Remote Sensing, then known as the Indian Photo-Interpretation Institute, through joint collaboration among the government of the Netherlands, the Survey of India and the ITC, Enschede (Behera 1988, p. 30), and the creation of the Centre for Survey Training and Map Production (Survey of India) at Hyderabad with UNDP assistance (Agarwal 1989, p. 29). The National Remote Sensing Agency (NRSA) was established in 1975 under the national Department of Space. The Department of Space (DOS) / Indian Space Research Organization (ISRO) is the nodal agency for establishing an operational remote sensing system in India (Joseph 1990, p. 31). In 1979 a Landsat Earth Station was established by NRSA near Hyderabad. In the same year India's first earth observation satellite (Bhaskara I) was launched, followed in 1981 by the launch of Bhaskara II. The Bhaskara satellites had a two-band television payload for land applications and a satellite microwave radiometer for oceanographic / atmospheric applications (Joseph 1990, p. 32). In March 1988 the IRS-1A satellite was launched with similar specifications to the Landsat Multispectral Scanner and Thematic Mapper sensors. With the IRS-1A satellite, India was the third country, after the United States and France, to launch a satellite for resource management applications (Fox 1991). A second satellite (IRS-1B) with identical capabilities to the IRS-1A satellite was launched in 1991. Future plans include the launching of additional satellites with greater spatial resolution and possibly microwave remote sensing capabilities.

Even with increased availability of remotely sensed imagery, one of the major barriers to information access is still the cost. However, in terms of the timeliness and completeness of coverage, the cost per square kilometer of collecting remotely sensed satellite imagery is often lower than the cost of ground-based surveying, particularly in more remote areas. Some of the published prices for remote sensing products from the National Remote Sensing Agency are listed in Table 1.

While the cost of these data is expensive relative to the level of average income[1], it is perhaps not unreasonable to believe that a locally focused agency may be able to afford to acquire complete coverage of the geographical area in which it is interested (which is often less than the area covered by the full image scenes) through the purchase of the 512 x 512 pixel or 1024 x 1024 pixel subscenes. Certainly this data source is substantially more expensive than topographic or thematic maps which might be available. However, with thematic and topographic maps, cultural and natural features have already been classified, reflecting the biases and mandates of the agencies which produced the maps. Also, topographic maps can be substantially out of date by the time the local agency is ready to make use of them and there may have been substantial changes upon the ground. One significant advantage of utilizing satellite data is that the imagery can be analyzed and classified based upon criteria that is meaningful in the local context. Certainly this requires some technical training and skill at image interpretation but the possibility does exist that satellite image data could be used effectively at a local level, thus changing the level at which the creation of land information has traditionally been controlled.

Table 1. Prices for Selected IRS Data Products (1992)

Product	Price[1]
Full scene based raw data products[2]	Rs 3300 US$ 300
Full scene based photo products	
1:250,000 B&W Paper Print (72.5 m resolution)	Rs 1200 US$ 120
1:125,000 B&W Paper Print (36.25 m resolution)	Rs 1200 US$ 120
1:250,000 Colour Paper Print (72.5 m resolution)	Rs 3000 US$ 300
1:125,000 Colour Paper Print (36.25 m resolution)	Rs 3000 US$ 300
Subscene segments on Floppy Diskette[3]	
512 pixels by 512 pixels by 4 bands	Rs 600 US$ 60
1024 pixels by 1024 pixels by 1 band	Rs 600 US$ 60

Notes:

[1] Rs - Rupees
[2] A full scene would cover approximately 148 km x 174 km for 72.5 m resolution, 73 km x 87 km for 36.25 m resolution.
[3] 512 x 512 = 37.12 km x 37.12 km for 72.5 resolution, 18.56 km x 18.56 for 36.25 m resolution; 1024 x 1024 = 72.24 km x 72.24 km for 72.5 m, 37.12 km x 37.12 km for 36.25 m

Source: NRSA Data Centre, Hyderabad, 1992.

[1] For comparison, the 1994 estimated gross domestic product per capita for India was US$1,360 and for Canada US$22,760 (CIA 1995).

However, the cultural and political structures within an area will influence strongly if and how digital geographic information technologies are adopted and by whom. In Asia, Fox (1991) argued, the use of spatial information technologies on an operational basis for promoting human welfare or resource management objectives is constrained not by technical issues but by social, economic, and political ones. Fox (pp. 61 - 63) also identified institutional factors as playing a major role in constraining the use of these technologies. Some of the factors he identified include official restrictions, the "culture" of government organizations, the accuracy and sensitivity of land ownership data, lack of proper training resources, high costs, and the sectoral structure of government agencies.

Often more restrictive than economic barriers are the institutional ones. In India, for example, there are substantial barriers to public access of even the most rudimentary geographical information in the form of topographical maps. This is illustrated in restrictions to Survey of India topographical materials. The following statement is from the Survey of India map catalogue (Survey of India 1991).

> Maps of the RESTRICTED Zone
>
> Maps on scales larger than 1:1 million of certain areas, published by the Survey of India are classed as "RESTRICTED". The limit of such areas has been shown by a thick line on the index maps. "Restricted" maps are issued to Government Officials, Educational and Scientific Institutions and Semi-Government Organizations including Public Undertakings for *bona fide* purpose. Applications for such maps must, however, be made on Form O.57 (a) obtainable from any of the Survey of India sales offices mentioned at serials 1, 3, 4 and 5 above. Issues of maps are made subject to the conditions mentioned in the form and these are liable to be revised by the Ministry of Defence, Government of India. Every indent should clearly indicate the purpose for which the maps are required. Private individuals and organizations/commercial firms can also obtain "RESTRICTED" maps subject to their demand being approved by the Ministry of Defence, through the State Government to whom they should apply.

The area classified as restricted is substantial, covering over one third of the entire country (Figure 10). Almost the entire southern coastal state of Kerala falls within the restricted zone. This restricted zone covers all border regions and includes coastal areas (inland to a distance of between 50 to 200 kilometers) and most of the Himalayas (as they border upon China, Pakistan, and Nepal). These areas are some of the most ecologically sensitive in the entire country.

Often, national security is cited as the reason for such restrictions, reflecting a military survey mentality that still dominates the discipline of cartography in many nations (Taylor 1988, p. 145). This can be a limiting factor in the emergence of a new and effective cartography for development.

> Satellite and airborne surveillance systems have confirmed the irrelevance of such policies [relating to military security], but it is a mistake to argue against such policies on technical grounds alone. We must learn to calculate the cost of security restrictions on economic development. (Leatherdale 1992, p. 343)

A strong implication of the restriction on access is that if a group or individual's research does not correspond to official government policy, access to topographical materials will likely be denied. It would seem doubtful that any research which might be critical of government policies or government-sponsored projects would be permitted access.

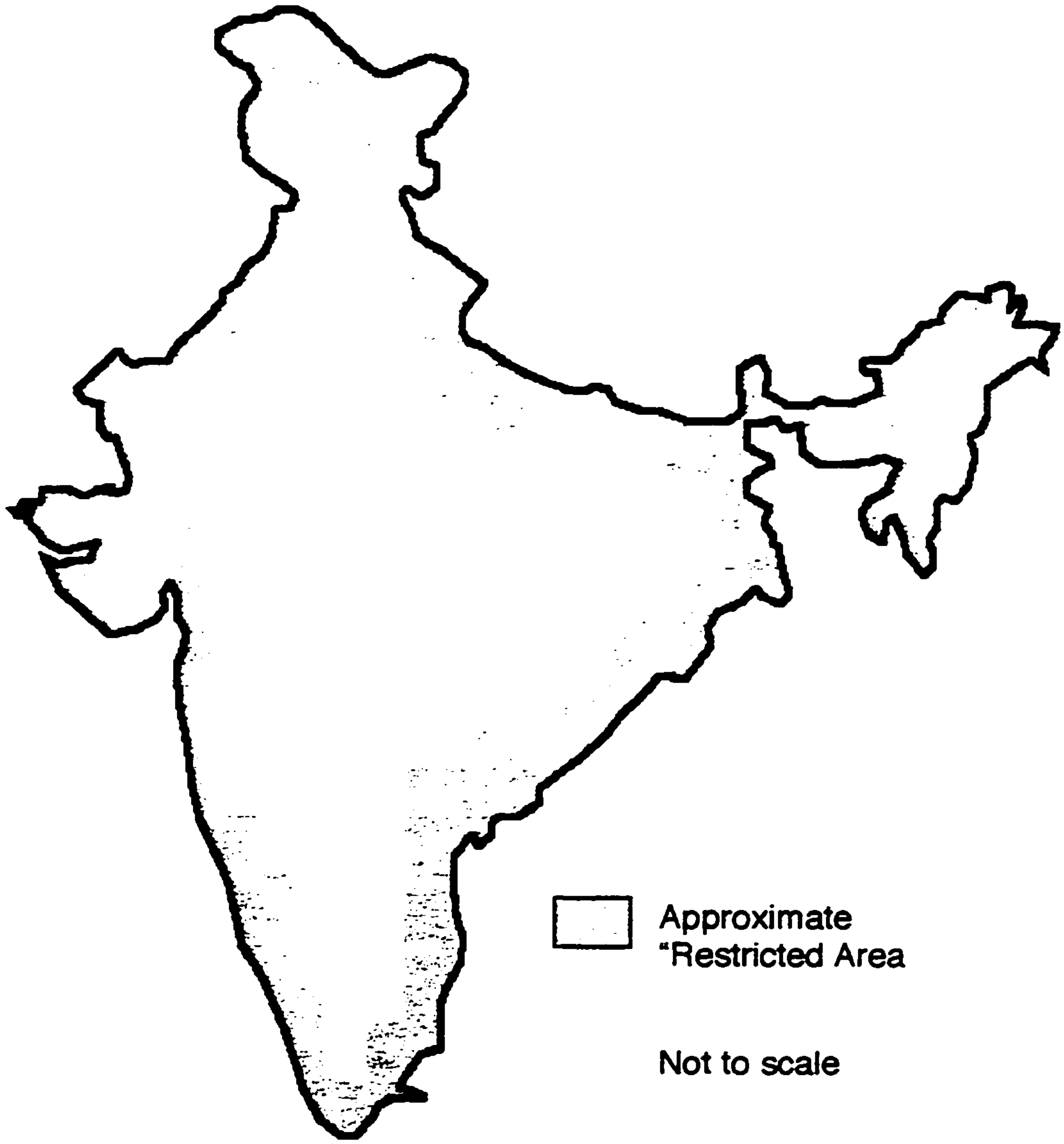
If this is the situation with respect to paper-based standard topographical maps, then certainly similar issues of access need to be raised with regard to digital geographical information. Harley (1990, p. 13) has argued that

> ... generally available *published* maps of any country, issued at a reasonable cost, are the most democratic way of making geographical knowledge about that country and people widely available. Whatever is said to the contrary, there remains the risk that computer technology will remain elitist and that its public availability will be either limited or centrally controlled and that it will be more difficult for ordinary persons to assess data quality (emphasis in original).

He further noted that,

> It is only the topographical map that can inscribe the gestalt of the ordinary landscapes of the world. It is only the topographical map that is intelligible and available to a larger proportion of its citizenry. A topographic picture - an integrated picture - of environmental and social conditions and a topographical record of salient cultural legacies are vital adjuncts to the art of living and to the making of decisions. (p. 17)

Figure 10. Survey of India Topographic Map Coverage



Source: After Survey of India, 1991

However, access to information is of little use if the message being conveyed is not appropriate or applicable to the local circumstances. If the land classification categories employed on the thematic maps are in conflict with local land management categories, the maps will either be ignored or upper-level objectives and decisions will be imposed without sufficient local cooperation. This leads to the final issue in this discussion, namely, control of geographical information creation.

