# DIGITAL THEMATIC ATLAS - DESIGN ISSUES AND METHODS OF UPDATION INCORPORATING THE INFORMATION SUPERHIGHWAY POTENTIAL

THESIS

Submitted in partial fulfilment

of the requirements for the degree of

DOCTOR OF PHILOSOPHY

By

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Under the supervision

of

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BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE

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## CERTIFICATE

This is to certify that the thesis entitled 'DIGITAL THEMATIC ATLAS - DESIGN ISSUES AND METHODS OF UPDATION INCORPORATING THE INFORMATION SUPERHIGHWAY POTENTIAL' and submitted by Harsh Verma, Id. No. 90PZYF404, for award of Ph.D. Degree of the Institute, embodies original work done by him under my supervision.

15.5.96

Signature of Supervisor

Name of Supervisor : Lt Gen G.C. Agarwal (Retd)

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(Harsh Verma)

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| AS | Atlas Storehouse | 53 |
| AU | Atlas User | 53 |
| BBS | Bulletin Board System | 46 |
| CBMS | Computer Based Messaging Systems | 47 |
| CCITT | Consultative Committee of International Telephone & Telegraph | 44 |
| CDR | CorelDraw | 5 |
| CGM | Computer Graphics Metafile | 5 |
| CMFP | Centre of Minor Forest Products | 87 |
| DBMS | Data Base Management System | 27 |
| DNIC | Data Network Identification Code | 121 |
| DoT | Department of Telecommunications | 119 |
| DTA | Digital Thematic Atlas | 59 |
| DVD | Digital Vector Data | 4 |
| DXF | Drawing Exchange Format | 4 |
| EDI | Electronic Data Interchange | 46 |
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| INTERNIC | INTERnet Network Information Centre | 131 |
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| ISNET | BBS ISNET Bulletin Board System | 108 |
| ISO | International Organisation for Standardization | 43 |
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| MIME | Multipurpose Internet Mail Extension | 49 |
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| NUI | Network User Identification | 127 |
| OSI | Open Systems Interconnection | 43 |
| PA | Protected Areas | 73 |
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| P-S-U | Publisher-Storehouse-User | 51 |
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| UP | Uttar Pradesh | 68 |
| URLs | Uniform Resource Locators | 135 |
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| VR | Virtual Reality | 39 |
| VSAT | Very Small Aperture Terminal | 50 |
| VSNL | Videsh Sanchar Nigam Ltd. | 119 |
| WII | Wildlife Institute of India | 73 |
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# Chapter One

## 1 INTRODUCTION

### 1.1 PREAMBLE

Information of varied nature, such as political, physical, climatic, demographic, agricultural, mineral, industrial or pertaining to specialised disciplines, such as forestry, wild life, geology, archaeology, petro-chemicals, defence and a host of other related fields which are coming up every day with growing complexities of life, is provided to a user in a number of ways.

Since very early times one method adopted has been through preparation of plans or maps. As the number of maps dealing with different aspects of information regarding man and earth multiplied, the collection came to be called an **ATLAS**.

According to Webster's New Encyclopaedia Dictionary, an 'Atlas' is (1) a book of maps often including descriptive text (2) a book of tables, charts or illusttations. In brief, an Atlas is basically a volume of maps, often with statistical tables or other information about the subjects included (figure 1.1).

Atlas was one of the Titans or giants of Greek mythology, whose rule of the world in an early age was overthrown by Zeus in a mighty battle. Atlas was believed to be responsible for holding up the globe.

The sixteenth century Flemish cartographer, Gerhadus Mercator, in his published collection of maps, included on the title page, a picture of Atlas supporting the heavens and he gave the book the title 'Atlas'.

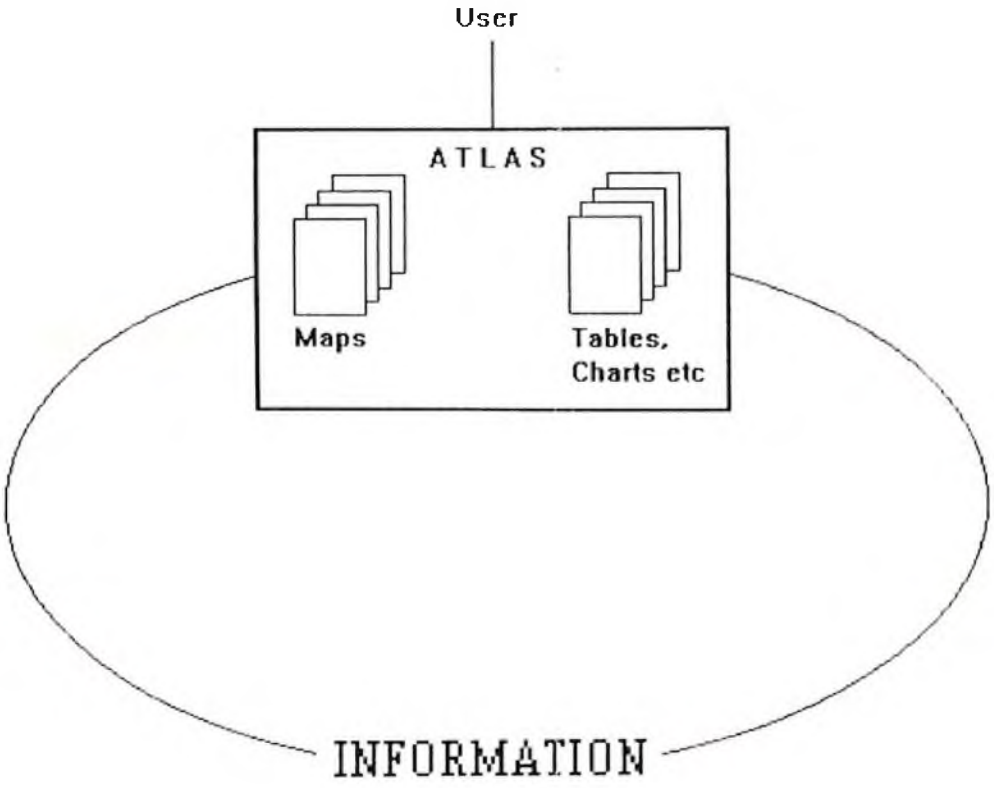



Fig. 1.1 ATLAS - A COMPENDIUM OF INFORMATION

The world's first modern atlas, 'The Theatrum Orbis Terrarum' by Abraham Ortelius, was published in Antwerp in 1570 [1].

In 1679, Jean Domenique Cassini, an Italian cartographer, for the first time, conceived the idea of a large-scale map on which geographical data could be recorded, revised and updated, as and when information was received from observatories and correspondents and special expeditions sent all over the globe. This is how the map was kept up to date regarding location of cities, harbours and other details during the early days.

An atlas, in fact, can be thought of as a Home of Maps. It is no more a mere collection of maps as the name signifies [1]. There are many different types of atlases - school atlas, modern atlas, political atlas, national atlas, forest atlas and so on. The basic essence of all atlases is that they provide the users with maps and additional relevant information to satisfy their needs and requirements.

From the primary school upwards we need atlases to support and supplement studies not only in Geography but a host of other disciplines and social sciences - the scope and diversity getting enlarged as one goes up the ladder [1].

With the Information Explosion, effective access requires greater interaction between the users and the atlas. Information has become an important resource in all walks of life [4], [5] and is global and available to all. Today, people are willing to share information and knowledge.

Till the beginning of the last quarter of this century, the only Atlas maps available to the user were those printed on paper. They had one serious limitation. As preparation of a set of maps took years, by the time it was published, it soon became out of date. Such fixed and static maps fail to satisfy the users today.

## 1.2 EXISTING MAPPING TECHNOLOGY

To make up for the deficiency, one method adopted by users has been to prepare slides of maps from different sources relevant to their study and navigate from slide to slide in a particular order.

With the advent of computers, it has become possible to digitize a map which can enable the generation of the map as required for scientific analysis of an area.

Present-day mapping technology has made it possible to have computer-generated maps. The concept of a computer-generated map is now well-understood and digitized maps are being created by following standard techniques.

The viability and formulation of a working model for adopting a digital approach for producing colour-separated scribed negatives for printing of topographical maps on a production line basis has been successfully carried out by Survey of India [7].

The digital technique, when adopted by Survey of India, will automatically create a Digital Cartographic Database along with the hard copy topographical map. This up to date digital map database would provide the base data for a National Cartographic Database. A National Standard Exchange Format for Digital Vector Data (DVD), extracted from SOI topographic maps on 1:25,000, 1:50,000 and 1:250,000 scales, has been recently identified [8].

Basic digitized Map and Image files, in binary format, containing selected base categories of topographic data, are the **Base Maps** on which further work will be carried on. A typical use of these base maps is to combine them with other geographically referenced data, enabling various automated spatial analyses to be conducted [3].

Besides Survey of India, a number of other organisations are also developing Base Maps or are using Base Maps computerised by other agencies with in-house mapping facilities.

Similar developments in the United States, Great Britain and elsewhere have identified standards for geomatics data transfer. Spatial Archive and Interchange Format (SAIF) and many other interchange specifications of geomatics data have been evaluated by working groups of Canadian General Standards Board [3]. Spatial Data Transfer Specification (SDTS) has also been adopted by the US government and is being used as a basis for the development of national data exchange standards by a number of other countries including Australia [10].

A number of standard packages and data exchange formats which allow scanned digital images of paper-printed maps to be used for simple applications are available nowadays. The Tag Image File Format (TIFF), PC Paintbrush (PCX) and Graphics Interchange Format (GIF) have been designed to introduce standardisation in the interchange of digital image data transfer by Aldus, Microsoft and several other computer companies [61]. Some vector-based popular formats are the Windows Metafile (WMF), Corel Draw (CDR), Computer Graphics Metafile (CGM) and the Drawing Exchange Format (DXF). The Encapsulated PostScript (EPS) format is useful for printing to PostScript-compatible printers. Some formats also allow typical images to be compressed to between 1% and 50% of their original size, depending on their type and content, thus allowing for less storage space and faster operations on topographical maps.

## 1.3 VALUE-ADDITION IN THEMATIC MAPPING

Digitization, however, does not mean mere computerisation. In addition to topographical maps which show basic features of the land, there is an increasing demand for 'Value-added' maps or resource-specific maps e.g. forest maps, soil maps, industrial

layout maps, wild life maps etc. Such maps contain information about a single resource or an object or a theme and are called 'thematic maps'.

Thematic maps are generally drawn over a simplified topographic base. 'Planned Development' methodology for National Development planning of a country requires thematic maps and atlases as a base document [1]. Thematic Maps with their information databases are being integrated [4] into the area of planning, management and decision-making. Various users from Government Departments, Non-government Departments, Research Institutions, Universities, Educational Institutions and Ministries are becoming conscious about the indispensability of thematic maps for Policy-making, Planning and Decision-making in various fields, as shown in figure 1.2.

Recent advances in remote sensing technology enable a user to obtain rapid and reliable information on the natural resources [11] and demonstrate the utility of satellite imaging in thematic mapping. Stereo SPOT imagery has further added flexibility to the use of satellite data for the updation of existing topographic maps [12]. India's IRS-1C remote sensing satellite put up by ISRO, will soon provide data on the Indian environment at a relatively low cost.

A thematic value-added data base with its specialised resource information may be required to be studied and archived along with other socio-economic, scientific and historic or quantitative data. New methodologies and new techniques are being developed which can be used to update overlays of 'object data' of various resources over a specific thematic map.

Various sets of thematic information would be provided in different thematic overlays of Base Maps. It goes without saying that all overlays of data have to be digitally compatible. This is too difficult a task to be carried out on paper maps since periodical revision of maps can be undertaken only after a span of a decade or more and it takes anywhere between 6 to 10 years, even by optimistic estimates, for the publication of a map [7].

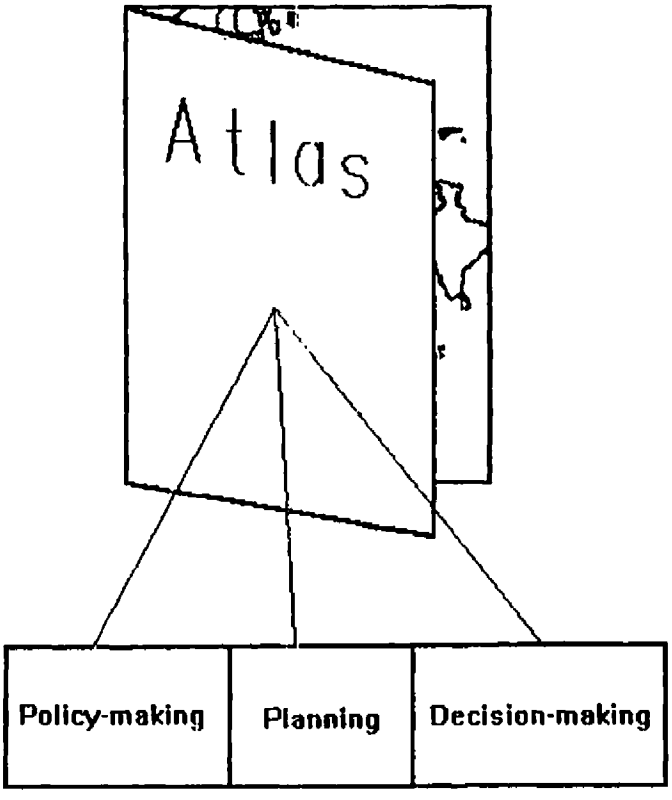



Fig. 1.2 THE ATLAS AS A TOOL IN THE HANDS OF DECISION-MAKERS

Thus, the strong emerging need to generate various digital thematic maps is a very important aspect of today's mapping technology. There are a number of advanced applications already in use in U.S. and Canada. The ARC/INFO system of Environment Systems Research Institute (California, U.S.A.) has taken up various case applications of thematic maps such as :

| | | |
|---|---|---|
| Irrigation and Water Map | - | for location of irrigation schemes in African countries. |
| Resources Potential Map | - | for determining various forms of resources. |
| Sample Forest Maps | - | for help in strategy planning of harvests. |
| Water Uses Map | - | for use in investigation of water rights. |
| Fishing Waters Map | - | Minnesota fishing waters and supplementary lake information displayed on this map acts as reference for tourists at Minnesota Land Management Information Centre. |
| River Basin Map | - | Water Rights maps for legal claim assistance in Little Colorado. |
| Wetland Inventory Map | - | Information on wetlands based on vegetation, visible hydrology and geography, as part of a joint project by the U.S. Fish and Wildlife Service.Maps, 23 in number, were created by scanning aerial photographs. |
| Primary Vegetation Map | - | for selection of primary vegetation types in lake areas of Alaska.. |
| Ecological Planning Map | - | for integration of natural resource considerations into regional planning. |

In India digital thematic maps which deal with such specialised information are still to be made available for public use.

## 1.4 STEPS INVOLVED IN DEVELOPING A MAP

The operations involved in building a map database are quite complex and detailed, involving a number of steps.

**Data Gathering**:

Data is gathered from a variety of sources and compiled together on the computer. Sources of map information can be existing maps and documents, surveys carried out to generate maps like land surveys, aerial surveys, subsurface etc. or even existing digital databases which may have been generated by other agencies.

**Conversion**:

Next, the initial data gathered is translated from different map sources to a standard database format, using conversion methods and softwares.

There are two technologies which are popularly used today for conversion operations.

(i) **Scanning** is used to convert an existing map to a raster image in bit-image format. The raster image, if required, is then converted to vector format.

Scanning is the quickest method of data conversion by way of which information on a printed paper map is converted into computer format.

Although sophisticated digital mapping systems are still hampered by non-availability of digital imagery and high costs of hi-resolution image scanning [13], the method of scanning to create Base Maps of Topographical Information and adding Thematic Information, thereby generating a Digital Thematic Map, will soon become widespread.

**Cleaning** refers to the task of raster-based operations in which noise or any other analog cause of irrelevant information is removed, pixel by pixel, to make the map even more useful than the original.

(ii) **Digitizing** incorporates converting map attributes to computer graphics form. Earlier used as a method of generating simple maps, this technique is very time-consuming and skill-oriented, and is mainly used for editing, vectorisation and attribute-setting operations.

**Transformation** :

Transformation is an important stage during which a variety of map segments differing in size, scale and projection are merged into a single continuous map of the desired area. The net result is an **integrated digital map** which incorporates information captured from different sources.

**Editing** :

Editing is a rectification task carried out to review map contents. Proof plots are taken which are compared with the original document to verify accuracy of coded features or graphic representations. Any discrepancies found are corrected at the graphics workstation using a cursor to interactively select and initiate menu commands.

Automated **error-checking** routines are also available to locate incorrect polygon closure conditions before processing overlay data sets.

**Displaying**:

For displaying map information, dynamic feedback techniques are applied to provide for viewing and analysing operations. Base information stored in database files

connected with different layers along with map symbology stored in tables are applied to map displays as required.

Various colour and patterning techniques help in differentiating attribute values. These techniques could be Colour, Raster Data Colour Fill, Hidden Line Suppression, Patterning and Cross hatching.

## 1.5 CREATING A THEMATIC MAP

After having created a Base Map, the procedure to create a thematic map is through the following steps:

i. generating a Theme-Sensitive polygon coverage from point locations in the point coverage to define proximal areas;

ii. generating a State boundary polygon from National Atlas data residing as an ASCII file; and

iii. clipping the Theme-Sensitive polygon coverage with the state boundary polygon coverage to produce the Theme-subject polygon coverage.

Thematic display on maps could also include statistical data. As per Arthur Robinson et. al. (1978), and Nitin R. Patel (1987) [14], a number of standard methods exist for such data handling.

## 1.6 MAP-WALKING

Once the Base Maps and Thematic Maps are created, it is possible to use them for a variety of interactive applications.

The study of interactive video systems provides the way in which both systematic spatial referencing and a looser form of geographical association can coexist (Openshaw and Mounsey 1987, Rhind and Openshaw 1987; Magazine 1989), Shepherd [15].

The concept of 'Map-Walking' enables the users to make a search for a location by travelling (i.e., zooming and panning visually across large areas of map display), or by entering a place name which is checked against a huge gazetteer of place names. When an appropriate map is found, the user may display photographs and pages of text associated with some part of the area covered by that map.

Alternately, users could search for textual material by entering appropriate keystrokes. The associated photographs and maps are then retrieved and displayed by the system [15].

Thus, 'value-addition' of digital maps combined with map-walking provides much more advanced methods for information retrieval than paper maps have been able to provide.

## 1.7 STATEMENT OF PROBLEM

From the foregoing discussion, the following basic problems are identified:

1. The compilation and publication of paper thematic atlas (PTA) is a complex and time-consuming task. A Paper-based Atlas covers a wide spectrum of information and thus poses problems of access involving the selection and combination of information required by a user. A comprehensive and detailed atlas could at times be confusing to a casual user and be difficult to handle.

2. There is no nation-wide networking of data banks for thematic maps of various natural resources, administrative boundaries, infrastructure facilities and other socio-economic variables.

3. Updation of PTA is not taken up at regular intervals and therefore the atlas becomes a *static* entity, published at any point of time on one definite theme, while today's fast-changing scenario requires *dynamic* collections of information composed *on-demand* and in flexible formats.

4. India is one of the earliest nations to carry out Surveying and Mapping on a regular basis. However, it has yet to develop digital thematic maps for wider use by different interested user groups.

The above problems motivate us to think of a Digital Atlas.

## 1.8 MOTIVATION FOR A 'DIGITAL ATLAS'

The phrase 'Digital Atlas' could generate different responses in the minds of different persons. A 'Digital Atlas' would imply more than computerisation of a traditional atlas. The process of replacing paper by electronic storage leads to three major advantages:

i) storage in digital form

ii) direct communication to obtain material

iii) efficient and immediate updation.

There is a need for an initiative for a Digital Atlas in the field of Atlas Publication, its Updation and Application in India.

In this context, the NSF/ARPA/NASA $24.4-million Digital Library Initiative launched by U.S. Government legislation and a number of funding bodies in 1993 is worth mentioning (Fox et al, 1995) [6]. 'The California Environment' is a large collection of diverse kinds of data about the environment, which will contain reports for the State of California, supporting computer models, aerial and ground photography, maps, videos and databases [16]. Another example of such an initiative is a major exercise for establishing National Land Information System or NLIS, in the United Kingdom, under a programme 'Doomsday 2000' [48], with the objective of surveying the entire country by the year 2000 AD, identifying every square metre of land in terms of ownership, value and usage and making this information available to users through a wide area network [17].

The Digital Atlas will revolutionise spatial information flow in the country and the map of the future may not be the traditional printed map [2]. **On-demand** printing of hard copy could be obtained as and when needed [2]. It could also allow for multiple views on the information according to different themes of interest.

We can also expect to see new centres of influence and new communities coming up because of the application of such digital technologies. To be productive in the new world, individuals now performing information services will have to rethink about their activities. Rethinking will mean trying to consider the likely locales of future services and identifying nodal agencies which will provide them. There will be new methods and architectures for the information flow [9].

A Digital Atlas thus developed could prove highly useful in bringing new ideas and methodologies in scientific application, education and learning. The application of Digital Atlas could bring about a dramatic shift in intellectual, organisational and economic practices within society. At a higher level, research scholars, scientists and engineers who are working on development projects and need multi-disciplinary information which could be extracted only from a computer database of a Digital Atlas, will get the right tools to solve their difficulties. At a lower level, as well, it could enable school and college teachers and

students who are also 'widespread users' of atlases to study various subjects in a manner that have been so far conceptually and physically impossible.

As digital acquisition and storage costs go down [6] relative to the cost of manual printing on paper and updation, trends in converting traditional data to digital form will increase. Newer forms of growing data like digital databases, digital images, digital libraries and digital maps will develop.

## 1.9 AIMS AND OBJECTIVES

The aim of the present research work is to integrate and complement, as much as possible, the base work already on the anvil and identify new research and development techniques and methodologies for a visualised system of a global Digital Thematic Atlas with facilities for updation, periodically and promptly and yet economically in a friendly environment between the user and the publisher, incorporating the potential of the Information Superhighway.

The objectives to achieve the above-stated aim are:

1. to identify the basic design issues of a conceptualised Digital Thematic Atlas;

2. to develop a framework for integrating various components of DTA and their inter-relationship, with a view to developing a Back-end for the Publisher and a Front-end for the User;

3. to demonstrate the framework developed under 2. above by the use of selected case applications;

4. to identify the methods of networked updation techniques and various Search Tools for global operations; and

5. to develop Solution Models for networked compilation and updation of DTA for local, country-wide and world-wide approaches, utilising the Information Superhighway potential.

## 1.10 SCOPE AND LIMITATIONS

The scope of this research is to identify the basic design issues involved in developing a networking approach to a global Digital Thematic Atlas by formulating a framework for integrating thematic information and to develop Solution Models to create a dynamically updated atlas.

The design issues shall be taken up in a top-down manner dealing with (i) the major components of a digital thematic atlas first and (ii) methods of updation later, with model examples of data representation, structure and application.

The scope would be limited to designing a framework for integrating spatial databases and traditional attribute data with basic map base, design of query and reporting system and creating an environment for exploring such models.

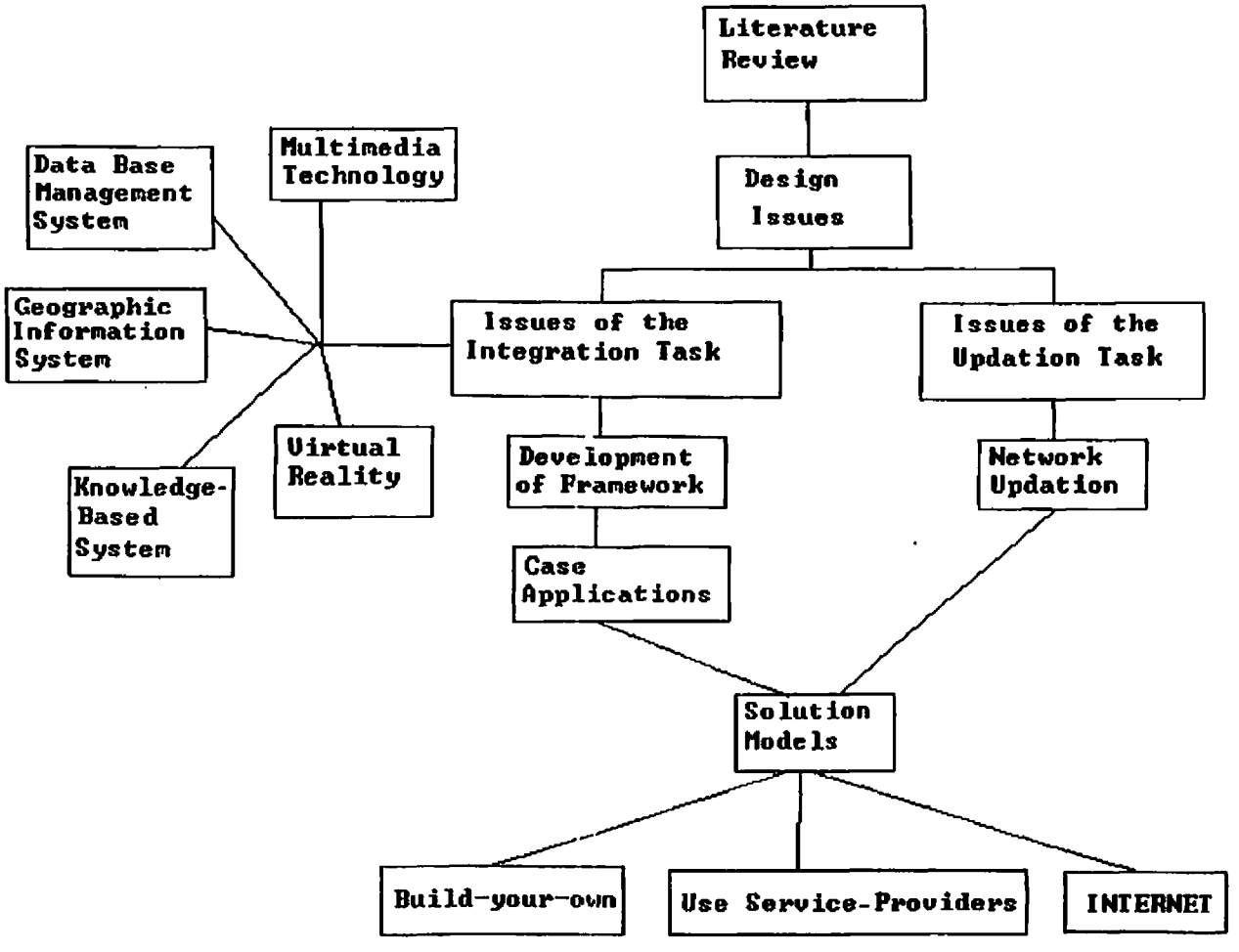
Two Case applications shall be taken up for the study:

a. An Endangered Species Atlas

b. A Minor Forest Products Query System

Finally, a model for a conceptualised Digital Thematic Atlas shall be developed which would present an approach to resolve the various requirements that such application systems would derive from computer networks and the Information Superhighway.

## 1.11 METHODOLOGY



# Chapter Two

## 2 BASIC DESIGN ISSUES OF A DIGITAL THEMATIC ATLAS

As stated in the previous chapter, the objective of this research is to identify basic design issues for a future Digital Thematic Atlas with new approaches to updation, incorporating the Information Superhighway potential. What shall be the methods of designing a Digital Atlas? In what ways will a Digital Atlas be similar and dissimilar to the paper-based atlas? What shall be the components of a Digital Atlas?

