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GIS FOR DISTRICT-LEVEL ADMINISTRATION IN INDIA: PROBLEMS AND OPPORTUNITIES[1]

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Abstract

This paper describes a research study, carried out over the period 1993 to 1995, of the efforts made in India to develop and use geographical information systems (GIS)[2] to aid district-level administration. We give a detailed description of our research approach, drawing from contextualism as a broad research methodology and using actor-network theory for analytical purposes. The main section of the paper provides an in-depth analysis of a major GIS initiative from a particular Indian government ministry. We conclude that the creation and maintenance of a relatively stable set of key actors with aligned interests related to the GIS technology had not been achieved in any of the districts studied by the end of the research period. Our analysis leads to implications for future action that go beyond traditional prescriptions, such as improved participation or better training, toward the need for higher-level interventions in such areas as educational processes and administrative structures. We then turn to criteria for judging the merits of an intensive research study and illustrate to what extent this study satisfies the criteria. Finally, we draw conclusions on the contribution of this paper to the promotion of intensive research and to the opening up of new fields of IS research.

Keywords: GIS, implementation, India, developing countries, actor-network theory, contextualism, intensive research, IS research agenda

ISRL Categories: AI0113, AI0802, BD05, BD06, EL05, FD05, HB14, IB04

Introduction

Information technology has become an important aspect of the attempt by the so-called developing countries to achieve economic progress, and the relative success in this area of various Asian economies, such as Singapore, has been intimately connected to IT. India is an interesting current case since, although it has taken to computerization rather later than some of the other economies in the region, it has already achieved some well-publicized successes, such as the thriving software export industry (Heeks 1996). This industry is an example of India's increasing emphasis on the private sector in recent years, but the public sector remains a major part of the

[1]Allen Lee was the accepting senior editor for this paper.

[2]The Appendix provides a full description of the acronyms and abbreviations used in the paper.

economy, and an interesting question is to ask what degree of penetration of IT use has been achieved here.

This paper addresses the application of IT in one particular area of public sector activity in India, namely that of district-level administration. India is divided into states and union territories for administrative purposes; these are further subdivided into districts. The population of the districts varies considerably, but with an overall population of over 900 million people and 477 districts, the average size of a district is around 2 million people. District level administrators are involved in the administration of a multiplicity of developmental activities—everything from education to agriculture and from infrastructure development to wildlife management.

A major initiative for the application of computers in connection with district-level administration in India started in the late 1980s, and their use in this area has grown since that time, although significant problems have been encountered such as lack of political support for decentralized management, inappropriate systems, and lack of adequate training (Madon 1993). The particular focus of this paper concerns an aspect of IT which has not been widely reported on previously in the context of India, namely that of geographical information systems (GIS). This paper describes the results from a study that investigated India's attempts to develop and use GIS to aid district-level administration.

A key reason for this choice of research topic was that GISs appear to have considerable potential for district-level management in India and in developing countries more generally. Many issues at this level are highly spatial in nature: for example, the planning and upgrading of roads, the location of health facilities, the choice of areas for particular agricultural development, or the management of natural and planted forests. In addition to their potential value in particular functional areas, GISs offer a basis for the integration of the work of different district-level agencies by providing a common conceptual frame of map-based systems with different thematic overlays. Many district-level issues are recognized as being multidisciplinary in nature: for example, the management of natural resources involves forestry, agriculture, wildlife management, and infrastructure development.

In the general context of developing countries, Taylor (1991) noted that the potential of GIS for development planning had been recognized by a number of the international aid agencies, but it was also recorded that there was very little real use of GIS in developing countries by the early 1990s. There were many pilot projects and research exercises, but little of any substance had been achieved in terms of actual application. The key questions motivating our research study, therefore, were: has GIS been implemented successfully for real applications in district-level administration in India, and if not, why is this the case and what can be done about it in the future? Our definition of successful implementation requires that the GIS be used in a substantive way by administrative field officers in their day-to-day work.

Our research involved a longitudinal study over a period of three years from early 1993 to late 1995. We started our work by investigating a particular set of GIS projects that were taking place under the umbrella of the Ministry of Environment and Forests (MOEF) of the government of India. At a later stage, we widened our study to include other central government agencies. In the end, our research took into account all district-level GIS initiatives in India, although in this paper we only report in detail on the MOEF initiative.

The paper is structured as follows. First, we describe the research approach employed in this "intensive" research study (Weick 1984), with details of research methodology, theory, and method. Next, in the main section of the paper, we provide a detailed description and analysis of the MOEF GIS initiative, drawing on actor-network theory in the analytical sections. We return to our research questions in the following section, and in particular we discuss the question of how to promote "successful" GIS use in the future, both in India and more generally. In the penultimate section of the paper, we draw on a published framework to provide a detailed set of criteria for judging the merits of an intensive research study and illustrate and discuss to what extent our own study satisfies these criteria. Finally, we draw conclusions on how our paper

addresses the broad goals of this special issue on intensive research.

Research Approach

We wished to study how GISs were being used in Indian district-level administration, whether their use was successful, and the reason for success or failure. We thus needed to gain an in-depth knowledge of the GIS technology that had been developed in particular locations, the views of the human stakeholders concerning the use of the technology, and the changing contexts within which the attempted technological introduction was taking place. Empirical studies that collect such data can be broadly classified as "interpretive case studies" (Walsham 1995). There is an increasing body of work in the IS literature based on this approach (for example, Boland and Day 1989; Markus 1983; Orlikowski 1991; Suchman 1987; Walsham 1993; Zuboff 1988). However, there are significant differences of methodology, theory, and method under the broad interpretive case studies label. The remainder of this section is devoted to a detailed description of the specific approaches we adopted for our research study and the reasons for our choices.

Methodology

The methodology we adopted for our study drew on contextualism (Pettigrew 1987, 1990; Walsham and Waema 1994), and can be summarized as follows: We wished to study the initiation, development, and implementation of GIS technology in particular field sites by examining in detail the actions and perceptions of human actors and the context within which these actions took place and perceptions were formed. We wished to place emphasis on both stability and change and to try to understand how actors' systems of meaning, aspects of their power relations, and their shared or contested norms of behavior resulted in particular outcomes. We wished to investigate both the intended and unintended consequences of the action taken by actors and the way in which their reflections on these consequences changed or maintained their perceptions and thus influenced their future actions.

We designed our study as longitudinal, in that we collected data over a period of three years as the events were taking place and following the various phases of the GIS projects. This enabled us to gain access to the complex and shifting nature of actions and interpretations, whereas historical reconstruction, which takes place with hindsight, tends to produce a picture that is tidied up and rationalized by the actors involved. It was not, of course, possible to use longitudinal research for the period prior to the start of our research study in 1993. Thus, we used historical reconstruction from archival documents and recollections of the past for this period, focused largely on 1991 to 1993 when the GIS projects in the MOEF were commissioned and operationalized.

Theory

The theoretical basis of our study evolved over time in response to both our deepening understanding gained through the collection of the field data and our changing ideas concerning appropriate theory, partly resulting from continuing study of the IS literature and that in related fields. We were influenced in the earlier part of the study by both structuration theory (Giddens 1984) and the literature on the social construction of technology (Bijker et al. 1987). However, for the purposes of this paper, we will focus on actor-network theory, which we utilized in the latter stages of the research and which will be used as the basis for the analysis of the case study in the later sections.

The initial development and application of actor-network theory was concerned with the sociology of science and was pioneered at the Ecole des Mines in Paris (Callon 1986; Latour 1987). Later work has also included a focus on technology (Latour 1996). The theory is not a stable body of knowledge that can be drawn on by researchers in an unproblematic way, since its developers themselves frequently revise or extend its elements. However, some key aspects of the theory have remained relatively stable over the last decade or so of its development and use (see Law 1992 for a more complete description). Table 1 provides a brief summary of key concepts. We now provide an outline of the theory, drawing on these concepts, and the later case study sections aim to demonstrate its relevance to our GIS study.

Table 1. Summary of Some Key Concepts in Actor-Network Theory

Concept	Description
Actor (or actant)	Both human beings and nonhuman actors such as technological artifacts
Actor-network	Heterogeneous network of aligned interests, including people, organizations and standards
Enrollment and translation	Creating a body of allies, human and non-human, through a process of translating their interests to be aligned with the actor-network
Delegates and inscription	Delegates are actors who "stand in and speak for" particular viewpoints that have been inscribed in them, e.g., software as frozen organizational discourse
Irreversibility	The degree to which it is subsequently impossible to go back to a point where alternative possibilities exist
Black box	A frozen network element, often with properties of irreversibility
Immutable mobile	Network element with strong properties of irreversibility and effects that transcend time and place, e.g., software standards

Actor-network theory examines the motivations and actions of actors who form elements, linked by associations, of heterogeneous networks of aligned interests. A key feature of the theory is that actors (or actants as they are sometimes labeled) are taken to include both human beings and non-human actors such as technological artifacts. A major focus of the theory when applied in particular contexts is to try to trace and explain the processes whereby relatively stable networks of aligned interests are created and maintained, or alternatively to examine why such networks fail to establish themselves. Successful networks of aligned interests are created through the enrollment of a sufficient body of allies and the translation of their interests so that they are willing to participate in particular ways of thinking and acting that maintain the network.