Control of Geographical Information Creation

As well as providing various data products to end-users, the Indian remote sensing programme has its own set of research activities, most of which are application driven (Joseph 1990, p. 31). Behera (1988) lists some of the numerous areas in which satellite imagery is being utilized in India (Table 2) (see also Rashid ed., 1993).

Table 2. Indian Remote Sensing Activities

• drought assessment and monitoring	• forest management
• drought management	• priority watershed delineation
• flood mapping	• land use / land cover mapping
• wasteland development	• soil mapping
• geotechnical / geo-engineering mapping	• saline & alkaline soils mapping
• crop hectarage & production estimation	• ground-water potential
• regional geological study for mineral targeting	• oil exploration

At issue here, however, is not the technical aspects of the introduction of digital geographical information technologies in India[1]. What is of greater concern is the issue of control over the creation and use of land information. Is such an application-driven

[1] This is not meant to imply that technical considerations are not important or that they have been largely resolved. The impact of error in spatial data handling (see, for example, Goodchild and Gopal, eds. 1989) and the representation of multi-scale spatial processes are examples of important technical issues which have not been satisfactorily addressed by the research community.

programme compatible with localized land resource decision making or does it reinforce a centralized, top-down approach? In order to examine this question, one of the most ambitious projects undertaken by the India's National Remote Sensing Agency will be examined. This example from contemporary India, which can be considered with respect to the control over the creation of geographical information, concerns the national programme of wasteland mapping and rehabilitation. However, before discussing the contemporary situation, it is necessary to examine some historical aspects.

It has been argued that a fundamental concern of imperial expansion was land resource extraction (Crosby 1986; Tucker 1988; Guha and Gadgil 1989; Shiva 1989; Gadgil and Guha 1992). The East India Company was concerned with forest and agricultural resource extraction and the profits which it could obtain from these activities. As a result, it is the East India Company's revenue surveying and mapping activities and, later, the imperial Government of India's forest policies that most clearly reflected the imposition of a European, specifically British, perspective upon human-environment relations onto the Indian landscape. As Bayly (1988, pp. 106-107) has stated, the British administration of India was firmly rooted in the principle of private property in land although in practice maximum military and financial security were strong guiding factors. This emphasis upon private land ownership, based upon the Lockean principle of the natural right to property, represented a fundamental break from the previous pre-European periods. Through the use of revenue and forest surveys, the East India Company was able to establish an administrative framework through which land resource extraction could be facilitated, one that was continued by the post-1857 Government of India. These surveys, and the maps derived from them, reflected and reinforced European, in particular British, perspective on human-environment relationships emphasizing private property, as well as the scientific separation of forestry, agricultural production, and animal husbandry. This often contrasted significantly with the land resource practices followed by the local populations, and often resulted in considerable conflict between the indigenous population and the imperial administration.

As argued by Blaikie and Brookfield (1987, p. 104), taxation was used by imperial powers as a major policy instrument for the extraction of commercial produce from farmers without direct acquisition of their land. India traditionally consisted of intensive agrarian societies. As such, much of the wealth of the land derived from agricultural production. The surveying and mapping of the Indian landscape for the purposes of land revenue collection was essential both to the financial operations of the Company and the general governance of the Company's territory, as was noted by Clements Markham, geographer of the East India Company,

> The Revenue Surveys of India are one of the bases on which the whole fiscal administration of the country rests. By their means the wealth of the various provinces is ascertained, as well as their food-producing capabilities, and their power to bear taxation. The surveys furnish the information comprised in agricultural statistics, without which the statesman is deprived of the knowledge enabling him to improve the condition of the people, to increase their means of subsistence, to avert famines, to add to the wealth of the country, and to adjust taxation. (Markham 1878, p. 180, quoted in Kain and Baigent 1992, p. 325)

Whether with the *ryotwari* land revenue system adopted in the Madras Presidency, that was based on a principle of direct collection from each cultivator, or the use of intermediary landlords or *zamindars* as in Bengal Presidency[1], the collection of land revenue by the East India Company was also instrumental in facilitating the expansion of British imperial interests.

> Seizure of the cash land revenues of India between 1757 and 1818 made it possible for Britain to build up one of the largest European-style standing armies in the world, thus critically augmenting British land forces which were small and logistically backward except for a few years during the final struggle with Napoleon. This Indian army was used in large measure to hold down the subcontinent itself, but after 1790 it was increasingly employed to forward British interests in southern and eastern Asia and the Middle East. (Bayly 1988, p. 1)

The revenue surveys of the British had substantial impacts on the local populace even though they did not always achieve the stated goals of fair and equitable settlement. An important aspect of the land revenue administration had to do with the land classification systems utilized by the British administrators. Again, a primary objective of the East India Company was to derive profit from its acquisitions. Thus, any land which was not

[1] It must be noted that the literature on British land policy and systems of land revenue is vast and complex. For more detailed discussions the reader is directed to Baden-Powell (1892), Mukherjee (1962), Mukherjee and Frykenberg (1969), Farmer (1974), Baker (1984), and Robb, ed. (1992).

generating revenue based upon agricultural production was considered *waste*. This was a major incentive for increased survey activity:

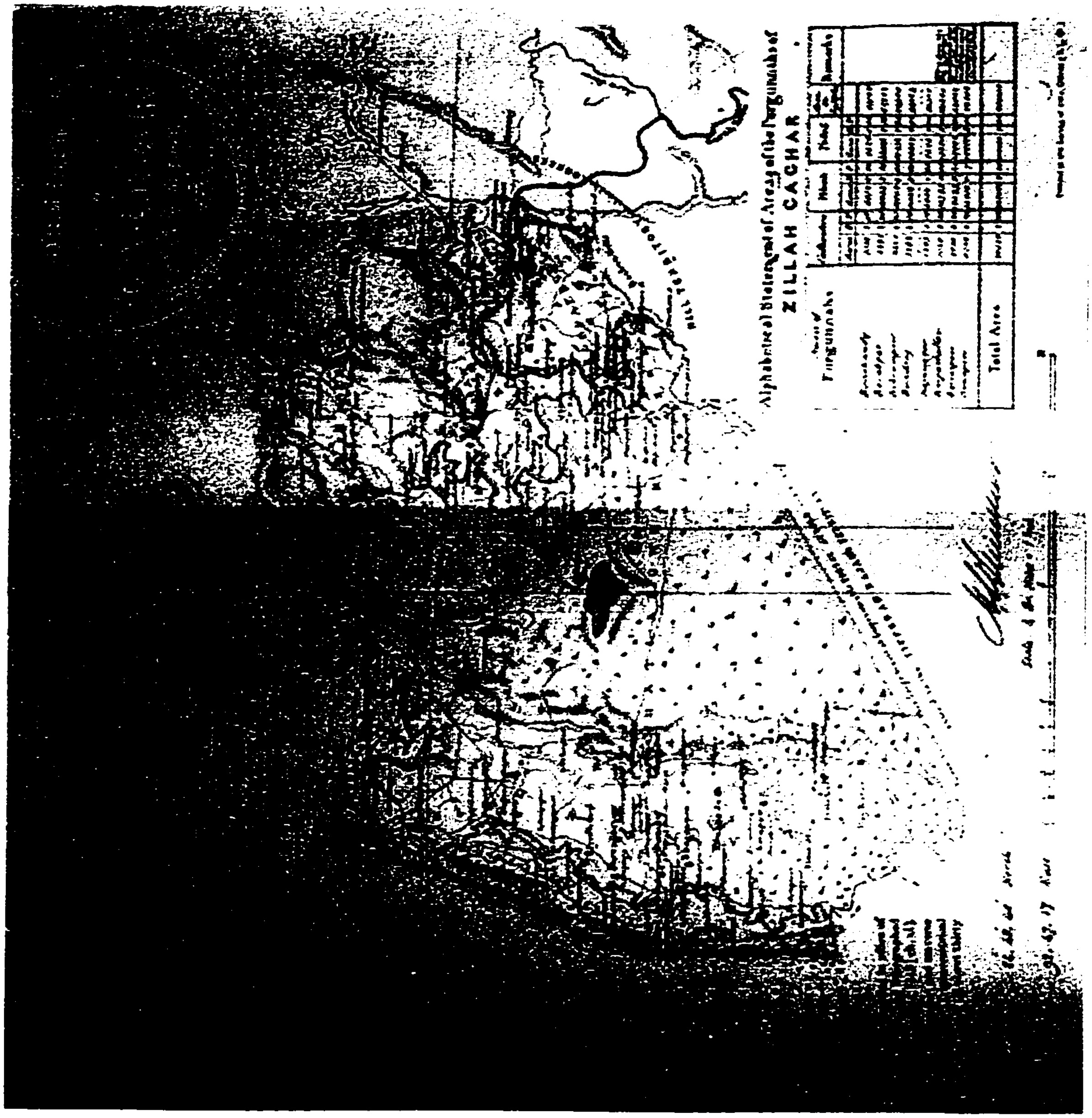
> Land revenue formed a very large proportion of Indian revenues, and it was widely recognized that much revenue, rightly due to Government, was never collected for lack of reliable records. It had long been accepted that the only system fair to Government and to individual *zamindars* and cultivators was to base the settlements on accurate professional surveys, and without such surveys it was impossible to ascertain what land was still lying waste that might be brought into cultivation to become a source of revenue. (Phillimore 1958, p. 7)

The map shown in Figures 11 and 12, from North Eastern India, is illustrative of the sort of information compiled and presented in revenue survey maps. In the accompanying table there are only two categories, cultivation and waste, which are considered as part of the classification. Such a classification does not consider the biophysical importance of the land, any cultural significance, or issues of suitability. Its main consideration is the ability to derive revenue from the land.

Early in the nineteenth century the government in Madras declared itself owner of all uncultivated lands (Farmer 1974, p. 24). Blaikie and Brookfield (1987, p. 103) do note that "the role of the state as ultimate landlord was well established in much of Asia in pre-colonial times."