It has to be appreciated that the prime purpose of an atlas, digital or otherwise, is to provide the user with maps and additional relevant information in accordance with his needs. While there are many types of atlases providing various data sets of information, the method of consulting an atlas is basically the same, as depicted by the flowchart in figure 2.1.

In simple terms, the atlas has a particular title and lies in a book-shelf along with other books and has to be *opened* for any application. Though a simple step, this is absolutely necessary to be able to look for information from within the atlas. After the atlas has been opened, the desired *map* is located. This could be done by browsing through the atlas, going through all the pages, or by looking at the index. Once the map is found, various *queries* are put up mentally to answer questions and obtain thematic information. This procedure is used to develop *intelligent linkages* between multiple data sets and to analyse the information. On the basis of the information gathered, certain *decision-actions* could then be taken for policy-making and planning operations.

The above user-oriented approach helps us to understand the actual work done in using an atlas to retrieve any required information, in order to identify the required methods of organising an atlas collection and to sketch out the problems of designing a Digital Atlas.

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As stated in the previous chapter, the objective of this research is to identify basic design issues for a future Digital Thematic Atlas with new approaches to updation, incorporating the Information Superhighway potential. What shall be the methods of designing a Digital Atlas? In what ways will a Digital Atlas be similar and dissimilar to the paper-based atlas? What shall be the components of a Digital Atlas?

It has to be appreciated that the prime purpose of an atlas, digital or otherwise, is to provide the user with maps and additional relevant information in accordance with his needs. While there are many types of atlases providing various data sets of information, the method of consulting an atlas is basically the same, as depicted by the flowchart in figure 2.1.

In simple terms, the atlas has a particular title and lies in a book-shelf along with other books and has to be *opened* for any application. Though a simple step, this is absolutely necessary to be able to look for information from within the atlas. After the atlas has been opened, the desired *map* is located. This could be done by browsing through the atlas, going through all the pages, or by looking at the index. Once the map is found, various *queries* are put up mentally to answer questions and obtain thematic information. This procedure is used to develop *intelligent linkages* between multiple data sets and to analyse the information. On the basis of the information gathered, certain *decision-actions* could then be taken for policy-making and planning operations.

The above user-oriented approach helps us to understand the actual work done in using an atlas to retrieve any required information, in order to identify the required methods of organising an atlas collection and to sketch out the problems of designing a Digital Atlas.

Each one of the above steps helps to focus on the design issues for technology implementation and integration of the Digital Atlas keeping the end-user in sight.

While identifying the basic design issues for a DTA, we have to think not only of the immediate needs of the user, but of emerging needs as well, keeping in view a vision of the distant future.

The design issues of conceptualising and developing a Digital Thematic Atlas could be classified into two broad categories:

1. Issues of the Integration Task

2. Issues of the Updation Task

## 2.1 ISSUES OF THE INTEGRATION TASK

A number of specialised information technologies are available today. While each one of them has scope for advanced applications in its own area, it is important to identify the need of integrating these technologies for the specific requirements of building up and adding value to the DTA. The objective is not merely to collate information, but to present it in the most effective manner to the user so that his demands are fully satisfied.

Certain issues are common to the task of integrating different design components of a Digital Thematic Atlas. *Structural integration* is concerned with combining fundamentally different data models [23]. Numerous approaches have been developed recently for integrating various independently developed systems. Proceeding in a top-down manner, the basic issues are concerned with the following major components that could help in integration of a self-contained DTA :

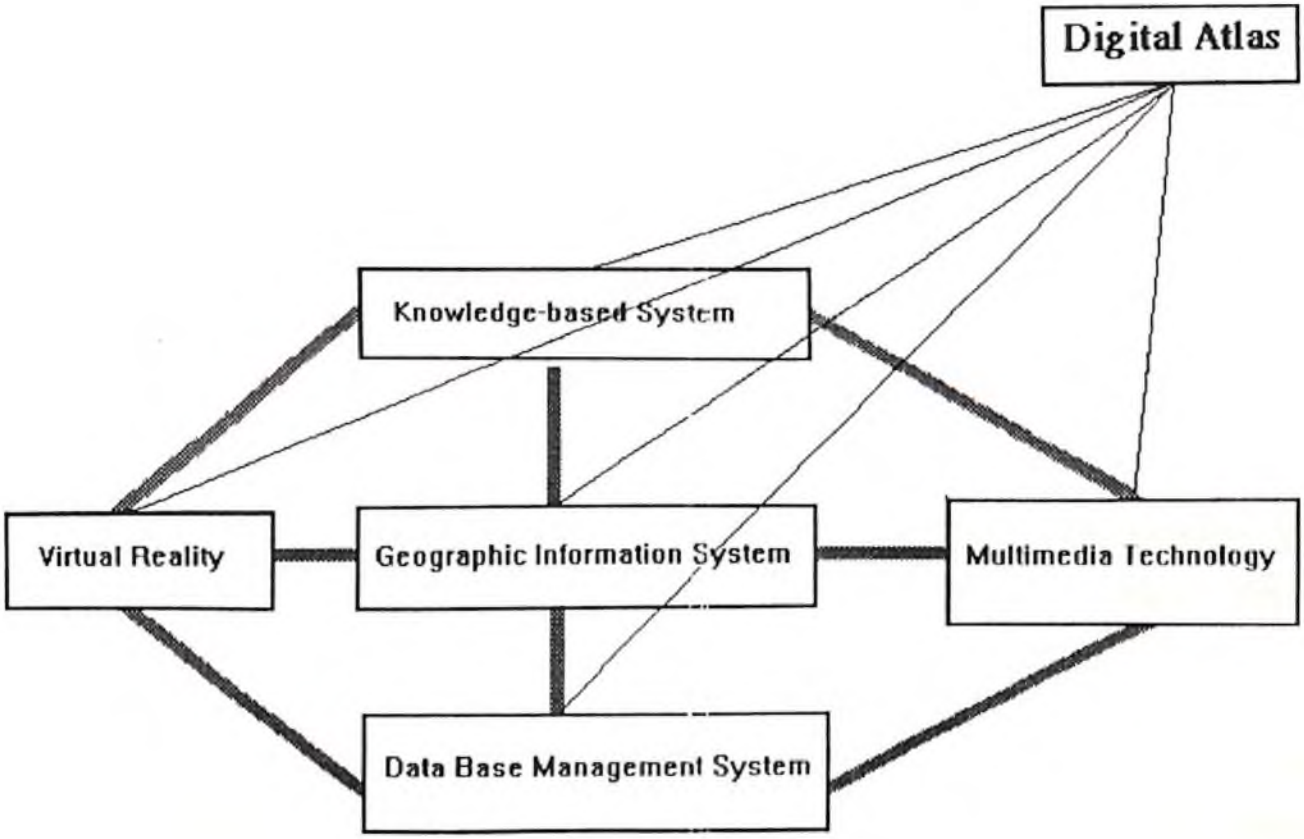


Fig. 2.2 ISSUES OF THE INTEGRATION TASK

i. Geographic Information System

ii. Data Base Management System

iii. Multimedia Technology

iv. Knowledge-based System

v. Virtual Reality

Figure 2.2 shows how these issues are inter-related and how their integration will lead to enrichment of the data-gathering process as well as its presentation.

### 2.1.1 Geographic Information System

Geographic Information System (GIS) provides the technological pillar of support to integrate spatial data composed of attributes that describe logical, physical and geographical features and is the prime component of the DTA.

GIS, which was first implemented in early 1980's on host computers accessed through ASCII graphic terminals [30], became available on microcomputers by mid-1980s and came onto workstations and LAN environments by late 1980s. Since then, the technologies of GIS and cartography have undergone major changes with the advent of computers, graphics, satellites for remote sensing and position location and associated systems [42]. Jack Dangermond is confident that GIS technology is becoming more reliable and more cost-effective [29] and has potential to bring together increasingly diverse kinds of spatially referenced data from different source media.

Basically, GIS lays down the format for feature coding, feature registration and all data capture/conversion activities for optimal topographic digital database generation.

Traditionally, GIS graphic data sets have been organised in layers. As a simple way of partitioning data, each layer consists of related information. Based on these types of layer assignments, selective display of layers can produce thematic views of feature data and associated attributes. The importance of a GIS in a conceptualised Digital Atlas is this capability to bring out different attributes on separate layers of information which can be updated independently.

One of the long-standing problems of operational GIS has been the separation of information derived from maps and information derived from images [15]. While map information has been typically vector-oriented data, image scanned information has been raster-oriented. Raster digital maps can be updated and directly plotted or printed out but need to be converted into vector form by vectorisation/digitization, if intelligence is to be added to the maps so that physical parameters like area, perimeter etc. can be measured and attributes added easily. Figure 2.3 depicts the integration of Raster and Vector data in a GIS. Some recently developed GIS packages have capabilities of displaying raster backgrounds beneath vector maps and linking images to vector coordinate systems [25]. ARC/INFO package allows vector information to be overlaid on raster images. Such capabilities will definitely help in creating a large bank of raster digital maps, drawings, photographs with value-added information needed for developing a DTA. Raster image data files are, however, much larger in size and would, therefore, take more time to be transferred over a networked-system and could require map data to be duplicated at select sites.

The availablity of GIS software packages has brought an advancement in thematic mapping through a greater degree of precision, capability to handle quickly large universes of databases and possibilities of comparative analysis of a large number of spatial attributes through overlays [8]. GIS packages are poised for a new wave of operations on workstation-based networks distributed over geographically distant areas. As larger numbers of people learn to start using GIS packages which are presently expensive and complex various kinds of applications and services shall develop. These will, in due course, become the foundation of vastly used map-based applications.

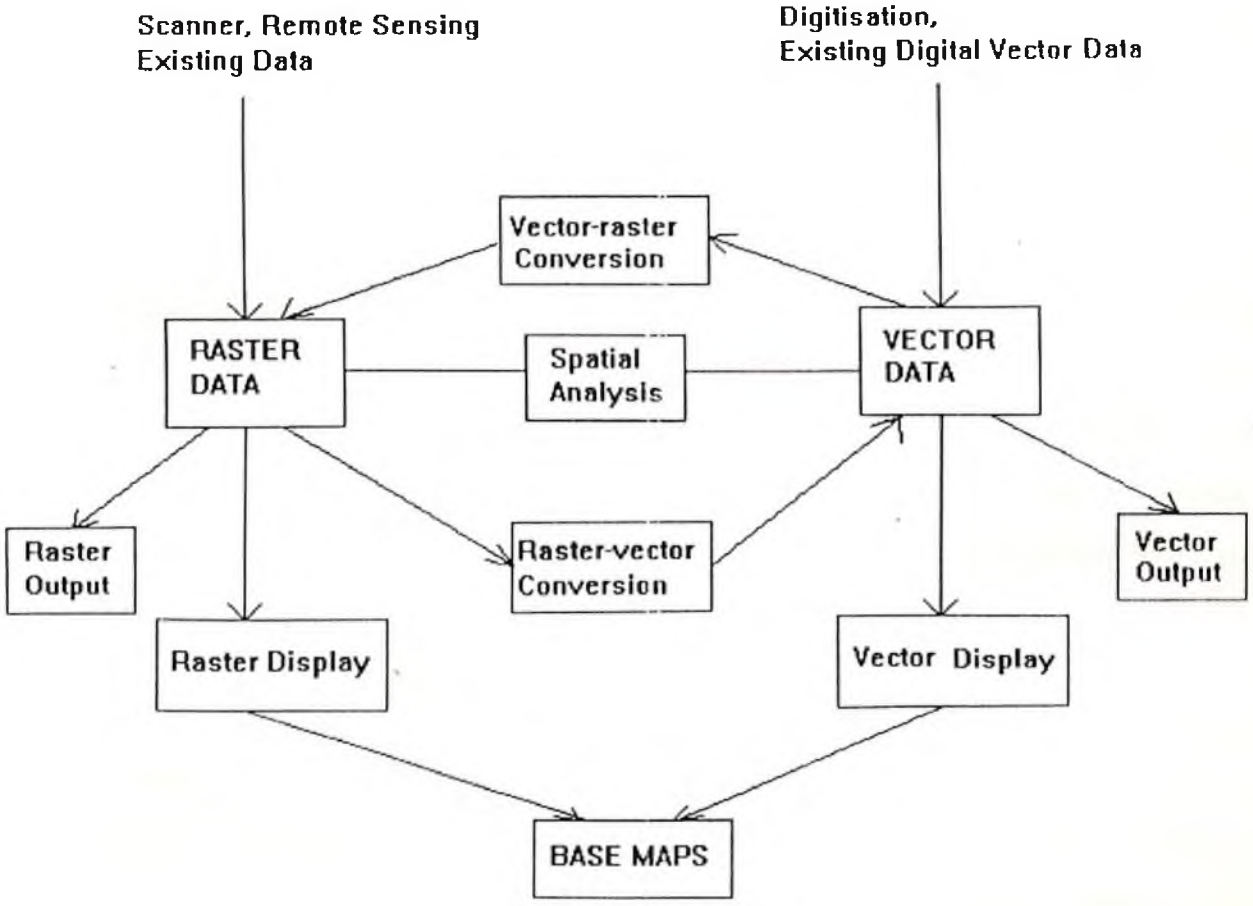


Fig. 2.3 RASTER AND VECTOR DATA IN A GIS

GIS is closely associated with other technologies listed in section 2.1 some of which are considerably more developed than GIS. The current requirement for broad access to GIS functionality is, therefore, the integration of GIS with other state-of-the-art computer technologies, as seen in figure 2.2.

GIS technology will have to provide various kinds of linkages with Data Base Management System and Multimedia technology for data gathering, querying and output operations. Geographic data is not commonly managed in a relational paradigm and there seems to be no accepted conceptual model for geographic or geometric data [19]. For example, ARC/INFO GIS package provides a very simple data management system called TABLES which helps to create, manipulate, list and manage attribute tables compatible with dBASE file format structures. Though it does not support MEMO items to be used in a feature attribute table which have to be stored in separate data files and accessed through the JOIN command, it does support use of a complete relational data base management system such as dBASE which can be used to provide intelligent linkages to attribute data. This makes GIS a powerful software tool for solving problems related to planning and developmental activities. It encompasses all disciplines and sciences which work on spatial data and natural resource data management.

The combining of GIS technology with expert systems (based on principles of artificial intelligence), the use of Global Positioning System (GPS) technology to enhance data capture for GIS, and the use of image processing to provide more rapid updating of GIS databases [29] are important associated areas where development will create and fulfil a user need for a future DTA for common applications.

Dangermond predicts that in the future GIS will be so widely accepted and frequently used in natural resource management that it will become not just transparent to its users but, to a considerable extent, invisible to them. In view of the present trend, it is felt that while today there are about 100,000 users of GIS in the entire world there are likely to be a million by the end of the decade [29]. More importantly, the Digital Atlas will replace the Paper-based Atlas with a much larger number of users.

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It is necessary to take up the following issues :

Could an average user of an atlas handle a GIS package?

Could it be possible to provide an expensive GIS package to every student user of an Atlas?

How could it be possible to overlay a Digital Atlas on a GIS engine which is used for integration and analysis of spatial data?

GIS technology has been successfully used for mapping and management of natural resources in recent years. What needs to be seen is the extent to which GIS technology can help in integrating a Digital Thematic Atlas. Certain issues of GIS need to be identified and understood in order to develop a framework for integrating GIS in a DTA.

a. Data volumes in GIS are enormous. Most of these are static as opposed to other data processing applications where data volumes are small but change rapidly [30].

b. Transactions in a GIS are very long and time-consuming, and queries highly resource-intensive.

c. Processing capacities require hi-speed computing power to be able to scan large quantities of data.

d. Data is obtained from different sources and integrated by the end-user.

e. The creation of a consistent geographical database requires effort at a number of distinct levels [15].

f. GIS packages are very expensive and an average individual user cannot afford to buy them.

It is felt that neither would the large data volume requirements of GIS be easily handled on user computing machines nor would users have time for lengthy transactions or data integration operations typical in a GIS. Similarly, the computing power required by GIS packages would not be available with end-user systems.

As such, although vast stores of spatial data exist, awareness of and access to these data sets, images and related documents continue to pose tremendous problems [20]. This situation is, in part, due to the lack of integration between Geographic Information Systems, storage management and network tools [20]. GIS packages are also not so freely accessible as are database management packages. Kacmar et. al. [20] suggest the use of a *Spatial Digital Library* that offers a solution to these problems through tools that support spatially-oriented cataloging, locator and access tasks.

It is felt that GIS, while being basically indispensable for the integration of the DTA, will all the same have to go into the background when it comes to a wider spread of distributed applications. GIS would have to be the silent engine working behind the scene and provide ***back-end support*** for the DTA.

### 2.1.2 Data Base Management System

Data Base Management System (DBMS) software packages used to create, append, store and update data in a database [73] are broadly categorised into three types [105] - a) Hierarchical Database Systems, b) Network Database Systems, and c) Relational Database Systems.

The *de facto* standard in the Database Model is Relational DBMS (RDBMS) which can be described as a system in which the user views the database as a number of interrelated "flat" files or tables [105]. There have been a number of advances in DBMS in recent years [36]. These have made substantial progress culminating in a very successful marriage between spatial and relational databases [13].

As a result of the spread of utilization of data base management system and the increasing sophistication of communication capabilities and information equipment, there has been a proliferation of what are called Transaction Database Services which combine the functions of databases and network services [79]. The *Globalization of Databases*, through liberalization of International Value-added Networks [79], could have a very high impact on the design of a Digital Thematic Atlas. International Value-added Network database services have become operational in Japan and the US since 1987. It has thus become practicable for operators in the area of commercial services to offer value-added services using dedicated international circuits. Earlier, it was unthinkable for vendors of value-added services to offer databases overseas via international dedicated lines and database access was limited. However, this new type of international value-added network service is expected to improve international database services dramatically, allowing future integration of database systems with other processing services, with improved and diversified procedures, easier operations and cheaper access.

The advent of high performance workstations and 32-bit notebook computers is going to have a profound effect on the utilization of database within a Digital Atlas. The use of databases will increase and databases will become personalized and used by a wider public. Through wider dissemination of notebook personal computers it will become possible to access map database easily from anywhere at anytime. With the increasing usage of *relational algebra* in DBMS, (Codd 1972), [105], the production of digital thematic databases is bound to proliferate.

When different types of DBMSs co-exist in a large organization, such co-existence presents problems for the users of one database system trying to gain access to the data stored in other database systems [11]. Some of the different data formats in existence are given in figure 2.4. The existence of diverse database formats has created a need for initiatives towards standardization to be put into effect. This has also led to linkages of databases which can be accessed through Global Database Libraries. Global approaches are characterized by a user view in which multiple, separate databases are seen as a single database through a unified global schema [23].

**Structured Data**

Database Formats: dBASE (DBF)
Spreadsheet Formats: DIF, WK1 and WKS, SYLK.

**Text**

Wordprocessing formats: Word Perfect, Word, Wordstar, DCA/RFT.
ASCII - Common formats are CDF and SDF.

**Line Drawings**

Line Art and Business Graphics Program Formats:

HPGL, CGM, Lotus PIC, Windows Metafile, General Parametric Videoshow, Postscript

CAD Program Formats: DXF, IGES, SIF, Set, Step/PDES.

**Maps**

DIGEST, VPT, NTF, DLG etc.

**Painted Pictures**

Painting Program Formats: PCX, GEM, IMG, TGA.

**Raster Images**

Scanned Image Format: TIFF, GIF
Fax Format: CCITT Group 3 and 4.

**Presentation**

NAPLPS, EPS.

**Documents**

ODA, CDA, DCA, DDIF, SGML, Edifact.

Fig. 2.4 SOME POPULAR FORMATS FOR DATA EXCHANGE

Global databases providing worldwide information are utilizing one of three different formats [86]. Some databases offer citations i.e., references; others offer short summaries and abstracts and still others provide full text or statistics which can be fully linked with the Digital Atlas. Keeping in view such global developments and introduction of electronic journals, issues of DBMS for integration into a DTA have become highly significant.

How could DBMS be linked in the integration of a DTA ?

DBMS would be required to develop sophisticated models of data relationships between various entities and to formulate queries in Digital Thematic Atlas. Entity-relationships would provide Knowledge linkage with the GIS. Query language interfaces would allow the user to issue queries against the thematic databases which would help in retrieving attribute information displayed through Screen Forms typically integrated in RDBMS. Query operations would help in scanning and filtering databases or could trigger off time-consuming transactions which may perform somewhere in background modes.

DBMS support would also be required for GIS data gathering and input operations for creating the initial thematic database, where GIS has been found to be lacking.

On the other hand, DBMS packages lack in graphical or geographical function commands and would need to be integrated with GIS and Multimedia systems to strengthen the support pillars of the DTA.

A major issue of integrating DBMS with GIS for DTA is that data storage mechanisms which are optimal for locational information are not optimal for attribute/thematic information (Morehouse 1985; Aronson 1985), [108]. On this basis, digital cartographic map files are stored as direct access system files, while thematic attribute data would be separately stored in RDBMS files as may be seen in figure 2.5. This is called the **Hybrid Data Model**. On the other hand, where the GIS serves as the query processor sitting on top of the database itself it is possible to store attributes in the same tables as the map feature database or in separate tables accessible via relational joins (Guptill 1987; Morehouse 1989) [108]. This is called as the

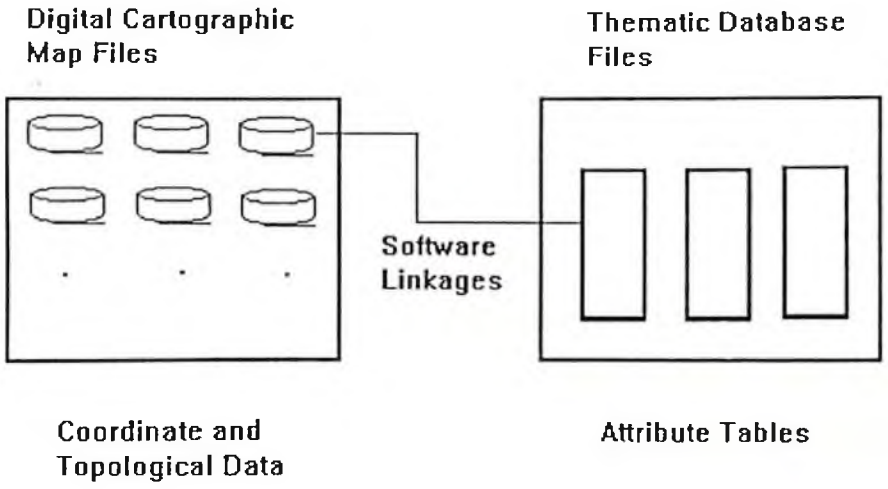



Fig. 2.5 THE HYBRID DATA MODEL

**Integrated Data Model.** Both hybrid and integrated models co-exist. To maintain a certain amount of system independence, it is proposed to use separate RDBMS files for thematic attribute data as in the hybrid model.

Another major issue related to query operation is that some type of data layer intersection (overlay) functions cannot be performed easily because they require operations beyond present DBMS query functions. One approach that is generally followed is to pre-process such queries and convert, if possible, the spatial operators into more complex but standard Structured Query Language (SQL), which is then passed to the database kernel. A second approach is to pre-process the query into a component that can be used to retrieve data from the DBMS. This data could then be processed by special functions to perform the GIS functions or display operations.

The best way forward seems to be the evolutionary approach of adding Object-oriented facilities to an existing database framework [108], which could provide compatibility with a number of systems and interface complex data structures at the Back-end, while developing the Front-end for query functions. The DBMS would need to be closely coupled with the GIS at the back-end.

### 2.1.3 Multimedia Technology

Multimedia technology provides a convergence of previously separate information-handling technologies like high-quality video and audio, digital and analogue, television and computing which permit users to access many types of information (Press 1990), [15] like characters, figures, diagrams, text, graphics, animation, video imagery and sound in which these elements can be related to each other.

The future Multimedia Data Base Management Systems will be the key to multimedia document storage systems and would have important implications on GIS technology. Multimedia technology provides a model of a real-life integrated situation in a manner

similar to the way that a database provides for ASCII coded raw textual data. Of course, the storage requirements of digitized images are greater than ASCII coded storage requirements.

There are high expectations from multimedia technology for specific application to a Digital Thematic Atlas where it could become necessary to produce visually complex creations as part of the atlas. Multimedia could bring maps, thematic information and reference material to life and have much wider applications to a digital thematic atlas than mere superficial addition to text databases of diagrams and images. They are likely to play a vital role offering advanced and diversified functions for the integrated control of multiple media, which could provide an ideal environment for a digital thematic atlas.

Incorporating Multimedia technology components in the DTA will require workstations equipped with Multimedia cards, video capture cards, image compression hardware and software, hi-quality microphones and speakers to create, edit, store and display appropriate pictures at desired stages of the DTA.

An international standard called the Multimedia PC Level 2 specification (MPC2) gives the minimum requirements for acceptable multimedia performance in a PC. A Multimedia PCs should be equipped with Intel 80486DX2/50 CPU, 8 MB RAM, hard disk capacity of 1 GB, Super VGA with 1 MB of video memory, dual speed CD-ROM, Sound/Video Blaster cards and Stereo Sound Speakers as shown in figure 2.6. Additionally, an interface to VCR and Video Camera would provide sophisticated input techniques for visual sequence generation.

As costs come down, it is possible to see the Multimedia PC find its way into common usage and this would provide the ideal *front-end* for the Digital Thematic Atlas.