Prior research points out that the analysis of the various stratagems employed, such as the use of persuasive rhetoric, to construct and maintain network allegiances draws much from Machiavelli (Bloomfield et al. 1992). However, that research notes the addition in actor-network theory of non-human resources, such as a graph in a scientific paper, can be used to "stand in and speak for," or be delegates for, particular viewpoints or truth-statements that help to maintain a particular network of alliances. A similar representational point with respect to computer systems and software has been made

> Modern information technologies embed and inscribe work in ways that are important for policy-makers, but which are often difficult to see . . . arguments, decisions and uncertainties . . . are hidden away inside a piece of technology or in a complex representation. Thus values, opinions and rhetoric are frozen into codes, electronic thresholds and computer applications. Extending Marx, then, we can say that in many ways, software is frozen organizational discourse (Bowker and Star 1994, p. 187).

The idea of software as frozen discourse is an example of an inscription that resists change and displays properties of irreversibility. The degree of irreversibility of a particular element of a network depends on the extent to which it is subsequently impossible to go back to a point where alternative possibilities exist and the extent to which the particular frozen element shapes and determines subsequent inscriptions (Callon 1991). A frozen element that is not "opened" to question by the actors in the network is termed a black box. Actor-network theory uses the concept of immutable mobiles to describe network elements that display strong

properties of irreversibility and are mobile across time and space; various software standards provide illustrations of immutable mobiles.

The philosophy and concepts of actor-network theory have become much more widely known in recent years and an increasing number of IS researchers are making explicit use of the theory in their work. Three examples are mentioned here (for a fuller set of illustrations of the use of the theory in IS research, see Walsham 1997). This first example provides an interesting case study of the development of a particular set of resource management information systems in the UK National Health Service (Bloomfield et al. 1992). That study uses the concepts of actor-network theory to illustrate an argument against the view of technology as a given, and instead illustrates how the boundary between the technical and the social, and the relationship between them, is the subject of ongoing struggles and trials of strength in creating "facts." The second example adopts the vocabulary of actor-network theory to describe activity-based costing as an accounting technology that has been made "true" and has been established as a widespread practice through a process of translation (Boland and Schultze 1996). Allies have been enrolled, black boxes have been constructed to enshrine the approach, and arguments have been built up into many layered defenses against adherents of traditional cost accounting techniques. The authors undermine the certainties of this fact construction process by telling a different story, or antinarrative, where the merits of the two techniques are reversed. The third example focuses on the role of standards, particularly those embedded in infrastructures, in prescribing and proscribing forms of interaction with information technology (Monteilo and Hanseth 1996). The examples in that study involve EDI systems in the Norwegian health sector and concern the definition of a message standard for identifying a drug prescription and for exchanging test results. In both cases, they illustrate the processes of translation and inscription that were taking place and contrast the relative successes of the network building. Similarly, in the next main section, we examine processes of network building in our GIS case study.

Method

Moving now to the details of our research method, we examined 10 GIS projects in the MOEF concerned with different districts in India, and we carried out detailed investigation on the five most advanced projects. We also investigated a further range of district-level GIS projects, initiated by agencies other than the MOEF, with detailed examination of six additional districts, but we focus on the MOEF projects because of space considerations. We carried out 127 formal interviews with 105 personnel at different hierarchical levels, in five separate field trips. Table 2 gives further details of the people interviewed; some key personnel in the scientific institutions and central government agencies were interviewed on more than one occasion. Interview length varied, but a typical interview lasted from 1.5 to 2 hours. Extensive notes were taken during each interview, by both field researchers where two of us were present, and the interview notes were then written up as soon after the interview as possible, often on the same day as the interview. Tape recording was used infrequently, and not at all in the later stages of the research, since it was felt that most participants were more inhibited in their opinions when being recorded.

In addition to formal interviews, other data sources included systems demonstrations that were conducted for our benefit at all the project sites, archival data in the form of reports and filed documents, and some informal contact with personnel outside the formal interviews. For example, we had substantial informal contact with the GIS project director in the MOEF throughout the research period, and we had frequent e-mail contact with him while the researchers were back in the host institution in the UK. The Indian Society of Geomatics provided additional background data on the state of GIS in India. A further data source was a two-day workshop on GIS implementation in New Delhi in July 1995, which we initiated. The participants of the workshop included a wide range of personnel from the field sites and from the central and state governments.

Research access was negotiated through the GIS project director in the MOEF. He was very keen for us to be involved with the GIS initiative and contributed much more to our research project

Table 2. Summary of the Interviews Conducted

Nature of Group	Number of Interviews						*Totals	
	Field Trip 1	Field Trip 2	Field Trip 3	Field Trip 4	Field Trip 5	Other	Number of Interviews	Number of Respondents
Scientific Institutions	11	6	4	5	Workshop		26	15
District Administration	3	10	5	7	21		46	46
Central Government (MOEF/NIC/DST)	6	9	8	5	6		34	23
Vendors	2	1	–			8 (6 in USA, 2 in UK)	11	11
Others (NGOs/Aid Agencies/Academics)	2	2	2	2	2		10	10
Totals	24	28	19	19	29	8	127	105

*The totals for the number of interviews in some cases are more than that of respondents because some of the respondents were interviewed more than once.

than access to the field sites, such as his enthusiasm and moral support in addition to his detailed knowledge. He obtained approval from his superiors for our involvement in the research, arguing that it would help the GIS project because an "independent third party" could provide evaluation and feedback about the implementation process. The main field researcher was an Indian national; the other researcher (who was present at 24 of the field interviews on three separate field trips), was a UK national who had worked in India on a number of earlier occasions. The Indian national was able to gain access to those field sites which would have been closed to the foreigner on security grounds.

In terms of analyzing the field data, the identification and development of concepts, themes and issues was achieved over the three-year period by careful reading and reflection on the field notes and by frequent discussion between the two researchers. Documents summarizing the field visits and emerging themes were produced after each project stage. An example of a set of themes identified at the research sites after the first set of field visits is given in Table 3. Themes were also discussed between the researchers and the GIS participants at the various field sites and in central government agencies in New Delhi. We did not use more formal structured methods to identify themes from the field notes, since the range and complexity of the field data did not lend themselves, in our view, to these essentially reductionist approaches. However, in common with ideas from grounded theory (Glaser and Strauss 1967; Orlikowski 1993), the earlier stages of the research involved more open-ended interviewing, whereas the later stages were more closely directed toward the emerging concepts and themes.

A final aspect of our research method concerns our role as researchers. We see a continuum of research positions here from the role of "independent observer" with a mainly descriptive objective through the strongly prescriptive stance of an "action researcher" with active involvement in the change process. In our research project, we started in the former position, but we gradually became more involved as time went on. We fed back impressions from the first few months of our work to all of the field sites, both through regular contact and through a formal report, and this undoubtedly had some impact on what we were observing. For example, the terms of reference for a later phase of the MOEF project drew heavily from some material that we had provided. By the end of our research in 1995, we had moved, in some respects, to the role of action researchers; for example, our Delhi workshop was directly concerned with plans for future action. We wish to make two comments here. First, the nature of longitudinal interpretive case studies over a long period of time, such as three years, inevitably involves the researcher becoming directly involved. Participants would not normally be willing to see a researcher on a number of occasions if the researcher were not prepared to offer opinions on important issues. A second comment is that we felt a particular moral imperative to get involved in advising on possible courses of action in a context such as Indian district-level administration. A refusal to offer ideas and constructive suggestions would reflect a lack of concern for the people in Indian districts, whose economic prosperity is among the lowest in the world.

The MOEF Case Study

This section provides the main description and analysis of our case study of the GIS initiative in the MOEF. First, a brief overview of the case study is given as the bare bones of the story, which is subjected to detailed analysis in the five subsections that follow. These involve a discussion of the interests inscribed in the GIS technology and an analysis of the processes of creation, maintenance, and extension of the actor-networks associated with the GIS initiative. Finally, we examine our own motivations and role as actors in these networks.

Overview of the Case History

A schematic of the various events and phases of the case study is shown in Figure 1. In this subsection, the history of the initiation of the project is outlined. We then describe Phase I, which took place from January 1991 until January 1993 and, finally, Phase II from early 1994 to the end of the research period in late 1995.