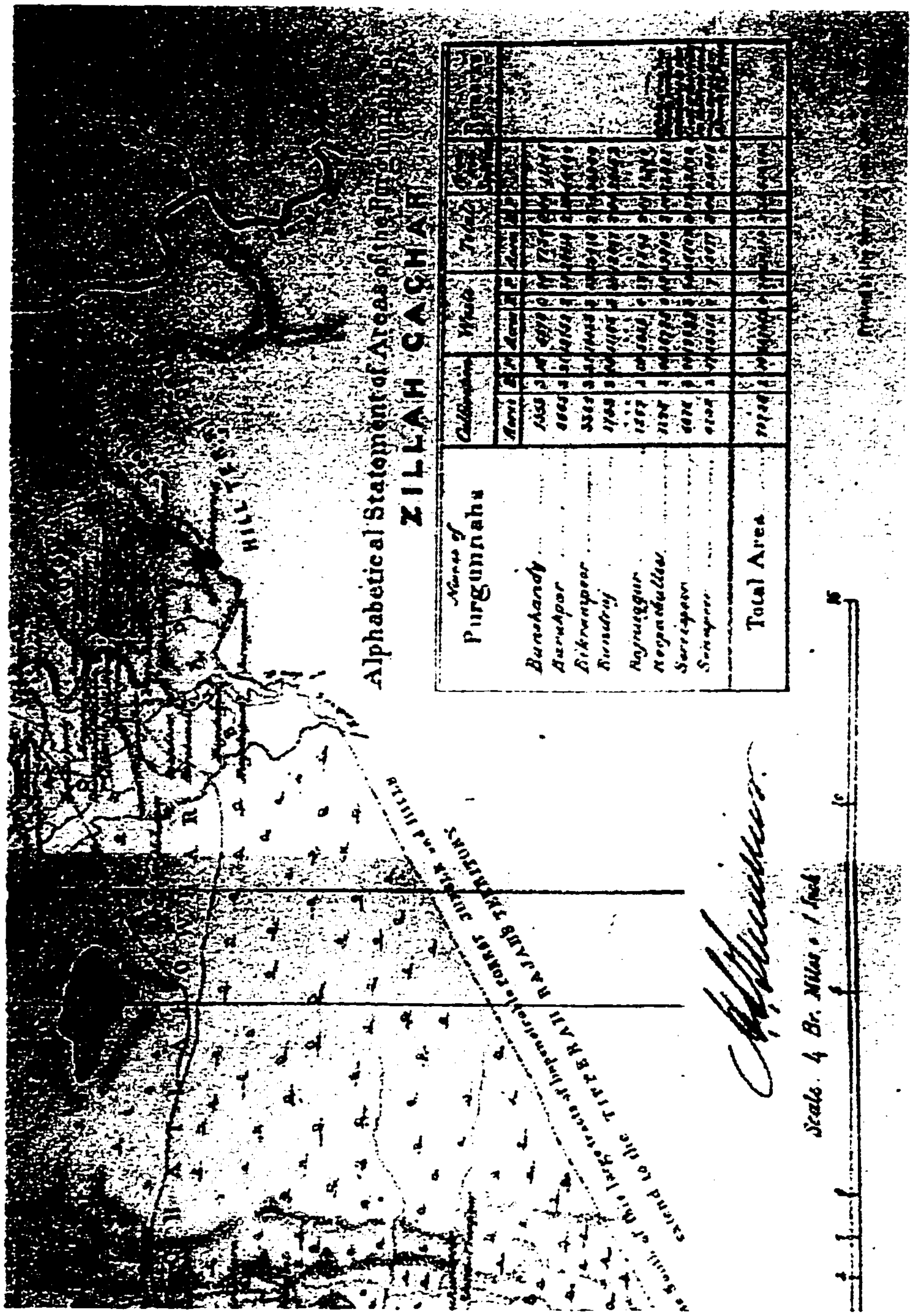
> In Asia, as well as in Africa, an important early step was the declaration of all 'uncultivated waste land' as the property of the state. In much of Asia pre-capitalist states had claimed this title before colonial rule, but there was an important difference in enforcement and purpose. Shifting cultivators were, in general, not restricted in their access to such land before colonialism, but subsequently they were and some of the 'uncultivated waste' land was then granted to European planters. (Blaikie and Brookfield 1987, p. 103)

In pre-colonial times power relations were relatively decentralized and the level of technological development was relatively low (Bryant 1992, p. 23). In the colonial and post-colonial periods these constraints were and are comparatively few and, as a result, control of land resources shifted from local communities to the state. This is elaborated upon by Gadgil (1993, pp. 170 - 171) with specific reference to British India.



Source: Phillimore 1958.

Figure 11. Revenue Survey Map



Source: Phillimore 1958.

Figure 12. Revenue Survey Map (Detail)

> In pre-British times autonomous village communities controlled their own common lands. A council of the leaders of the different caste groups in the village dominated by the upper castes provided a fairly effective community-based system. They involved quotas on quantity of fuelwood gathered or number of cattle grazed, restrictions on season as well as methods. The regulations were enforced by the community employing watchmen from amongst its own members and fining or otherwise punishing offending members. Pre-British regimes recognized the authority of such local communities, which paid taxes to the state as a group and which could both keep out non-group members from common lands and impose sanctions on group members. The British refused to recognize this form of authority; the state dealt directly with individuals to collect taxes and the state judicial apparatus took authority to deal with all offenses, including those relating to utilization of common lands. Common lands became state property controlled either by forest or revenue authorities. Rural people were granted privileges of biomass harvests from such lands without explicitly a particular piece of land being assigned for use by a particular group. No group had authority to prevent others or members of their own group from exercising such privileges, even if their behavior was perceived as leading to excessive resource harvests. This meant that all common lands came under an open-access regime, no man's land subject to totally unregulated usage. The natural outcome was a tragedy of the commons.

Revenue generation was not the only objective of British land classification. The classification was also part of the Company's strategy of maintaining order in the countryside. As Bayly (1988, pp. 107-108) noted,

> Control and distribution of forest and waste land was another important tactic in the settlement of rural society. Here the British broke cleanly with the practice of earlier rulers who had not generally assessed the waste alongside village lands. Instead they sought to parcel out such lands and create forms of private property whose owners would both pay them revenue and aid in the containment of 'unruly' elements. Their aim was to break up unstable concentrations of power on the fringes of the arable. Officials acknowledged that the assessment of waste in ryotwari areas was designed to secure a fixed population and to 'limit the spirit of emigrating'. If populations were to move it was to be the orderly emigration of wage earners from one district to the next, not the irruptions of armed peasant brotherhoods which had occurred in the previous era. (Bayly 1988, pp. 107 - 108)

Collection of information regarding agricultural production also had its basis in maintaining social order and the British fear of rising social unrest as the result of famines. Agricultural departments in the provinces arose in the last half of the nineteenth century, mainly as a result of these concerns (Voelcker 1893, p. 2). Voelcker described the duties of these departments as follows:

- *agricultural enquiry*: the collection of agricultural information to keep the authorities informed of the approach of famine
- *agricultural improvement*: with a view to the prevention of famine in the future
- *famine relief*: to take charge of operation in the campaign against actual famines

Voelcker (p. 2) elaborated:

> It was, perhaps, on the first of the three heads named above [agricultural enquiry] that the Famine Commissioners laid most stress, and the Government of India, in accepting the obligations laid upon them, went still further, and, seeing that no special Department could take (as the Famine Commission had contemplated) the administration of famine relief out of the hands of local officials, turned primarily to the organization of the Land Record system and the simplification of the Settlement operations. Improvements were made in the village establishments which had been created under the Land Record system for compiling annually and collecting the agricultural facts and statistics of every village in each Province; the Provincial Departments were made Departments of Land Records and Agriculture, and to them the maintenance of the above organization was entrusted; also on them was put the duty of examining the Land Records and Village Maps, and from these and by means of local enquiry there was to be made an "agricultural analysis," which should indicate, not only the circumstances on conditions of each tract, but also the requirements of each, whether for protection against famine, or for the improvement of the agricultural system.

In the first half of the nineteenth century, because of the East India Company's reliance upon agricultural revenue through surplus production, the administration viewed forested land largely as an impediment to the expansion of cultivation (Guha and Gadgil 1989, p. 144). As a result, a substantial amount of India's forested lands were converted to agricultural uses. A number of factors led eventually to the creation of a Forest Department in 1866 with help from experts from Germany which, at the time, was the leading European country in forest management (Gadgil and Guha 1992, p. 122). The first of these factors had to do with the environmental degradation caused by extensive deforestation.

> At the time of its creation, about 1866, the Forest Department found the forests of the country fast disappearing before the spread of cultivation, and before the reckless destruction carried on by the people. Agricultural resources were vanishing, and the climate was, not improbably, being affected injuriously. None too soon did the Forest Department step in to prevent the entire deforestation of the country, which would most certainly have taken place. (Voelcker 1893, p. 135)

As Voelcker suggested, one of the rationales behind the creation of the forest department was to counter the climatic effects of deforestation. This rationale, which had its roots in desiccation theory, bears a strong resemblance to contemporary discussions of global climate change and the greenhouse effect. Desiccation theory linked deforestation with rainfall change and generalised climatic change. First formulated by Theophratus in Classical Greece, it was revived between about 1590 and 1700, and became a major factor in promoting the introduction of forest conservancy in India after 1847 (following the establishment of a reforestation programme by the East India Company on the island of St. Helena) (Grove 1990, pp. 21-22).

As well as the purely physical aspects of increasing deforestation, Grove (1990, p. 23) also noted a socio-cultural dimension to the administration's forest policy rationale:

> Moreover, the colonial social critique of tribal forest peoples was already becoming extensive in the 1840s. When environmental damage started to be seen as a product of the agrarian systems of the forest dwellers, the environmental critique helped to reinforce existing social prejudice, and vice versa. It is no coincidence that political pressure for serious ecological controls in forest areas in India built up at the same time, in the late 1830s, as early 'tribal' anthropology began. ....

The tribal populations who generally inhabited the forested areas suffered the most as a result of the "scientifically-based" approach to forest control.

> Throughout the west coast of India, where the forests played a critical part in the early formulation of the scientific conservation ideology of the East India Company, programmes for resource control and conservation were increasingly used to justify political controls for which no other easy rationale could easily be found. Attaching blame to forest tribes for ecological as well as political trouble-making was a logical development at this stage and one that could be used to justify far more oppressive

> controls than might otherwise have developed. and in particular allow any customary land-rights to be ignored. (Grove 1990. p. 31)

The linking of the scientific knowledge of the day with the British administration's concerns with social stability was the impetus for the creation of the Forest Department.

> The combination of unpredictable physical conditions and a powerful state apparatus intimidated by the thought of social unrest meant that a relatively small number of scientists were able to wield a great deal of practical control over colonial land-use policy, although much earlier in French than British territories. This culminated, during the period 1837-47, in a process by which a handful of scientists in the East India Company medical service were able to propagandise connections between deforestation, drought and the threat of economic and social breakdown. These ideas were based largely on the writings of Alexander von Humboldt, whose work at this period was becoming frequently quoted in the new India scientific journals. They proved sufficiently convincing to coerce the East India Company into initiating a rigid forest conservation policy of a kind which it had, until that time, consistently resisted. (Grove 1990, p. 22)

A further political and economic rationale was provided by the events of the Mutiny of 1857. The Mutiny pointed out to British authorities the dangers of isolation and the importance of rapid communication (Shingi and Wadwalker 1986, pp. 4 - 5). The rapid expansion of the railways in the last decades of the nineteenth century and the subsequent demand for timber sleepers brought home the need for some form of forest management (Blaikie and Brookfield 1987, p. 103; Guha and Gadgil 1989, p. 145).

The Forest Act of 1865, which initially established the Forest Department, sought to establish the claims of the state to the forest resources it immediately required, subject to the provision that existing rights not be abridged (Gadgil and Guha 1992, p. 123). This was replaced by a more stringent revised Act in 1878 which aimed to safeguard state monopoly over forests. According to an entry in Volume III (Economic) of the Imperial Gazetteer (1907):

> The basis on which Indian forest law proceeds is that all uncultivated tracts in which private rights have not been acquired, either by individual or by a local community, are the property of the state. (p. 109)

There were two main categories of forests under the Indian Forest Act of 1878. *Reserved Forests* were those in which local people had no rights or privileges and *Protected Forests* were those in which they had certain privileges but no formal rights (Chandran and Gadgil 1993, p. 739). This affected the traditional common property resource characteristics of the forests. Local communities could no longer enforce sanctions to restrict harvesting, either by others or by members of the community itself, and the resulting overuse was then used as a justification for converting protected forests to reserve forests. Guha and Gadgil (1987, p. 145) observed that the Indian Forest Act enacted in 1878 "by one stroke of the executive pen attempted to obliterate centuries of customary use of the forest by rural populations all over India." As Grove (1990, p. 15) stated,

> Colonialism and its successor states have brought about a transformation in the nature of the tenurial relationships between people, forest and other non-arable land. This has involved, in essence, a transition away from locally evolved man-land relations towards direct private property status or to direct state control.

Surveying and mapping had a crucial role to play in imperial forest administration. In 1872 the Forest Survey Branch was established under the Forest Department (Indian Survey Committee 1905, p. 36). The Forest Survey Branch was responsible first for demarcating lands under control of the Forest Department and then surveying and inventorying these lands in detail. In 1900 the Forest Survey Branch came under the authority of the Survey of India and information from the forest surveys was used to supplement topographic surveys. As a result of re-organization of the Survey of India, the Forest Survey Branch was abolished in 1910 with the surveys of forest areas being subordinated to systematic execution of a definite programme of topographical surveys (Survey of India 1966, p. 1).