Several issues have to be identified in order to integrate Multimedia with other technologies for developing a framework for DTA. How to handle multimedia data like images

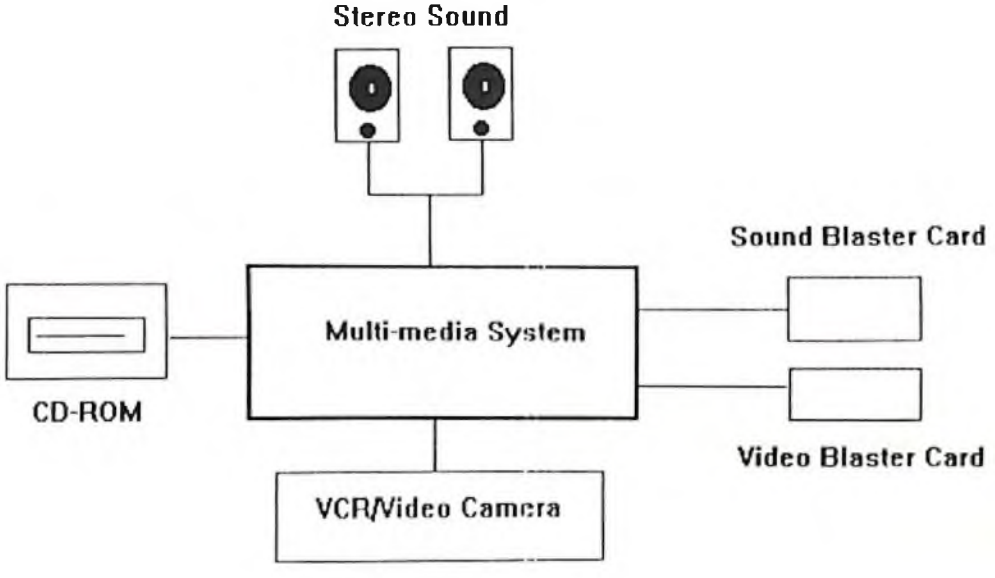



Fig. 2.6 MULTI-MEDIA TECHNOLOGY

**Sound Formats**

| | |
|---|---|
| SBI | Sound Blaster Card Files |
| SND, AU | Voice-grade sound format (8khz) used on work stations (e.g., Sun, NeXT, HP9000, etc.). |
| WAV | Microsoft Waveform used in Windows for event notification. |

**Still-video (Graphics) Formats**

| | |
|---|---|
| BMP | WindowsBitmap, uncompressed. |
| EPS | Encapsulated PostScript intended for embedded use. |
| GIF | Graphics Interchange Format, compressed files commonly used on CompuServe easy to render multiplatform. |
| JPEG<br>JPG | Joint Photography Experts Group. Highly compressed format for still images, widely used for multi-platform graphics. |
| PCD | Kodak Photo CD. Proprietary CD-ROM photograph format. |
| PCX | Zsoft Image, developed by Zsoft for PC Paintbrush, used in many graphics and desktop publishing programs. |
| PDF | Portable Document Format. Adobe's format for multi- platform document access through its Acrobat software. |
| PS | PostScript, Adobe's type discription language, used to deliver complex documents that include layout, font descriptions, and graphics over the Internet. |
| RLE | Run-Length Encoding Technique for compressing Windows BMP files |
| TIFF, TIF | Tagged Image File Format, supports up to 24-bit color images across a variety of formats, files may be compressed or uncompreseed, |
| WPG | WordPerfect graphics information. |
| XBM | X-Window Bitmap used by X-Windows primarily UNIX Workstation |

**Motion Video Formats**

| | |
|---|---|
| AVI | Audio Video Interleaved , Windows standard format found on many CD-ROMs. |
| DVI | Digital Video Interactiv, motion-video format also found on CD-ROMs. |
| FLI | Flick , Autodesk Animater motion- video format. |
| MPEG, MPG | Motion Picture Expert Group , Full-motion video standard using format similar to JPEG. |

Fig 2.7 COMMON SOUND, GRAPHICS AND MOTION-VIDEO FORMATS

and sound along with spatial data? How to handle the transfer and linkage of multimedia objects from the database? How to control the presentation of multimedia data?

To link images with thematic database records, a field can be assigned in the database which provides a filename pointer to an image stored elsewhere. Separate viewer programs could also be executed through system calls. Also important is the issue of deciding which spatial features could lead to which particular images. Taking an approach of linking an image to a point-located feature, the user may point to a protected area location on a state map and bring-up on screen a photograph of the park like Jim Corbett National Park, Pin Valley Wildlife Sanctuary, etc. or select an endangered wildlife species found in the park and zoom on to a real-life image of the animal like Asiatic Lion, Tiger, Snow Leopard etc. along with animation and sound. Similarly, querying for a non-timber forest product found in a particular state may bring up a photograph of the product onto the screen.

Multimedia technology has further led to **hypermedia** on a parallel to **hypertext**. Hypertext software (Conkline 1987; McAleese 1989; Nielsen 1990; Hall and Papadopoulos 1990), [15], initially suggested by Bush and developed by Ted Nelson, enables a user to follow chains of linked items of information, by pointing on screen to highlighted areas called 'hot spots' or 'hyper links'. On a similar basis, hypermedia would be able to link up multimedia information like graphics, pictures, animation, sound etc. Hypermedia treats all information universally as a single data unit, whether it be a word, sentence, file, picture, graph, image, sound or animation sequence, as opposed to GIS which functions on spatial and structured attribute data. Some common sound, graphics and motion-video formats are listed in figure 2.7.

Present techniques employ loose-coupling amongst data units, although tight linkages would be required in the future. The key idea is that all information and knowledge could be inter-connected and users should be able to browse through this atlas of information by using appropriate associations.

### 2.1.4 Knowledge-Based System

A major requirement of the Digital Thematic Atlas will be the ability to deduce intelligent linkages from information that is stored in spatial and attribute databases of the system. The development of Artificial Intelligence (AI) technologies, sometimes referred to as knowledge engineering [18], is rapidly becoming closely associated with databases.

While one view is that there is no essential distinction between data and knowledge, a basic issue is that while working with knowledge expertise is required to collect the material, whereas while working with data any automated process can be used to collect it (Smith and Smith 1977). Knowldege deals with abstractions and entity types (Wiederhold 1986) and involves a richer semantics for interpretation than does a Database (Brodie and Mylopoulos 1986) [24].

Knowledge-Based System (KBS) utilises advanced database technologies to construct the knowledge bases which are the nuclei of expert systems [114], [119]. Basically, knowledge consists of facts and rules available with 'experts' of a subject.

The stages of conceptualization, formalisation and implementation in the development of a Knowledge-based System known as expert system (ES) involve the transfer and transformation of an individual's tacit knowledge into an explicit representation or knowledge base [103], which is an important design operation for a Digital Atlas. Expert Systems try to focus on a narrow domain and emulate the methodology and performance of experts in the domain by extracting, storing and using the knowledge of the expert. It can be expected that knowledge-based systems linked with databases will find specialised applications in intelligent query processing, integration and the simplification of data input and retrieval through natural languages.

An important issue in the use of Knowledge-based Systems (KBS) for integration with GIS for a Digital Atlas is to identify appropriate approaches to development of intelligent linkages with reference to ease of use and efficiency.

The Relational Query language approach builds up typically on databases which use relational calculus. Query language techniques can be used for intelligently retrieving information from RDBMS which could be further linked with GIS functions, though standard relational query languages are not capable of handling recursive queries. Its success is in large part due to query optimization techniques.

The Logic-based approach using declarative languages like PROLOG on deductive databases and the application of rules provides for ease of user application. A natural language interface for a Digital Atlas Simulator - **ATSIM** [72], programmed in PROLOG language, demonstrates the use of Expert Systems and AI for developing a query system in English and its associated importance for a DTA.

The Object-oriented approach, one of the programming buzzwords of the 1990s [116], promises gains in programmer productivity over conventional software development methodologies because of characteristics like Inheritance, Data Encapsulation, Object Binding and an advantage of Reusable Code. For this purpose, we view GIS as DBMS that provides various models of a spatial domain.

Intelligence in digital database consists of attributes, descriptions, relationships, connectivity and procedure [44]. As seen earlier, the emergence of multimedia attributes in DTA has become an important issue. For handling large amounts of Multimedia information, integration of AI and Expert Systems with GIS will become necessary by developing generic Base Classes and providing Inheritance support.

Integration of Knowledge-based Systems with GIS presently employs loose coupling method in both spatial and non-spatial applications. Tight coupling and fully integrated systems are difficult to achieve but will have to be delivered in the future.

### 2.1.5 Virtual Reality

While developing our Flowchart for using a Paper-based Atlas we have identified the last step as 'Decision-Action' on the basis of information available from the atlas. Migrating to a digital atlas which would provide an integrated front of GIS, DBMS, Multimedia, Expert Systems and Knowledge-based Systems with advanced computer technology, it may be questioned if it is possible to provide the user of such a digital atlas an opportunity to 'test' out his decision-actions with a full sensory experience of the alternate world from the digital atlas itself?

The emerging technologies of Virtual Reality (VR) which stands for Alternate Reality [60], could make such decision-actions in a simulated world a near possibility. VR is a system that perceives a participant's actions in terms of the body's relationship to a graphic world and generates responses which create an illusion that his actions are taking place within the world. It is a product of state-of-the-art computer hardware, software, arts, graphics, advanced and sophisticated electronic measuring and sensing instruments and innovative effects created by optics and sound.

VR systems permit users to interact directly with the computer representation of the actual world, using a complete range of senses and faculties. Combined with GIS, this could help in producing realistic computer graphic displays of real-life-oriented maps and 'virtual proximity' [38] through the Digital Thematic Atlas. Typically, present digital maps are presented with a two-dimensional view, symbolised feature representation and well-structured data. While they contain information which is generally numeric, textual and visual, new developments in the areas of VR suggest that it would be possible to provide users with a multi-sensory representation of the world, involving a very large range of information [15]. This could provide the environment in which the user takes a 'decision' and interactively carries out an 'action' by modifying this artificial or virtual world which is fully three dimensional, represented naturalistically and in which changes occur in real time, thus providing multisensory feedback as a result of taking the action. Thus, for example, in an Endangered Species Atlas, it would be possible to 'see' and 'feel' the effect of taking a

particular action, like developing a Protected Area. Similarly, in a Minor Forest Products Atlas, the effect on Forest Types could be visualised realistically. This would greatly help in total planning activities which are the end-objectives of the Digital Atlas.

We have been able to identify the various issues for the integration task. The DTA integrates and interrelates diverse information which has first to be identified, modelled, made compatible and consistent. Different approaches to data integration will be possible for specific application. A general framework will have to be drawn out, unifying data models along with it and developing facilities for interlinking associated information.

## 2.2 ISSUES OF THE UPDATION TASK

After identifying the issues of the integration task for developing a DTA, it is important to see how the information could be updated. For this we identify two methods:

1. Manual Updation

2. Networked Updation

### 2.2.1 Manual Updation

Updation of paper-based maps is a time-consuming and extremely difficult task. The simplest technique to update digital thematic maps would be to ship out a new copy of the map whenever changes are made. Of course, this method of updation is feasible only when the frequency of updation is very low, files are of modest size and the number of users of data very small.

Manual Updation has also certain inherent problems: first, when data residing under one platform and in a specific format is required somewhere else on another platform or in

another proprietary format and structure or both [13] and, second when sharing data amongst disparate systems requires the transformation of data in form and format [83].

In addition, to address a larger number of users, data updation is usually carried out by requests made by telephone, fax or letter [3] and data transfer from or to the database handled by tape or disk.

Such methods have their own problems, as summarised below:

a. Map updation tasks are typically slow and time-consuming.

b. A small updation may have to be carried out by a large number of users leading to repetitive operations like data entry procedures, digitization, validation checks, proof plots, etc.

c. Such tasks, if left to users, could also be error-prone, while ownership responsibility of thematic information would be on the data-generating source.

d. A major problem is the inconsistency of information which could lead to increasing difficulties when utilised in other applications.

To overcome such problems, flopppy-disk-based updation and distribution methods have been used by suppliers of data in different fields. An example is the NIC district database distributed on a floppy disk. Updating by copying entire files stored on floppy disks can be done occasionally to ensure that the copies match exactly.

However, such methods, though successful in certain areas, have their own limitations. In today's fast-moving world, production and distribution of data over disks requires a complete cycle of operations like purchase of disks, replication of disks, labelling, documentation and distribution. These are cumbersome and time-consuming processes.

Disk-based updation also suffers from problems of inefficiency where mailing latest updated disks to end-users is concerned. Checking of version numbers becomes necessary to know if the user has received the latest updated information.These floppy-based operations are also prone to security problems, virus infection and even physical damage of disk when transported over distances.

Besides, disk-based information suffers from limitations of single organisation participation in data generation. Where each of these databases may be maintained by different organisations [30], it would become practically impossible to have regularly updated data.

In the pilot project of digital map generation undertaken by Survey of India [7], it was observed that in the workflow, data has to be transported to and from the PC-Cadcore system or to the Automap system which was done using floppies or magtape. With the establishment of Digital Mapping Centres in various Directorates all over the country, digital cartographic database would have to be transported to central nodal points where floppy-based operations will positively incur delays in updation of thematic information.

Finally, with a Digital Thematic Atlas being integrated with Map Database from Survey of India and/or other Map-generating organisations and Thematic Data from various other organisations, fragmentations would need to be carried out to isolate information with high update frequencies. Here, too, it would not be justifiable to allow errors to creep into floppy-based updation operations due to human factors.

To overcome the above shortcomings, it is necessary to identify the issue of network-based updation of DTA.

### 2.2.2 Networked Updation

Once problems of updation of a DTA are identified, the next logical step is to take up the issue of networked updation for moving a paper-based atlas to the Information Superhighway.

The Digital Thematic Atlas should be able to operate on an ***Integrated Systems Network*** wherein integrated geographic information in various formats is updated over a Network which utilises the ability of advanced packages to share integrated information with other systems.

It is important to identify issues of network configurations for Updation Methods of DTA. The implications of the network configuration may be extensive [19]. Networked Updation may revolve around a central computer or be distributed. Digital Thematic Atlas users should be able to access information from any node on the network. Users at each node will have their own set of information requirements. Some of these may involve data that is unique to users at a single node. Others require data that is shared among users at multiple nodes [31].

To be in-line with the International Organisation for Standardization (ISO), such an integrated network should be based on existing Open Systems Interconnection (OSI) Standards in Computer Communications, especially when such standards are still emerging or are relatively new. ISO protocols, based on the OSI reference model, establish computer type independence of network communication [21]. The OSI Model, [96], [97] proposed by ISO, uses seven layers of functional software which form the basis for an Integrated Network Architecture:

Applications Layer
Presentation Layer
Sessions Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer

The OSI Model has been successfully integrated into various kinds of Network Models.

Local Area Network models, now in existence like Point-to-point, Multipoint or Multidrop, provide Star Topology, Bus Topology, Mesh Toplogy and Ring Topology [96-98] and standard methods of access on LANs like CSMA/CD and Token Passing. It is important to standardise a method of working in the LAN environment. Standard LAN architectures are typically based on Ethernet (IEEE 802.3 10 base 2 and 10 base T). The DTA should utilise the Ethernet LAN System which has now become a de facto standard.

It is also necessary to have direct updation with LANs integrated to a WAN Node. X.25 [96], [97] Protocol formulated and recommended by **C.C.I.T.T.** (Consultative Committee of International Telephone & Telegraph) provides a communication standard which is an interface point for incompatible network communications to Local Area Networking, PCs, Mini Computers and MainFrames.

X.28 Dial-up provides facilities to originate or receive calls using a PSTN dial-up modem connected to a telephone [19], which is less expensive than X.25 and Frame Relay services. The user first dials a local telephone number of the Packet Switching Exchange to get connected to the Network after which he can establish call to any other user of the Network or other Networks through a Gateway Service. **TCP** (Transmission Control Protocol) [96], [98] and **IP** Internet Protocol [96] came about due to various internetworking needs. To provide the internetwork routing function, IP makes use of special nodes called **Gateways** which is a machine that allows dissimilar networks to be connected to one another.

Network operations for traditional data processing have improved tremendously over the past few years leading to the idea of incorporating such systems for a model of a Global Digital Thematic Atlas. Three major methods for Networked Updation of a DTA are:

i. ON-LINE
ii. E-Mail
iii. INTERNET

The issues related to these methods are discussed in the following sections.

**2.2.2.1 On-line Updation :** On-line operations are going to play a very significant role in the application of digital thematic file transfers in times to come. High-performance On-line services, running over X.25 networks, handle thousands of subscribers in parallel operation and offer messaging, on-line news, realtime interaction and information from many different sources at a very low price.

On-line services have become popular throughout the world for various reasons:

- Electronic Messaging - On-line services offer their users the ability to send and receive messages economically. Electronic Messaging would help in passing immediate information to a group of users about the availability of latest updated Maps available on the system.

- Information on-demand - On-line services are the cheapest and fastest way to get any specific Information and copy files.

- Discussion forums - The discussion forums of on-line services are the main cause of their popularity. A user can have a discussion or chat with other users. It is also possible to have on-line support forums on these on-line services. Discussion Forums and Support Forums would help in having extensive discussions on thematic applications.

- Interactive Sessions - Here, a user logs on to a computer system in another location via a telephone connection and has interactive sessions like on-line training, viewing of items and even remote control of different appliances. Interactive sessions could help in updating Base Maps particularly required for field operations.

Such services are helpful in identifying how the problems of manual updation could be resolved through the use of on-line services.

The issues involved are : Is it possible for On-line systems to help users requesting for thematic information of a Base Map? Could Maps with updated information be made

available for users to pick up from an on-line service so that it becomes their responsibility to maintain consistency?

It is seen that the various features of On-line Services have led to the concept of **Electronic Data Interchange (EDI)** which is the exchange of data between different computers in a standard message format, inclusive of such documents that are otherwise generated by computers, printed, sent, received and then keyed again into the computer (e.g. bills, invoice etc) [85]. EDI thus eliminates printing and keying processes and cuts short the time between sending and reception of documents. Today, the concept of EDI has become a worldwide standard. EDI prescribes a set of standards that lays down a document format for electronically submitting and processing forms like invoice and expense reports. It requires sender(s) and receiver(s) to agree on the message format before they become EDI participants [85]. But development of several independent message format standards (X12, UN/TDI, EDIFACT) has led to services which provide format translation.

The world's biggest services are CompuServe, America On-line and Prodigy, having over 2 million subscribers each. Charges which start at about Rs. 250/- a month are moderate.

In India, usage of on-line services is presently quite limited. This is due to the small number of PCs and the inadequate telecom infrastructure. A few On-line services like aXcess from Business India, India On-line, Gateway Packet Switched Service have been used for textual electronic messaging and other on-line operations. An important component missing from these services is digitized Map Base Information. To provide global connectivity, various networks in different countries should be integrated and networks within the country should be formed for country-wide updation operations. The National Telecom Policy 1994 has set up an environment for multiple-operator networks for the first time in the country. It could be conducive for digitized atlas updation operations.

A **Bulletin Board System (BBS)** is another concept in On-line operations which allows a user to log-in using a telephone line and a MODEM from a remote PC and perform a

number of on-line activities like internal E-Mail, discussions, conferences, file libraries, file transfers and shareware access. A large number of corporations in the USA prefer using BBSs for information exchange.

BBSs are primarily remote-user oriented - most of the users are people who log in via a modem. But these days, every BBS can also be used on a network - making it easy to use locally without a remote-login. The largest global BBS is the INTERNET itself which has been described subsequently.

Another on-line operation is **Facsimile**, popularly known as FAX, which allows transmission of paper documents from one place to another. Fax is no longer limited to dedicated Fax machines. Today popular FAX-MODEMs have Fax functions built into them which allow them to interface with computers and directly send or receive faxes between computers. A high quality fax machine can act as a typical output device on a Digital Atlas, wherein thematic information is displayed in colour or black-and-white.

A Fax can also be used as an Input Device when faxing a map image to a destination computer which has a Fax modem. When the Fax modem receives the image it is stored as a picture file on the computer and this file can be used as input and edited, printed or used for further updations.

**2.2.2.2 E-MAIL :** Electronic-Mail (E-Mail) is the generic name for non-interactive communication of text, data, image or voice messages between a sender and designated recipients by systems utilising telecommunication links. Telegraph, telex, fascimile, voice-mail and computer-based messaging systems (CBMS) fall within the perview of E-Mail.

Electronic mail is now a standard process for fast and efficient communications. It is cheaper as compared to voice, fax, telex etc. It is used to describe an entire class of text-oriented message transmission techniques. Of course, various methods can also be applied to

transfer digitized images and binary files. These communications may be node-to-node or from one node to many nodes.

A Packet Switched Data Network hub is a basic necessity for providing E-Mail facility. If a person has to send Information from Delhi to Madras, the Information is collected by the hub at Delhi, transmitted to the Madras hub, which is then available at the concerned digital address. However, the user has to be a subscriber of the E-Mail network.

An important issue is that although E-Mail is an extremely simple medium to use, it has still not become commonplace in India. This is attributed to the fact that till recently E-Mail service providers in our country had been Government-controlled like ERNET of DoE [74], SIRNET of CSIR, NICNET of NIC [76], GEMS400 of VSNL. However, with the advent of liberalisation, E-Mail services are now available through private service providers. These include aXcess of Business India Information Tech Group, Dart-mail of Dataline, Xec-Mail etc.

E-Mail has also not caught up in India to the extent it should have because of the extremely unreliable nature of our telephone lines and the grossly inadequate base of PCs installed in the country. Growth of professional level E-Mail also depends on the availability of leased lines and other infrastructure facilities.

The prime characteristic of E-Mail is that it is non-interactive i.e., a digital file on the Atlas is not transmitted to the other user at the same instant. There is a small delay in posting, transmitting and receiving mail, and there are no interactive sessions as in on-line operations. At the same time, E-Mail is much faster than Postal Mail or Courier Services needed for Floppy-based Updation. Is it possible to use E-Mail facilities to attach DTA Map and Thematic Base Files as ASCII or Binary Files to be sent to other users in any part of the country or the world on a common E-Mail network? If so, E-Mail could prove useful for Network Updation operations of the DTA, since it provides global connectivity amongst different users.

**2.2.2.3 INTERNET :** Internet is the network of networks, with about 40 million users connected over 40,000 networks and a global base of 3 million host computers reaching more than 140 countries and thus the world's largest on-line service. Internet is a worldwide entity, that could be defined, in technical terms, as a set of interconnected IP networks. There are several thousand local, regional and global computer networks interconnected with access to a large number of information resource tools.

Information resource tools provide many ways to access the vast amount of public information available across Internet. Could these tools allow the Digital Thematic Atlas user to view and download a wide range of documentation, graphic images, source code and other related information?

It is important to identify certain technical components and protocols on INTERNET.

Multipurpose Internet Mail Extension, (MIME) is becoming a popular method of sending and receiving attachments, and extends across operating systems, making Internet E-Mail a common tool for uniting PCs, Macs, and Unix systems [89], [115], [118].

E-Mail is distributed over the Internet via mail servers. If a user is logged on to a TCP/IP-based network, the user could set up clients to query the server at specified times. A user could also use a SLIP or PPP connections to dial into an Internet service provider and retrieve information mail from the server or scan mail headers before deciding which message to retrieve - depending on the server type.

The main types of Internet mail servers are Post Office Protocol (POP2 or POP3) and Internet Mail Access Protocol (IMAP). Both types are compatible - a POP client can communicate with an IMAP server. Similarly, an IMAP client can talk to a POP server.

From the Digital Thematic Atlas perspective, the difference is that POP servers act only as temporary repositories; they automatically forward all information during log on. IMAP servers, however, store messages indefinitely - The Digital Thematic Atlas User can

view message headers and download only the items desired. IMAP servers are quickly gaining popularity, especially with larger organizations.

Internet traffic can move over different physical channels - telephone lines, satellite links, wireless, phones or fibre optic cables. Users pay a small fee, based on volume of information transferred and connect time.

It is also possible to have direct connection to the Internet through a campus-wide network and the use of Very Small Aperture Terminal (VSAT), leased lines or a dial-up connection through a modem. The dial-up connection through Modem is the cheapest and most popular one although it is slow as compared to VSAT or leased-line-based connections.

The INTERNET Research Task Force Research Group on Resource Discovery (IRTF-RD) [81] encourages sites to run Gatherer Software that has been specially prepared to analyse files, and use sophisticated retrieval and distributed processing programs.

Internet could thus serve as an electronic distribution medium for a Digital Thematic Atlas and could also change the way Updation of an Atlas is done. Internet E-Mail addresses overlayed on a GIS world-map could provide an exhaustive directory for global Networked Updation.

While globally, Internet is now accessible to anyone linked to electronic networks which reach an ever-growing portion of the world's population [9], in India Internet-based on-line services are something which are at a very elementary level and have yet to emerge. Ironically, the potentials of Internet for applications of the Digital Thematic Atlas can be of greater value in India where we are still in the process of developing advanced computer-based information systems.

# Chapter Three

## 3 DEVELOPING A FRAMEWORK FOR THE INTEGRATION TASKS

### 3.1 PARADIGM FOR DIGITAL THEMATIC ATLAS

An ideal framework for a Digital Thematic Atlas should have the following characteristics:

a) an Integrated Global Schema for loosely assembled information components;

b) a Window-based Information Retrieval Front-end;

c) a User-friendly Query-support System; and

d) an ability to distribute applications with intelligent agents handling background requirements.

A paradigm for the DTA is proposed and displayed in fig 3.1. It provides for a dynamic set of map-based information from a network of map generation and distribution sources or centres to the end-users, organizing spatial information in the same way as atlas maps and catalogues organize today's paper-based Atlas Systems.

The Atlas Publisher-Storehouse-User (P-S-U) Paradigm provides for three major building blocks of the DTA :

1. Atlas Publisher

2. Atlas Storehouse

3. Atlas User

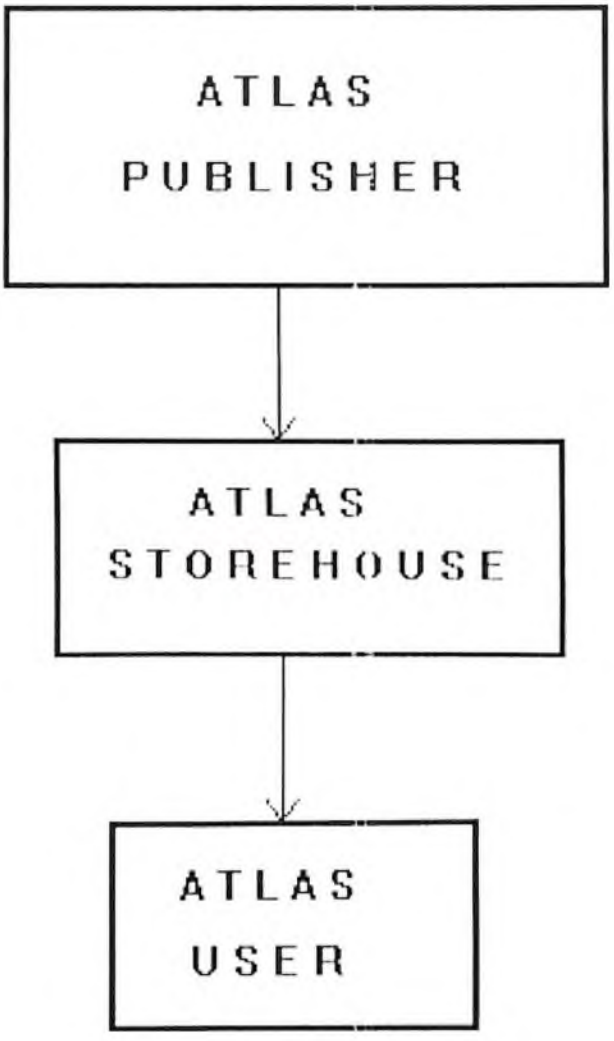



Fig 3.1 THE ATLAS PUBLISHER-STOREHOUSE-USER (P-S-U) PARADIGM

1. The **Atlas Publisher** (AP) is the set of collaborative Publishing and Data Generating Organisations that either generates data or adds thematic value to Base data.

2. The **Atlas Storehouse** (AS) is the clearinghouse or nodal centre from where an Atlas Map generated by the Atlas Publisher would be available.

3. The **Atlas User** (AU) is the end-user who wishes to have access to a digital thematic map and **contacts or queries** the Atlas Storehouse for up to date information.

### 3.1.1 Flow of information :

The Atlas *User* may already have a copy of his map on his computer, may request the *Storehouse* for it or even ask the *Publisher* for a direct copy. Thus, the Publisher may provide the Atlas directly to the end-user or make it available through the Storehouse. This generates two possible models for our P-S-U Paradigm, as shown in figure 3.2.

On the basis of the above paradigm and to establish the active roles of the participating entities, relationships are identified between its members to develop a direction of data-flow or map-flow. These entity relationships are illustrated in figure 3.3. The map flow could be:

A P -> A U

A P -> A S

A S -> A U

(a) A P -> A U

The AP provides the Atlas to the AU directly.