Table 3. Set of Themes After the First Field Visits to Seven Scientific Institutions

Scientific Institution	Themes
1	Conflicting objectives Personal agenda A managerial perspective Lack of faith in district administration
2	Dominance of the technical tradition Focus on details Strong focus on education The U.S. interactions built around aid
3	A strong remote sensing and natural resources tradition Focus on database management Focus on small and manageable Diminishing levels of interest
4	Local head a key influence Strong formal interactions Legitimization through the scientific tradition Initiation influences complex and not understood
5	Focus on detail Extensive external contacts Field site located in progressive state Positive about next phase of project
6	Conflicting mandates Who provides the sustained field presence? Are the right questions being asked? Need the shift of focus to the district
7	A strong technological focus Limited involvement of users Is the use of NIC the right approach? The USAID involvement restricted initiation activities

Initiation

The National Afforestation and Ecology Board (NAEB), a part of the MOEF, initiated 10 GIS projects in January 1991, in collaboration with eight scientific institutions in India, with the aim of examining the potential for using GIS technology to aid wasteland development. Wastelands are categorized as degraded land, which can be brought under vegetative cover with reasonable effort but which is currently underutilized, and land that has deteriorated due to the lack of appropriate water and soil management. The scientific institutions were two remote sensing agencies, three research groups within universities, and three other scientific agencies concerned with forestry, space research, and the study of science and technology in development.

The initiation of the project in 1991 can be traced back to two earlier events, according to our reconstruction of the history prior to the research period. In 1986, the government of India started the National Wasteland Identification Project to identify different wasteland categories in India. Figure 2 shows on overall map of the distribution of these wastelands in the various states of India. Detailed maps were produced on a 1:50,000 scale for 147 selected districts using remote

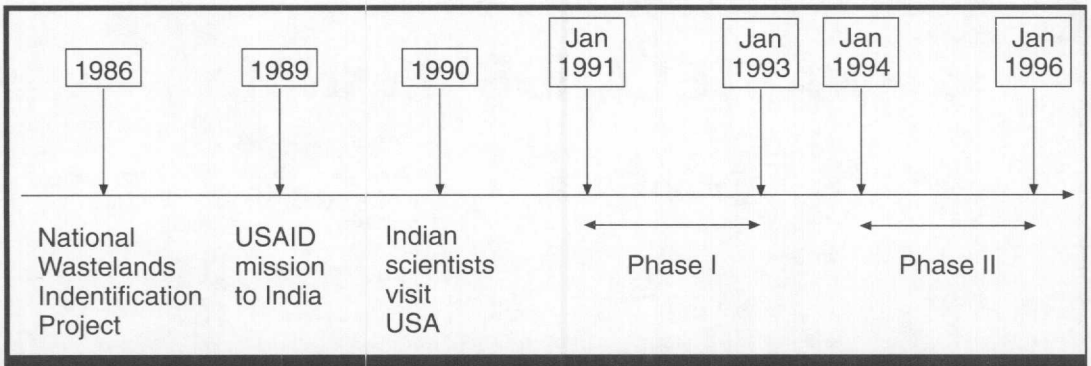

Figure 1. Key Events and Phases in the Case Study

sensing techniques for data collection. The existence of these maps provided a basis for considering how to develop and manage these wastelands, but the stimulus for the possible application of GIS to this issue was provided by a chance encounter of some GIS experts from Ohio with Indian government officials from the MOEF.

This chance meeting, occurring in the context of a general USAID mission to India in 1989, triggered a sequence of further activities starting with a USAID-sponsored visit of an Indian expert team to see GIS installations in the U.S. in 1990. This visit was followed by setting up GIS training workshops for Indian scientific staff and the donation of some GIS software. Finally, the eight scientific institutions referred to above were invited by the MOEF to test the efficacy of GIS in wasteland management and to demonstrate the capability and ability of GIS packages for local area planning.

The director of the NAEB, who was the project director in the MOEF responsible for coordinating the GIS initiative, made a conscious effort to impart diversity into the projects in terms of types of software, hardware, and methodologies adopted by the different institutions. He felt that much could be learned about the value of the GIS technology by comparing different approaches. For example, with respect to methodology, some institutions worked at a 1:50,000 scale, while others worked at the level of 1:10,000; some adopted a watershed as the unit of analysis, while others used a village as the basis. The research sites allotted to the institutions by the NAEB were priority development areas and represented different national agro-climatic zones. The districts within which the field sites were located were relatively near their respective scientific centers in some cases, but in other cases they were as far away as a thousand miles.

Phase I

The staff of the scientific institutions saw the objectives of the project to be primarily technological in Phase I, involving the scientific demonstration of the potential utility of using GIS technology for wasteland management. Eight of the 10 projects were successfully completed by early 1993 in terms of producing working GIS systems based on real data from the field sites in their particular districts.

The detailed models and systems developed by the institutions tended to reflect their view of themselves as scientific research and development centers. For example, there was a heavy reliance on data obtained by sophisticated remote-sensing techniques, reflecting the nature of the interests of the typical research scientist in these institutions. There was less emphasis on other socio-economic variables relevant to wasteland management, such as population and livestock data. In addition, and of crucial importance to later development of the project, many of the scientists involved in the project saw their institutional mandate to be limited to the development of technology rather than to its transfer to administrators at district level.

Phase II

Although the Phase I projects were completed in early 1993, proposals for continuation were not

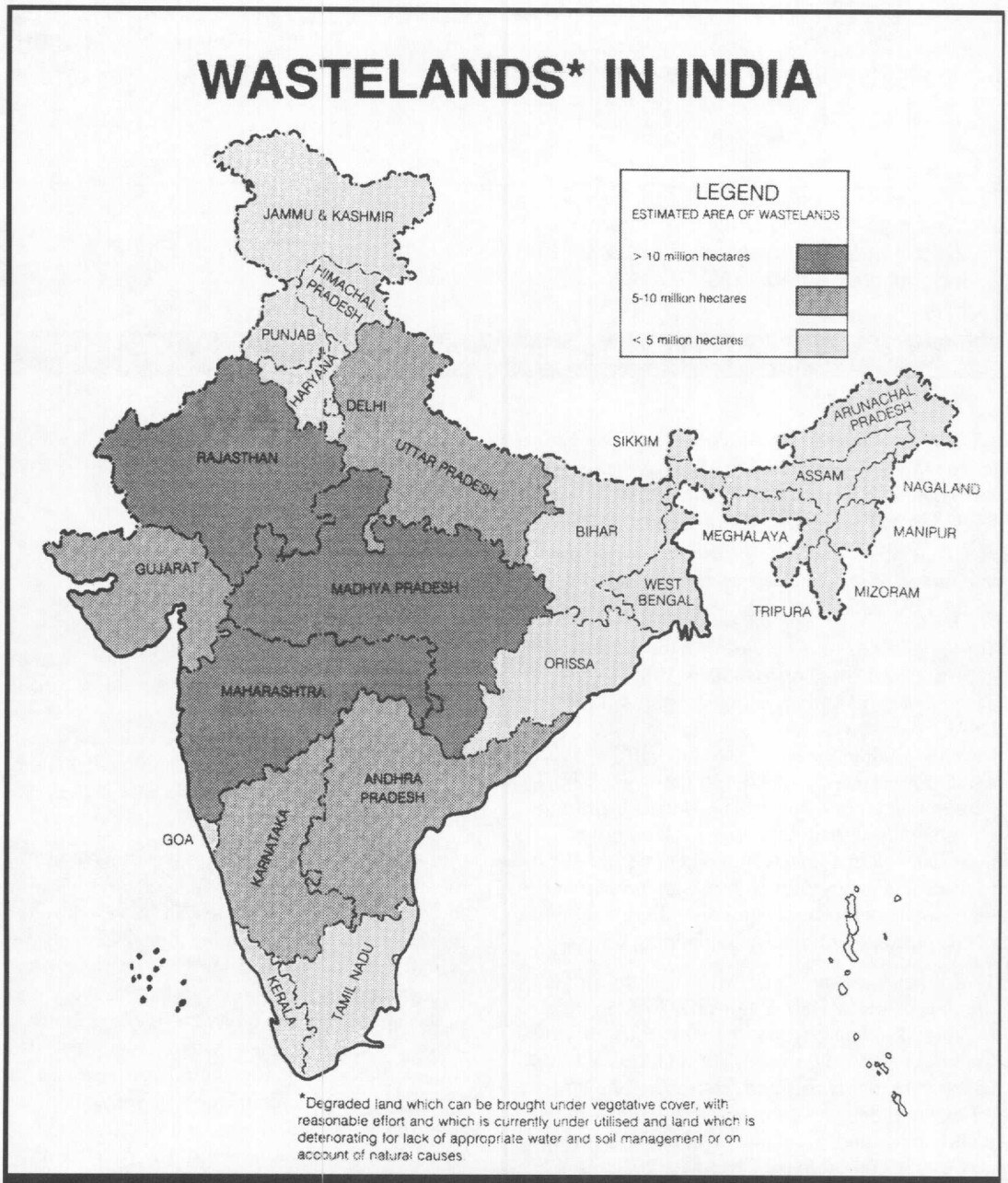

Figure 2. Map of Wastelands in India

submitted until about a year later and then only by five of the original eight institutions. This period of transition from Phase I to Phase II was characterized by uncertainty about the objectives and nature of the continuation phase. The project director saw it as involving the transfer of the developed systems to the district level so that they could be used for real management applications. However, the project managers in the scientific institutions did not view their staff skills or

resources to be adequate for this task in most cases. The institutions asked for further funding largely to provide more hardware and software, whereas the project director felt that the institutions should concentrate on using the existing equipment and on its transfer to the field.