The Forest Department was originally intended to be a revenue-paying one and was substantially in conflict with agricultural activities. As Voelcker (1893, pp. 135 - 136) noted,

> Indeed, we may go so far to say that its interests were *opposed* to agriculture, and its intent was rather to *exclude* agriculture than to admit it to participation in the benefits (emphasis original).

One of the reasons given by the Forest Department for the exclusion of agricultural activities, especially grazing, from forest lands was that grazing in forests would destroy young seedlings and make natural reproduction of forests impossible (p. 136). Gadgil and Guha (1992, p. 141) stated:

> Grazing and shifting cultivation, the life-blood of tens of millions of Indians, were singled out by foresters as activities to be totally banned in areas under their control. Such hostility bears the mark of its origins, for, in other countries dominated by German forestry techniques, agriculture and forestry were likewise considered separate and often opposed activities.

The traditional forest activity most in conflict with the imperial forest policies was the practice of *jhum* or shifting cultivation (also termed *dhya*), generally practiced by 'tribal' groups in the hill areas of India. *Jhum* involved clearing tracts of forest which were cultivated for a relatively short period of time (*e.g.*, five years) and then left fallow for an extended number of years (Gadgil and Guha 1992, p. 150). Forest administrators viewed the practice as backward and primitive, and as one which greatly diminished the economic value of the timber resource. Yet, for most of the tribal population who practiced *jhum*, it was intricately linked with their culture and spirituality. There was often stiff resistance to imperial forest policy by the shifting cultivators and the conflict between the tribal population and the forest administration was often violent (pp. 150 - 158; Jewitt 1995). As argued by Jewitt (pp. 73 - 74), this image of "a childlike 'native' population benefiting from the 'stern' paternalistic rule of a 'superior' colonial power" (p. 73) was thoroughly Orientalist in character.

Shiva (1991; 1989) suggested that the separation of forests from agricultural and animal husbandry (which traditionally had been linked sustainably through nutrient cycles) resulted in substantial environmental degradation and unsustainable forestry and agricultural practices as well as considerable social hardship. As Blaikie and Brookfield (1987, p. 103) observed,

> In many parts of India, cultivators used the forest for fuelwood, construction timber, wild foods, spices and as a source of fodder for livestock. Preservation thus adversely affected the self-provisioning ability of local cultivators, and had far-reaching implications for the management also of privately held land.

Additionally, the revenue generation emphasis of imperial forest practices resulted in a change from the largely mixed forests of India to species that had an established market value (Guha and Gadgil 1989, p. 147).

Another major transformation in forest ecology concerned,

> ... the sale, at extremely low prices, of large expanses of woodlands to Europeans for the development of tea, coffee and rubber plantations. Although many areas had been taken over before 1864, in its early years the forest department was besieged with requests for land by coffee and tea planters who enjoyed considerable influence in the colonial administration (Gadgil and Guha 1992, p. 143)

Associated with the expansion of plantations was an even greater need for better road and railway networks and the need for packaging material, both of which also impacted forest exploitation.

A final illustration of strategic value of forest products can be seen by their utilization in the two world wars, both of which had substantial impacts upon the state of India's forests (Gadgil and Guha 1992, pp. 138 - 139). In the First World War, timber and bamboo were required by the war effort for the construction of bridges, piers, wharves, buildings, huts, and ships. The Second World War saw even more extensive exploitation since India was "the sole supplier of timber to the Middle East theatre, and later to the Allied forces in Iraq and the Persian Gulf" (p. 138). When, two years after the end of World War II, India achieved Independence, its forest resources had been considerably diminished from what they had been before the war.

The period following Indian independence saw continuation of imperial forest policies with legislative reinforcement of the right of the state to exclusive control over forest protection, production, and management embodied in the national forest policy of 1952

(Gadgil and Guha 1992, p. 185), and further reflected in the draft Forest Act of 1980[1], that reproduced eighty-one out of eighty-four sections of the 1878 Forest Act (Jewitt 1995). There was also substantial increase in industrial-commercial orientation of forestry, replacing strategic imperial needs as the basis of policy (see also Rangan 1997)[2]. It was noted above, concerning imperial land revenue practices that the British introduced, as part of their land revenue administration, a notion of *wastelands* which was a category of lands which did not yield revenue to the imperial administration (Shiva 1989, p. 85). These lands were further characterised as being either cultivable or non-cultivable, the difference being that the former were judged to have the potential for cultivation whereas the latter were not (*e.g.*, bare rock, glaciers). No account was taken in the classification of suitability for cultivation (or other activity) nor was consideration given to ecological factors such as biological productivity. Here a contemporary approach to wastelands is examined with particular emphasis upon the role of geographical information in their treatment. Specifically, the question of whether recent wasteland mapping programmes are substantially different in focus from imperial surveying and mapping activities in terms of objectives, methods, and expected outcomes is examined.

The first national wasteland mapping project undertaken by the National Remote Sensing Agency (NRSA) involved a national mapping project at the scale of 1:1 million. Using Landsat Multispectral Scanner (MSS) imagery from 1980-82 (80 metre spatial resolution), a standard classification scheme for the entire country was developed and area estimates of each wasteland category were made at both the state and the national levels[3]. Reacting to the results of this undertaking, then Prime Minister of India, Rajiv Gandhi, made the following statement in 1985 regarding ecological degradation in his country:

> Continuing deforestation has brought us face to face with a major ecological and socio-economic crisis. The trend must be halted. I propose

[1] The draft 1980 Forest Act was staunchly and successfully defeated (Jewitt 1995).

[2] Rangan (1997) identifies three post-independence phases which have shaped resource policy: 1) Economic Reconstruction, 1947-1969; 2) Self-Sufficiency and Import Substitution, 1970-1985; and 3) Economic Liberalisation, 1985 onward.

[3] Nationally, 32.83 million hectares was estimated to be culturable wasteland (NRSA 1991, p. 26). This represents approximately 11% of the country's total land area of 297 million hectares.

> immediately to set up a National Wastelands Development Board with the object of bringing five million hectares of land every year under fuelwood and fodder plantations. (NRSA 1986, p. 9)

Using information from the initial 1:1 million scale mapping, 146 districts in the country deemed to be critically affected by wastelands were prioritized by the NRSA in conjunction with the National Wastelands Development Board, and mapping was carried out at the scale of 1:50,000 (NRSA 1991, pp. 25-27). The 1:50,000 scale wasteland maps produced by the National Remote Sensing Agency were prepared by visual interpretation of enlarged Landsat Thematic Mapper (TM) False Colour Composite (FCC) imagery (1986-87 period - 30 metre resolution) generated from Bands 2, 3, and 4 (green, red, and near infra-red portions of the spectrum) (NRSA 1991, p. 3). Additional districts were later mapped using Indian Remote Sensing (IRS) satellite data (LISS-II - 36.5 metre resolution) instead of Landsat data. The reported cost of this project was approximately Rs. 30.4 million (about US$1 million at an exchange rate of US$1 = Rs. 30) (National Wastelands Development Board 1990, p. 130). There is no other country which has undertaken such an effort to catalogue the extent of land degradation.

Although the scope of the national wastelands mapping project is technically admirable, the underlying motivation has been criticized. Commenting upon the wastelands recovery programme in her 1989 book, *Staying Alive*, Indian ecologist Vandana Shiva makes the following statement regarding the wasteland development initiatives.

> Recovering five million hectares of the commons in India each year could signal the end of rural poverty and a reversal of the ecological collapse of critical life-support systems like soil, water and vegetation. Yet the wasteland development programme, far from being a recovery of the commons project, will in fact, privatise the commons, accentuate rural poverty and increase ecological instability. In one stroke it will rob the poor of their remaining common resources, the only survival base to which they have access. The usurpation of the commons which began with the British will reach its final limit with the wasteland development programme as is. (Shiva 1989, p. 83)

What is of interest in the context of this research is the role of geographical information in the political ecology of wastelands development. Although much of the political ecology research has focused upon various aspects of environmental *degradation*, Schroeder (1993, p. 350) suggests that a parallel research agenda is also needed to explicitly address the political aspects of environmental renewal or *stabilization*, such as afforestation programmes. Schroeder argues that these types of programmes are no more "neutral", politically, than the processes of environmental degradation which have been the focus of much work in political ecology.

In order to assess the political aspects of geographical information, the meaning of the term *wastelands* needs to be considered. A typical definition of wastelands used by the National Remote Sensing Agency is:

> ...degraded land which can be brought under vegetative cover with reasonable effort, and which is currently under-utilised and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as by location, environment, chemical and physical properties of the soil or financial or management constraints. (NRSA 1991, p. 2)

Most striking with this description is the use of normative valuations of land such as *degraded*, *under-utilised*, *deteriorating*, and *disabilities*. Yet, definitions of the appropriate grade, the proper level of utilization, or the criteria by which deterioration or disability is judged are not addressed in the methodological statements which follow from this definition. Similarly, there is no statement as to why vegetative cover is considered the ideal land cover, irrespective of any biophysical or social context.

As with imperial classifications of wasteland, the classification employed by the National Remote Sensing Agency is generally expressed in terms of agricultural activity. The two-level classification system used for their wasteland maps is shown in Table 3. An important characteristic of this wasteland categorization utilized by the NRSA is that it has been standardized for the entire country. This was viewed as desirable as it would allow for national estimates of wastelands to be consistent. However, considering the incredible biodiversity of India (see, for example, Gadgil 1993), it is questionable whether such generalized categorizations will be useful for actual rehabilitation efforts, which is stated as the *raison d'être* of the 1:50,000 scale wasteland maps. As Weiner *et al.* (1995, p. 38) note with respect to a similar situation in South Africa,

Table 3. Wastelands Classification System

LEVEL I	LEVEL II
1. Cultivable Wastes	1.1. Gullied and/or ravinous land
	1.2. Undulating plain with or without scrub
	1.3. Surface water logged and marsh
	1.4. Salt affected land
	1.5. Shifting cultivation area
	1.6. Degraded forest land
	1.7. Degraded pastures/grazing land
	1.8. Degraded non-forest plantation land
	1.9. Strip lands
	1.10 Sands
	1.11. Mining/industrial wastelands
2. Uncultivable Wastes	2.1. Barren rocky/stony wastes/sheet rock area
	2.2. Steep sloping area
	2.3. Snow covered and/or glacial area

Source: National Remote Sensing Agency 1986, p. 14

> A prescriptive, technicist program that ignores community perceptions and local knowledge by employing "textbook" definitions of agro-ecological potential and constraint is unlikely to address the true needs and capabilities of the inhabitants and may consequently be rejected or resisted.

Similarly,

> Local people use many categories in different parts of the world to describe types of land, landscape, crops, wild plant species and other natural resources. The categories and names used by them usually differ from those used by scientists. In addition, the criteria of classification are usually functional, that is, related to use, unlike the standardized categorization criteria derived from physical sciences. (IDS 1989, p. 31)

Further, as well as being spatially diverse, India's landscapes are temporally dynamic, both seasonally and annually. Yet the imagery from which the wasteland maps were derived is for a single point in time. As acknowledged by the NRSA (1991, p. 11),

> The occurrence of wastelands, as shown on the map, is subject to conditions of land as it was at the time when the satellite data was collected to generate imagery. Since the map is prepared through

> interpretation of imagery, [Survey of India] topo-map and limited field checks, the wastelands shown on the map need actual verification on ground before reclamation measures are contemplated.