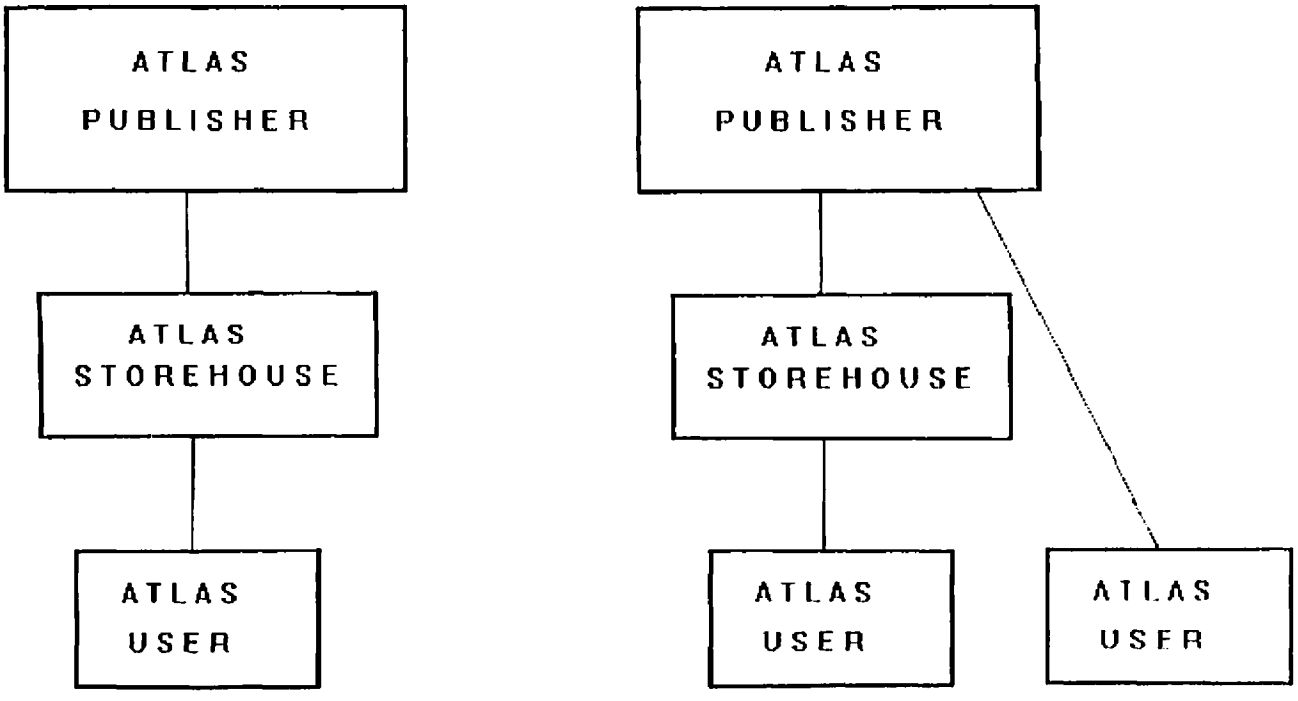



Fig. 3.2 THE TWO MODELS OF THE ATLAS P-S-U PARADIGM

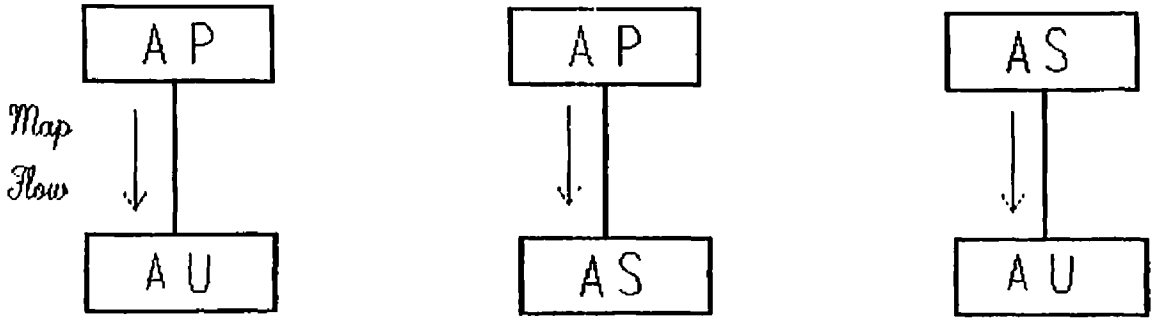



Fig. 3.3 RELATIONSHIPS BETWEEN THE MEMBERS OF THE P-S-U PARADIGM

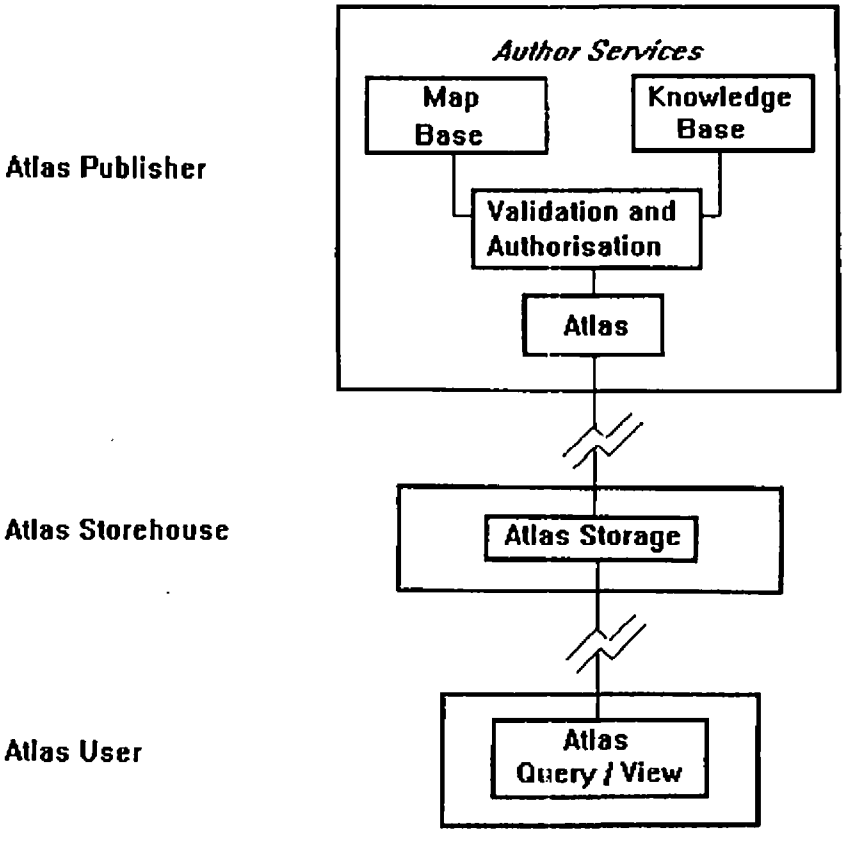



Fig. 3.4 FUNCTIONAL ROLES OF THE ATLAS PUBLISHER, STOREHOUSE AND USER

(b) AP -> AS

The AP provides the Atlas to the AS. The AS may be a Mapseller, Bookseller, Library, Shop, Vendor, any other organisation, any other department of the same organisation, or even just another computer in the same section of the AP.

(c) AS -> AU

The AS provides the vast storehouse of Atlas Maps to the AU.

The role of the Atlas Publisher is to publish the DTA by developing the Map Base and the Knowledge Base either by its own Data Sources or by "hiring" various **author services**, after due process of vetting, validation and subsequent authorisation for change. The "published" DTA would be made available from the Storehouse which may be either part of the Publisher's set up or an independent entity. The role of the Atlas Storehouse is to maintain a stock of information. The Atlas User, as a **client** of the Storehouse or Publisher, would like to have interactive views of his desired maps along with various queries for information retrieval. Figure 3.4 illustrates the functional roles of AP, AS and AU.

On the basis of this, a framework for the integration task is developed which provides an environment for i) Map Base, ii) Knowledge Base, iii) Query System, and iv) Network Updation, as shown in figure 3.5.

## 3.2 DEVELOPING A MAP BASE

The first and foremost role of the Atlas Publisher, as part of the DTA framework, is building up the Map Base. The Map Base forms the pillar of the Digital Atlas on which the Theme-Subject Maps may be superimposed.

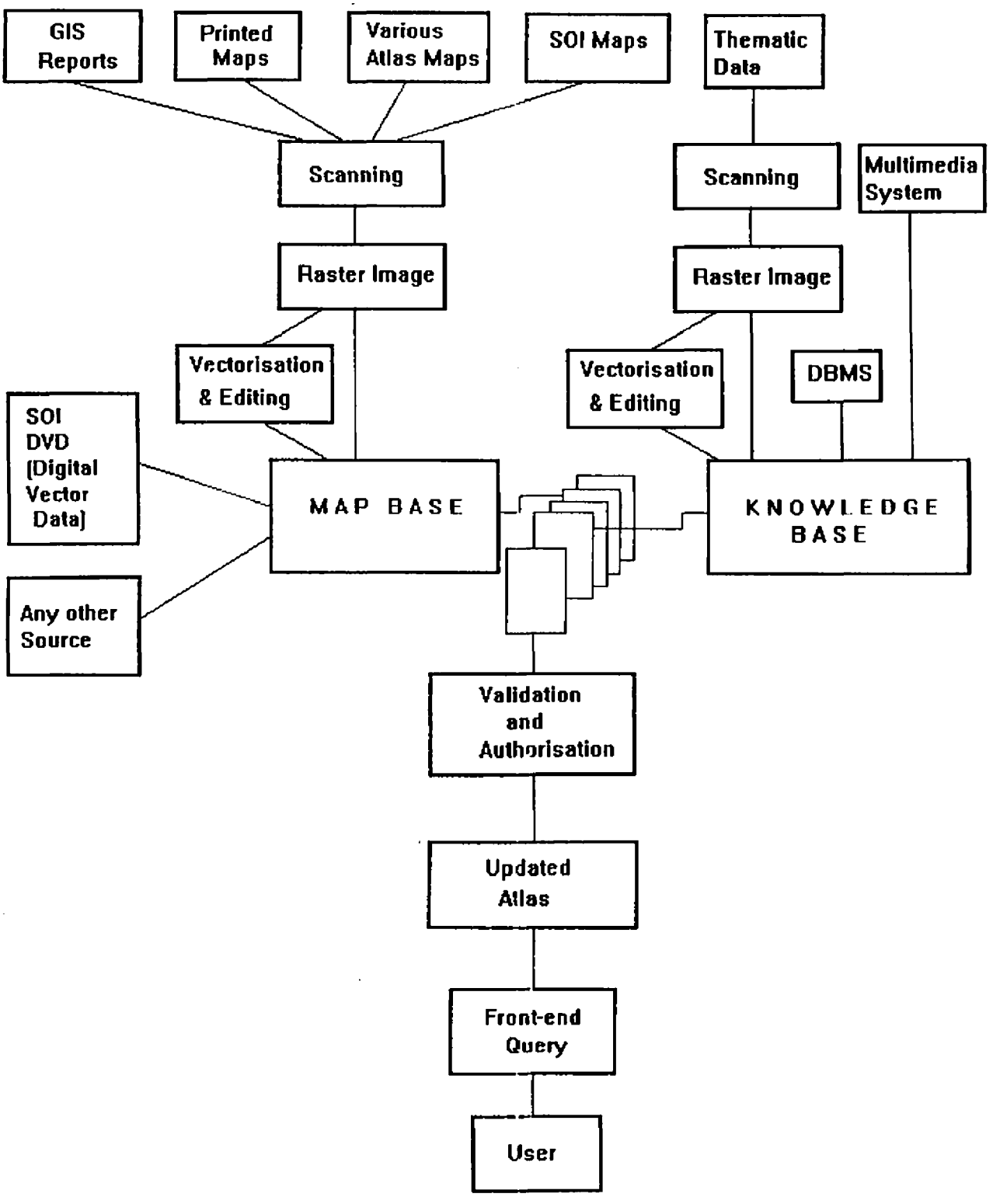



Fig. 3.5 FRAMEWORK FOR THE INTEGRATION TASK

The Map Base could be in Vector or Raster format [15]. A Digital Thematic Atlas would require raster base for applications on natural resources and could also integrate remote sensing data, while a vector base would be required for carrying out analysis like a transportation study, etc.

The Map Base is typically stored in the data structure of the GIS used in Raster or Vector form. From the integration task of the Atlas Publisher (figure 3.6), it is seen that the accuracy and availability of the Base Maps are the major deciding factors for the overlaying of the Theme-Subject Information System. These Maps are prepared by Survey of India, the National Mapping Organisation and are also available from Paper-based Atlases, Printed Maps, Research Reports etc.

To build a comprehensive Map Base, a number of steps have to be taken which have been illustrated through examples at the end of the chapter. Initial data-gathering was carried out from a number of map sources.

### 3.2.1 Geographic Information System

The Geographic Information System is the engine for providing the Atlas Publisher or Author with a spatial analysis tool for the Subject-theme and would be loosely coupled with the KBS. It would be the responsibility of Atlas Publishers to provide comprehensive GIS-based reports and information templates to be put up on the Atlas.

The **ARC/INFO** GIS package was used at the first stage to provide the initial building block of the DTA. ARC/INFO is a package which has an easy interface and is extremely popular. The digitised topographical maps for research study are presently available on this system. This package could provide methods for integrating KB inputs which have been discussed in a later section.

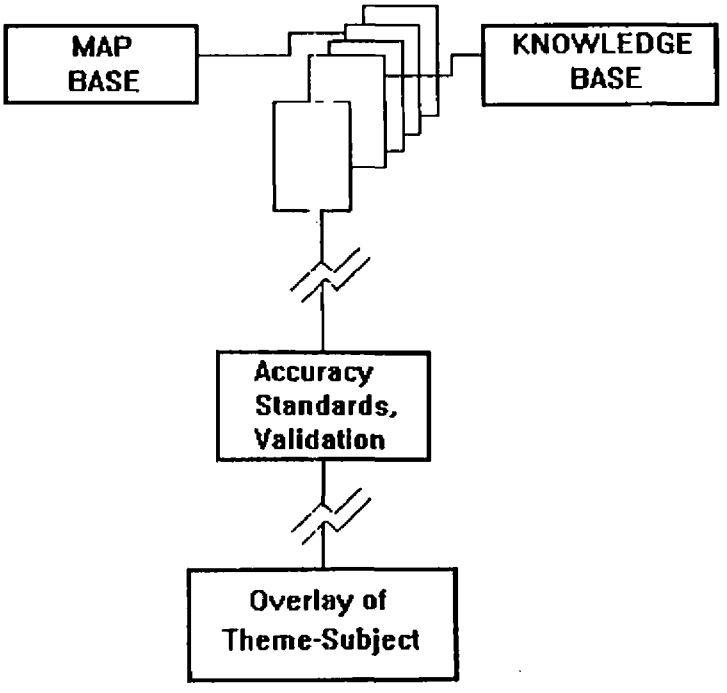



Fig. 3.6 INTEGRATION TASK OF THE ATLAS PUBLISHER

The input for the GIS is a Map on which various analyses and manipulations were carried out. The output of the GIS could be used as direct material for the Map Base or printed and published reports which could be further scanned by other authors for publishing value-added maps.

However, as seen earlier, GIS is an expensive resource and would not be easily accessible to individual users. Thus it was necessary to identify other methods of Map Base generation.

### 3.2.2 Printed Maps and Atlas Maps

Various high-quality, high-resolution topographical and thematic maps as well as simple low-resolution maps are available as printed maps in the market. Also, a number of excellent atlases of various types are available. A cross-section of maps were scanned for experimental purposes. Digital Map Base information could also be available from other Software Packages which provide data conversion modules for digitised outputs.

### 3.2.3 Digital Vector Data

Digital Vector Data from Survey of India, intended for use as a fundamental source for Map Base, would be available on 1:25,000, 1:50,000, 1:250,000 and other scales after approval from the Government of India. At present, the data is not available in digital form. Moreover, the cost of the data is a bit high. The format is available and has been studied and could be incorporated along with other data in the framework. In future, it is expected that DVD form would be the fundamental method of supplying digital data.

Various experiments were carried out and different maps were scanned using DeskScan and HandyScanner Systems. As seen from figure 3.7, the process of Editing and Updating Digital Atlas Maps for cleaning, zooming, noise removal and other operations was carried out with different Software tools like AUTOCAD, CorelDraw and Windows Paintbrush.