Eventually, five institutions agreed to terms for Phase II, and these continuation projects were authorized by the MOEF. Soon after this, the project director left the NAEB, and there was very limited central direction of the Phase II projects to the end of our research period. Despite this lack of coordination from the center, all of the five Phase II projects went ahead in different ways and with different levels of success in terms of the stated project goals. At the end of the research period, some progress had been made in some of the sites toward transferring the technology to district level, but there were no actual working systems receiving real use. There were, however, some optimistic signs for the future of GIS-based approaches in at least two of the district sites, in terms of increased awareness of the technology by officers at that level, and some qualified enthusiasm for its application.

The Interests Inscribed in the GIS Technology

GIS technology can be viewed as comprising hardware, software, and data. Each of these components inscribes the interests of various human agents and can be thought therefore to be a delegate that "speaks on their behalf." The enrollment of other actors in networks surrounding the technology requires that these actors adopt attitudes and actions congruent with those of the interests inscribed in the technology. We now examine this statement in more detail, using specific examples from our Indian field data.

First, computer systems, such as the ones described in this paper, reflect the societal interests and attitudes of their Western developers. In Western society, explicit data and rational decision-making processes are the legitimate bases for planning and management. By contrast, in India, these are not widely accepted norms, and value is placed on intuitive approaches and goals such as the maintenance of personal relations. A dominant feature of Indian intellectual thinking has been the supremacy accorded to non-rational forms of reasoning (Saha 1992). Even though the principles of rational analysis were known in India in ancient times, cultural ideology has emphasized approaches to decision making such as those dealing with *karma*, rebirth, and the belief that reason is unable to discover the truth. Indians often view work as a duty to their families (Sinha and Sinha 1990), and there is a preference for personalized relationships rather than formal channels of communication, often manifesting through personal political influence. The district collector of a particular district received a phone call in the middle of one of our field interviews. At the end of it, he said to us:

> You ask me about how I use GIS. I have just got this phone call from [a local politician] who has told me where exactly to put the new wells—in his constituency. There are two processes taking place in parallel—the scientific and the political. Decisions over here are made by political process and GIS helps to legitimize what we do.

It is possible to overemphasize the above divergence between Western and Indian societies, since Western decision makers also value intuition and personal relations and are subject to political influence. In addition, some Indian decision makers are comfortable with explicitly rational styles, but nevertheless there is a marked contrast in the dominant underlying attitudes between India and Western countries in this area. The particular context of the bureaucracy of Indian district administration tends to sharpen the distinction in our case.

A second divergence between Indian conceptualizations and those of the West, which is of particular relevance to GIS technology, concerns the existence of a map-based culture. Typical Indians will rarely, if ever, use maps in their daily life. For example, on one of our field visits to a GIS scientific institution, we spent over an hour in the heat of the middle of the day trying to find the location of the institution in the town we had arrived at by asking local people. None of the Indian scientists, or for that matter the Indian author of this paper, had considered the production or use of a map for this purpose and when this was jokingly queried by the non-Indian

author of this paper, he was firmly told that "we don't use maps for this purpose in India."

A GIS project leader in the National Informatics Centre (NIC), one of the other institutions in India trying to introduce GIS, said:

> The most difficult part of GIS introduction is getting people to think spatially. There is no simple strategy here. A first step would be to motivate NIC's own people. They must start thinking spatially first.

We must be careful not to be too categorical here, since maps have been present in India for many years, and maps have been developed and used in organizations such as the Survey of India. However, these maps have been paper-based, rather than electronic, and their use has normally been confined to limited technical issues rather than more general socio-economic problems. Some efforts at digitizing maps have been made as noted in the earlier description of the initiation of the MOEF project. However, security concerns provide a significant constraint on the widespread use of maps for planning purposes. The project leader on one of the MOEF GIS projects noted:

> The availability of maps is a major issue and people have been discussing it in many different forums. Of the total maps we have, about 30% is restricted and about 60% to 70% is unrestricted. To obtain the restricted maps, one has to take special permission from the government departments which is not very easy to get. The Survey of India is planning to create electronic copies of the toposheets and in it they will block out the security risk areas. A committee is looking into it but it moves very slowly. The outcome of a meeting is normally fixing the date for the next meeting.

In Western societies, children are brought up with maps, and the explicit display of spatially related data is a common feature of daily life. The map-based culture of Western societies is taken for granted by the Western developers of GIS technology, and the assumption that users will be comfortable with maps is inscribed into the technology. When GIS technology is transferred to India, these implicit cultural assumptions embedded in the technology can prove highly problematic. The president of the GIS company with the highest share of the world market, Jack Dangermond of ESRI, has a special interest in India and is well aware of the above issue. In 1994, he announced a one million dollar grant in aid for geomatics training in secondary schools and colleges to help create a new generation of spatially literate children in India.

A final example of the inscription of Western values in GIS technology concerns the embedded assumption of coordinated action. The multilayered nature of GIS systems, where data on different characteristics are brought together as overlays in the same map-based system, assumes that management issues will be addressed in a coordinated way. For example, the management of land resources in any country can be thought to involve a wide range of disciplinary specializations, including agriculture, forestry, wildlife management, and many others. However, in India, these issues have typically been handled in relative isolation by the different agencies involved. Over 20 separate government agencies operate at the district level in India, each dealing with a particular functional area and reflecting the wider governmental funding structures built around departmentally based schemes. An employee in a non-governmental organization operating at the district level in India described this as follows:

> The main problem is the compartmentalism of activities. Different departments do not speak to each other. There is a problem of attitude; people do not want to do things. The crux of the problem is not technical but that of sustained coaxing. The district level engineer says that he is interested only in dams, the agricultural scientist in soils, the forester in trees. Everyone says that I am fine and no one sits and talks with each other. There is extreme compartmentalization. There is a mental barrier among the people.

This attitude is a key influence in Indian social and religious life. One of the sacred Hindu texts, the Bhagavad Gita, says "And to thy duty, even if it be humble, rather than another's, even if it be great. To die in one's duty is life: to live in another's is death." A critical analysis of this functionality uses the following illustration:

> The man who makes the dingy bed in the hotel room will be affronted if asked to sweep the gritty floor . . . the c erk will not bring you a glass of water even if you faint . . . study these four men washing down the steps of this unpalatable Bombay hotel. The first pours the water from a bucket, the second scratches the tiles with a twig broom, the third uses a rag to slop the dirty water down the steps into another bucket, which is held by the fourth (Naipaul 1964).

Naipaul describes every man in India as an island, tied to his individual function, and having his private contract with God.

Again, it is possible to overemphasize the divergence between Western societies and India in regard to rigid functionality and uncoordinated action, since these are certainly encountered in Western administrative practice and different Indian government agencies do interact to some extent; but it is undoubtedly the case that district-level management in India has tended to be relatively uncoordinated, which contrasts with the cultural attitudes to coordination that are inscribed in the GIS technology.

It has been argued here that GIS technology inscribes the values of its Western developers, which are to some extent at odds with Indian values, in at least the three dimensions of rational decision making, a map-based culture, and coordinated action. The technology is a black box in the terminology of actor-network theory, with strong properties of irreversibility, since, although the maps can be changed or the layers varied, the basic assumptions embedded in the technology, such as the three dimensions above, are invariant. The technology is an immutable mobile in the sense that these attitudes are carried across time and space through the medium of the technology. Does this create major difficulties for the transfer of GIS technology from the West to India? We now investigate this in some detail for the MOEF project.

Creating the Network for Project Initiation

The remainder of this section presents an analysis of the dynamic creation and maintenance of the actor-networks surrounding the GIS technology in the MOEF projects. The events we describe should be viewed as a continuous change process. However, for the purposes of exposition, the evolution of the networks will be analyzed under four separate headings: creating the network for project initiation; maintaining the network during project development; extending the network to district-level administrators; and our own role in the actor-network.