In the wasteland mapping project, there is no assessment of *capability* or *suitability* for agriculture or any other activity. This classification system is essentially a descriptive one with respect to land cover. Without consideration of the capability (whether an activity *can* be supported in a given location) or suitability (whether an activity *should* occur at a given location), it is unlikely that rehabilitation efforts based upon this information will be appropriate to local ecological conditions. Moreover, in many instances the wasteland categories themselves are at odds with principles of ecologically sound and sustainable development. For example, in the *Manual of Procedure for Wastelands Mapping Using Remote Sensing Techniques* (NRSA 1986), the category "surface water-logged land and marsh" is defined as:

> Surface water-logged land is that land where the water is at/or near the surface and water stands for most of the year. Marsh is a land which is permanently or periodically inundated by water and is characterised by vegetation which includes grasses and reeds. (p. 15)

As a footnote, the following is also mentioned with regard to this definition:

> Marshes are classified into salt, brackish and fresh water categories depending on the salinity of the water. The importance of eco-conservancy may be taken into account before classifying these lands as wastelands. (p. 15)

Wetlands serve important ecological functions including provision of wildlife habitat and stabilisation of the hydrological cycle, including flood control (Jayal 1987), yet the emphasis in this definition is not upon "eco-conservancy" (the footnote is the only point in the Manual where the concept is mentioned).

As elsewhere in the world, the explanations of environmental degradation in India are often contested. For example, many Indian government and forestry officials view deforestation as largely the result of increasing population pressures, whereas Indian environmentalists and social activists contend that deforestation stems from increasing commercialization of Indian forestry (Haeuber 1993, p. 486). The wastelands mapping project by NRSA is an expert-driven, top-down initiative with very little local involvement. Such a structure does not readily admit to a diversity of perceptions as to what constitutes degradation. As Blaikie and Brookfield (1987, p. 16) have argued,

> There *are* competing social definitions of land degradation, and therefore the challenge of moving away from a single "scientific" definition and measurement must be taken up. This means we must put the land manager 'centre stage' in the explanation, and learn from the land managers' perceptions of their problems.

The wastelands mapping programme of the National Remote Sensing Agency does not do this. It also does not take into account local patterns of land use, nor the role of common lands for meeting the subsistence needs of the poor (Shiva 1991, 168 - 180; 1989, pp. 83 - 86). Instead, it has supported the privatization of common lands classified as *waste* through policies, sponsored by agencies such as the World Bank[1], which have given preference to corporate initiatives instead of local, small-scale approaches to development.

In assessing the use of digital geographical information technology in an undertaking such as the wastelands mapping programme, it is important to distinguish between data acquisition (surveying) and data presentation and dissemination (mapping). Remote sensing is essentially a data acquisition technology. With the wastelands mapping programme, the data collection methods have changed quite substantially from previous land use mapping projects. Yet, the way in which the information is being presented bears remarkable similarity to the revenue mapping activities of the imperial period with the use of standardized "scientific" categories.

Does this mean that digital geographical information technologies are simply means to accomplish the same tasks which have been carried out for years, only in a more rapid manner, thus reinforcing top-down planning and administration? As will be argued in the remainder of this section, the answer to this question is a cautious no.

[1] The World Bank has had substantial involvement in the formulation of India's forest policies with emphasis upon privatization and commercialization (Shiva 1989, p. 84).

Prospects for the Use of Digital Geographical Information Technologies

Typically, control over the cartographic production process has not been in the hands of localized agencies but has tended to rest with larger, centralized government departments or with corporate interests. It is not surprising that the programmes and policies of these organizations may differ substantially from certain non-governmental agencies including environmental, anti-poverty, and women's groups, and that the cartographic products may reflect and reinforce these differences. This was evident in the National Wastelands Mapping Programme. However, with the advent of geographical information systems, it is possible that control can move from large bureaucracies to more localized non-governmental agencies, which may have different social and political agendas.

One example of this is the *Gender Atlas of India* which was produced using Arc/Info (Kumar 1996). This project was undertaken at the Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi. The Gender Atlas is an attempt to communicate information about the socio-economic status of women in different parts of India, and is designed for use by both government and non-government organizations, and by researchers working on gender issues (Kumar 1996, p. 29). This project demonstrates that through the use of GIS technologies, researchers can have substantial control over the cartographic process, which can result in thematic maps and atlases which can shed light on important social issues. Kumar concludes that, based on the experience of producing the Gender Atlas, both paper and electronic atlases can be produced much more rapidly than is possible with conventional cartographic techniques.

Yet, even with the claimed success of the project, the possibility of widespread use of the technology in this manner is questionable. Kumar (p. 35) admits that costs of the technology limits its adoption in developing countries to a handful of government organisations and in some universities in collaboration with foreign funding agencies (this project itself was sponsored by the British Council of India in conjunction with the University of Durham, England).

One critical assessment of geographical information system application in development comes from Weiner *et al.* (1995) who examined a GIS being developed for land and agrarian reform in the Kiepersol locality in the Eastern Transvaal region of post-apartheid South Africa (see also Harris *et al.* 1995 for a complementary article). Their work draws upon regional political ecology and many of the critiques of GIS technology which have been identified in the present research. They argued that, applied cautiously and as part of a participatory process, GIS can allow for multiple representations of the landscape. However, key to their conclusion is the term *participatory*.

In recent years, both paper-based and digital maps have become a tool more readily utilized in participatory research. In an example from the GIS literature, Hutchinson and Toledano (1993) discuss a project for the use of GIS for wasteland development in India involving the U.S. Agency for International Development (USAID) and the Wastelands Development Board under the Ministry of Environment and Forests. Although they argued for the need for a "participatory" approach in demonstrating the technology, at no point did they question whether GIS itself is appropriate in this context. They identified the "clients" of the technology as being district level development officers rather than suggesting a truly bottom-up approach in which the participation of local individuals is sought.

In the research that uses mapmaking in a more localized participatory manner (*e.g.*, Gupta and IDS Workshop 1989, Wickham 1993), the task is often to have local people draw their own maps about the village or area in which they live or work. These maps are then analyzed for the local information they provide and the perceptions of the local people that they reveal. This derives from the mental map work of behavioural geographers (see, for example, Gould and White 1986). Occasionally pre-prepared outline maps are utilized with details to be filled in by the local people and differences between individuals' maps discussed so as to arrive at a "consensus map". Conway (1989) also examined the use of diagrams (not just maps) in participatory research, but again, the focus is upon local people being allowed to draw their own diagrams and not on the use of pre-existing cartographic products. Such approaches may be a much more appropriate use of maps for local participatory development where substantial cultural and/or physical variability exists between locales. In these instances, standardized topographic maps may in fact hinder effective dialogue between researchers or extension workers and local people.

Participatory approaches do not necessarily ensure local control of information and information creation. Often participatory research programmes have benefited outside researchers and development agencies more than the local communities who were the source of the information. Such criticisms have driven the evolution of rapid rural appraisal methodologies (see for example, Chambers 1983; Chambers *et al.*, eds. 1989) to more participatory rural appraisal approaches which are less extractive and less outsider-driven (Wood 1995).

Local control over the information creation process is important to ensure that land resource decisions compatible with local conditions are made. Local control also includes control over not allowing something to be mapped. Should, for example, local communities be allowed to prohibit the mapping of sacred sites? With the advent of satellite imagery and widely disseminated digital information, it becomes much more difficult for local communities to retain control over information relating to them.

> In the case of GIS and the related new technologies of spatial data processing, we must ask whether we are building systems which foster democratic practices or machines which, like their forerunners, will usher in a new age of accounting and accountability, of standardization and normalization, and of competition and capital accumulation. The debate about the struggle to assert the rights of communities and individuals to gain access to public data and to protect private information is little developed in regard to surveillance technologies, and hardly developed at all in regard to GIS. (Pickles 1991, p. 87)

As was indicated in the previous section, although still a substantial inherent bias in the use of geographical information, access to the technology itself is perhaps the most easily addressed aspect. Universities and non-governmental organizations increasingly are able to acquire or otherwise access computer equipment as prices continue to decrease. Of greater interest are the issues of access to information and control over information creation.

In contrast to remote sensing, to date there have been relatively few examples discussed in the literature regarding the use of geographical information systems in India. The expense (both of equipment and often more importantly of data acquisition) and skill requirements have typically imposed significant barriers in the use of this technology. Those cases which have been discussed are often conceptual in nature or limited pilot projects (see, for example, Madras-Waterloo University Linkage Programme 1995; Rashid, ed., 1993).

Yet, even though there are significant obstacles to their use, digital geographical information systems have the potential to provide locally focused agencies more control over creation of mapped information, and can provide a means by which to communicate on a more equal footing with government and judicial agencies. This is increasingly viable with decreasing hardware costs and through the use of relatively inexpensive systems which have been designed with users in lesser developed countries in mind, such as Idrisi from Clark University in the United States and ILWIS from ITC in the Netherlands (Meijerink *et al.* 1988).

Further, the increasing availability of global positioning systems (GPS) technology has made collection of geographically referenced information by local agencies and individuals much more economically feasible than was possible with more traditional survey methods. GPS allow for the acquisition of geographical position based on signals from a series of earth orbiting satellites to accuracies of within 100m (much higher if differential methods are employed which involves the simultaneous use of two GPS units - a base unit left at a site with verified coordinates, and a mobile unit) (Poole 1995, p. 7). Low cost yet effective GPS units can be acquired for under US$500.

Such technology has the possibility to decentralize and allow more local control over land information collection, analysis, production, and dissemination. Examination of the literature indicates a strong acceptance of these technologies for land management decision making as well as computer-assisted cartography (see, for example, Swaminathan, ed. 1993; Hutchinson and Toledano 1993; Agarwal 1989; Nag 1987). That this is becoming an increasingly realistic scenario is evidenced by a recent report published by the Biodiversity Support Program (a USAID-funded consortium of the

World Wildlife Fund. The Nature Conservancy. and the World Resources Institute). Poole (1995) surveyed 63 mapping projects carried out by indigenous communities or their associations. These projects all involved some form of mapping, from sketch mapping and aerial imaging to advanced GIS. and were either community-based initiatives. or. if introduced by outsiders, under local management. Based on this survey. Poole (pp. 2-5) has outlined six ways in which geographical information technologies can be integrated with traditional knowledge:

1) to gain recognition of land rights
2) to demarcate traditional territories
3) to protect demarcated lands
4) to gather and guard traditional knowledge
5) to manage traditional lands and resources
6) to mobilize community awareness and resolve conflicts

Poole suggests some possible matches between application, data requirements, and mapping technology (Table 4) although local circumstances and capabilities will determine the most appropriate match.

Table 4. Matching Applications with Mapping Technology

APPLICATION	DATA NEEDED	MAPPING TECHNOLOGY
Land Use & Occupancy	Maps based upon local knowledge and practice	Sketch mapping, basic mapping, GPS for more accuracy
Demarcation	Positional	GPS, traditional survey methods base maps / images if available
Gathering & Protecting Traditional Knowledge	Traditional environmental knowledge	Sketch mapping, basic mapping, GPS for more accuracy, GIS for map-making
Boundary Monitoring	Sequential visual data	GPS - aerial video satellite imagery, radarsat imagery
Resource Mapping	Local data upon base map	Aerial video/photo - GPS, GIS for map-making
Ecological Recuperation	High resolution imagery	Aerial photography
Impact Monitoring	Aerial imagery	Aerial video/photo - GPS
Resource Management	Comprehensive cultural & ecological information	Aerial video/photo - GPS, satellite, GIS for analysis
Local Communication	Local views & landscape data	Ephemeral maps, sketch maps, aerial photos

Source: Poole (1995, p. 9)

It is most likely that workable solutions to land-resource management will come from local levels. using geographical information creation and dissemination adopted to local circumstances. Introducing geographical information technologies for use at local levels will require a different set of questions being asked than has previously been the case. One question to be asked is whether formalized geographical information is used in land-resource decision making, and, if so, how? By whom? If not, should it be? Informal maps are perhaps adequate for local use, while more formalized cartographic products may be required for transactions with external agencies (Poole 1995, p. 2). Local capacity building in land resource information of course cannot occur in a vacuum. One must ask what is, and what should be, the role of both governmental and non-governmental organizations and what is the role of international development agencies?