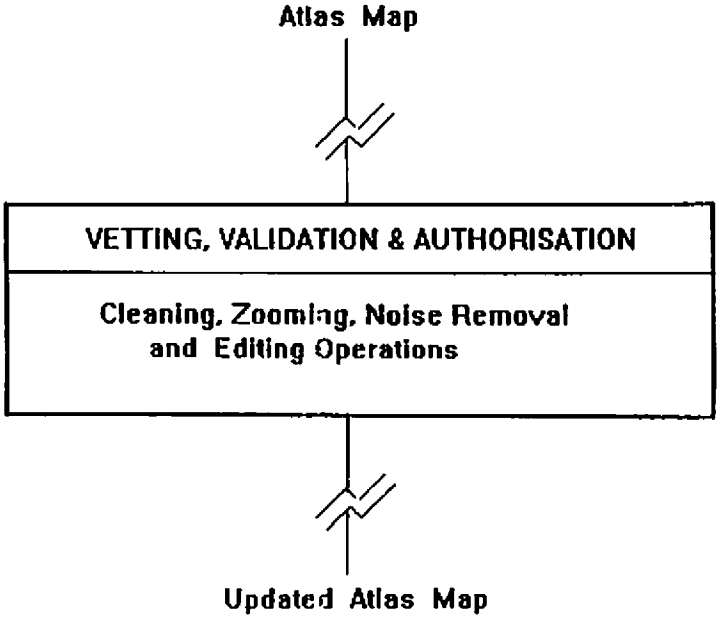



Fig. 3.7 THE PROCESS OF EDITING AND UPDATING A DIGITAL ATLAS MAP

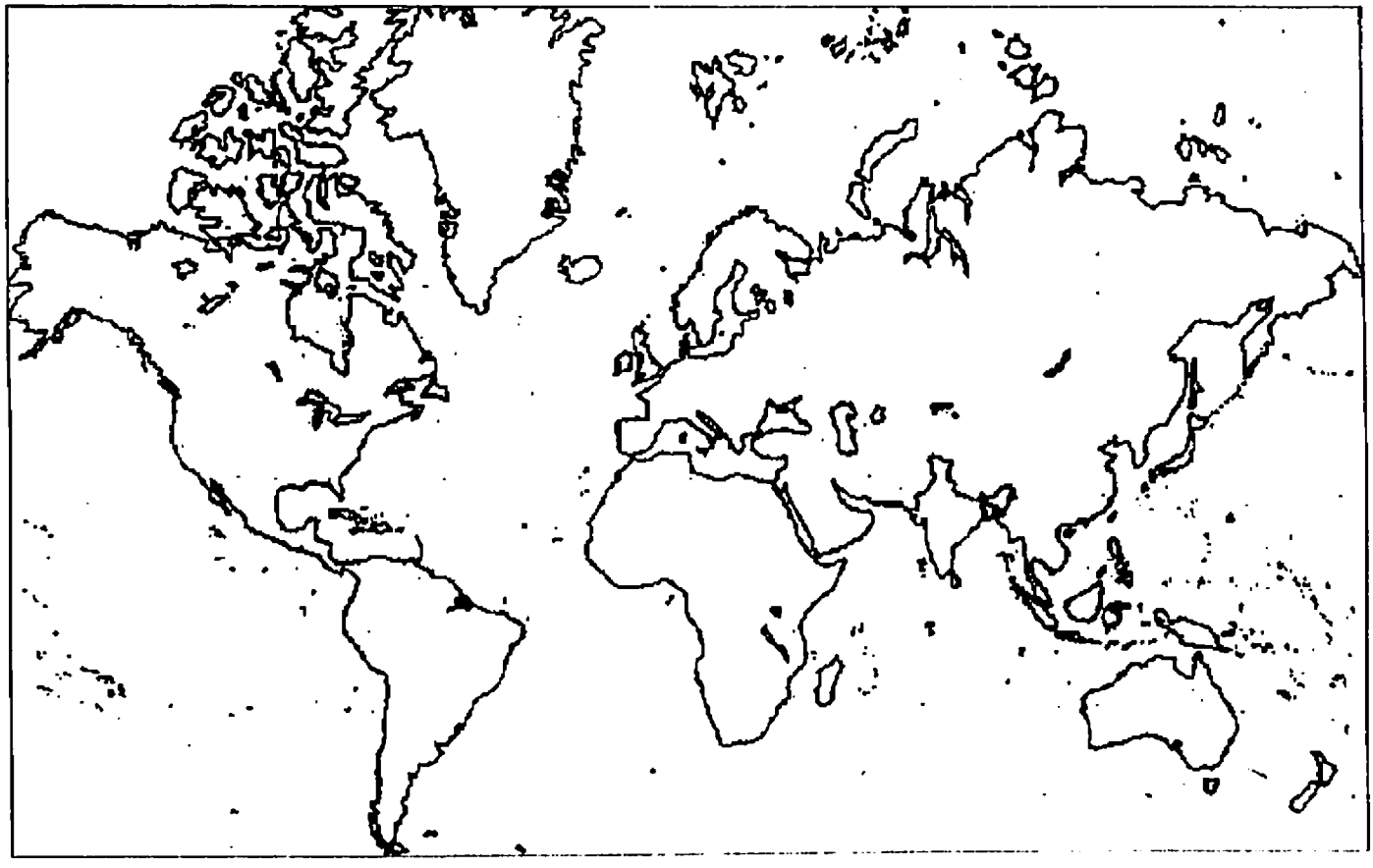


Fig. 3.8 BASE MAP OF WORLD

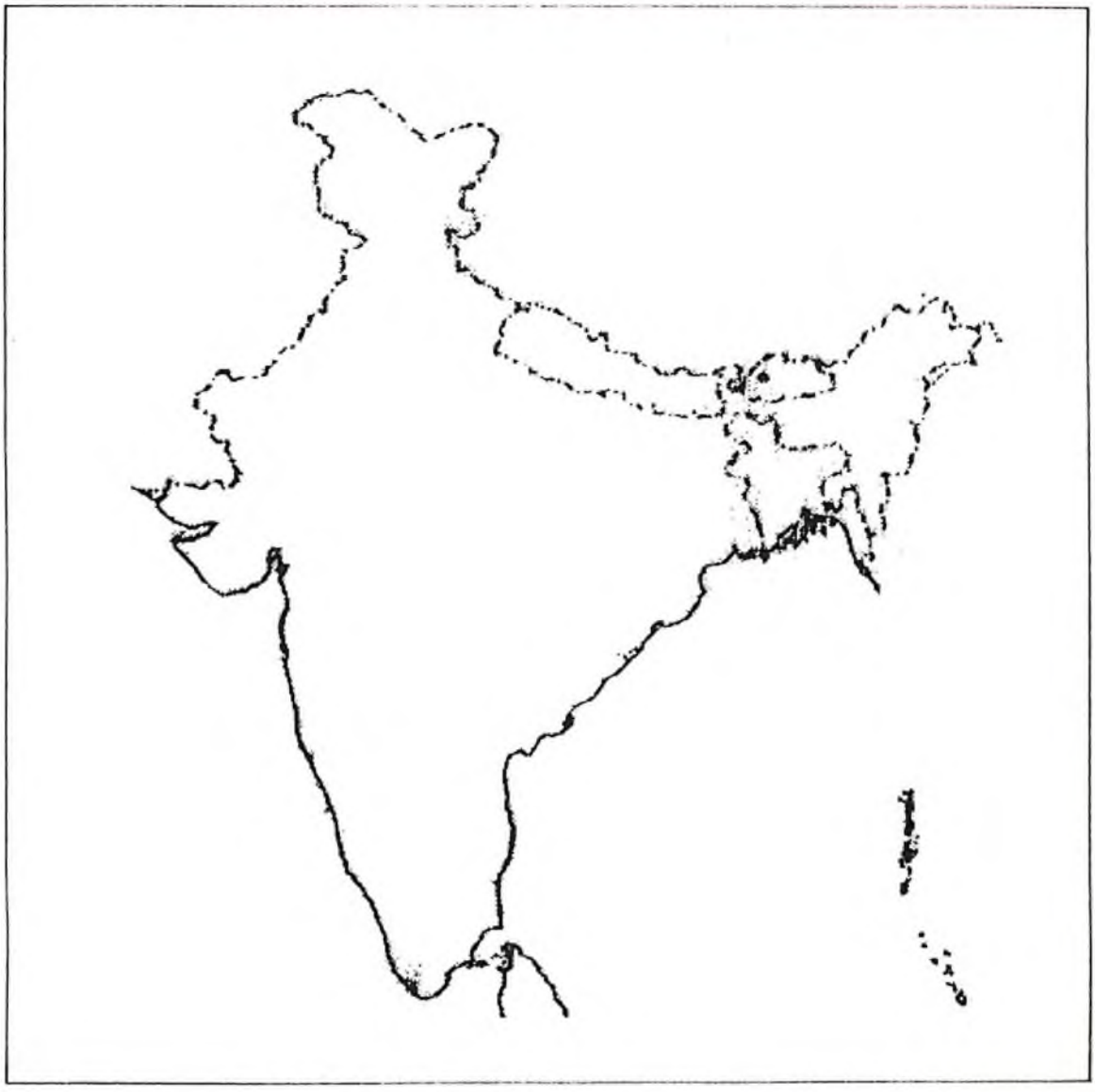


Fig. 3.9(A) BASE MAP OF INDIA

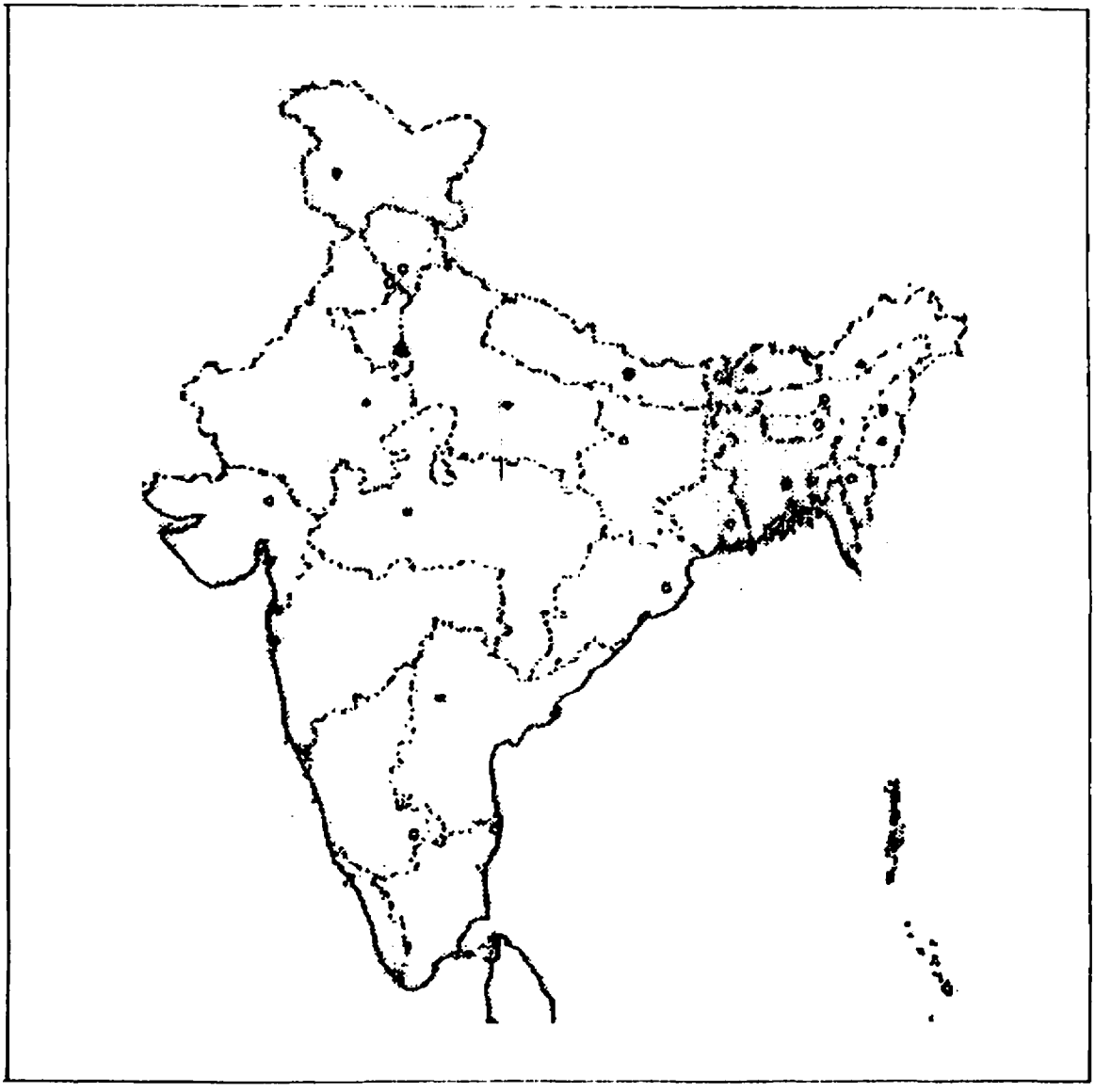


Fig. 3.9(B) BASE MAP OF INDIA SHOWING STATE BOUNDARIES AND STATE CAPITALS

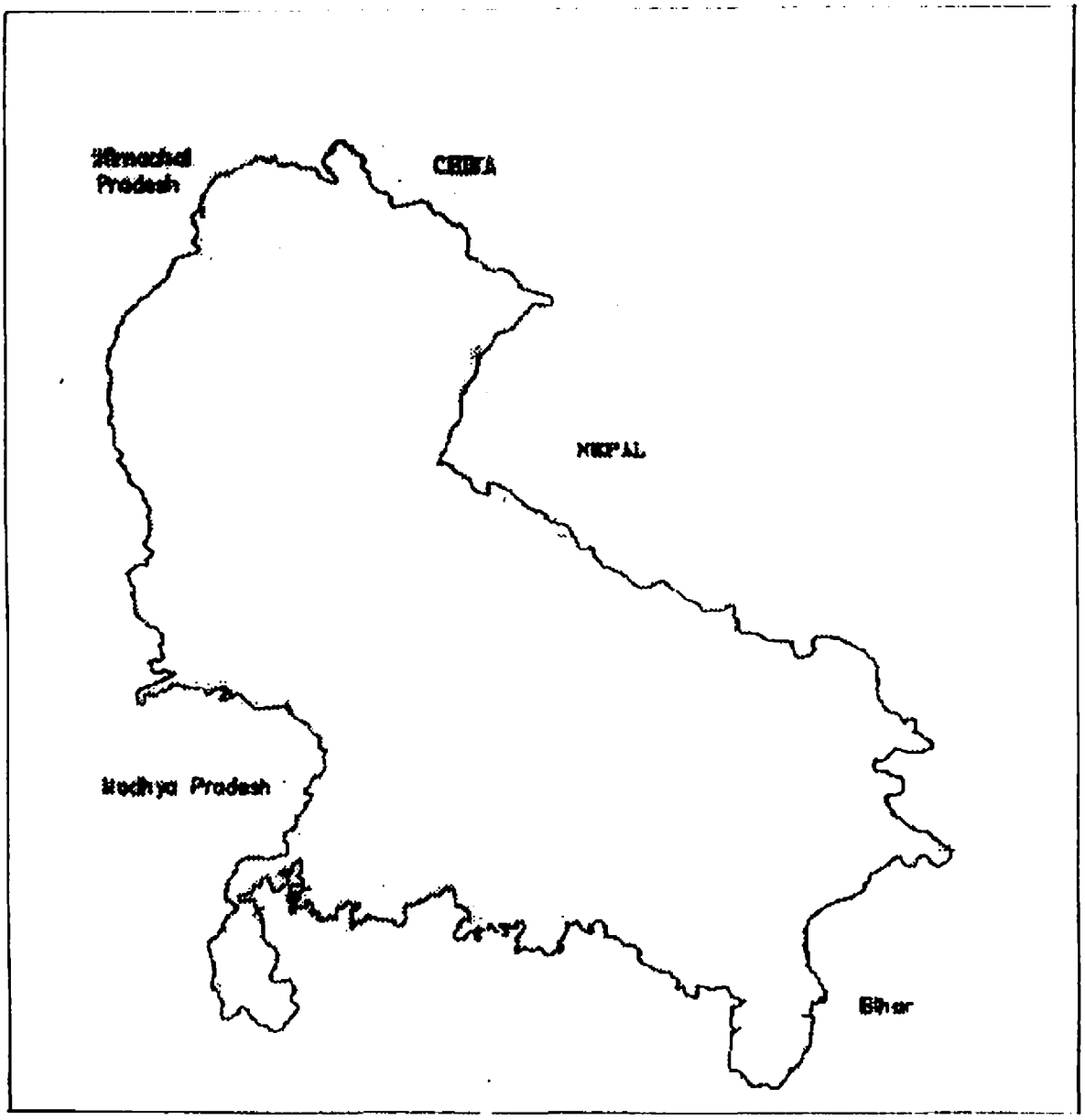



Fig. 3.10(A) BASE MAP OF STATE - U.P.

The Raster images generated after scanning operations were then used as inputs for vectorisation operation. The vectorisation was studied and experimented with in PC-CadCore and CorelDraw environments.

Example Base Maps used for developing a Map Base were World Map, Country Map of India, State Maps - Himachal Pradesh and Uttar Pradesh, cross-section of Dehradun Map etc. as shown in figures 3.8, 3.9(A), 3.9(B), 3.10(A), 3.10(B) and Appendix A3.1.

Map Base was thus generated and ready for thematic Value-Addition Operations and Knowledge-Base Integration.

Thus it will become easy for an author to scan a map from any report or book.

## 3.3 DEVELOPING A KNOWLEDGE BASE

The second aspect of the Atlas Publisher is building a Knowledge Base which is successfully integrated along with the Map Base. The Knowledge Base adds Thematic Information to the Map Base and provides a comprehensive Knowledge System to the Inference System. Various Thematic Overlays could be added in parallel to the theme-subject.

An important task of the Publisher is to design the representational scheme that will allow an author to codify knowledge in such a way as to facilitate its subsequent application in the atlas. Aspatial Information like the Knowledge Base and related Databases is stored as data files to be related to the Spatial Information - Map Base of the Digital Thematic Atlas as required.

A Knowledge Base Schema, consisting of Static and Dynamic Information, Relationship Linkages, Rules and Object Attribute Data, was developed, integrated along with the Map Base, and built up through a process of Knowledge Acquisition.

### 3.3.1 Knowledge Acquisition:

The process of Knowledge-acquisition - transfer of domain-related expertise - was carried out as required above.

Since Knowledge Acquisition in the DTA was modelled to be built up, it was possible that:

i) immediate use was made of available knowledge of thematic databases as well as technology used.

ii) adequate inputs were available for the knowledge acquisition process.

iii) knowledge collected in later phases supplemented the knowledge collected in the earlier phase to allow for proper updation procedures in the DTA.

### 3.3.2 Thematic Images and Multimedia

The concept of Thematic Knowledge Images and Multimedia Information has been introduced in our Framework for the Atlas Publisher Knowledge Base creation.

In this, thematic images are scanned and icons generated from Icon Object Libraries to represent Thematic Knowledge which would be useful to an Atlas User for Querying operation.

Similarly, Multimedia information image and sound files are integrated into an animation sequence to create **flic** (.flc) files, which are activated upon a **Viewer** trigger by the Atlas User.

It is proposed to introduce Virtual Reality concept along with Multimedia to create realistic displays of the DTA. The concept of introducing VR was studied and examined.

Though found feasible, this aspect has not been experimented upon practically because of the high costs of equipment and infrastructure.

The integration of Object Data with a Base Map could result in a comprehensive digital Map Database where object areas or entities contained **intelligence** based on linkages of knowledge.

### 3.3.3 Inference system

The Inference System, also called the Inference Engine [114] of the KBS, would retrieve Information from the Knowledge Base and provide the user with vital outputs for decision-making and a complete query system. The inference system would also provide the user with a functional interface and loose coupling with the GIS.

With this process is developed the knowledge framework which helps in identifying the location and information stored on the DTA.

## 3.4 DEVELOPING A QUERY SYSTEM

The Atlas User, in our paradigm, would like to query for the right information before retrieving it from the DTA. It is, therefore, important to develop a Query System for the Atlas User.

An Information Access Query Model (IAQM) for DTA has been developed for user participation in a cycle of query formulation, presentation of search results and query reformulation, as suggested in The Information Theatre paradigm by Cutting et.al., 1990, as reported by Ramana Rao, [45]. The query may include specific geographic position or time criteria [3], or management information system [50], [22], [4] like specific objects or types of features [3] for which menu options need to be provided.

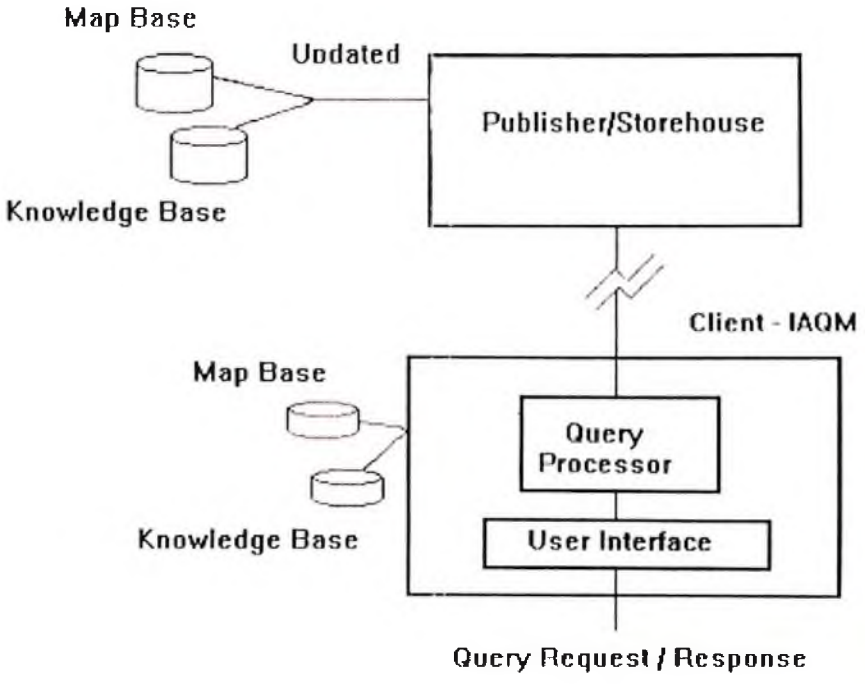



Fig 3.11 THE INFORMATION ACCESS QUERY MODEL

Once the user makes his initial query after selection through a ***Front-End Query Window***, the system scans the database and *clusters* the collection into a small number of document groups and presents short summaries of the groups to the user.

These summaries are presented to the user as a "page" for each identified item, along with a Menu at the bottom of the screen. The user can either go through the results page-by-page or browse again, querying for specific records or make a refined search. The user may then locate a particular record and display its Summary Page.

This kind of browsing paradigm is called *Scatter/Gather* as proposed by Cutting et.al. 1992/1993 which, according to Rao et.al. [45], allows a user to rapidly assess the general contents of a very large collection by scanning through a hierarchical representation that acts as a dynamic table of contents.

The IAQM approaches the requirement for an Atlas User, wherein global information has to be scanned and presented dynamically, as presented in figure 3.11.

The role models for the Atlas Publisher and the Atlas User have been taken up so far. To take up a discussion of the role model of the Atlas Storehouse, we need to understand that the Storehouse has to provide up to date information of the DTA for the user and also collect all *published* information from the Atlas Publisher as and when required. This covers the Updation tasks of the DTA. Since this is an important objective of this research work, we shall discuss the Network Updation Techniques in the next chapter and then proceed to evolve the Solution Models of the Network Updation.

## 3.5 ILLUSTRATIVE EXAMPLES

After developing the Map Base for our Atlas Publisher, it is necessary to add the thematic-value. For this, two case examples have been taken up to fulfil the role requirements made by the framework for Map Base, Knowledge Base and Query System.

### 3.5.1 Case Application I : Endangered Species Atlas

Knowledge Acquisition process was carried out and Thematic Information obtained from **Wildlife Institute of India** (WII) Knowledge is available from experts, research papers, reports, databases and GIS.

From the Map Base created earlier, the State Maps of Himachal Pradesh and Uttar Pradesh, shown in figure 3.10, were used.

Specifically studying the details of the state of Himachal Pradesh (HP), it is seen that HP covers 56,000 sq km and embodies the full range of Himalayan ecosystems. Once densely forested, HP now has a legal forest cover of only 38%.

The knowledge base comprises :

1) Endangered Species

2) Protected Areas (PA) where the above species would be found

3) Knowledge Linkages between Species and PA.

Knowledge acquisition [113], [114] [119] of the endangered species comes from the species database and reports published from the database cell of WII.

Sample information for the following 5 endangered species has been taken up:

i. Indian Elephant

ii. Tiger

iii. Asiatic Lion

iv. Snow Leopard

v. Blackbuck.

The Species Knowledge Base is given in Appendix A3.2 (a), (b), (c), (d), (e). A database structure for the species data reports from WII is given in figure 3.12. The above knowledge was designed and represented as a **Species** Class [116], [117]. An object-oriented data structure for Species class is given in figure 3.13.

### 3.5.1.1 The Wildlife Protected Area Knowledge Base

The PA knowledge has to be developed with at least 4 levels of reference topographical data -

World level

Country level

State level

Park level

In order to demonstrate the concepts evolved so far, we narrow down our knowledge base to a specific area. At the World level, the knowledge model is limited to India, because data is more easily available for the country. Country-wide knowledge for India for example case application is available from Wildlife Institute of India.

W.A.Rodgers and H.S.Panwar in their report "Planning a Wildlife Protected Area Network in India", prepared for the Department of Environment, Forests and Wildlife, at Wildlife Institute of India, in March 1988, have shown the protected areas in India as in 1987 as well as the enhanced areas as recommended by them.

According to Rodgers and Panwar, in mid 1987, there were 54 parks of 21,003 sq km and 372 sanctuaries of 88,649 sq km giving a combined coverage of 109,652 sq km in 426 protected areas or 3.3% of the country.

| Field | Field Name | Type | Width | Dec |
|---|---|---|---|---|
| 1 | S_CODE | Character | 7 | |
| 2 | NAME | Character | 50 | |
| 3 | S_NAME | Character | 50 | |
| 4 | CONF | Character | 1 | |
| 5 | END | Character | 1 | |
| 6 | THR | Character | 1 | |
| 7 | ABUND | Numeric | 1 | |
| 8 | BIOUNIT | Character | 50 | |
| 9 | HABITAT | Character | 50 | |
| 10 | H_LOSS | Numeric | 7 | 2 |
| 11 | H_PROTECT | Numeric | 7 | 2 |
| 12 | H_PROPOSE | Numeric | 7 | 2 |
| 13 | RH_PROTECT | Numeric | 7 | 2 |
| 14 | EX_PR_POP | Numeric | 6 | |
| 15 | EX_TOT_POP | Numeric | 6 | |
| 16 | AGE_POP_PR | Numeric | 4 | |
| 17 | STATUS | Character | 15 | |
| 18 | C_STATUS | Character | 15 | |
| 19 | S_CITIES | Numeric | 7 | |
| 20 | S_PR_COUNT | Character | 50 | |
| ** Total ** | | | 343 | |

Fig. 3.12 DBASE DATA STRUCTURE FOR SPECIES

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

```
struct list_species
{
        int s_code;    // Identification code for the species
        char *name; // Name of the Species
        char *s_name;  //Scientific Name of the Species
        char conf;
        char end;
        char thr;
        int abund;
        char* habitat[10];  //In which habitat is suitable for Species
        char* biounit[20];
        float h_loss;           // % original habitat lost
        float h_protect;        // % original habitat protected
        float h_propose;        // % original habitat proposed
        float rh_protect;       // % remaining habitat protected
        int ex_pr_pop;          // expected protected population
        int ex_tot_pop;         // expected total population
        int age_pop_pr;         // % population protected
        char* status;           // red data book status
        char* c_status;         // computer assigned status
        int s_cities[30];       // species listed on cities appendix
        char* s_pr_count[30];   // species protected in countries
};
```

Fig. 3.13 OBJECT-ORIENTED DATA STRUCTURE FOR SPECIES

Their report contains recommendations to bring the total protected area network to 651 areas totalling 151,342 sq km or 4.6% of the country. This will include 148 parks with a coverage of 50,797 sq km and 503 sanctuaries with a coverage of 100,545 sq km.

The protected areas are not evenly distributed among the states or biogeographic regions and several states have no parks or have very poor coverage.

State-wide knowledge of protected areas is given for the State of HP. The database and information for park areas as well as the basic GIS digitisation for the state has been completed and is available from WII. There are proposals to create a major PA in north Spiti and upgrade and enlarge some other key PAs. The total protected area network will be 5,412 sq km or 9.6% of the state. There are 30 existing PAs and 2 proposed PAs.

A List of PAs of Himachal Pradesh, existing and proposed, is given in Appendix A3.3. The overlaid information can also be observed from the Map of HP, given in figure 3.20.

Summary reports for the following 3 PAs of HP have been taken up:

i. Pin Valley National Park (NP)

ii. Shikari Devi Wildlife Sanctuary (WS)

iii. Great Himalayan National Park (NP)

Their reports are given in Appendix A3.3 (a), (b), (c). A database structure for the PA reports from WII is given in figure 3.14. The above knowledge was designed and represented in a *class* **Protected_area**. An object-oriented data structure for the above class is given in figure 3.15.

The PA database requires a lot of information about the species confirmed from the PA. Of particular importance, naturally, is the status of the species being called Endangered Species.

| Field | Field Name | Type | Width | Dec |
|---|---|---|---|---|
| 1 | NAME | Character | 30 | |
| 2 | DUP | Character | 1 | |
| 3 | RESNUMBER | Numeric | 3 | |
| 4 | LOCNUMBER | Character | 4 | |
| 5 | BIOUNIT | Character | 3 | |
| 6 | COUNTRY | Character | 12 | |
| 7 | STATE | Character | 25 | |
| 8 | STATCAT | Character | 15 | |
| 9 | NATCODE | Character | 10 | |
| 10 | DATE | Character | 8 | |
| 11 | DATER | Character | 8 | |
| 12 | LOWERALT | Numeric | 4 | |
| 13 | UPPERALT | Numeric | 4 | |
| 14 | NEARTOWN | Character | 30 | |
| 15 | NEARRAIL | Character | 25 | |
| 16 | NEARAIRP | Character | 25 | |
| 17 | CATEGORY | Character | 1 | |
| 18 | RAINFALL | Numeric | 4 | |
| 19 | MAB | Character | 1 | |
| 20 | WHSITE | Character | 1 | |
| 21 | GAZETTED | Character | 2 | |
| 22 | NOTIFNO | Character | 150 | |
| 23 | BIBCODE1 | Character | 5 | |
| 24 | BIBCODE2 | Character | 5 | |
| 25 | TOTAREA | Numeric | 10 | 2 |
| 26 | HABITAT1 | Character | 3 | |
| 27 | AREA1 | Numeric | 8 | 1 |
| 28 | HABITAT2 | Character | 3 | |
| 29 | AREA2 | Numeric | 8 | 1 |
| 30 | HABITAT3 | Character | 3 | |
| 31 | AREA3 | Numeric | 8 | 1 |
| 32 | HABITAT4 | Character | 3 | |
| 33 | AREA4 | Numeric | 8 | 1 |
| 34 | HABITAT5 | Character | 3 | |
| 35 | AREA5 | Numeric | 8 | 1 |
| 36 | HABITAT6 | Character | 3 | |
| 37 | AREA6 | Numeric | 8 | 1 |
| 38 | MANEFF | Character | 1 | |
| 39 | MANPLAN | Character | 1 | |
| 40 | STAFF | Numeric | 4 | |
| 41 | BUDGET | Numeric | 12 | 2 |
| 42 | CCODE | Character | 2 | |
| 43 | SCODE | Character | 3 | |
| 44 | FLAG | Numeric | 1 | |
| 45 | VEHICLES | Character | 3 | |
| 46 | BUILDINGS | Character | 3 | |
| 47 | ACCOMODAT | Numeric | 4 | |
| 48 | VISITORS | Numeric | 8 | |
| 49 | SPECIAL | Character | 48 | |
| 50 | ZONED | Character | 1 | |
| 51 | ZONES | Character | 30 | |
| 52 | GRIDS | Character | 20 | |
| 53 | LONGIT | Character | 21 | |
| 54 | LATIT | Character | 21 | |
| 55 | COORDINATS | Character | 20 | |
| 56 | LASTUPDATE | Date | 8 | |
| 57 | STATUS | Character | 12 | |
| 58 | MAP | Character | 30 | |
| 59 | TEMP | Character | 18 | |
| 60 | DISTT | Character | 50 | |
| 61 | WETLAND | Character | 20 | |
| 62 | APPROACH | Character | 254 | |
| 63 | HUMANHAB | Character | 254 | |
| 64 | RESEARCH | Character | 254 | |
| 65 | ACKN | Character | 150 | |
| ** Total ** | | | 1706 | |

Fig. 3.14 DBASE STRUCTURE FOR PA

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

```
class protected_area
{
        private:
                char* name;
                char dup;
                int resnumber;
                char *locnumber;
                char *blounit;
                char * country;
                char * state;
                char * statecat;
                char * natcode;
                char * date;
                char * dater;
                int loweralt;
                int upperalt;
                char *neartown;
                char *nearrail;
                char *nearairp;
                char category;
                int rainfall;
                char mab;
                char whiste;
                char * gazetted;
                char *notifno;
                char *blbcode1;
                char *blbcode2;
                float totalarea;

                struct
                {
                        float area;
                        char *habitate;
                }hab_area[6];
                char maneff;
                char manplan;
                int staff;
                float budget;
                char *ccode, *scode;
                int flag;
                char *vehicles, *building;
                int accomodate,visitors;
                char *special;
                char zoned;
                char *zones, *grids;
                char *longit;
                char *latit;
                char *coordinates;
                char *lstupdte;
                char *status;
                char *map;
                char *temp;
                char *distt;
                char *wetland;
                char *approach;
                char *humanhab;
                char *research;
                char *ackn;

};
```

Fig. 3.15 OBJECT-ORIENTED DATA STRUCTURE FOR PA

The PA database has detailed attributes of the PA. Some of the knowledge attributes needed modification so that information could be extracted easily.

| | | |
|---|---|---|
| LONGIT | C | 15 |
| LATIT | C | 15 |

Fields mentioned above as character, were changed to numerics, with widths as follows.

| | | | |
|---|---|---|---|
| LONGIT_F | N | 6 | 2 |
| LONGIT_T | N | 6 | 2 |
| LATIT_F | N | 6 | 2 |
| LATIT_T | N | 6 | 2 |

When Raster Base Maps from Map Base are used as a background the above linkage is not required, but since Raster Maps allow only display operations to be made, this is required to provide intelligent linkage with the Vector Maps from Map Base which provides thematic intelligence to the maps.

### 3.5.1.2 PA & Species Knowledge Linkage

It is important to be able to retrieve information about a species confirmed from a particular PA. Similarly, it is equally important to be able to retrieve PA details for a particular Species. This requires a two-way linkage, the concept of which has been shown in figure 3.16.