The network of aligned interests that enabled the initiation of the GIS projects in the MOEF can be considered to have contained three broad groups of human actors, in addition to the GIS technology itself as a non-human actor but with inscribed interests. These three groups consisted of the U.S.-based actors, central government officials in India, and the Indian scientific institutions subsequently involved in GIS development. We consider each of their interests in turn, and address the processes of enrollment that took place to enable their participation in the network of aligned interests.

First, the U.S.-based actors included the GIS experts from Ohio, officials from USAID, and, later, GIS technology vendors. No effort needed to be devoted to the enrollment of the first and last of these groups, since their interests were already directly aligned with those of the GIS technology. The situation of USAID is rather more complex, but USAID consultants were already involved with GIS at the time of the initiation of the Indian project, and the agency had sponsored the development of particular GIS software, IDRISI, at Clark University in the U.S. More generally, the interests of international aid agencies are becoming increasingly linked to GIS technology. For example, the Rio Summit explicitly mentioned the need for the use of GIS for natural resources management.

Central government officials in the MOEF were crucial to the creation of the network for project initiation, and the project director in particular was undoubtedly the key figure at this stage. He was convinced of the high potential of GIS for planning wasteland development in India, and he formed an alliance with the U.S.-based actors to try to bring about project initiation. He had the public support of the then Minister for Environment and Forests, who made the following statement in a printed speech:

> In India, we see great prospects for computerized GIS. Environmental data management is a vast area where geographic information plays an important role . . . . Use of computerized GIS in biodiversity conservation programmes is another emerging field.

The project director in the MOEF was also instrumental in the processes of enrollment that brought the eight scientific institutions into the network of aligned interests. These scientific institutions did not, however, need extensive persuasion at this stage, since they saw their role as research and development and were keen to obtain sophisticated technology. The scientists were enthusiastic about taking on a project in a relatively new technology such as GIS, reinforced on their trip to the U.S. in 1990, provided that they received adequate funding to acquire the technology and to carry out the project. This latter was achieved, in the first instance, with financial support from USAID. It is interesting to note that USAID dropped their support for the MOEF projects in a later phase, when their perceived interests conflicted with those of the Indian government scientists. One of the Indian scientists expressed this in a letter:

> The U.S. experts are of the opinion that emphasis should be problem driven, and not technology driven as we are assuming. However, we do not agree with the assumption [of the US experts] since we feel that GIS is a tool which we are utilizing to address a specific problem of reclamation of wastelands. Further, it is not our aim to equip ourselves with equipment which is not required for the project. At the same time, we [the scientist's institution] being a lead agency, we feel we should have the kind of hardware and software which we need not only to develop a package of solutions but also to carry out some R&D as this kind of application of GIS tool is being done for the first time.

The USAID officials, on the other hand, criticized the Indian approach as representing a desire to acquire technology more for its own sake than for application (Hutchinson and Toledano 1993). A further disagreement between USAID and the Indian project sites was the aid agency's insistence on the use of the IDRISI software, which was strongly resisted by the Indian scientists. This divergence of opinion contributed to the eventual withdrawal of USAID.

Maintaining the Network During Phase I

After the initiation phase, the network of aligned interests was largely maintained through Phase I of the projects, with the project director in the MOEF remaining the principle coordinator. Although USAID dropped out of the network during this phase, their initial financial support to enable project initiation had already been provided, and thus, this action did not weaken the network in a fatal way, although it caused some significant time delay in seeking alternative funding. In the end, the MOEF provided additional financial resources, reinforcing their commitment to the GIS projects. The main group of scientific institutions remained enrolled and, although two of the 10 projects in Phase I were not completed, this rate of attrition can be considered relatively low in the complex and difficult conditions that India presents for new technology-based projects.

It is worth noting the role of the local GIS vendors in the creation and maintenance of the GIS network. The establishment of the GIS initiative was delayed by the relatively slow response of the local GIS vendors, and their support during the projects was generally considered to be poor by the scientific institutions. The vendors could be thought to have a strong interest in the maintenance of a GIS network, but delays in receiving payment and staff problems contributed to their relatively weak support. In addition, the main vendor office was located in Delhi, creating major logistical difficulties for them in attending to problems in other locations. One of the GIS project scientists described the technical and financial difficulties resulting from poor vendor support:

> The software . . . has been inoperable for several months. The hardware lock has got damaged and the vendor is asking for two lakhs of rupees [about US $6,000] to sign an annual maintenance contract which will become valid backdated . . . . Our director feels that [this] is too much money and will not pay at present.

This particular problem resulted in a period of over one year during which the GIS software could not be used at this particular institution.

It is of critical importance to examine the role and interests of district-level officials during Phase I of project development. At one level, some of them can be considered as having been brought into the network surrounding GIS technology during this phase, since data were gathered at the district level and incorporated within the GIS at the various scientific institutions. However, the role of the district officials was one of data supplier, not primarily as a GIS user. It is true that occasional system demonstrations were given to district-level administrators by the GIS scientists, but these can be considered as inadequate to achieve the necessary translation so that district-level officials would make the major leap necessary to align their interests with those of the GIS technology. Indeed, the relationships between the scientists and the district-level administrators tended to be uneasy. The compartmentalization of interests described earlier meant that the scientists viewed their role as producing accurate scientific models, which they expected the district-level officials to use. They saw little need for consultation in this process, as expressed by one of the GIS scientists:

> There is no problem in getting technology out to the field because once people saw the scientific basis on which the recommendations had been developed they would adopt the technology. The involvement of local people is not really required in this process. We can specify the alternatives and give recommendations to the local people. They can take the suggestions.

In contrast, a junior member of one of the GIS teams was aware of the limitations of the scientific models from the perspective of local officials and local farmers:

> GIS will say "grow mustard" as it gives most economic yields, but the farmers rather than trying to maximize profits will try to minimize risks. Growing mustard is a risky business because it is prone to insect attacks. However, growing wheat assures the farmer a minimum return, and he will prefer that to growing mustard.

A second feature of the scientific approach, as mentioned briefly earlier, was the dependence on data that was generated using remote sensing technology—for example, firewood and fodder availability—aligned to the interests of the scientific institutions but not necessarily to those of the district-level officials, who may be concerned with issues related to population or livestock. This mismatch was acknowledged by one of the GIS scientists:

> But all our GIS experimentations . . . have this natural resources/remote sensing kind of bias . . . . These [wasteland reclamation problems cannot] be solved by remote sensing . . . . What is getting addressed is the. . . fancier, academic, spatial modelling kind of problems.

Extending the Network to District-Level Administrators

The extension of the network to include district-level administrators was the primary goal of Phase II of the projects, at least as articulated by the project director. This goal was not widely supported by the scientific institutions. There was a long delay between the end of Phase I and the start of Phase II, during which there was considerable disagreement between the center and the institutions on the role and purpose of Phase II. Indeed, some institutions saw little need to carry on at all since they had completed their task, which they saw as the production of the scientific models:

> He [the project director] was interested in continuation and all that. But all of us [the GIS scientists] more or less without consulting each other came out with almost the same statement. Simply because [of] the kind of priorities we had in our respective organizations, it tells us okay, now that you have spent 18 months or 24 months on a project, and it is about time now you must shed it, there is nothing new coming out of it.

Two of the institutions and three of the projects were not continued into Phase II, and some of the institutions involved in Phase II continued to adopt a technically oriented approach, with few resources being devoted to the highly difficult task of trying to enroll district-level

administrators. Indeed, many of the scientists did not see this as a legitimate part of their job:

> One problem is that an organization like ours is essentially handling R&D, right. We really don't have either the infrastructure or the time to do this kind of detailed effort, which we really need [on implementation in the field]. I don't know who can do it but it really requires an extended interaction, and as I said it means every month going and checking what is happening, talking to them, and then maybe only after a year will you start some absorption, some results.

Why was the task of enrolling district-level officers so difficult? We have already noted that GIS technology requires a commitment to rational and coordinated management based on explicit data, including map-related spatial data, and that these are not common norms in Indian society. We have also noted the special features of the GIS systems produced as being heavily reliant on remotely sensed data and not a ways being in tune with the interests of local people such as farmers. Although these issues present serious and substantial difficulties from the perspective of GIS implementation, they are not necessarily insurmountable in all cases. Some district-level officials, particularly those who are younger, are sympathetic to new approaches such as those offered by GIS. One district official in the south of India said:

> The GIS would be very useful for applications such as the identification of barren land and the types of plantations which could be grown there . . . comparing remote-sensing data with existing manual records could give useful results. Departments like forestry, agriculture, engineering, soils could benefit from GIS. Though GIS would involve a change in work practices, people would welcome it. It would be useful for people who already had land as well as for wastelands development.