Summary

This chapter has attempted to expand the critical perspective introduced in Chapter Three to accommodate digital geographical information technologies such as remote sensing and geographical information systems. especially with respect to their application within land management contexts in developing countries. In order to demonstrate this. the chapter focused upon an example from contemporary India, namely the national wasteland mapping programme carried out by the National Remote Sensing Agency.

Although technically sophisticated, it is argued that this programme has not been substantially different in approach from revenue mapping activities of the imperial period. In fact, the conceptualization of wastelands as unproductive lands is essentially a carryover from the imperial period. The stated purpose of the programme was to provide "basic data on the type and extent of wastelands at village level for management and planning of such lands for proper productive use" (NRSA 1991, p. 2). However, the land classifications employed were standardized for the entire country, irrespective of localized conditions. Only after the satellite imagery was classified into the predetermined categories would the information be utilized at a more localized level. Local perspectives on land utilization would be expected to conform with the top-down categorization imposed upon the data. The use of remotely sensed imagery in this instance has significantly decreased the time required for data collection, and has served to increase the centralization of land use decision making. This does not necessarily mean that the inherent biases of digital geographical information technologies are always towards greater concentration of land resource decision-making power. To examine this further requires extending Brian Harley's perspective introduced in the previous chapters to take into account the unique characteristics of digital versus paper-based mapping.

Brian Harley's critical approach to cartography placed emphasis upon the cartographic artifact (*e.g.*, the map). With digital geographical information, there often is not an artifact which can be studied. The ease by which a digital "map" can be created, manipulated, and deleted means that the map is often ephemeral and does not exist beyond the computer screen. The aspects of Harley's approach which emphasize deconstruction of the text or symbology of the map in some ways become ineffective when there is no "permanent" text to be examined. The fact that there is often no artifact is, in itself, a very important aspect of the nature of digital geographical information.

Rundstrom (1991) argued for the need to examine the cartographic *process* rather than the cartographic text. By focusing upon the entire mapping process, instead of simply the map artifact, the social and political influences upon the construction and use of maps, both analog and digital, can be more fully explored. This focus upon process requires that more emphasis be placed upon the power-knowledge aspects of cartography which Harley adopts from the work of Michel Foucault, and less upon the text-based and iconological aspects.

Three dimensions which affect the creation and use of geographical information have been identified. These are access to geographical information technology, access to geographical information, and control over geographical information creation. By focusing upon these issues, the possible political impacts of geographical information technologies can be more deeply appreciated. Understanding the political impacts of information technologies, geographical or otherwise, becomes increasingly important as their use continues to grow and expand into more and more regions of the world. This is particularly true with respect to human-environmental relations as better information is being promoted as an essential component in many sustainable development strategies.

By examining the inherent biases of the technology across each of these dimensions (as summarized in Table 5), we are in a better position to understand how the use of digital technologies such as remote sensing, geographical information systems, and global positioning systems may influence control of land information. Although there are still significant, primarily economic, barriers of access to technology which bias the use of this technology in favour of the already powerful in society, the costs of hardware and software have been steadily decreasing over the years. Although it unlikely that individual villages will be in a position to acquire and utilize the technology, it is becoming reasonable that locally focused agencies may be able to establish some sort of computer-based mapping capability.

There is, however, cause for concern that the ability to access even basic land information, such as topographic maps, may become more difficult for economically and socially marginalized groups (which are most often without access to computer technology) as more and more information is increasingly available only in digital form. With increasing computerization, the gap between the information haves and have-nots may increase substantially.

Somewhat paradoxical, however, is the fact that digital technologies may overcome the need to acquire geographical information from central agencies. Historically, one of the centralizing tendencies of surveying and mapping programmes has been the substantial costs of data collection (*e.g.*, through field surveys or through aerial reconnaissance). Only well-funded agencies, such as the Survey of India and the National Remote Sensing Agency, have been in a position to be able to undertake such programmes. Because geographical information reflects, implicitly or explicitly, the ideological perspectives of those who have produced it, the information would be biased towards the goals and objectives of the agency which created it. As seen with the information produced by the wasteland mapping programme, even if it is accessible to local decision makers, the information portrayed and the categorizations used may not be appropriate for the context.

Table 5. Inherent Biases of Digital Geographical Information Technologies

ISSUE	INHERENT BIAS
Access to Technology	Strong tendency to increase centralization of information control due to financial costs of hardware and software acquisition. However, both hardware and software costs are decreasing substantially, making this somewhat less of issue.
Access to Information	Digital storage of geographical information means that those without access to the technology may have greater difficulty acquiring even basic information (*e.g.*, topographic maps).
Control Over Data Creation	Technologies such as global positioning systems allow for less expensive and much more decentralized geographically referenced data acquisition than possible with traditional surveying methods. Although centralized due to initial capital costs, provision of relatively inexpensive remotely sensed imagery can facilitate locally controlled land classification. Geographical information systems can allow more localized control over the map creation and dissemination processes.

By focusing upon the issue of control over geographical information creation, some of the decentralizing tendencies in the use of increasingly affordable geographical information technologies can be considered. Although still expensive compared to average income levels, the cost per square kilometer of collecting land cover information by means of remotely sensed data (either paper based or digital), as compared to extensive field studies, is significantly lower. Further, the land use classifications employed can be readily adopted to local circumstances. Similarly, global positioning systems offer a cost-effective approach to collecting geographically referenced data. Finally, even modest geographical information systems designed for use by organizations with small budgets can provide locally focused groups the means by which to achieve greater control over the land information creation process. Poole's (1995, p. *ix*) study of local mapping with respect to biodiversity conservation concluded that there is great potential for the use of these technologies, coupled with non-digital approaches, in five main areas:

- conserve and reinforce local/traditional knowledge;
- amplify community capacities to manage and protect lands;
- raise and mobilize local awareness of environmental issues;
- increase local capacities to deal with external agencies; and
- enable local and global groups to play reciprocal roles in global programs for biodiversity conservation.

There is still much uncertainty as to the ways in which the introduction of digital geographical information technologies may alter political relationships with respect to land resource decision making. The answers to the questions of the societal impacts of the technologies are not simple nor will the answers necessarily be the same in different locales. Maps, geographical information systems, remote sensing, and other similar technologies are not inherently good or bad. However, as this chapter has explored, these technologies do have inherent biases which influence the ways in which they can be used. Learning to recognize and appreciate these inherent biases offers a means by which to gain a better understanding of the possible impacts of the use of these technologies.

CHAPTER SIX - SUMMARY, CONCLUSIONS, RECOMMENDATIONS, AND IMPLICATIONS

Digital geographical information technologies increasingly are being introduced to assist in sustainable development initiatives around the world, and in recent years much has been written about the technical aspects of the use of remote sensing and geographical information systems in land resource management situations, both in developed and developing countries. However, until quite recently, relatively little attention has been given to the political aspects of the introduction of these technologies. As has been shown by many authors (see, for example, Innis 1950, 1951; McLuhan 1964; Ellul 1964; Winner 1986; Haraway 1991) new technologies can have substantial political impacts, often unintended by those who develop and use the technologies. As such, it is somewhat curious that as developments in digital geographical information technologies have embraced quantitative and Cartesian representations of space, the discipline of geography has moved away from these positivistic approaches of the 1960's and has embraced more humanistic approaches including, among others, Marxism, behaviouralism, feminism, postmodernism, and poststructuralism. Even more troubling is that this has occurred with little critical reflection either by GIS and remote sensing practitioners, or by geographers who eschew these technologies.

This research has sought to examine some of the political aspects of the introduction of geographical information technologies. The term *political* was interpreted to mean the "authoritative allocation of values" (Caporaso and Levine 1992, p. 16), and the ways in which authority is reflected in both the map artifacts and the mapping process have been of primary concern in this research. The research has attempted to apply a critical perspective through which the role of geographical information technologies in mediating and altering political and human-environment relationships could be examined. It has attempted to expand the boundaries of previous discussions with respect to these technologies, particularly concerning their introduction into so-called "developing" countries and regions. It has done this by introducing questions about control over data and information (both creation and access) and control over technology (again, both creation and access). These questions are not frequently asked, at least not by GIS and remote sensing practitioners. However, if these technologies are going to be utilized in a manner which is benevolent rather than malevolent, democratic rather than authoritarian, and empowering rather than repressive, then these types of issues must be addressed.

The primary inspiration for this research has come from the writings of an historian of cartography, Brian Harley. As with much of Harley's analysis, the methodology employed for this research is interpretive, as opposed to scientific, in nature. Harley did not provide an explicit methodology or a set of techniques for critically examining cartographic materials but rather sought to ask critical questions of the social and political forces behind cartographic production. Yet Harley's approach did not address how maps and other cartographic materials might influence human-environment relations. In order to account for the effects of geographic information technologies upon human-environment relations, it has been suggested in this research that concepts from political ecology could be informative. Further, because of the lack of explicit examination of the role of information in influencing human-environment relations, it has also been argued that political ecology research could be enhanced through consideration of Harley's work.

Harley's ideas are also extended to account for recent developments in geographical information technologies, particularly remote sensing and GIS. This discussion includes an examination of a contemporary wasteland mapping programme undertaken by the National Remote Sensing Agency. In examining this programme, it is argued that the primary feature which differentiated it from revenue or forest mapping programmes of the imperial period was that the data acquisition component had become significantly less time consuming because of the use of remotely sensed data. Beyond that, it has been suggested that the top-down approach and the land classification employed were not substantially different from the earlier revenue and forest mapping activities.

From this analysis, one conclusion regarding geographical information technologies is that the information provided by these technologies has tended to reflect and reinforce the biases and assumptions, both explicit and implicit, of those involved in the production of the information. This is indicated in both the historical and contemporary examples drawn from India. Perhaps not so obvious is the conclusion that the technologies themselves have inherent political biases which make them more compatible with certain political arrangements. Because of their high cost, many geographical information technologies are biased in favour of the already powerful in society and are not readily conducive to the agendas of participatory local development or democratic governance. This is particularly true of the new digital technologies, contrary to the views of many geographic information system and remote sensing practitioners. In a simplified manner, Tables 6 and 7 summarize the situation of top-down implementation of digital geographical information technologies.

Yet, the conclusion to be drawn is not necessarily a pessimistic one. If the use of geographical information technologies (ephemeral, paper-based, or digital) can be controlled at local levels in a local capacity-building approach, perhaps in collaboration with government agencies, non-governmental organizations, and international development agencies, then the benefits of these technologies which are so often espoused in the literature can in fact be realized. Poole's (1995) survey of indigenous mapping suggests that such efforts are already underway. The key, however, is to recognize and acknowledge the inherent political biases in these technologies. Only by acknowledging the inherent biases of the technology might practitioners be able to overcome them. This has generally not happened to date.

Table 6. Geographical Information Conditions for Participatory Development / Land Management

ISSUE	WHO CONTROLS?	COST?
Access to Technology	Citizens	Low
Access to Information	Citizens	Low
Control Over Data Creation	Citizens	Low

Table 7. Current Conditions of Digital Geographical Information Technology Implementation

ISSUE	WHO CONTROLS?	COST?
Access to Technology	• Government • International Development Agencies • Technology Developed by Western Corporations / Academics	High
Access to Information	• Government • International Development Agencies	High
Control Over Data Creation	• Government • International Development Agencies	High

This suggests many opportunities and challenges to expand and enhance the work presented here. As noted in the introduction, the conclusions and recommendations drawn from this research will be most relevant to GIS and remote sensing practitioners involved in international development work, and for non-governmental organizations operating in developing countries.