The linkage design is basically a Relational Table Design as used in a Relational DBMS. A search for an item in the Species file locates the details of the desired species. The corresponding code is used in the Linkage file to locate the natcodes of the list of PAs, which subsequently gives

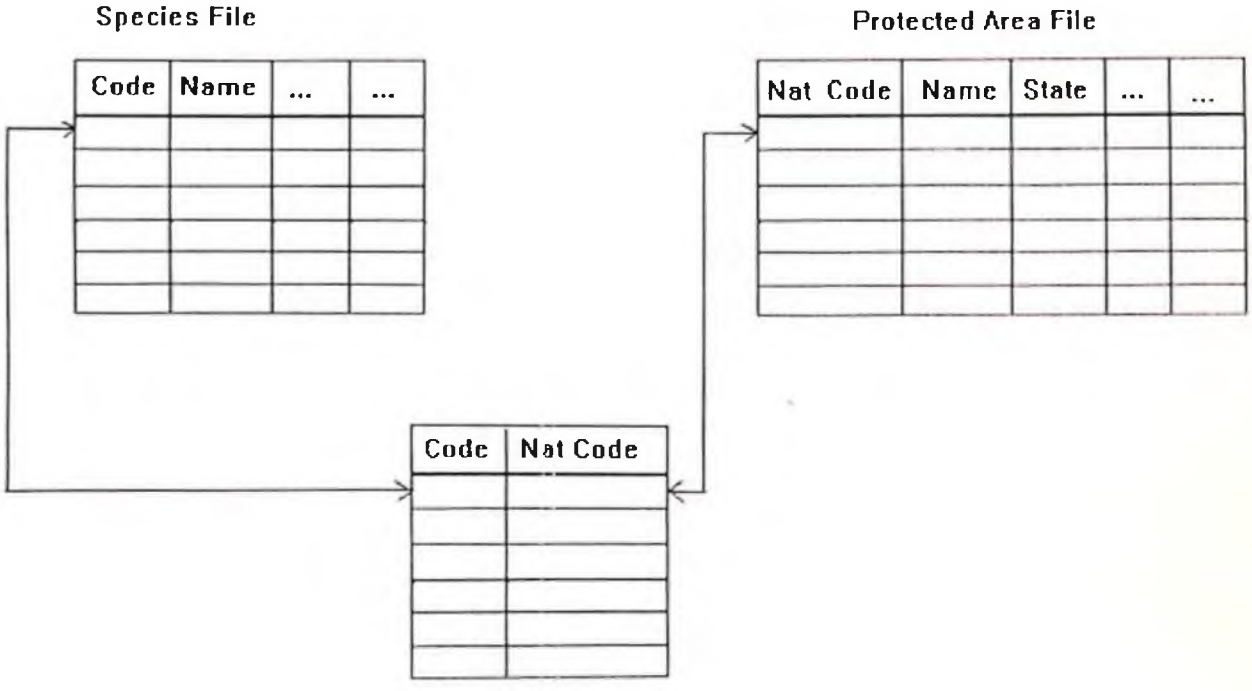



Fig. 3.16 SPECIES-PA LINKAGE FILE

| Field | Field Name | Type | Width | Dec |
|---|---|---|---|---|
| 1 | S_CODE | Character | 7 | |
| 2 | NATCODE | Character | 10 | |
| 3 | CONF | Character | 1 | |
| 4 | ABUND | Numeric | 1 | |
| ** Total ** | | | 20 | |

Fig. 3.17 DBASE DATA STRUCTURE FOR LINKAGE FILE

```
struct link
{
        char s_code;     // code for species
        char* natcode;   // code for the park
        char conf;
        int abund;

};
```

Fig. 3.18 OBJECT-ORIENTED STRUCTURE FOR LINKAGE FILE

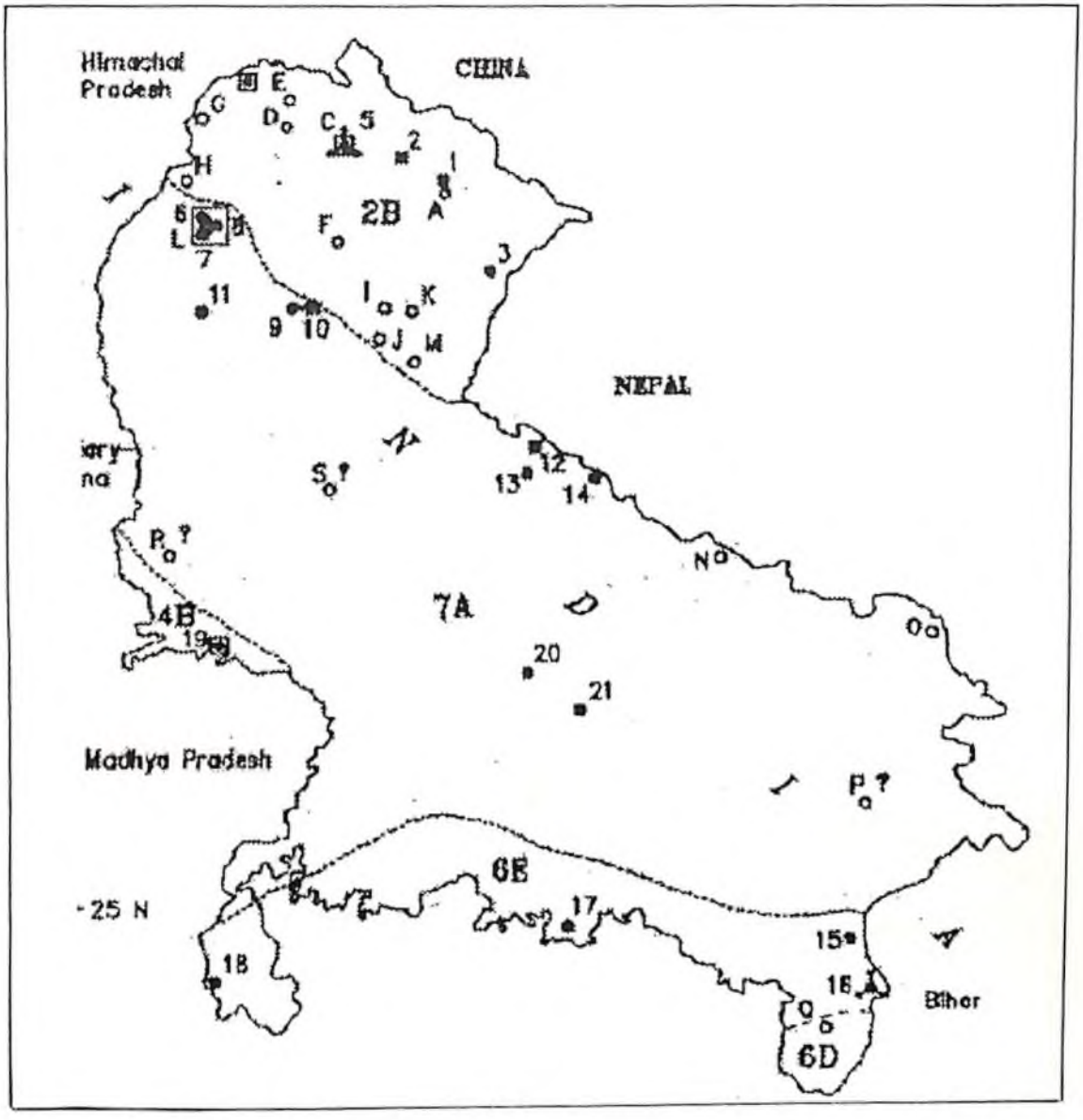



Fig. 3.19(A) THEMATIC MAP OF U.P.

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

- Existing Wildlife Sanctuary
- Existing National Park
- Existing Park – Sanctuary Unit
- Proposed Wildlife Sanctuary
- Proposed National Park
- Proposed Park – Sanctuary Unit
- Adjacent Sanctuaries
- Proposed Extension to Existing Sanctuary/Park
- Sanctuary Proposed as Park
- Biotic Province/Sub–division Boundary

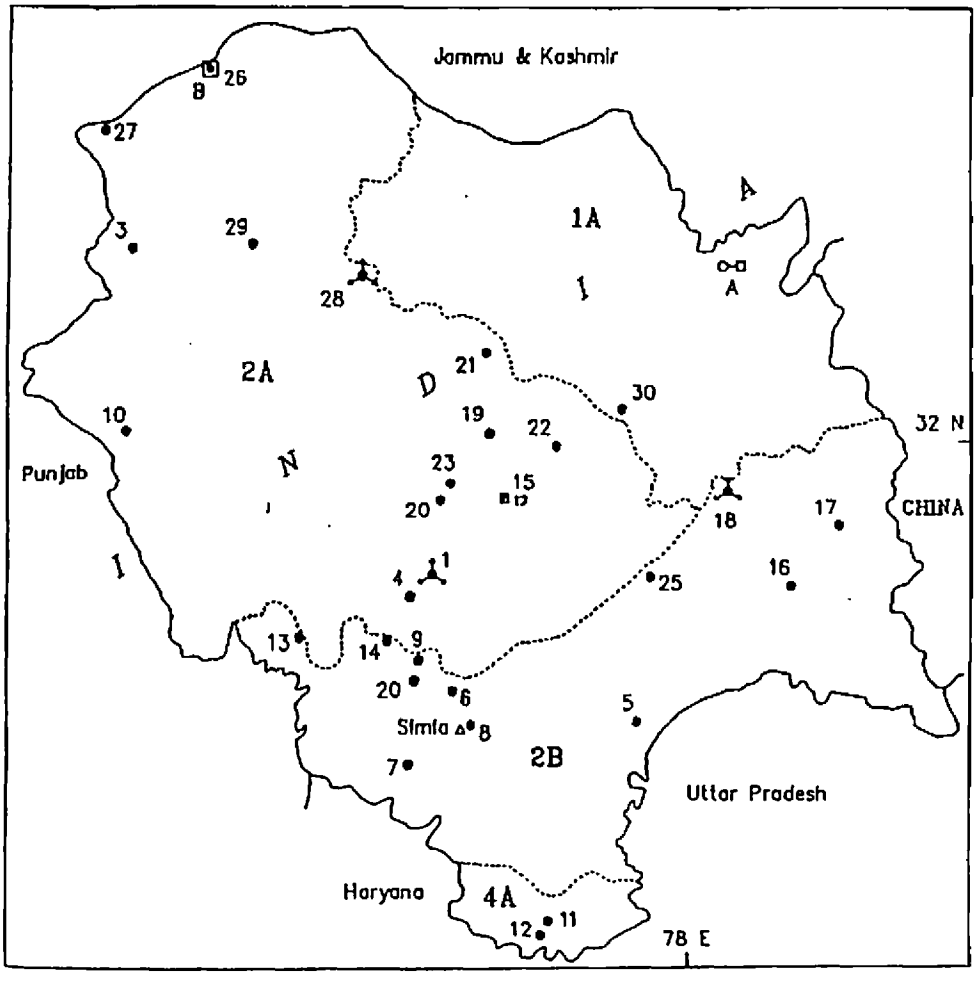



Fig. 3.19(B) THEMATIC MAP OF H.P.

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

- Existing Wildlife Sanctuary
- Existing National Park
- Existing Park – Sanctuary Unit
- Proposed Wildlife Sanctuary
- Proposed National Park
- Proposed Park – Sanctuary Unit
- Adjacent Sanctuaries
- Proposed Extension to Existing Sanctuary/Park
- Sanctuary Proposed as Park
- Biotic Province/Sub–division Boundary

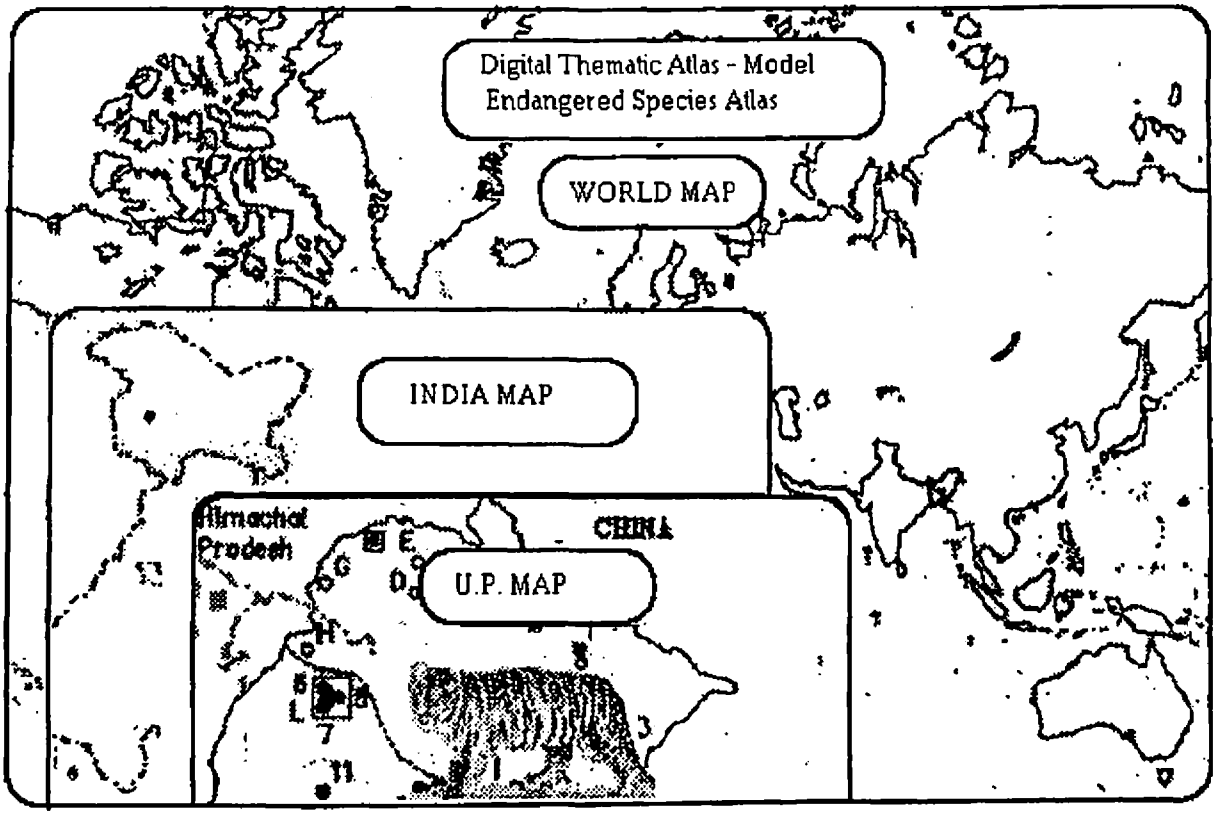



Fig. 3.20 ENDANGERED SPECIES ATLAS MODEL

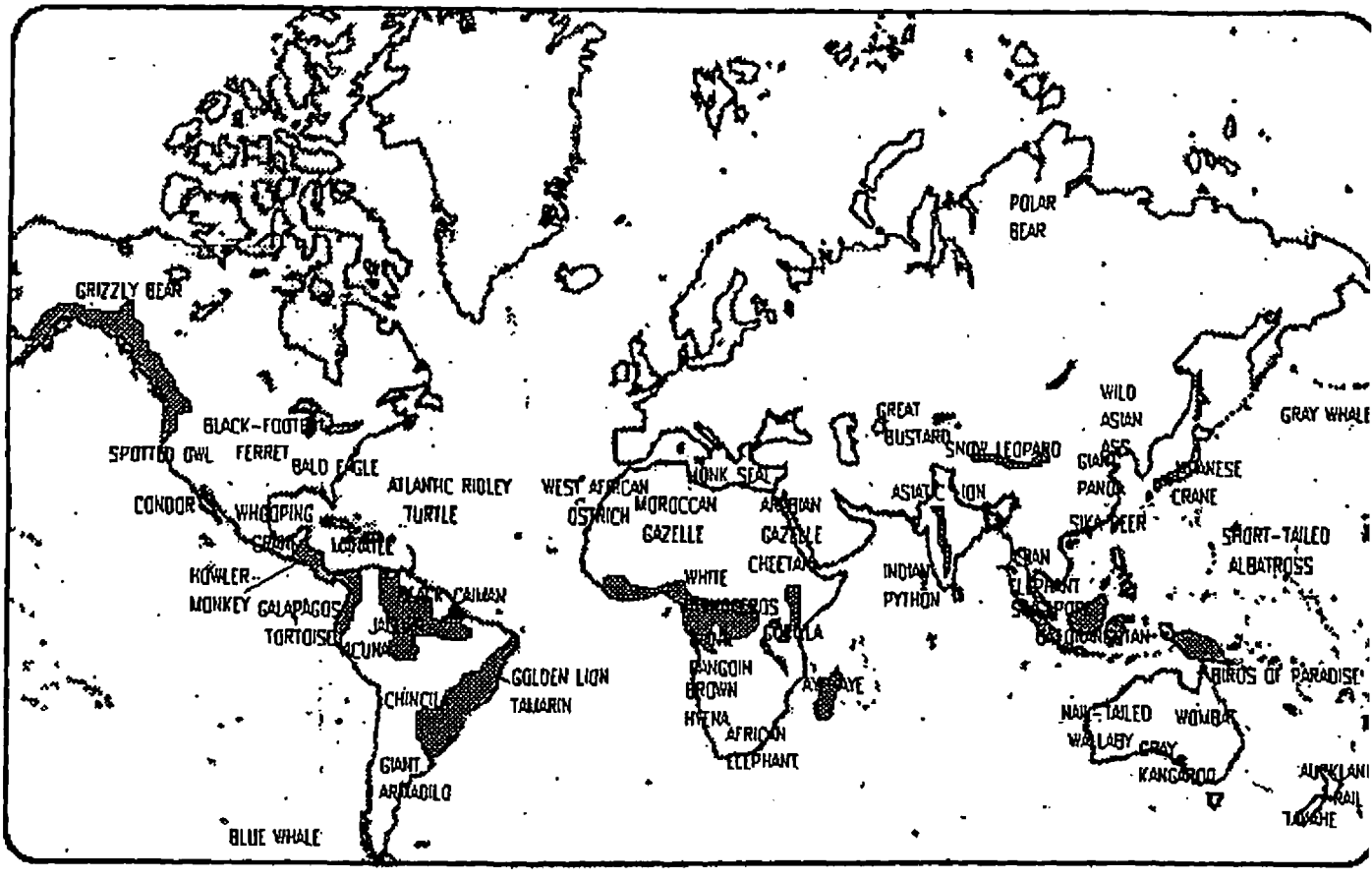



Fig. 3.21 ✓ THEMATIC MAP OF WORLD

ENDANGERED ENVIRONMENT

complete information about all the PAs associated with the particular species. Similarly, a search for an item in the Protected Area File locates the details of the desired PA. The corresponding natcode is used in the Linkage file to locate the codes of the list of species, which subsequently gives complete information about all the species associated with the particular PA.

The Database Structure for the Linkage File is shown in figure 3.17, while the Object-oriented Model for the same is shown in figure 3.18.

An *application framework*, made up of a collection of classes, with the idea that users will use inheritance to define new classes [70], has been developed as a skeletal structure.

A thematic map of Uttar Pradesh which was also used in various experiments has been shown in figure 3.19. A final model for the DTA has been shown in figure 3.20.

Figure 3.21 shows a model for the World Map updated with thematic information showing Endangered Species and their Environment, source - GEM's School Atlas [121].

At the next stage, additional thematic knowledge was provided in the form of visuals by scanning images of endangered species. A real-life picture of a Tiger and an Asiatic Lion was retrieved from a Multimedia system library and exported to Animator system and further linked with the Base Maps to demonstrate a complete sequence of User Information Retrieval. Animator Pro, VPIC, 3D-Studio were used for the purpose of animation sequence generation and viewing.

Thus, we have been able to develop an integrated framework for the DTA using a model for endangered species, with a Base Map and Knowledge Data Base. Having done this, we demonstrate the development of Query System through the second Case Application i.e., MFP Atlas.

### 3.5.2 Case Application II : Minor Forest Products Atlas

Forests, which a few decades ago represented an almost idyllic remoteness in the minds of people around the world, are now becoming frontlines in economic, international trade, environmental, political and other types of controversies. GIS technology has been associated with the mapping and management of natural resources, including forests, from the inceptions of its use [29]. Forests and forest products will have a high relevance to the development of a query system on a Digital Thematic Atlas.

A Minor Forest Products (MFP) database was selected to build a query model on a Digital Thematic Atlas. The MFP database has been developed by the **Centre for Minor Forest Products** (CMFP), Dehradun, as a project sponsored by the Ford Foundation "Assessment of NTFP Resources of India for Better Management" [50]. The objective is to provide different users with MFP-related information covering various aspects like silviculture, nursery techniques, methods of propagation etc. in a quick and easy-access format [50]. This database incorporates thematic information covering various knowledge parameters and is shown in figure 3.22.

The distribution of a particular species has been categorised in four different ways, viz.,

State-wise Information

Forest Type Information

Agro-ecological Regionwise Information

Eco-floristic Zonewise Information

This thematic information covering MFP parameters mentioned is codified for selective retrieval of information. The Agro-Ecological (AE), Eco-Floristic (EF) and Forest-Type

| No | Knowledge Parameter | Field Name | Type | Length | dec |
|---|---|---|---|---|---|
| 1 | Family Name | FNAME | C | 25 | 0 |
| 2 | Botanical Name of Species | BNAME | C | 25 | 0 |
| 3 | Trade Name | TNAME | C | 25 | 0 |
| 4 | Habit | HABIT | C | 5 | 0 |
| 5 | Rainfall | RAINFALL | C | 50 | 0 |
| 6 | Altitude | ALTITUDE | C | 50 | 0 |
| 7 | Temperature | TEMP | C | 50 | 0 |
| 8 | Requisites | REQUISITES | C | 60 | 0 |
| 9 | Distribution | DISTRIB | C | 60 | 0 |
| 10 | Zone Code-Agro-Ecological | AE | C | 50 | 0 |
| 11 | Zone Code-Eco-Floristic | EF | C | 50 | 0 |
| 12 | Forest Type | FT | C | 50 | 0 |
| 13 | Soil Type | SOILTYPE | C | 50 | 0 |
| 14 | Uses | USE | C | 60 | 0 |
| 15 | Part-Used for | PARTUSED | C | 120 | 0 |
| 16 | Active Ingredients | ACINGRED | C | 65 | 0 |
| 17 | Value-Added Products | VAP | C | 60 | 0 |
| 18 | Technology Used | TECHUSED | C | 50 | 0 |
| 19 | Yield-per tree & per ha. | YIELD | C | 60 | 0 |
| 20 | Potential Production | POTPROD | C | 50 | 0 |
| 21 | Actual Production | ACTPROD | C | 50 | 0 |
| 22 | Cultivation Possibilities & Expected Production | CPEPROD | C | 50 | 0 |
| 23 | Closest Substitute | SUBSTITUTE | C | 50 | 0 |
| 24 | Supply | SUPPLY | C | 50 | 0 |
| 25 | Demand | DEMAND | C | 50 | 0 |
| 26 | Trade Economics | TRADECON | C | 50 | 0 |
| 27 | Silvicultural Requirements | SILVIREQ | M | 10 | 0 |
| 28 | Phenology | PHENOLOGY | C | 50 | 0 |
| 29 | Methods of Propogation by Seeds | MOP_SEEDS | M | 10 | 0 |
| 30 | Vegitative Methods of Propogation | MOP_VEG | M | 10 | 0 |
| 31 | Nursery Techniques | NURTECH | M | 10 | 0 |
| 32 | Harvesting Technique | HARVESTECH | M | 10 | 0 |
| 33 | Grading and Processing | GRAD_PROCS | C | 150 | 0 |
| 34 | Storage | STORAGE | C | 50 | 0 |
| 35 | Pests,Diseases (in Field/ During Storage/ Remedies) | MEDICARE | C | 50 | 0 |
| 36 | Economics of Cultivation/ Production | ECONOMICS | C | 50 | 0 |
| 37 | Employment Potential | EMP_POT | C | 50 | 0 |
| 38 | Additional Advantages/ Utility | PLUSPTS | C | 50 | 0 |
| 39 | Important References | IMPREF | C | 150 | 0 |
| 40 | Resource Persons | RESPERSON | C | 100 | 0 |

Fig. 3.22 THE MFP KNOWLEDGE PARAMETERS

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

(FT) Codes for the system have been designed and are illustrated in Appendix A3.4, A3.5, A3.6.

A Window-based query system on the IAQM basis has been programmed for the MFP MIS. First, when the user loads the system, he has to log-in and submit his user identity and password as shown in figure 3.23. After successful log-in operation, he is presented with the MFP MIS menu, as displayed in figure 3.24.

The user can choose an option by moving the cursor and making a selection. The database uses codes whenever possible which are linked to a **Codes Dictionary**. The codes are used internally and information displayed on the server is more meaningful to the user and appears *codeless*.

A query system has been developed for the MFP Management Information System (MIS) [22], [4]. This demonstrates the possibilities of building a practical MIS, utilising an Information Retrieval Menu System on a Digital Thematic Atlas.

When a query is made from the system, it scans the database searching about 1280 species and displays the records on the screen so that the user can select previous or subsequent records or ask for detailed information in an interactive manner. Sample runs for query operations are shown in figure 3.25 (A), (B).

As the user selects and identifies his information from the system, the query is built up and the information base filtered through stages as discussed earlier. In addition to Summary Information, detailed Secondary Information, Agro-Ecological Information, Eco-Floristic Information and Forest Type Information is also displayed. The Screen Page Display of two search iterations of the IAQM in three stages each are shown in figure 3.26 (A), (B).

The Information Retrieval Menu of the MFP MIS searches the database for information by using codes for AE, EF and FT along with State codes. The user could overlay these on a Map Base. The Query system (which was demonstrated during the International Seminar on