Although individual district-level administrators sometimes expressed support, they are frequently moved between districts, which can destabilize any local GIS network being established. A member of a non-governmental organization at the district level noted this as a major problem:

> The biggest bottleneck [for a particular GIS project] was in the frequent transfers of people involved in the project. Also, from fear of pending transfers, people took a very short term kind of approach and hence did not fully support the project which obviously was a long term kind of project. There is no surety about who would be there in a particular post for a long time.

It is interesting to note that, in two of the MOEF Phase II projects, some positive movement had been made toward the establishment of a network around the GIS, as evidenced by statements of interest in GIS applications from district officials. In both these cases, this interest could be directly related to the attitudes of the project leader in the related scientific institutions. These two project leaders had a personal interest in district-level implementation and had made considerable efforts to interest and involve district-level officials. The idea being pursued was to try to integrate GIS into ongoing development programs in the particular districts. It was too early to say whether these efforts would result in the end in substantial GIS use, but there were some positive signs in at least these two cases.

The indication of some movement toward the enrollment of district-level administrators in one or two cases, based on the personal efforts of the scientific project leaders, needs to be counterbalanced by noting the fragility of networks that rely on the attitudes and actions of single individuals. This applies to the networks for the individual district-level projects, both in terms of the GIS scientist moving on to other projects and in terms of district administrators moving to another district. This problem of network fragility can be further emphasized by the results on the broader MOEF GIS network of the transfer of the project director. After he left, little further effort at central coordination was made, and the individual projects were left to continue in relative isolation.

Our Role in the Network

It is worth commenting in some detail on our own role as actors in the GIS network of the MOEF projects. During the latter part of our research, we tried to maintain some contact and coordination between the different GIS projects

and between the district level and the center in New Delhi. We set up the workshop in Delhi in 1995 and enrolled the minister of the MOEF in the workshop. Our efforts at network maintenance were, however, limited by our position as outsiders, although we believe that we did have some effect on the positioning of Phase II of the projects as being concerned with GIS implementation at district level and in raising the visibility of the GIS projects at higher administrative levels in the Indian government. However, we are aware of the limited results from our ad hoc intervention, and some deeper discussion of possible future interventions in GIS practice is given in the next section.

How were we regarded by our respondents during the research project? We were certainly perceived as aligned with the project director to some extent, and this may have affected the directness of the response to us, although we tried hard to be perceived as supportive of individuals by offering help in various personal and professional matters. Our status as coming from a famous university no doubt helped us at more senior levels, as articulated by the minister:

> I am very happy that Cambridge University is involved. Maybe we could get into a formal collaboration.

Such status is a two-edged sword since we were clearly regarded with apprehension by some interviewees, certainly in the initial interviews, and particularly when the more senior non-Indian author was present. We tried to diffuse these concerns by being friendly and open about ourselves and our motives, particularly at the start of interviews. How were the two of us differently regarded? Undoubtedly, the Indian national was less threatening and it is likely that respondents were more open with him when he was interviewing on his own. Also, at least in the north of India, his familiarity with Hindi was an added advantage. On the other hand, the UK national carried higher status and more novelty value. It is rare for a non-Indian to be involved directly at the district level, and this created considerable interest.

What were and are our own motivations with respect to the use of GIS for district-level applications in India? We would broadly align ourselves with the GIS project director in the MOEF, who saw GIS as potentially valuable if sensitively applied to the Indian context by local scientists and administrators. GIS technology is being pushed in India by a number of influential groups, including international aid agencies with environmental concerns. In addition, Indian companies in places such as Bangalore and Delhi are involved in the development of GIS software for export to Western countries. Is the development and use of GIS technology in India a form of cultural imperialism in that we have already noted the inscription in the technology of Western values at odds, to some extent, with traditional Indian values? Our position is that Indian society is not isolated from the world and is changing rapidly at the present time, partly in response to its increasing global interconnectedness. We believe that India cannot and should not ignore Western technology but that it should actively and reflexively consider how and whether such technology is relevant and desirable to its own needs. We hope we have contributed in a small way to such processes of reflection while recognizing that we have already exercized some influence in a domain where we admit that we are uncertain as to what is ultimately desirable.

Implications for GIS Practice

Returning to the key questions that motivated our research project, there are some pockets of minor use or significant interest in applying GIS for district-level administration in India, but we must give the broad answer "no" to the issue of whether GIS has been used successfully to date, defining success in this case as substantive use, rather than the more complex question of desirability of use discussed briefly above. For example, substantive use could involve district forest officers using the GIS outputs on a regular basis to support decisions on what kinds of trees should be planted in particular wasteland areas in order to help restore these lands. Such use has not occurred to date, and we have also tried to answer the question of why this is the case, with the general conclusion being that the creation and maintenance of a relatively stable set of key actors with aligned interests related to the GIS

technology had not been fully achieved in any of the districts we studied, and in many cases such a situation could be considered far away.

This section addresses our final research question, which was to ask what could be done to achieve successful use in the future, assuming that this is a desirable goal. It is important to note straight away that the translation of the interests of diverse actors and their enrollment in stable networks is not a simple process and is unlikely to happen quickly. We are talking about deep-seated change to social attitudes and structures, and such change does not occur overnight. For example, we have argued that maps are not deeply embedded in Indian daily life, but GIS require users to adopt a map-oriented approach to their work. A transition of this sort, on the part of a wide range of Indian district-level administrators, would be a major social change and, if it is to happen, it will take years rather than months to achieve. A GIS group leader in the NIC responded to a question from us in this area by noting that change is already occurring but that time is needed:

> Although India is not a map-based culture, people are changing, although the transition to GIS is a little difficult. It is not desirable to put in complicated GIS software; it is an evolutionary process—keep it simple.

This leads us to techniques of value in interesting and involving potential district-level users of GIS and the approach suggested above is an example of the concept of starting with relatively simple maps or problems. An example of this was given in a district in Bangalore in one of the GIS projects being carried out by the Department of Science and Technology (DST):

> We are getting very good response from the user departments, for example the Fisheries Department came out with their own problem—the location of tanks. Now, they have a tank inventory and they can decide what to lease to farmers.

The use of GIS to address highly visible local problems is a related idea, which was pursued in another DST project:

> The chief executive [of the district] has asked us to locate on the maps all the infrastructure for health centers, schools, etc. When we did it, the maps showed discrepancy between villages—some statistics show 10 [centers] and some show two. The chief executive is now interested in GIS, and we proposed, and he agreed, to include GIS in the next plan.

Although some limited success may be achieved by the individual efforts referred to above, a more general use of GIS for district-level administration would require a more fundamental and widespread change of attitude and work practice on the part of district-level officials. The senior managers at district level are all Indian Administrative Service (IAS) bureaucrats, who are not generally oriented toward the use of technology in their work. Even if a particular district gets a top manager who is enthusiastic about embracing GIS for district–level administration, such officials are frequently rotated to other posts in other parts of the country. This implies the need for action at a higher level in the Indian political and administrative system, either to change the system of rotation, which is highly unlikely, or more realistically to change the education process for IAS officials so that GISs are perceived as relevant to their interests. It is worth noting that some steps in this direction have already been initiated, as described by a senior government official in Delhi:

> We have recently started having courses on advanced technology such as GIS and remote sensing for the IAS officers . . . . These courses should give them exposure to the technology and also to the application areas. If the person in charge of the district will be knowledgeable about the technology then he can promote its use in the district.

GIS training is part of a much wider IAS educational issue concerned with styles of decision making and the related use of IT-based systems. It would be foolish to imply that the educational process could be changed easily or quickly, but it is clear that this type of deep-seated change is needed if GIS and other IT-based systems are ever to be widely used at the district level in India.

Changes to educational processes for the civil service would require high-level political support,

and the provision of financial resources, and other policy changes related to GIS would also need action at this level. For example, cooperation between central government agencies in India, such as the MOEF, DST, and NIC, is not the norm, yet they are all trying to introduce GIS at district-level and benefit could be gained by collaboration. The only manner in which this might happen in any substantial way is if it were agreed at the highest political level. A first step in this direction could involve the development of policy and action on the issue of data coordination and sharing. GIS require base maps at various levels of detail together with a wide range of thematic data related for example to soils, climate, agriculture, infrastructure, or forestry. These data are expensive to collect and often need frequent updating. In addition, in the Indian context, the volume of data required is immense. If agencies go their own way in collecting, storing and using such data, this will involve a duplication of effort and a major waste of resources, apart from any loss of the synergy which could be achieved by more coordinated action. A short proposal for coordinated action on these data issues was sent to the minister of Environment and Forests by the authors at his request, following a discussion of this issue at the Delhi workshop referred to earlier, where the minister made the following remark on the issue of data sharing:

> Any user who generates data can make it available to others through the internet and the subsequent user can format it in any manner he likes. This is what is popularly referred to as an information superhighway. An information highway is perhaps the only kind of highway which can be built without attracting the provisions of the Forest Conservation Act for diversion of forest land and cutting trees!