For practitioners, there is a need to become more critically engaged. By drawing on the approaches offered by critical theory (as did Harley), practitioners are able to gain a better understanding of the social and political contexts in which mapmaking occurs, and that geographical knowledge (as with other knowledge) is local, contested, and imbedded with power relations. However, as Gregory (1994, p. 10) has stated, the multiple discourses of critical theory seek not only to make social life intelligible, but also to make it better. There is evidence that this is starting to occur with the publication both of a special issue of the journal *Cartography and Geographic Information Systems* concerning GIS & Society (Sheppard and Poiker, eds. 1995), and of the book *Ground Truth: The Social Implications of Geographic Information Systems* (Pickles, ed. 1995), and with a recent National Center for Geographical Information and Analysis (NCGIA) research initiative entitled "GIS and Society: The Social Implications of How People, Space and Environment are Represented in GIS" (Harris and Weiner 1996). This initiative has sought to bring together GIS practitioners and social theorists to discuss issues such as the social history of GIS, the ethics of geographical representation, community-based GIS projects, and the importance of local knowledge and multiple realities.

Of course, remote sensing and GIS practitioners involved in international development generally are not working independently, but often under the umbrella of an international development agency (e.g., USAID, CIDA, the United Nations). Therefore, those responsible for managing development projects and for setting policy must endeavour to be cognizant of the political aspects of geographical information technologies.

As a means of fostering such critical engagement, there are significant opportunities in the area of curriculum development (Warren 1995). Users of digital geographical information technologies must be made aware of the social and political aspects of the use of these technologies, as a complement to the technical training they receive. This has not occurred in most GIS and remote sensing training programmes. For example, in the 1990 Core Curriculum produced by the NCGIA (Kemp and Goodchild 1991), a comprehensive set of materials (1000+ pages) designed for university level education, there was very little consideration of social issues with respect to GIS. The only topic which dealt with social concerns was a section of Legal Issues, and it was included under a broad heading of Other Issues. With the current development of a revised curriculum, the situation has changed substantially. The four main branches of the new Core Curriculum are titled "Fundamental Geographic Concepts for GIS", "Implementing Geographic Concepts in GIS", "Geographic Information Technology in Society"; and "Application Areas and Case Studies". The new emphasis on social (and, by extension, political) issues follows closely from the NCGIA research initiative mentioned above.

There are also activist roles that those involved in mapmaking can take on. These can include becoming involved in community focused mapping for local empowerment (see, for example, Aberly, ed. 1993; Poole 1995; Nietschmann 1995) or increasing public awareness of the biases in maps, as exemplified by the work of Mark Monmonier (1991, 1995). Those considering the introduction of digital geographical information technologies into a specific locale need to be mindful of the notions of ecological and economic inappropriateness with regard to science and technology (Shiva 1991, pp. 233-234):

> Ecologically and economically inappropriate science and technology can become causes of underdevelopment, not solutions to underdevelopment. Ecological inappropriateness is a mismatch between the ecological processes of nature which renew life support systems and the resource demands and impacts of technological processes. Technological processes can lead to higher withdrawals of natural resources or higher additions of pollutants than ecological limits allow. In such cases they contribute to underdevelopment through destruction of ecosystems.
>
> Economic inappropriateness is the mismatch between the needs of society and the requirements of a technological system. Technological processes create demands for raw materials and markets, and control over both raw materials and markets becomes an essential part of the politics of technological change.

Developing means by which to assess inappropriateness on a project specific basis would be an important contribution. This would likely involve drawing upon the extensive research from social impact assessment and monitoring (for an overview of this area of research, see Lang and Armour 1981; Branch *et al.* 1984). Further, in assessing whether GIS and related technologies are appropriate, the broader context of appropriate technology needs to be acknowledged. Yapa (1991, p. 52) has argued that full implementation of appropriate technologies (beyond information technologies) in a locale is not possible without GIS, because GIS provides a means for "discovering" local resources contextually. Without this knowledge of local resources, appropriate technology cannot evolve as a viable alternative to current modes of development. This is an area of inquiry which needs to be encouraged.

Another important area for researchers to consider is the continual development of low cost yet effective means by which digital geographical data can be collected, stored, manipulated, analyzed, and presented. The work of the Idrisi Project at Clark University in the United States, and of the ILWIS developers at ITC in the Netherlands demonstrates that inexpensive but effective software can be designed for users who do not have access to state-of-the-art facilities and equipment (Meijerink *et al.* 1988). Much more of this sort of work, both by non-profit and commercial agencies, in both developed and developing countries, needs to be accelerated. Both Yapa (1991) and Edney (1991b) have argued for relaxation of proprietary rights over existing GIS software or provision of low cost / no cost software which can build on the computer infrastructure already in existence in developing countries.

It seems certain that geographical information technologies will play a significant role in India's efforts towards sustainable development (as well as in other locales). The ways in which these technologies will be employed still remain uncertain. Continuation down the present path of technological development will most likely help perpetuate the present socio-economic and political inequities. The beneficial (however defined) use of these technologies will require much closer attention to the issues raised here.

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APPENDIX II - Summary of Selected Historical Events

General historical events
Surveying and mapping events
Other information collection and publication events

1498	Vasco da Gama first reached India
1600	British East India Company established
1612	British East India Company "factory" established at Surat
1628	British East India Company "factory" established at Masulipatam
1640	British East India Company "factory" established at Madras
1723	**French geographer Delisle publishes maps of southern coasts of India which give a fair picture of the general outline**
1737	**French geographer Bourguinon d'Anvile's map of India published based upon reports from Jesuit missionaries**
1757	Battle of Plassey leads to East India Company's political dominance in Bengal; British now firmly established as Indian power
1763	Jagir lands (near town of Madras) granted to East India Company by Nawab of Arcot
1765-1771	**James Rennell undertakes survey of Bengal**
1767	**Survey department established in Calcutta**
1767-1774	**Thomas Barnard undertakes revenue survey in Jagir lands**
1768	Circars (north of Krishna River in Madras Presidency) granted to East India Company by Nawab of Arcot
1776	Adam Smith publishes *Wealth of Nations*
1788-1794	**Trigonometric surveys carried out in Madras Presidency by Michael Topping (Madras Astronomer) and John Goldingham (assistant)**
1784	Pitt's India Act expands parliamentary control over East India Company; right of patronage retained by Company
1784	Asiatic Society founded (Calcutta)
1792	**Michael Topping establishes Madras Observatory**
1792	**Survey department established in Bombay**
1793	**Permanent Settlement for land revenues introduced in Bengal Presidency**
1798-1815	**Earliest effective taxation surveys of Madras [Presidency] under British rule were made and reduced to one inch to a mile (1:63,360) (based on Lambton's triangulation)**
1799	East India Company defeats Tipu Sultan at Seringapatam, Mysore
1799-1808	**Colin Mackenzie's survey of Mysore**
1802-1806	**William Lambton initiates triangulated survey in Madras Presidency**
1807	Geological Society of London founded
1810	**Survey department established in Madras**
1814	Conclusion of war with France
1815	*Walter Hamilton's East India Gazetteer published*
1815	**Survey departments abolished in Madras and Bombay**
1817	**Great Trigonometrical Survey commences (extending Lambton's earlier work)**
1822	**Aaron Arrowsmith publishes Atlas of the South Peninsula**
1823	**William Lambton dies; George Everest becomes Superintendent of the Great Trigonometrical Survey**
1823	**Atlas of India begins production at order of Court of Directors, East India Company**
1823	**Revenue surveys commenced in North West provinces**
1825-30	**George Everest returns to England (for health), learns new developments in surveying)**
1830	Royal Geographical Society founded (London)
1833	British East India Company ordered to cease trade activities but allowed to continue as administrators
1834	**posts of Deputy Surveyor General (Bombay and Madras) abolished**

1837	**Survey of India begins regular fiscal surveys plotted on maps at four inches to a mile (1:15,840), which become known as the Revenue Surveys**
1843	**George Everest dies; Great Trigonometrical Survey has been extended from south of the subcontinent to Dehra Dun in the Himalayas**
1843	**Andrew Waugh becomes Surveyor General**
1844-51	**John Ouchterlony carries out detailed survey at 1,000 feet to an inch in Nilgiri Hills (Madras Presidency) which distinguished Government land from tribal land**
1851	**Official manual of surveying for India published (Smyth and Thuillier)**
1854	*Edward Thorton's Gazetteer of the Territories under the Government of the East India Company published*
1855	**Madras Government determines that systematic surveys throughout the whole presidency are essential - should be based upon GTS without being a full topographic survey**
1857	Mutiny
1857	**Commencement of first Presidency-wide land revenue survey in Madras**
1858	Government of India Act & Proclamation extends crown rule to India
1861	**Andrew Waugh publishes "Instructions for Topographical Mapping" (adopts rules in Thuillier's manual for topographic mapping)**
1861	**Andrew Waugh retires as Surveyor General in March; H. L. Thuillier becomes Surveyor General; James Walker becomes Superintendent Trigonometrical Surveys; Waugh saw completion of the principal triangulation north of parallel 24°**
1861	**Under H. L. Thuillier's administration the Survey Department was reorganized into three distinct branches (topographic, trigonometric, revenue)**
1872	*Completion of 1st census covering British India*
1865	First Indian Forest Act introduced
1866	Forest Department established
1871	Agriculture Department first established
1872	**Forest Survey Branch established within Forest Department**
1877	Queen Victoria proclaimed Empress of India
1878	**Thuillier retires as Surveyor General; James Walker becomes Surveyor General**
1878	**Survey of India created and three distinct branches amalgamated**
1878	Agriculture Department abolished
1878	Revised Forest Act introduced
1880	Report of Famine Commission (famines in 1876-1879, 1896-1900)
1881	Agriculture Department reconstituted
1881	*1st all-India synchronous census*
1881	*First edition of Imperial Gazetteer of India published*
1885-1887	*Second edition of the Imperial Gazetteer published*
1900	**Forest Survey Branch comes under authority of Survey of India**
1905	**Report of the Indian Survey Committee released**
1907-1909	*New revised edition of the Imperial Gazetteer published*
1910	**Forest Survey Branch abolished**
1911	**Survey of India Handbook of Topography published**
1927	**Indian Air Survey Committee formed**
1928	**Wild Phototheodolite purchased**
1943	Great Bengal famine
1939-1945	World War II (**Survey of India responsible for much military mapping)**
1947	Indian Independence and partition of India and Pakistan
1948	**Heaney (Surveyor General) initiates proposal for training of Survey of India officers in London as prelude to introduction of photogrammetric survey in India**
1950	Uttar Pradesh introduces Zamindari Abolition & Land Reforms Act (1st of many major reform laws by Indian states)
1951	India initiates 1st of a series of Five Year Plans for economic development
1956	Reorganization of Indian states on linguistic lines
1965	**Indian Photo-Interpretation Institute established (later becomes Indian Institute of Remote Sensing)**

1965	**Centre for Survey Training and Map Production established by Survey of India at Hyderabad**
1975	**National Remote Sensing Agency established**
1979	**Landsat Earth Station established by NRSA near Hyderabad**
1979	**Bhaskara I (earth observation satellite) launched (Bhaskara II launched in 1981)**
1985	**Establishment of the National Wastelands Development Board**
1988	**IRS-1A satellite launched (IRS-1B launched in 1991)**

Sources: Agarwal 1989; Kain and Baigent 1992; Phillimore 1945-1968; Swartzberg (ed.) 1978

APPENDIX III - Agenda 21: Chapter 40

REPORT OF THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

(Rio de Janeiro, 3-14 June 1992)

Chapter 40

INFORMATION FOR DECISION-MAKING

INTRODUCTION

40.1. In sustainable development, everyone is a user and provider of information considered in the broad sense. That includes data, information, appropriately packaged experience and knowledge. The need for information arises at all levels, from that of senior decision makers at the national and international levels to the grass-roots and individual levels. The following two programme areas need to be implemented to ensure that decisions are based increasingly on sound information:

(a) Bridging the data gap;

(b) Improving information availability.