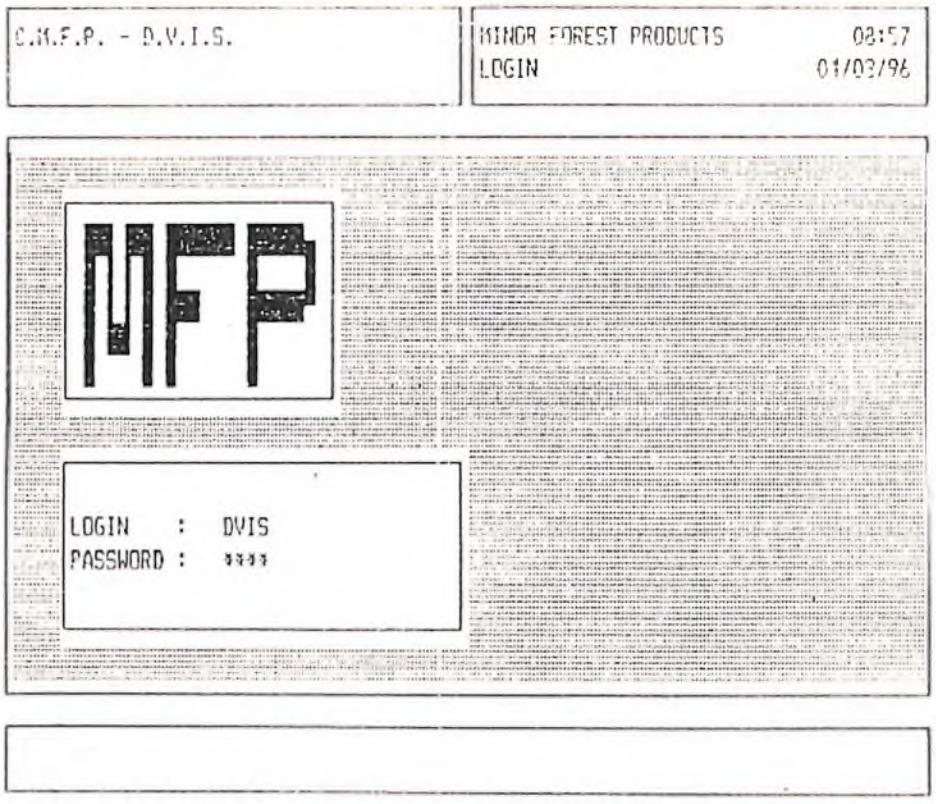



Fig. 3.23 MFP LOGIN SCREEN

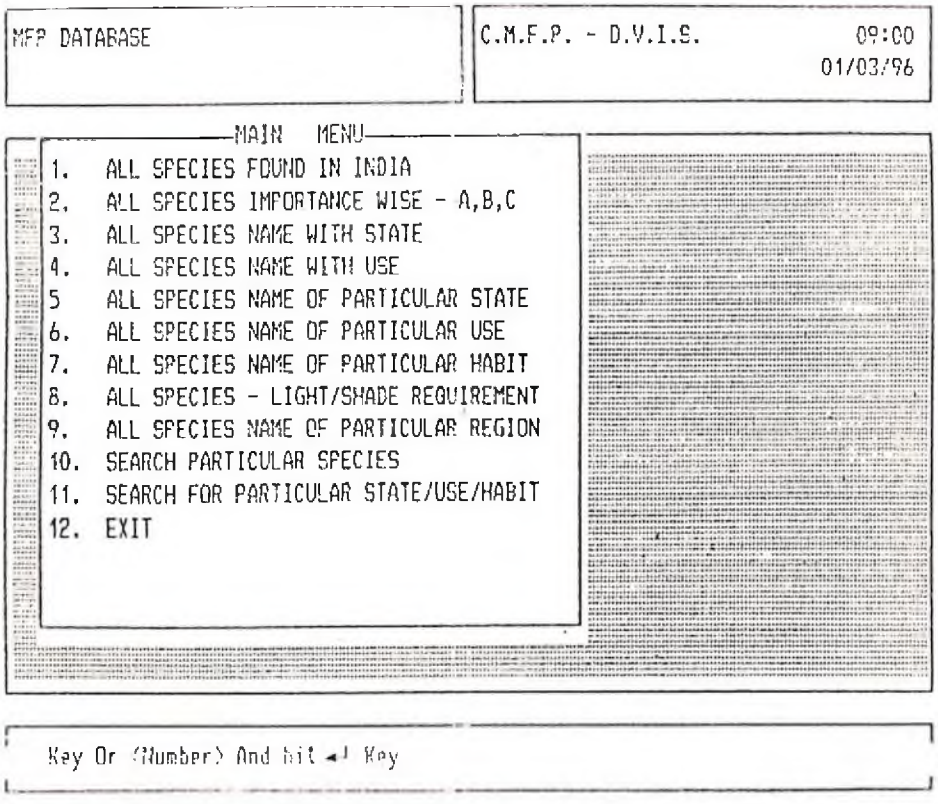
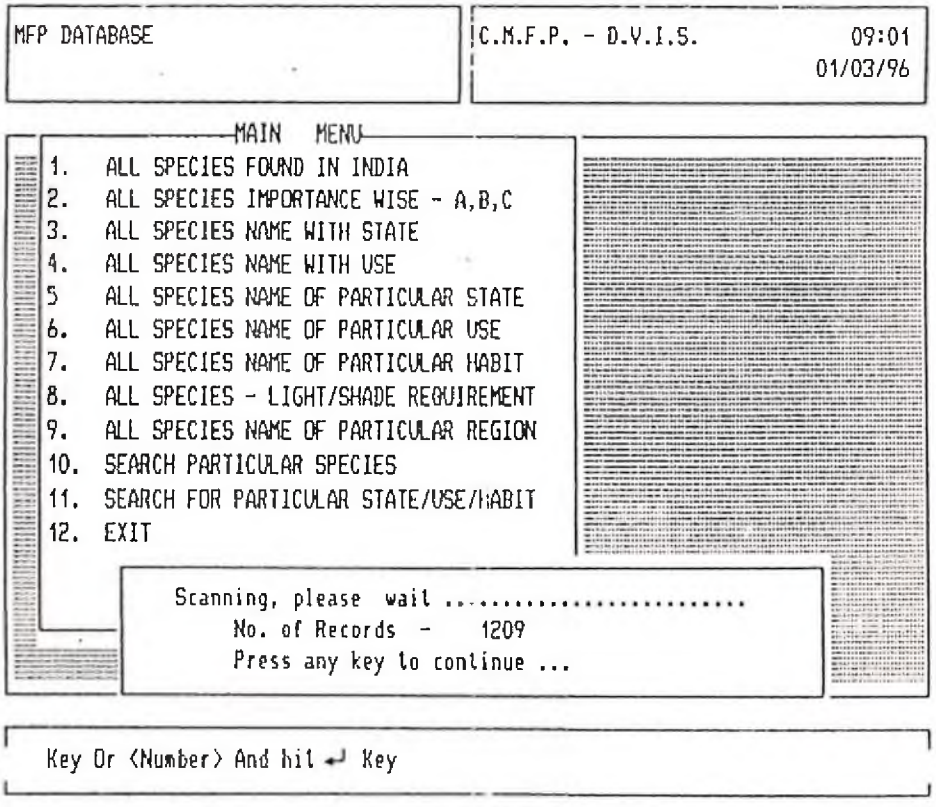
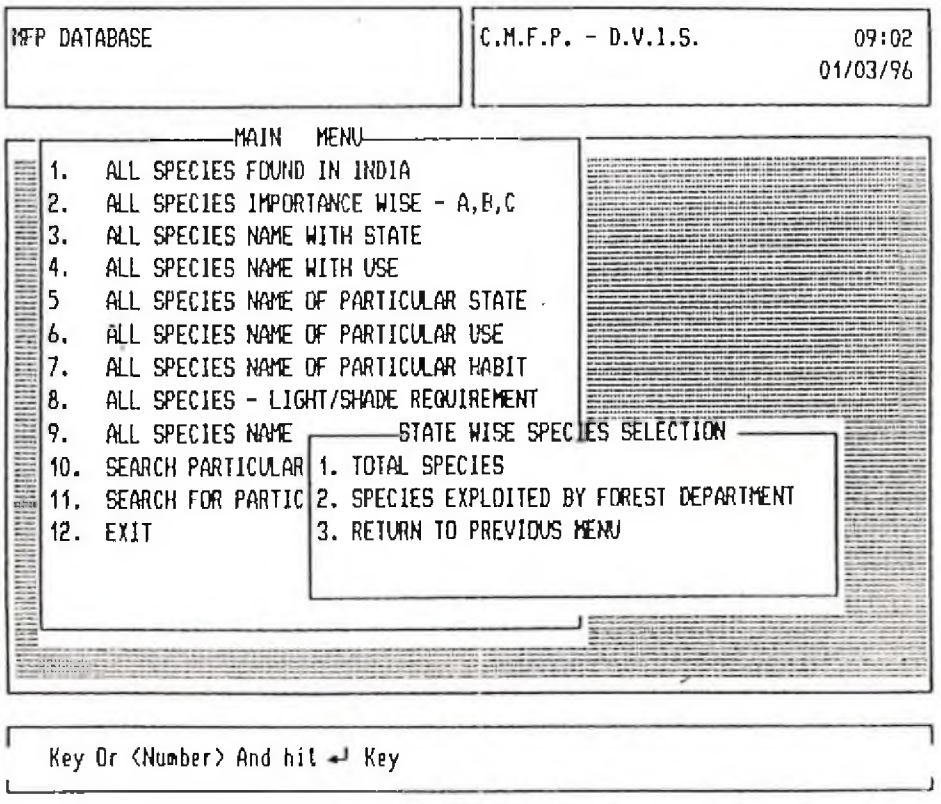



Fig. 3.24 MFP INFORMATION ACCESS QUERY MODEL - MAIN MENU




(A)




(B)

Fig. 3.25 SAMPLE RUNS ON MFP IAQM

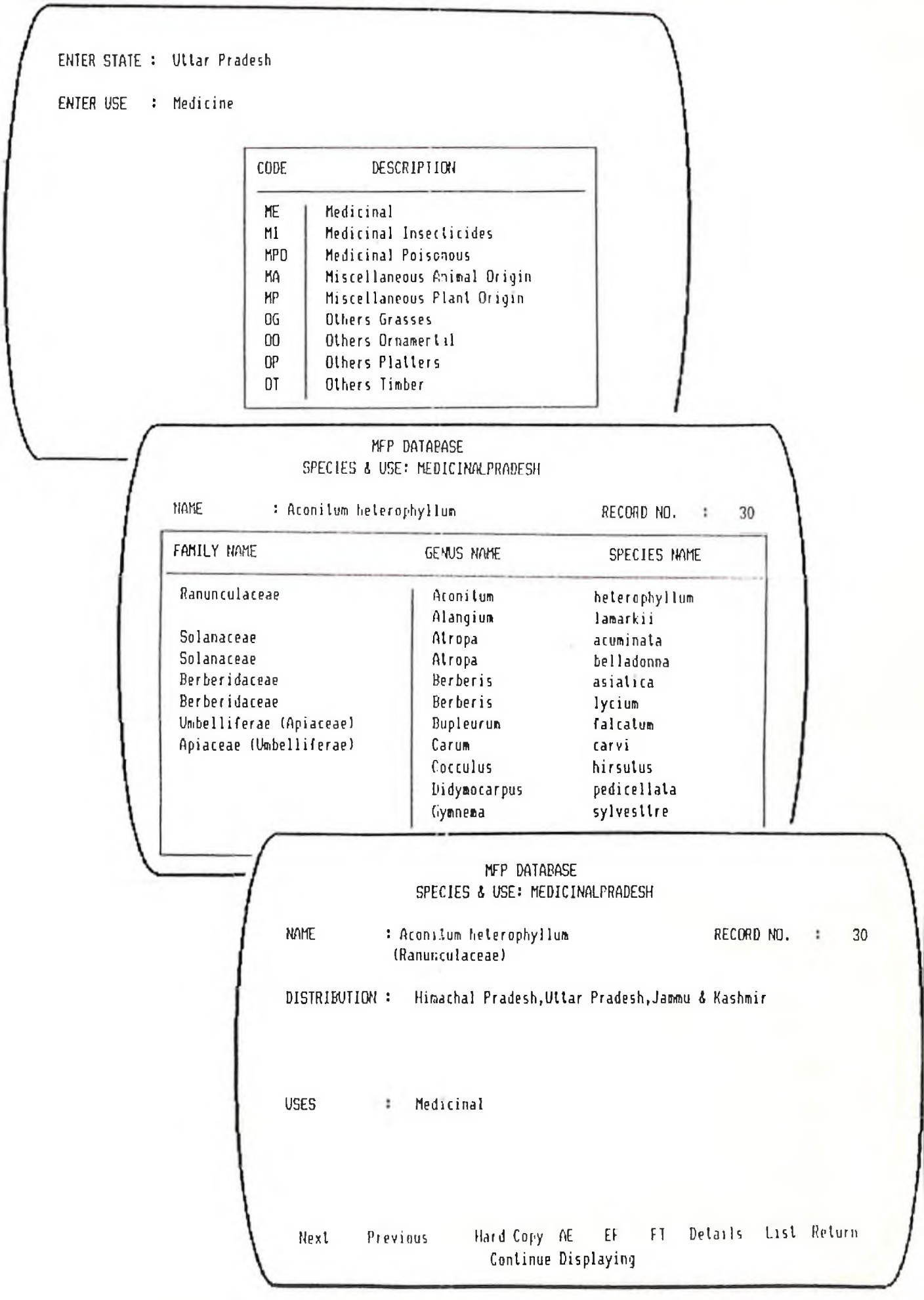



Fig. 3.26(A) MFP SPECIES PAGE DISPLAY ( IAQM SEARCH IN 3 STAGES )

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

ENTER FOREST TYPE REGION :

| DESCRIPTION | CODE |
|---|---|
| SUBTROPICAL BROADLEAVED HILL FOREST | 08 |
| SUBTROPICAL DRY EVERGREEN FOREST | 10 |
| SUBTROPICAL PINE FOREST | 09 |
| TROPICAL DRY DECIDUOUS FOREST | 05 |
| TROPICAL DRY EVERGREEN FOREST | 07 |
| TROPICAL MOIST DECIDUOUS FOREST | 03 |
| TROPICAL SEMI-EVERGREEN FOREST | 02 |
| TROPICAL THORN FOREST | 06 |
| TROPICAL WET EVERGREEN FOREST | 01 |

MFP DATABASE
BOTANICAL SPECIES OF FOREST TYPE : TROPICAL MOIST DECIDUOUS FOREST

NAME : Abies pindrow
(Abietaceae)

RECORD NO. : 4

HABIT : Tree

STATE :
Himachal Pradesh,Punjab,Uttar Pradesh,Jammu & Kashmir

Next Previous . Hard Copy AE EF FT Details List Return
Continue Displaying

MFP DATABASE
BOTANICAL SPECIES OF FOREST TYPE : TROPICAL MOIST DECIDUOUS FOREST

NAME : Abies pindrow
(Abietaceae)

RECORD NO. : 4

AGRO-ECO.ZONE Western Himalays,Covering Ladakh & Gilgit districts,Wester n part of Rajasthan(Marusthal),Southwestern part of the st ates of Haryana & Punjab,Kutch peninsula & northern part o f Kathiawar peninsula,Parts of Northern Plain,Central High lands & Gujarat Plain,Part of northern Indo-Gangetic Plain ,including piedmont plain of the Western Himalays,Bundelkh and part of M.P & north-eastern part of Vidarbha region,Pa rts of eastern Plateau comprising Chhatisgarh region of MP & south-west Highlands,Eatern Plains,Covers north-eastern Uttar Pradesh & northern Bihar, including foot-hills of C entral Himalayas,Comprising of W.Himalays,Covers J&K,HP&no rth-western hilly areas of UP

Fig. 3.26(B) MFP SPECIES PAGE DISPLAY ( IAQM SEARCH IN 3 STAGES )

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

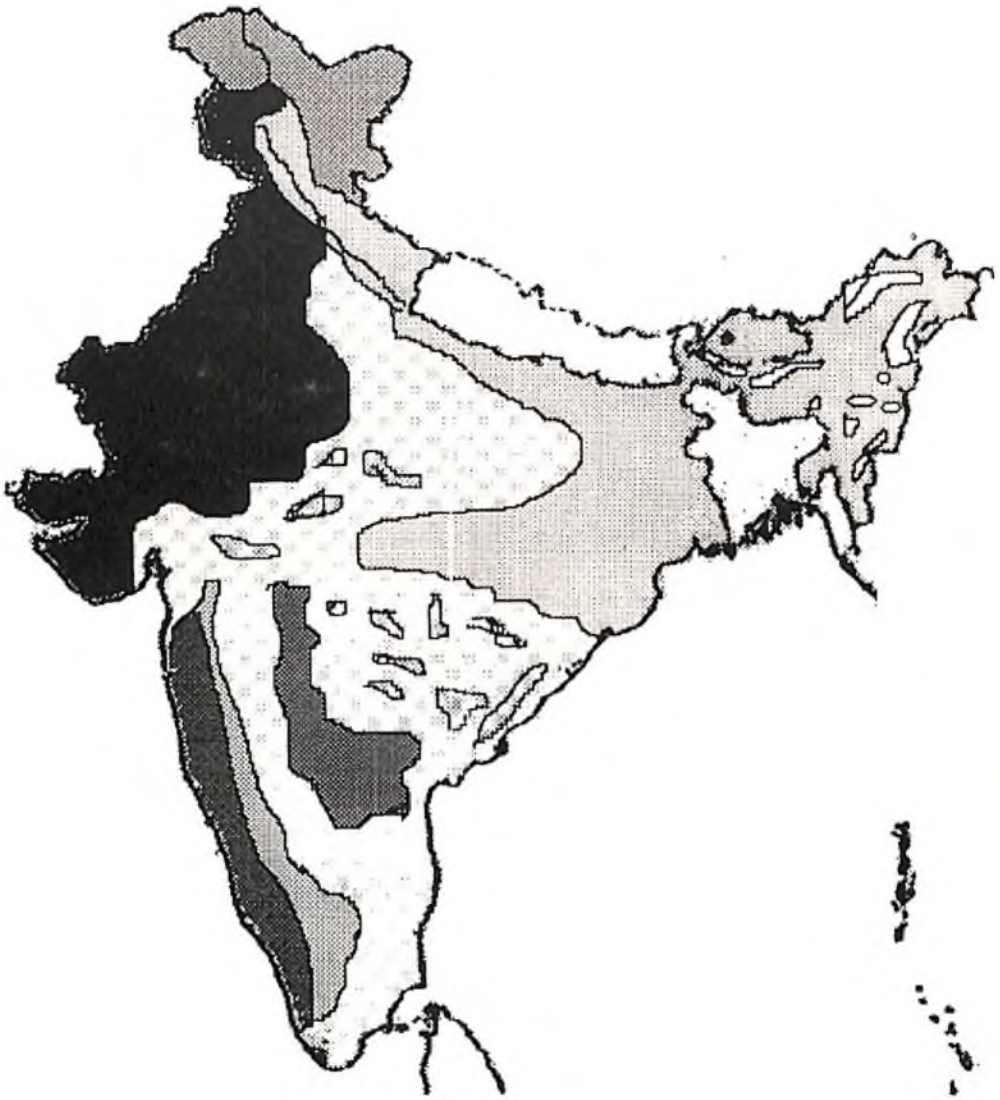


Fig. 3.27 THEMATIC MAP SHOWING FOREST TYPES AND MFP INFORMATION QUERIED BY OPERATOR

"Management of MFP" organised by CMFP) can be activated on a Digital Thematic Atlas and will prove to be of tremendous use to the forestors, scientists and researchers including ecologists, social scientists, botanists, chemists and representatives of related industries. A final sample model of an output thematic map showing Forest Types and MFP information, linked loosely with the filtered codes generated by the query system of the IAQM is shown in figure 3.27.

The MFP MIS thus provides a Front-end Query Model of a Digital Thematic Atlas, while updation of data could be carried out through data networks.

So far we have been able to achieve the following:-

Design and develop a framework for the integration task incorporating Map Bases from GIS and other sources, and Knowledge Base extracted from the Data Base and Reports of the Wildlife Institute of India, for the case application of Endangered Species Atlas.

Design and develop a Query Model for the Minor Forest Products Atlas demonstrating important Query tasks upon a database having about 1200 records of 40 fields. The query model follows an interactive query system useful for interactive query operation.

Along with the Data base, it is also possible to incorporate pointers to Multi-media pictures or Animator Software such that the Digital Thematic Atlas could display Multi-media information.

Various conceptual experiments showed how it is possible to bring up the DTA with the World Map shown in the first frame. Thereafter, a user could use Point-and-Click method to select and choose a sub-continent or country using a mouse or cursor. After displaying the country map, the user can further select and choose the state map he desires. After locating the desired state he can ask for the Protected Areas in the state which will be displayed as a

thematic map. If the user now wants to locate a particular Protected Area or Wildlife Sanctuary he can select the area and ask for the display of the endangered species there. This would display the picture of the endangered species and, through multi-media and animation techniques, it would also be possible to have a small animation sequence related to the object located, i.e, the particular endangered species queried.

The system concept has been experimented, using the Maps of the World, India, Himachal Pradesh and Uttar Pradesh State. The State Maps are available without thematic information as well as in Thematic map form. The Knowledge Base of 5 endangered species has been programmed into the system.

A large number of Maps of the entire country need to be scanned and digitized for complete information. However this exercise covers the basic Design Issues of the integration task of the various technologies involved in a DTA, i.e., GIS Base Maps, Knowledge Base and Multimedia Technology.

Map Base, taken as input for the experimental tasks, were obtained from GIS Software, using Base Maps from Survey of India as well as Maps scanned over Deskjet Scanners. Knowledge Base has been designed as an object-oriented class structure which could provide Object Linking and Embedding (OLE) in various systems.

The concept demonstrated has been conceived over various systems, prototype applications developed and industry-standard packages which need to be Window-driven and loosely-coupled on PCs.

The next task is to build different models for the network-updation task. For this, a prior study of the Network Updation techniques is important. The next section identifies various Network-based Updation Techniques.

# Chapter Four

## 4 NETWORK UPDATION TECHNIQUES

As seen in the framework designed in chapter three on the basis of our Atlas Publisher-Storehouse-User paradigm, after developing the Map Base and the Knowledge Base for Atlas Publisher, the Query System for Atlas User, the task before us is to identify and develop the Solution Models for Network Updation so that the Atlas Publisher could provide an updated DTA to the User.

Before we can decide the approach to be taken for updating the DTA by various networking methods, it is important to identify the techniques for Network Updation. Today's network updation techniques are typically modelled on the Client-Server architecture.

### 4.1 CLIENT-SERVER MODEL

In a **Client-Server** model, clients access the data by sending requests over a network to the address of a well-known destination - the server, which carries out the work and sends back the replies, as shown in figure 4.1.

A Server is a system that offers a service and a **back-end** for management of data that can be reached over a network. The client provides a Graphical User Interface (GUI) based **front-end** responsible for interaction with the user. Communication always takes the form of request-reply pairs, always initiated by the clients, never by the server. The Network provides the vehicle for a co-operative processing system.

A common example is a network of diskless personal computers or workstations, called **clients**, that communicate over a network with a **server** having a high capacity disk on which all

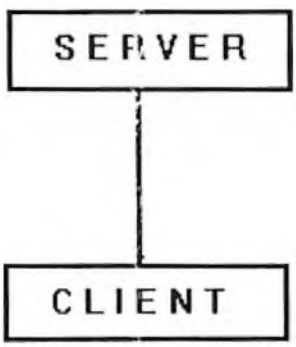



Fig. 4.1 THE CLIENT SERVER MODEL

the data is stored. Z3950 is a standard for Client-Server information retrieval. While it has many appealing features, it lacks some of the power inherent in database query languages, such as SQL3 [16]. Internetworking and Client-Server Model concept with distributed Data Base shall provide a technological transition for application of expensive Map and Knowledge Bases in a Digital Thematic Atlas.

On the basis of the Client-Server Model, it is necessary to identify Models for the Atlas Publisher-Storehouse-User paradigm. The base model is given in figure 4.2(A).

An '*Atlas Server*' would be an *Atlas Publisher* who would provide the Atlas Storehouse with Map Base and Thematic information for storage. On-line Atlas Servers will have a key role to play as enablers of electronic transactions which would have a tremendous impact on Updation Techniques for a Digital Thematic Atlas.

The Atlas Storehouse will play the role of an "**intelligent Atlas-Agent**" performing the task of going through massive amounts of GIS data from diverse Atlas Publishers or Servers and retrieving thematic information that is relevant for the user's application. In such a case, it could be expected that the Atlas Server functions would be required from the *Atlas Storehouse* also, as shown in figure 4.2(B).

Thus it becomes important to study the methods of file trasfer protocols on diverse servers and search tools required for them.

## 4.2 FILE TRANSFER PROTOCOL

On-line File Updation is carried out by executing various File Transfer Protocols (FTP) [88],[89] on a Server. File Transfer implies copying files from one system to another. FTP thus allows access from one computer to another across the network. Many departments of U.S. Universities are now keeping some of their reports on an FTP Server [81] to facilitate the process of easy information availability.

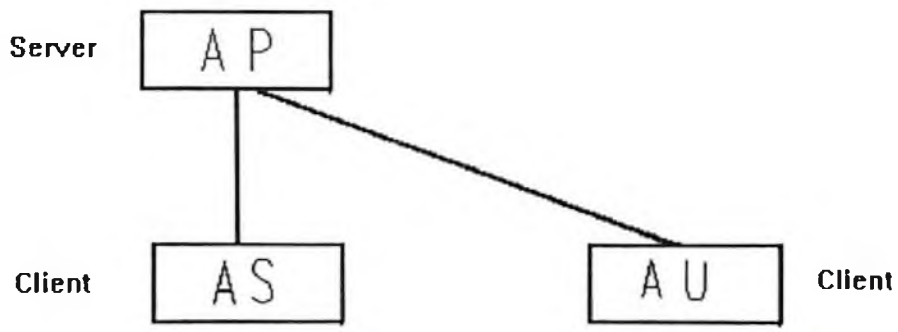



Fig 4.2(A) THE P-S-U PARADIGM AND THE CLIENT-SERVER CONCEPT

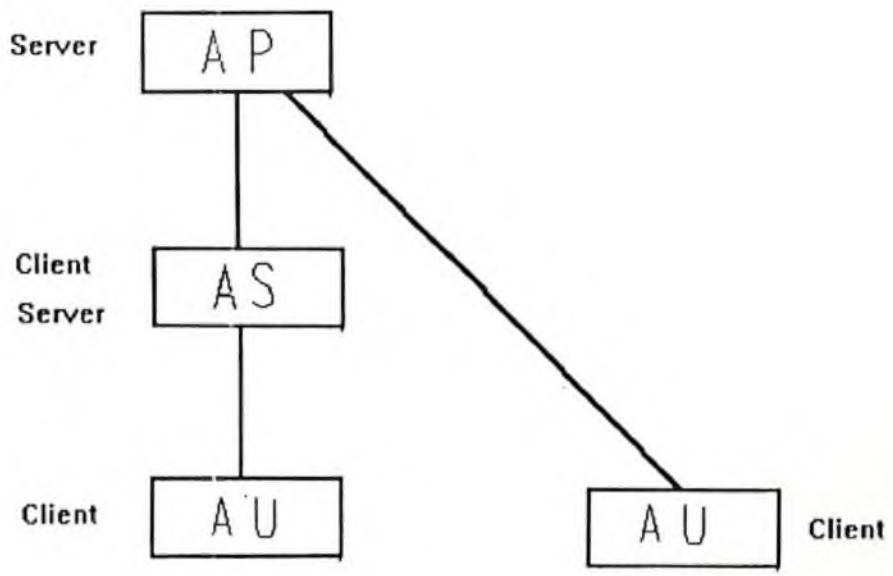



Fig 4.2(B) THE P-S-U PARADIGM AND THE CLIENT-SERVER CONCEPT

FTP sites may be polled in order to build a centralized master index [81], from extracted map and data bases of various Atlas Servers. Subsequently, index searching has to be supported on this **Unified Atlas Report Index**.

While FTP is a popular file-copying method available on INTERNET, a Central Server design has performance, availability and cost drawbacks. Any centralized resource will become a bottleneck as the number of users increases [92]. Many times, users do not have access to FTP. In future, particularly in the Indian environment, non-Interactive E-Mail-based File Updation should become more popular.

Two general methods of Mail-updation File Management could exist - **manual** and **automatic**. Manual updation is a traditional way, in which the updation message is read by an individual person who updates various files etc. It would be more efficient to have Updation done automatically as it saves human intervention. Automatic Mailing Managers are a family of programs known as Autoresponders, LISTSERV and Majordomo.

Mail **Robots** are becoming a popular way to query databases and retrieve files because it would be much easier to set up a connection that handles E-mail than to set up one that handles file transfer. A message could be sent to the robot, referred to as a **mail server**, which takes some action based on the contents of the message and sends back a response.

The BITNET [78] network maintains a large mailing list which involves a lot of human intervention and manual work, so the program LISTSERV was developed which runs on IBM mainframe computers. An interesting point is that earlier only users on machines directly connected to BITNET could use LISTSERV. However, today anyone with an Internet address can use LISTSERV by sending a brief E-Mail to LISTSERV. The concept of a Mailing List is that the List itself has an E-Mail address, and any information sent to that address is subsequently forwarded to all the users on the list.

A proposed Unified Atlas Report Index should be able to retrieve reports that appear interesting [81] on the basis of abstracts, summaries, bibliographic data or sample Map Base

*contributing* [111] information sources. FTP is a standard method for copying a file. However, in order to copy a file, the Atlas storehouse server will have to search and look for a desired Map or Thematic Information requested by an Atlas user. In order to search for information various tools on Internet will have to be used.

## 4.3 TOOLS FOR INTERNET

On the Internet, various Network robots exist which help a user to save time by sifting through information of any kind. With the use of specialized robots it would be possible to search many - even hundreds of - sources for specific information. There are many network Robots which utilize E-Mail forms to let a user send or request specific information from recipients. Various tools to access, search, query and update information from the Network Robots are enumerated below:

### 4.3.1 Archie

Archie [88], [89] is a tool used for searching for information on the Internet, or for **archiving** information. There exist various servers, across the world, called as Archie servers, which help in searching or checking databases, looking for files that match the required description. The Archie Database identifies the names of the desired files although it cannot give the contents of the files. After finding the file name, 'FTP' can be activated to get the files.

There are **three ways to access** the Archie Database:

- On the host computer with an Archie client program
- By connecting to a computer with an Archie server
- Through mail

**4.3.1.1 Accessing Archie on a host computer** : The best method is to use an Archie client program which is usually just called 'Archie'. A search can be formulated which is then sent over the Internet.

**4.3.1.2 Using Archie by Archie client** : It is a Unix command which gives all the arguments on the command line. Archie servers allow a user to connect to them through the 'telnet' program. When prompted to log in, a user could key in the name 'Archie' and then give commands to specify the subject of interest. Archie then returns the matching list of files. For example,

% archie endangered

The argument in the above command line looks into the closest Archie database for all files with "endangered" in the title and returns a list.

It is a slow method, wastes Internet resources and prevents others from getting their requests filled by holding up the server.

**4.3.1.3 Using Archie by mail** :

It is possible to send e-mail to any of the Archie servers. The server will read the mail and respond in the same format as in the case of the Archie client. The mail server replies by sending a mail with the results. Each line of the mail message sent to the Archie mail server is basically a command.

A straight and simple way of searching for information is to send an E-mail to archie@*servername* where *servername* is any of the Archie servers like:

| | |
|---|---|
| archie.rutgers.edu | New Jersey |
| archie.sura.net | Maryland |

| | |
|---|---|
| archie.mcgill.ca | Canada |
| archie.doc.ic.ac.uk | UK and Europe |
| archie.ad.jp | Japan |
| archie.ncu.edu.tw | Taiwan |

However, it must be reiterated that while Archie technique is useful for *finding* the desired information, FTP will have to be used for copying operation.