For those people familiar with the relatively chaotic nature of the Indian government, and the strong sense of inertia in its procedures, the above appeals for policy change may perhaps be perceived as naive. However, although we recognize the difficulty of achieving change in such a complex and deeply rooted system, we do not accept that change is impossible. Over the last decade, India has undergone major changes in its political approach—for example, toward a more open economy. In addition, computerization is now a major issue of debate in India in both the public and private sectors in a way that was not the case 10 years ago, so it would be wrong to assume that the next 10 years will necessarily involve stagnation on policy matters. In addition to any internal initiatives for change, India is increasingly subject to the international pressures resulting from globalization. For example, with respect to GIS, there is increasing international concern on environmental issues, and GISs are being promoted by many environmental agencies as providing a valuable platform for analysis and action in the environmental arena. India is not immune to this pressure, not least since it is often directly related to financial aid.

This returns us again to the question of the influence of global society on countries such as India and whether, and in what respects, this influence is desirable. With respect to GIS specifically, the argument has been made that there is the need for a critical approach to the examination of the ways in which this technology and its products reconfigure broader patterns of cultural, economic, and political relations (Pickles 1995). We have only touched on this issue in the current paper, but we would agree that Indian society needs to reflect on and choose its own path between the two extremes of reproducing old attitudes and accepting all new Western ideas uncritically.

Although we have discussed the implications of our research study specifically for the practice of GIS for district-level administration in India, many of the ideas discussed in this context are of potential relevance in attempts to apply GIS for decentralized management in other developing countries. We have, for example, examined some of these issues in the context of Malaysia, and the following comments draw partly from this experience. Some general implications for GIS practice are summarized in Table 4 and are discussed below.

There will always be a need to create a network of aligned interests of the scientific developers of the GIS and the potential users at the level of the district or other administrative unit. The use of simple maps or focusing on key local issues may provide a useful starting point in the creation of such networks. At higher political levels, issues such as data sharing, and other cooperation between different agencies, will be relevant in all

Table 4. Summary of Implications for GIS Practice
GIS for Decentralized Administration in Developing Countries
• Create network of aligned interests of technology, developers, and users • Can start with simple maps or key local issues • Address issues of data sharing at higher political levels • Change education process for administrative officials
GIS Implementation in General
• View GIS as non-human actor with inscribed interests • Enroll stakeholder groups to align their interests with the technology • Is complex and long-term issue due to deep-seated social structures and multiple agencies

countries. The educational process for administrative officials will also be an important policy issue in all countries, although specific approaches to this will need to be developed depending on the particular history and context of the country in question.

If we widen the scope of our discussion of practice further to the use of GIS more generally, our research suggests some concepts and theory potentially helpful to practitioners. In terms of concepts, GIS can be viewed as a non–human actor with inscribed interests. There is a need for the enrollment of stakeholder groups through the translation of their interests so that they are perceived as aligned to those of the technology. There are often significant difficulties in achieving this translation, since the problem normally relates to deep-seated social structures and work practices. For example, the difficulties in achieving widespread use of GIS in local government in the UK have been described and related to the embedded cultural attitudes of local government planners (Campbell 1994). A final comment for general GIS practice is to note that the nature of these systems is such that multiple agencies and stakeholder groups are normally involved and that the creation of a stable network is therefore likely to be particularly problemat c.

Implications for Intensive IS Research

The purpose of this section is to reflect on the conduct and written reporting of intensive IS research studies by providing criteria for judging the merit of such work, and by illustrating and discussing how and to what extent our own study satisfied these criteria. We use the paper by Golden-Biddle and Locke (1993) [GBL from now on] as the basis for our discussion. They describe three broad criteria as to how ethnographic texts convince the reader of their merit, and thus that of the associated research project. First, *authenticity* concerns the ability of the text to convey the vitality of everyday life encountered by the researchers in the field setting. Authenticity means being genuine to the field experience as a result of having "been there." The second criterion is *plausibility,* which focuses on the ability of the text to connect to the personal and professional experience of the reader. Finally, *criticality* concerns the ability of the text to actively probe readers to consider their taken-for-granted ideas and beliefs. Although the criteria are illustrated using ethnographic texts, GBL consider that they can be applied for any qualitative work, "especially that in the interpretive tradition which seeks to understand members' views of their realities" (Golden-Biddle 1998; private communication). We comment further on this point after we have examined our own text from the perspective of these criteria.

The criteria and their associated subcriteria are listed in Table 5. We consider each of the criteria with respect to our paper in some detail below, but we also identify two distinct versions of the paper in the analysis. Version 1 is the original manuscript that was submitted to the journal's reviewers the first time around and

Table 5. Criteria for Convincing Texts (Golden-Biddle and Locke 1993)

Main Criteria	Subcriteria	Example in the Paper
Authenticity	Particularizing everyday life	Getting lost in the heat of the Indian day
	Delineating authors' relationship in the field	Our own motivations with respect to GIS in India
	Depicting the disciplined pursuit and analysis of data	*Set of field site themes—Table 3*
	Qualifying personal biases	Different perceptions of UK and Indian researcher by participants
Plausibility	Normalizing unorthodox methodologies	Scientific practice—tables and figures
	Drafting the reader	*Implicit joining of authors and reader into uncertainty of GIS desirability*
	Legitimating the atypical	Actor-network theory applies to GIS in other contexts
	Smoothing the contestable	Extensive discussion of whether India is a map-based culture
	Differentiate their findings	Contributing to underrepresented research areas
	Dramatic anticipation	Language—role compartmentalism on the Bombay hotel steps
Criticality	Carving out room to reflect	Is change impossible in India?
	Provoking the recognition and examination of differences	Differences between the West and India on rational decision making
	Imagining new possibilities	GIS knowledge having a divine-like status

returned to the authors with a "major revisions" recommendation and detailed criticisms and suggestions for change from the referees and editors. Version 2 is the revised paper that was submitted to the journal the second time around. The reason for discussing both versions is that major changes were made to respond to the criticisms of Version 1, and these changes often provide excellent illustrations of the above criteria, since we are able to point to areas where the reviewers found Version 1 less than convincing and to show how we addressed these concerns in Version 2. This approach relates to a comment made by CBL (p. 614) on how their work could be extended:

> Interesting additions to the present study would be to examine ethnographic manuscripts that had been rejected, or the various iterations that a single article undergoes from the initial draft until publication.

Authenticity

In order to establish authenticity, GBL argue that the authors must show through their text that they have been "there" in the field. The first way to do this is by *particularizing everyday life* by showing familiarity with the language of those in the field study, their actions, and what they think about their lives in their particular organizations. In Version 1, we used no direct quotes at all in the interests of a concise write-up. This was heavily criticized by the referees, and these criticisms may be seen as questioning the authenticity of the research study, or more particularly the write-up of the study, since the referees noted that we must have extensive field notes for the purpose having carried out over 100 field interviews. In Version 2, we used many quotes from the participants themselves, including descriptions of how they viewed life in their organizations. In terms of actions, a

good example is the description of getting lost in the heat of the Indian day, which was added in Version 2, and is an attempt to show that many Indians do not use maps in their daily lives. It also provides an authentic glimpse of ourselves in a field situation.

The above example leads on to GBL's second way of establishing that the authors were there, namely by *delineating their relationship in the field*. This includes the length of their stay, their role, and the context of their fieldwork. We described these aspects in some detail in Version 1, but the associate editor summarized one concern in this area as follows:

> The authors have already been considerably more open about their role than most, and the reviewers are asking for even more self-reflexiveness . . . given the context of this special issue, confronting and discussing some of [the] difficult aspects of the researcher role in the field would be particularly appropriate and valuable to others.

In response to this concern, in Version 2 we added further material on our own role and attitudes. In particular, the statement of our own motivations with respect to the use of GIS in India as potentially valuable if sensitively applied by local people, and our discussion of whether GIS represent a form of cultural imperialism, provide examples of the expanded material.

GBL also argue that authors establish authenticity by showing that they have been "genuine to their field experience" through *depicting the disciplined pursuit and analysis of data* and by *qualifying personal biases*. The second of these relates strongly to reflexivity, which we discussed above; a further example of this is our discussion of the differences in response of the participants to the UK and the Indian researcher. The data collection and analysis depiction can be achieved, according to GBL, by identifying the types of data collected, the detailed processes of data collection, and the iterative movement between data collection and analysis. We described the first two of these in Version 1, but the data collection/analysis cycle was treated in a fairly cursory fashion, attracting criticism from one referee particularly. This was addressed in Version 2, and in particular, Table 3 and its associated text is a later addition, giving a specific example of the themes produced at a particular intermediate stage of the study.