PROGRAMME AREAS

A. Bridging the data gap

Basis for action

40.2. While considerable data already exist, as the various sectoral chapters of Agenda 21 indicate, more and different types of data need to be collected, at the local, provincial, national and international levels, indicating the status and trends of the planet's ecosystem, natural resource, pollution and socio-economic variables. The gap in the availability, quality, coherence, standardization and accessibility of data between the developed and the
developing world has been increasing, seriously impairing the capacities of countries to make informed decisions concerning environment and development.

40.3. There is a general lack of capacity, particularly in developing countries, and in many areas at the international level, for the collection and assessment of data, for their transformation into useful information and for their dissemination. There is also need for improved coordination among environmental, demographic, social and developmental data and information activities.

40.4. Commonly used indicators such as the gross national product (GNP) and measurements of individual resource or pollution flows do not provide adequate indications of sustainability. Methods for assessing interactions between different sectoral environmental, demographic, social and developmental parameters are not sufficiently developed or applied. Indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems.

Objectives

40.5. The following objectives are important:

(a) To achieve more cost-effective and relevant data collection and assessment by better identification of users, in both the public and private sectors, and of their information needs at the local, provincial, national and international levels;

(b) To strengthen local, provincial, national and international capacity to collect and use multisectoral information in decision-making processes and to enhance capacities to collect and analyse data and information for decision-making, particularly in developing countries;

(c) To develop or strengthen local, provincial, national and international means of ensuring that planning for sustainable development in all sectors is based on timely, reliable and usable information;

(d) To make relevant information accessible in the form and at the time required to facilitate its use.

Activities

(a) Development of indicators of sustainable development

40.6. Countries at the national level and international governmental and non-governmental organizations at the international level should develop the concept of indicators of sustainable development in order to identify such indicators. In order to promote the increasing use of some of those indicators in satellite accounts, and eventually in national accounts, the development of indicators needs to be pursued by the Statistical Office of the United Nations Secretariat, as it draws upon evolving experience in this regard.

(b) Promotion of global use of indicators of sustainable development

40.7. Relevant organs and organizations of the United Nations system, in cooperation with other international governmental, intergovernmental and non-governmental organizations, should use a suitable set of sustainable development indicators and indicators related to areas outside of national jurisdiction, such as the high seas, the upper atmosphere and outer space.

The organs and organizations of the United Nations system, in coordination with other relevant international organizations, could provide recommendations for harmonized development of indicators at the national, regional and global levels, and for incorporation of a suitable set of these indicators in common, regularly updated, and widely accessible reports and databases, for use at the international level, subject to national sovereignty considerations.

(c) Improvement of data collection and use

40.8. Countries and, upon request, international organizations should carry out inventories of environmental, resource and developmental data, based on national/global priorities for the management of sustainable development. They should determine the gaps and organize activities to fill those gaps. Within the organs and organizations of the United Nations system and relevant international organizations, data-collection activities, including those of Earthwatch and World Weather Watch, need to be strengthened, especially in the areas of urban air, freshwater, land resources (including forests and rangelands), desertification, other habitats, soil degradation, biodiversity, the high seas and the upper atmosphere. Countries and international organizations should make use of new techniques of data collection, including satellite-based remote sensing. In addition to the strengthening of existing development-related data collection, special attention needs to be paid to such areas as demographic factors, urbanization, poverty, health and rights of access to resources, as well as special groups, including women, indigenous peoples, youth, children and the disabled, and their relationships with environment issues.

(d) Improvement of methods of data assessment and analysis

40.9. Relevant international organizations should develop practical recommendations for coordinated, harmonized collection and assessment of data at the national and international levels. National and international data and information centres should set up continuous and accurate data-collection systems and make use of geographic information systems, expert systems, models and a variety of other techniques for the assessment and analysis of data. These steps will be particularly relevant, as large quantities of data from satellite sources will need to be processed in the future. Developed countries and international organizations, as well as the private sector, should cooperate, in particular with developing countries, upon request, to facilitate their acquiring these technologies and this know-how.

(e) Establishment of a comprehensive information framework

40.10. Governments should consider undertaking the necessary institutional changes at the national level to achieve the integration of environmental and developmental information. At the international level, environmental assessment activities need to be strengthened and coordinated with efforts to assess development trends.

(f) Strengthening of the capacity for traditional information

40.11. Countries, with the cooperation of international organizations, should establish supporting mechanisms to provide local communities and resource users with the information and know-how they need to manage their environment and resources sustainably, applying traditional and indigenous knowledge and approaches when appropriate. This is particularly relevant for rural and urban populations and indigenous, women's and youth groups.

Means of implementation

(a) Financing and cost evaluation

40.12. The secretariat of the Conference has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about $1.9 billion from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Institutional means

40.13. Institutional capacity to integrate environment and development and to develop relevant indicators is lacking at both the national and international levels. Existing institutions and programmes such as the Global Environmental Monitoring System (GEMS) and the Global Resource Information Database (GRID) within UNEP and different entities within the systemwide Earthwatch will need to be considerably strengthened. Earthwatch has been an essential element for environment-related data. While programmes related to development data exist in a number of agencies, there is insufficient coordination between them. The activities related to development data of agencies and institutions of the United Nations system should be more effectively coordinated, perhaps through an equivalent and complementary "Development Watch", which with the existing Earthwatch should be coordinated through an appropriate office within the United Nations to ensure the full integration of environment and development concerns.

(c) Scientific and technological means

40.14. Regarding transfer of technology, with the rapid evolution of data-collection and information technologies it is necessary to develop guidelines and mechanisms for the rapid and continuous transfer of those technologies, particularly to developing countries, in conformity with chapter 34 (Transfer of environmentally sound technology, cooperation and capacity-building), and for the training of personnel in their utilization.

(d) Human resource development

40.15. International cooperation for training in all areas and at all levels will be required, particularly in developing countries. That training will have to include technical training of those involved in data collection, assessment and transformation, as well as assistance to decision makers concerning how to use such information.

(e) Capacity-building

40.16. All countries, particularly developing countries, with the support of international cooperation, should strengthen their capacity to collect, store, organize, assess and use data in decision-making more effectively.

B. Improving availability of information

Basis for action

40.17. There already exists a wealth of data and information that could be used for the management of sustainable development. Finding the appropriate information at the required time and at the relevant scale of aggregation is a difficult task.

40.18. Information within many countries is not adequately managed, because of shortages of financial resources and trained manpower, lack of awareness of the value and availability of such information and other immediate or pressing problems, especially in developing countries. Even where information is available, it may not be easily accessible, either because of the lack of technology for effective access or because of associated costs, especially for information held outside the country and available commercially.

Objectives

40.19. Existing national and international mechanisms of information processing and exchange, and of related technical assistance, should be strengthened to ensure effective and equitable availability of information generated at the local, provincial, national and international levels, subject to national sovereignty and relevant intellectual property rights.

40.20. National capacities should be strengthened, as should capacities within Governments, non-governmental organizations and the private sector, in information handling and communication, particularly within developing countries.

40.21. Full participation of, in particular, developing countries should be ensured in any international scheme under the organs and organizations of the United Nations system for the collection, analysis and use of data and information.

Activities

(a) Production of information usable for decision-making

40.22. Countries and international organizations should review and strengthen information systems and services in sectors related to sustainable development, at the local, provincial, national and international levels. Special emphasis should be placed on the transformation of existing information into forms more useful for decision-making and on targeting information at different user groups. Mechanisms should be strengthened or established for transforming scientific and socio-economic assessments into information suitable for both planning and public information. Electronic and non-electronic formats should be used.

(b) Establishment of standards and methods for handling information

40.23. Governments should consider supporting the efforts of governmental as well as non-governmental organizations to develop mechanisms for efficient and harmonized exchange of information at the local, national, provincial and international levels, including revision and establishment of data, access and dissemination formats, and communication interfaces.

(c) Development of documentation about information

40.24. The organs and organizations of the United Nations system, as well as other governmental and non-governmental organizations, should document and share information about the sources of available information in their respective organizations. Existing programmes, such as those of the Advisory Committee for the Coordination of Information Systems (ACCIS) and the International Environmental Information System (INFOTERRA), should be reviewed and strengthened as required. Networking and coordinating mechanisms should be encouraged between the wide variety of other actors, including arrangements with non-governmental organizations for information sharing and donor activities for sharing information on sustainable development projects. The private sector should be encouraged to strengthen the mechanisms of sharing its experience and information on sustainable development.

(d) Establishment and strengthening of electronic networking capabilities

40.25. Countries, international organizations, including organs and organizations of the United Nations system, and non-governmental organizations should exploit various initiatives for electronic links to support information sharing, to provide access to databases and other information sources, to facilitate communication for meeting broader objectives, such as the implementation of Agenda 21, to facilitate intergovernmental negotiations, to monitor conventions and efforts for sustainable development to transmit environmental alerts, and to transfer technical data. These organizations should also facilitate the linkage of different electronic networks and the use of appropriate standards and communication protocols for the transparent interchange of electronic communications. Where necessary, new technology should be developed and its use encouraged to permit participation of those not served at present by existing infrastructure and methods. Mechanisms should also be established to carry out the necessary transfer of information to and from non-electronic systems to ensure the involvement of those not able to participate in this way.

(e) Making use of commercial information sources

40.26. Countries and international organizations should consider undertaking surveys of information available in the private sector on sustainable development and of present dissemination arrangements to determine gaps and how those gaps could be filled by commercial or quasi-commercial activity, particularly activities in and/or involving developing countries where feasible. Whenever economic or other constraints on supplying and accessing information arise, particularly in developing countries, innovative schemes for subsidizing such information-related access or removing the non-economic constraints should be considered.

Means of implementation

(a) Financing and cost evaluation

40.27. The secretariat of the Conference has estimated the average total annual cost (1993-2000) of implementing the activities of this programme to be about $165 million from the international community on grant or concessional terms. These are indicative and order-of-magnitude estimates only and have not been reviewed by Governments. Actual costs and financial terms, including any that are non-concessional, will depend upon, inter alia, the specific strategies and programmes Governments decide upon for implementation.

(b) Institutional means

40.28. The institutional implications of this programme concern mostly the strengthening of already existing institutions, as well as the strengthening of cooperation with non-governmental organizations, and need to be consistent with the overall decisions on institutions made by the United Nations Conference on Environment and Development.

(c) Capacity-building

40.29. Developed countries and relevant international organizations should cooperate, in particular with developing countries, to expand their capacity to receive, store and retrieve, contribute, disseminate, use and provide appropriate public access to relevant environmental and developmental information, by providing technology and training to establish local information services and by supporting partnership and cooperative arrangements between countries and on the regional or subregional level.

(d) Scientific and technological means

40.30. Developed countries and relevant international organizations should support research and development in hardware, software and other aspects of information technology, in particular in developing countries, appropriate to their operations, national needs and environmental contexts.

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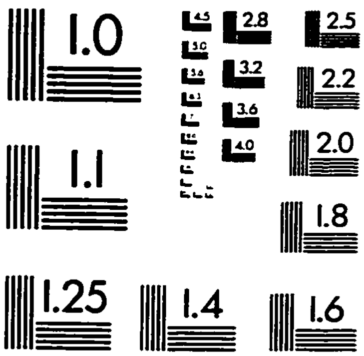
IMAGE EVALUATION TEST TARGET (QA-3)



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