Plausibility

GBL argue that the essence of plausibility is an ability of the text to connect to the reader's world view, formed through their personal and professional experience. They split this into the two broad questions from the reader's perspective of "does this make sense to me" and "does it (the paper) offer something distinctive."

Does This Make Sense to Me?

With respect to the first of these, GBL identify four ways for the author to attempt to achieve sense-making contact with the reader. The first of these involves *normalizing unorthodox methodologies*, consisting of organizing articles in a manner that is generally consistent with that of a scientific account, and using schematics such as tables and figures that express findings in a standardized reductionist form, consistent with accepted scientific practice. Both of these aspects were criticized in the review of Version 1, the first on the grounds of describing the use of too many theories in the paper, and the second on the grounds of there being only one schematic in the whole paper, a table summarizing the interviews conducted. Version 2 restricted the theoretical description to one theory only, namely actor-network theory, and had four tables and two figures, including a wastelands map.

GBL's second way for the author to try to access the reader's world is by *drafting the reader*, for example, through the use of "we" to include the author and the reader. The text added at the end of Section 3 provides an implicit example of the drafting of the reader when we say that, with respect to the question of the desirability and cultural impact of the technology transfer process, "we admit that we are uncertain as to what is ultimately desirable." Although this "we" refers to us as authors, the implication is that it includes the reader as well, since it would be a rare reader who felt that they knew what was "ultimately desirable" in this complex area.

The third way that GBL describe to "make sense" to the reader is by *legitimating the atypical,*

namely mitigating against the case being perceived as obscure and irrelevant, for example, by describing a broader set of relevant organizations to which the ideas of the article might be applied. We did this in our paper by suggesting that the ideas of actor-network theory could be applied to GIS more generally than in the Indian case, citing the example of GIS in local government in the UK (Campbell 1994). In Version 2, we included a more extensive survey of the use of actor-network theory in IS, suggesting that the ideas in our paper are more generally applicable both to other contexts and to other technologies.

Finally, with respect to sense making, GBL recommend *smoothing the contestable*. We suggested in Version 1 that India was not a map-based culture. This was questioned by the reviewers on a number of grounds, including the view that reality was more differentiated than this, since paper maps have existed in India for a long time, and the MOEF GIS initiative itself can be seen as an example of an interest in maps. In Version 2, we attempted to smooth the contestable assertion by showing a more complex picture including GIS scientists interested in maps in their professional life at least, and government officials at the center and the districts, some of whom expressed interest in the use of maps and GIS. However, we also added quotes from Indian participants to back our basic assertion that many Indians still do not internalize maps as a valuable method of accessing the real world.

Does the Paper Offer Something Distinctive?

In order to establish the second dimension of plausibility, namely the distinctiveness of the contribution, GBL argue that authors must *differentiate their findings* from those of others, for example, by defining "lacunae" or missing areas of research, or by sharpening the contrast between their work and that done in the past. We tried to do this in the current paper in at least two ways. First, in the final conclusions section, we identify two missing or underrepresented research areas to which we argue our paper has contributed. Second, again in the conclusions section, we argue that our work goes beyond traditional concerns of the management of data and information to examine deeper-seated social attitudes. We did not change this material between Versions 1 and 2, since the reviewers did not seem to question the distinctiveness of the paper's contribution.

The final way identified by GBL to establish a distinctive contribution is through *building dramatic anticipation,* which can be related to the view that what tends to convince is the "grace, wit and felicity" of a textual argument (Van Mannen 1989). We would not claim that our piece achieves this in the grand manner of Jane Austen, or John Van Maanen for that matter, but we have attempted to add a little spice to our writing through, for example, quotes on political interference, on the slowness of movement of committees on data security, on Naipaul's example of role compartmentalism on the Bombay hotel steps, and on growing mustard rather than wheat.

Criticality

The third criterion of GBL for convincing texts—criticality—is concerned with whether the text activates readers to re-examine assumptions underlying their work. GBL assign a different status to this dimension than their other two, noting that texts need to achieve authenticity and plausibility, but that criticality is not essential. They also argue that "the more the text has intentions of criticality, the more actively the rhetoric needs to be formulated."

The first subcriteria under this heading is *carving out room to reflect*. GBL give an example of a piece of text that tries to stop the reader in midarticle and includes rhetorical phrases such as "should give one pause." In reading our own text, there are no explicit stop signs such as this, but an implicit example is in the discussion of the "chaotic nature of the Indian government," which goes on to challenge the view that future change is impossible and cites evidence that significant change has been seen over the last decade, not least in the area of computing in India.

Second, GBL suggest stimulating criticality can be achieved by *provoking the recognition and examination of differences* between prevailing views and the ones articulated in the text; for example, by actively prodding the reader with a series of questions. Our material on the differences between Western countries and India in terms of the dimensions of rational decision

making, a map-based culture and coordinated action provides an illustration in our text, ending with the single question as to whether this creates major difficulties for GIS technology transfer. The implicit implication is that the IS reader should critically examine their own views and approaches to issues of information technology transfer, since deep-seated cultural differences occur between any two countries and often between organizations in the same country.

Finally, GBL identify the dimension of *imagining new possibilities* as a way of stimulating criticality in the reader, and they suggest the use of metaphors as one way of achieving this. They give an example from Barley (1983), who argued that culture researchers need to study more than overtly symbolic phenomena such as stories and rituals in order to grasp the depth and complexity of culture, since "terms, tales and totems are but lit candles hovering above the icing and cake of culture." Have we managed any such imagery in this paper? We think not, but in another publication on this work, we have compared the GIS scientists to the holders of supreme knowledge, highly valued in Indian culture, and thus acquiring almost a divine-like status. We have also compared the scientist-user relationship with the strong parent-child relationship in India. We do not have the space to expand on this imagery here, and indeed we would argue that this current paper is not strongly oriented to the criticality dimension, although it does provide some examples as discussed above.

Conclusions

The editors of this special issue stated two broad goals for the issue and indicated how authors should attempt to support these goals. First, they wished to promote intensive research by publishing models of how to do it, together with illustrations of criteria by which such research should be judged. In this paper, we have addressed the former by providing a detailed description of our research approach, including our use of theory and methodology, the research methods employed, how we analyzed our field data, and our role as researchers.

With respect to criteria for judging the merit of an intensive research study, we have drawn on a published framework in the literature as to how ethnographic texts may be made convincing to the reader. We have illustrated each of the criteria in the framework using our own text and have thus demonstrated the relevance of the criteria to an interpretive case study such as ours, extending the original paper, which dealt specifically with ethnographic texts. We have added a further new dimension to the earlier work by carrying out the analysis using two versions of the paper, showing how we tried to improve the credibility of the text in the second version by responding to the reviewers' comments.

The second goal for the special issue was to open up new fields of IS research that go beyond traditional concerns with the management of data and information. We would argue that our study contributes to this goal in three ways. First, our research concerned GIS, studies of which are currently underrepresented in the mainstream IS literature. As an illustration of this relative neglect, an earlier classification paper did not even mention GIS as an IS system type based on "combing [the] literature on IS and computers" (Ein-Dor and Segev 1993). Second, our study dealt with IS in developing countries, which again is a relatively neglected topic in the mainstream IS literature, despite the widespread use of computers in many of these countries. Finally, and perhaps of most significance, we feel that our study went beyond traditional concerns of the management of data and information by examining some of the fundamental attitudes, perceptions, and social structures that provide the context for IS implementation, in India in our case, and are deeply implicated in the implementation problems that arose. We have shown how actor-network theory can be used as a theoretical basis to examine such concerns. We have argued, in our case, that in order to address such problems, it will be necessary to go beyond traditional prescriptions concerning participation in design or good user training toward higher level interventions in areas such as educational processes and administrative structures. Although such results were derived from our work in India, we believe they have relevance in many other GIS and IS implementation contexts.

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APPENDIX

Acronyms and Abbreviations

DST	Department of Science and Technology
EDI	Electronic data interchange
ESRI	Environmental Systems Research Institute
GBL	Golden-Biddle and Locke (1993)
GIS	Geographical information systems
IAS	Indian Administrative Service
IDRISI	GIS software package (named after medieval cartographer)
IS	Information systems
IT	Information technology
MOEF	Ministry of Environment and Forests
NAEB	National Afforestation and Ecology Board
NGO	Non–governmental organization
NIC	National Informatics Centre
UK	United Kingdom
U.S.	United States of America
USAID	United States Agency for International Development