With Network-based Updation becoming very popular and servers having to handle a hundred requests at a time, continuously 24 hours a day. Some On-line or Telnet based operations would be slow. In cases where the operation is going to be slow, it would be more productive to send in a request by E-mail and meanwhile continue doing other operations. As soon as the requested server completes the request, it posts the answer in the mailbox from where it may be collected and utilised when convenient.

### 4.3.2 Gopher

Gopher is another tool for searching information on the Internet. It is a client/server system that lets a user navigate through the Internet without using commands.

Gopher is a navigation tool that provides computers with access to files and services on remote servers that support gopher software based on a menu system for easy browsing. It helps to browse library card catalogues and automatically retrieves the information desired, irrespective of where the library is located (as long as it is part of the gopher system).

It is a simple menu-driven program that makes finding information much easier. Here, directory trees are shown as lists. To choose a file for viewing or transferring operations, there is no need to type its name.

Gopher can link to other services, eg., a user can have an entry that automatically starts a link to another computer through the 'telnet' program, and can handle any kind of information e.g., text, programs, pictures, etc.

There is a database which has headings from virtually every Gopher Server on the Internet. This is called **VERONICA** which stands for Very Easy Rodent-oriented Net Index to Computerised Archives. VERONICA is a popular tool, built into Gopher, which allows a search for an item from virtually every Gopher Server on the Internet.

### 4.3.3 Mosaic

Mosaic, a graphical browser for the web, is one of the primary means of "net-surfing" on the NET. It also supports Gopher, FTP, Telnet, [115] and WAIS. Mosaic can be run over phone lines, but the minimum recommended speed is 9600 baud. However, the problem with Mosaic is that it is too slow.

### 4.3.4 Netscape

A more advanced and powerful browser, Netscape, much faster than Mosaic, supports forms and could be used where human operations are required. This means that the Digital Thematic Atlas User could be asked to enter information which could then be processed by a special program on the server. This technique can also be used to generate "dynamic" documents or "dynamic books" [9], which are created depending on the query the user has made. So, one moment the Digital Thematic Atlas user could be retrieving information from an Atlas Server in Dehradun, and the very next moment, be connected to another Atlas Server in Hyderabad or say, California, for that matter.

With the above-noted facilities like "net-surfing" available in Netscape, it is identified as a right tool for the Digital Thematic Atlas.

# Chapter Five

## 5 SOLUTION MODELS FOR NETWORK UPDATION OF DIGITAL THEMATIC ATLAS

So far, the Basic Design Issues for Digital Thematic Atlas have been studied along with various examples for thematic application over Base Maps. Issues of the Updation Task have also been identified and a Framework for the Integration Tasks for the Digital Thematic Atlas developed. Network-based Updation Techniques too have been identified. In this chapter, it is proposed to identify various operating Solution Models for Atlas Publisher-Storehouse-User paradigm.

An environment consisting of integrated prototypes and models catering for required functions was set up. As a whole, they covered major issues relevant to the development of Networked Digital Atlases of the future. An operational plan for providing DTA-based updation using a combination of two alternatives, as given below, has been identified and subsequently modelled :

1. New centres will have to be developed to support new network elements and new services [39] for the DTA, incorporating the Information Superhighway.

2. Existing procedures for providing maps will have to be changed to support new network elements and new services [39] on the DTA.

The best possible solution for updation of Digital Thematic Atlas utilising the potential of the Information Superhighway emerges as a combination of three approaches :

1. Build-your-own - Concept of an Integrated Systems Network

2. Use Service-Providers - Co-operative Models

3. Internet - Global Model

## 5.1 APPROACH 1 - BUILD-YOUR-OWN CONCEPT OF AN INTEGRATED SYSTEMS NETWORK

To update Digital Thematic Data Base and Map Base over the Network, we require an integrated system which should be able to support the framework built for the DTA, specifically provide Map Download and File Transfer facility, a Map Information Updation facility by reading the status or 'Notices' of Map Base, and an on-line support for Query System.

This gives the concept of an Integrated Systems Network which would support the integrated framework identified earlier.

### Design of ISNET

A model for Acquisition and Updation of Digital Thematic Atlas Data over Networks was conceptualised and evolved. This has been called as the Integrated Systems Network (ISNET).

A prototype Base Design for Data Communication has been developed for ISNET to study the potential of the Information Superhighway for the Digital Thematic Atlas. This prototype would also study the problems faced in developing such activities.

### ISNET Bulletin Board System

Working on the principle, *"Think Global - Act Local"*, at the metropolitan level, the **ISNET Bulletin Board System (ISNET BBS)** was set up as a model of a new centre of influence which could develop an Atlas User community as described in our Paradigm and provide local connectivity for Updation and other important support activities to these User Members.

The Bulletin Board System provides On-line support and services which could be modelled for AP and AS functions. In the Build-your-own approach, an AP or AS with certain minimum infrastructure can set up an Atlas Server for basic AU applications. Intelligent updation support may be provided in two ways - a) Autoresponder System; b) Human Counselling System. Both these methods would also supplement the Information Access Query Model functions of the AU which has two requirements - to view the Atlas and to Query for useful information.

It was conceptualised that at a **local** level, the Client-Server approach could be modelled into a concept that has been named as **Father-to-Son**. In the Client-Server system, when the Client requests a Server for certain information it generates possibilities of the Server giving extraneous and irrelevant information to any client requesting for the same. Under the **Father-to-Son** approach, the server takes a parental attitude, provides Counselling Support and filters/scans the information to provide only useful and relevant information. This approach also helps to make users aware of a new technology without fear of complex terminologies and provides a friendly attitude which is a very important concept in the realm of BBSs.

The Father-to-Son concept shall also lead towards the concept of trust-building or **trusted-network approach**, which is very important when confidential information is being transferred over the network. Constraints and Security Processing System on such a trusted-network could even allow the possibility of making Classified Maps available to restricted User Members. This kind of system would also shield users from being loaded with unimportant details of accessing diverse sources [107] of information and waste resources of the user. This solution model is illustrated in figure 5.1.

**The ISNET Community**

Under the ISNET model, it was desired to provide initial connectivity to all Nodal Users who would subsequently require Atlas Data or even become Digital Thematic Data

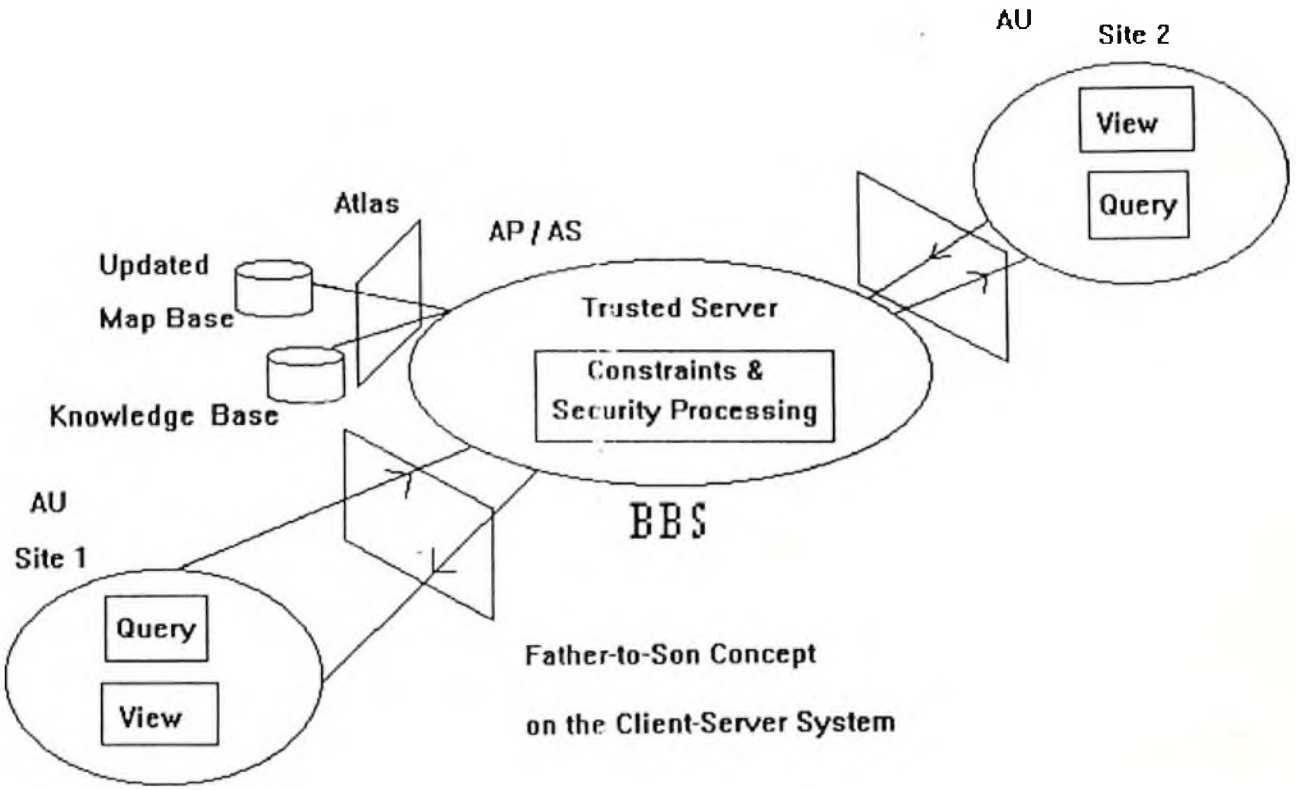



Fig. 5.1 BUILD-YOUR-OWN : ISNET BBS

| Id | Unit |
|---|---|
| hqt.isnet | Headquarters, ISNET |
| bombay.isnet | Bombay Virtual Node, ISNET |
| delhi.isnet | Delhi Virtual Node, ISNET |
| madras.isnet | Madras Virtual Node, ISNET |
| calcuta.isnet | Calcutta Virtual Node, ISNET |
| wii.isnet | Wildlife Institute of India |
| cmfp.isnet | Centre for Minor Forest Products |
| sgosoi.isnet | Surveyor General Office, Survey of India |
| dmcsoi.isnet | Digital Mapping Centre, Survey of India |
| dsasoi.isnet | Director Survey, Air, Survey of India |
| cmdongc.isnet | CMD, ONGC |
| disongc.isnet | DISC,ONGC |
| rdiongc.isnet | RD, KDMIPE, ONGC |
| ipongc.isnet | KDMIPE,ONGC |
| imdongc.isnet | IMD, ONGC |
| lbsnaa.isnet | LBSNAA, Mussoorie |
| fri.isnet | FRI |
| ppcl.isnet | PPCL |
| rlek.isnet | RLEK |
| sja.isnet | St.Joseph's Academy |
| shomie.isnet | The Doon School |
| wbs.isnet | Welham Boys School |
| rec.isnet | Ramchandani Educational Consultants |
| acctrly.isnet | Railways, New Delhi |
| rites.isnet | RITES, New Delhi |
| skksdr.isnet | SDR, New Delhi |

FIG. 5.2 THE ISNET USER COMMUNITY

| Id | Unit |
|---|---|
| hqt.isnet | Headquarters, ISNET |
| bombay.isnet | Bombay Virtual Node, ISNET |
| delhi.isnet | Delhi Virtual Node, ISNET |
| madras.isnet | Madras Virtual Node, ISNET |
| calcuta.isnet | Calcutta Virtual Node, ISNET |
| wii.isnet | Wildlife Institute of India |
| cmfp.isnet | Centre for Minor Forest Products |
| sgosoi.isnet | Surveyor General Office, Survey of India |
| dmcsoi.isnet | Digital Mapping Centre, Survey of India |
| dsasoi.isnet | Director Survey, Air, Survey of India |
| cmdongc.isnet | CMD, ONGC |
| disongc.isnet | DISC,ONGC |
| rdiongc.isnet | RD, KDMIPE, ONGC |
| ipongc.isnet | KDMIPE,ONGC |
| imdongc.isnet | IMD, ONGC |
| lbsnaa.isnet | LBSNAA, Mussoorie |
| fri.isnet | FRI |
| ppcl.isnet | PPCL |
| rlek.isnet | RLEK |
| sja.isnet | St.Joseph's Academy |
| shomie.isnet | The Doon School |
| wbs.isnet | Welham Boys School |
| rec.isnet | Ramchandani Educational Consultants |
| acctrly.isnet | Railways, New Delhi |
| rites.isnet | RITES, New Delhi |
| skksdr.isnet | SDR, New Delhi |

FIG. 5.2 THE ISNET USER COMMUNITY

Servers in the future. The *Domain Name System, DNS* of **INTERNET** which uses integration operators to define the complete electronic address of a unit or entity on the network was utilised to form the ISNET model identification system for the user members. The ISNET User community is depicted in figure 5.2, and it is perceived that in subsequent times, each user member could become an Atlas Server, for specialised thematic knowledge information.

The flowchart illustrated in figure 5.3 shows the method of operation for utilising the modelled Atlas Server.

Users dial-in to ISNET BBS on the prescribed telephone number using a PC and a MODEM. Upon dialling the correct number, the user is able to 'open' a connection on the Atlas Server and is presented with a Log-in screen which displays the Atlas Server Message and requests the User to register his Identity (Id) as shown in figure 5.4. Next, the user enters the Id and Password provided to him to validate and authorise him to use the Atlas Server. A new user who does not have a valid Id and Password may still log-in and become a Guest User of the System with limited facilities and services.

Next, the user is guided to the Front-end Screen shown in figure 5.5, which is modelled as one of the 'Pages' of the Atlas Server. This is also the 'Home Page' of the particular Atlas Server, developed as an ASCII display, from which branches run to various operational modules as menu options.

Through the Atlas Home Page, a User has options, such as:

(a) Read Map Information Noticeboard

(b) Chat and Counsel

(c) Library of Thematic Information

(d) Map Files Download or Upload

(e) Virtual World

(f) Virtual Classroom

(g) Return to Previous

By reading the Map Information Noticeboard, the user can obtain Map Information Status of the dynamic Atlas, Inventory Position at the Atlas Server, Index Charts and Notes/ Messages from other Atlas Users for collaborative purposes. He can also post a Message or Informative Note for other Users.

Thereafter, the user can Chat and Counsel with a human Systems Operator (SysOp) for Querying functions, Map Download/Upload Assistance or Thematic Information. If the human counsellor (the SysOp) is unavailable, the Autoresponder System may take down Queries and requirements from the user and provide assistance in a later session.

After an initial Counselling Session or after browsing through the Atlas Index, the User can display a page of thematic information from the Library. The user may be validated at this stage by checking his Id and access level.

The user can download Map files by using various file transfer protocols (ftp), which have been implemented in **ISNET BBS Father-to-Son**. When he wants to transfer or copy a digital map file or knowledge base file, he has to select the file transfer protocol, for e.g., X-Modem, Y-Modem, Kermit etc. and, thereby, begin his file transfer operation. At the Server end, programs have been built to carry out the operation automatically like a Network Robot.

Various prototype test Base Maps of World, India, Uttar Pradesh and Himachal Pradesh, along with image files of endangered species like Tiger, Lion etc, picture viewer and multimedia flic files for animation in Endangered Species Atlas that were scanned and created earlier and thematic database files of MFP, are stored in a Directory **\Atlas** and are available for usage. These maps were transferred using X-Modem, Y-Modem and Kermit

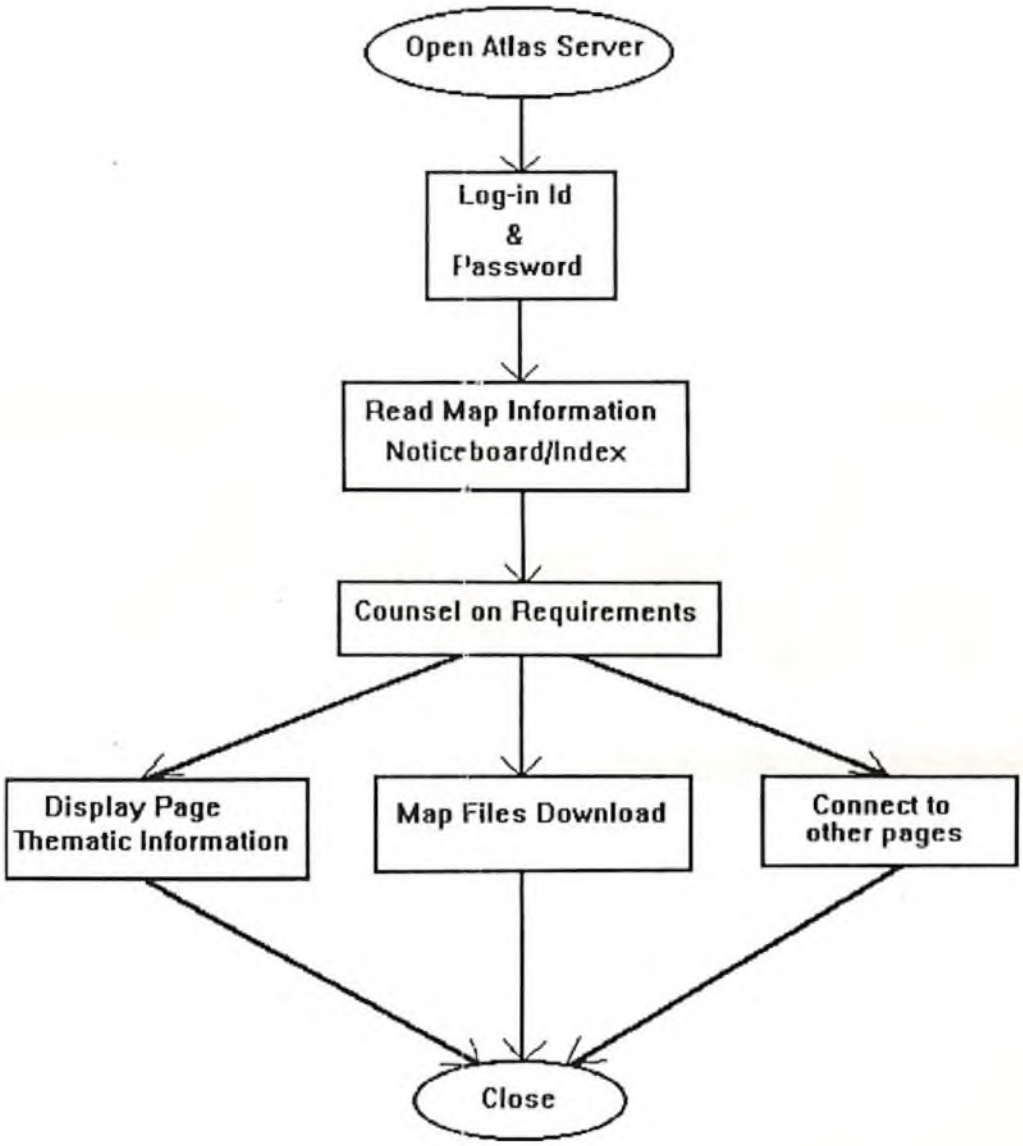



Fig. 5.3 FLOWCHART FOR USING THE ATLAS BBS SERVER


ID :

Fig. 5.4 ISNET BBS - ATLAS SERVER LOGIN SCREEN

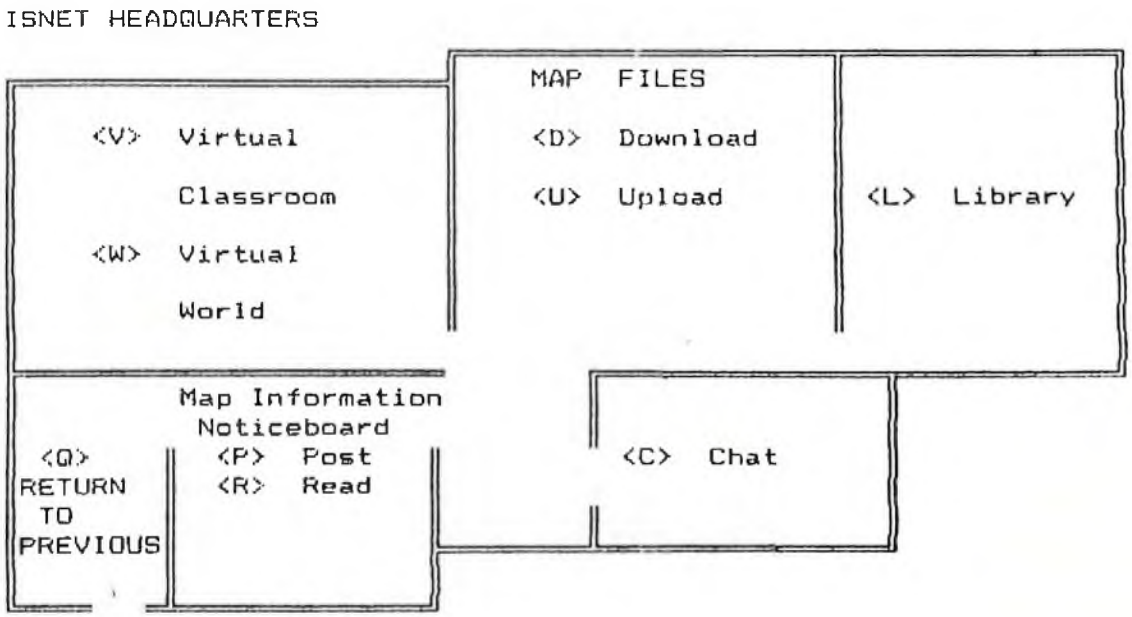



Fig. 5.5 HOME PAGE FRONT-END SCREEN

protocols between the Atlas Server ISNET BBS and Member Users of ISNET, to test and build a Basic Core Network at Dehradun for Map Data Digital Atlas Users.

The Virtual World option allows the user to connect to other pages put up by other member users of the ISNET community. An experimental prototype **Doon Virtual World** map was formed which provided linkages to proposed model home pages of other users. In such a model, users can develop their own feature pages and put them up in the Virtual World section. This provides an opportunity to users to develop thematic application forums for specialised needs.

As an additional facility and an unplanned advantage of the Atlas Server, it has been possible to model a *centre of learning* from the digital atlas by incorporating the Virtual Classroom option. This option provides a user the facility to load a training session with the Server as an automated teacher supporting a thematic lesson for a user. A digital atlas can thus have a major role to play in informal education and learning set-ups by providing students and teachers who are familiar with the concept of a book atlas with knowledge through a variety of new methods. A teacher teaching about some particular place could leave comments [51], or special notes on a forum section of digital atlas itself which could be later read by the students. The Digital Thematic Atlas could thus allow access to unique updated information, faster & more effective in quality, both in classrooms and at home, introducing a much better system of learning, particularly informal in character.

The User may quit from the system by returning to previous option which closes his session with the Atlas Server, disconnects him and allows him to continue his previous operations. Thus the user, who may have been executing the IAQM front-end programme at his end and had made a connection with the Atlas Server to obtain required updated information, could now continue with his previous task.

**ISNET BBS** model working as an Atlas Server with a Father-to-Son concept over a Client-Server system providing above facilities of an Atlas Storehouse to an Atlas User,

proved highly beneficial in bringing new ideas and methodologies in Atlas Map Updation and a model of the P-S-U paradigm.

Digital Atlas ISNET BBS will thus be able to provide benefits similar to those being visualised by upcoming 'Digital Libraries', which propose to offer opportunity for users to deposit as well as use information. Both students and teachers can easily be compilers as well as users in 'Digital Libraries' [51].

At a higher level, this model would allow scientists, engineers, artists, industrialists and others to communicate and share common information resources through Digital Thematic Atlases. Particularly, work and play come together as learning and professional work merge to generate an informal environment with common resources to solve real problems.

The above elaborates the concept of **build-your-own** Network for Digital Thematic Atlas. It should be practicable to develop ISNET-BBS Atlas Server Sites in large cities of the country with a view to supporting Local Map Updation and Map-Based facilities for atlas users all over the country.

## 5.2 APPROACH II - USE SERVICE-PROVIDERS COOPERATIVE MODELS

In the previous section, it was seen how a BBS-Based Atlas Server could provide network updation support activity at local level, say within a city. In order to have a cross section of atlas server users across the country it will be necessary to build up ISNET BBS sites all over the country.

Since building up atlas server sites all over the country would be a time and money consuming process and is also out of the scope of this research work, it was decided to build models which would develop building **'Service-Provider'** support.

The term, 'Service-Provider', is a new one, although the concept of providing services is ages old. Practically anyone can be a Service Provider. However, in India, still in the dawn of the age of Telecommunications and Networking, the provider will have to be licensed by the Government or the services will be provided by the Department of Telecommunications, Government of India.

Various Cooperative Models have been built based on experimentation using the following three Service Providers:

1 Gateway Packet Switching Service offered by Videsh Sanchar Nigam Ltd (VSNL).

2 Packet Switched Public Data Network service offered by the Department of Telecommunications (DoT), Government of India.

3 E-mail Services offered by aXcess, Business India, licensed by the Department of Telecom.

The details of Cooperative Models are discussed below.

### 5.2.1 Gateway Packet Switching Service

A cooperative model for utilising international PSPDNs for DTA updation was developed. This model is shown in figure 5.6, and uses Gateway Packet Switching Service (GPSS) [75], a new networking facility provided by VSNL.

A dial-up connectivity to GPSS was established by obtaining Identification (Id) and Password from VSNL. Through PC and modem hookup, utilising Procomm Software, linkage to Gateway Packet Switched Node (GPSN) at Delhi was experimented upon at 2400bps speed.

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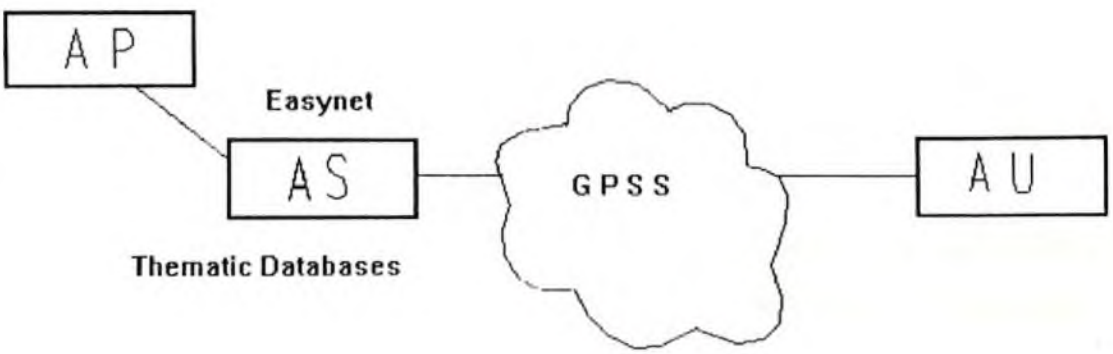



Fig. 5.6 CO-OPERATIVE MODELS : GPSS

Further, work was done to connect via X.121 address format and subscribe to a collaborative arrangement with Easynet [87] located at Philadelphia through VSNL. From Dehradun STD dial-up was made to Delhi which linked the call to GPSS. Thereafter, a Data Network Identification Code (DNIC) a 14-digit X.121 address for Easynet was provided. The X.121 address of Easynet is 31102150004910.

Additional Password for accessing Easynet was also acquired and it provided the link to Easynet Global Database to evaluate methods of updating global thematic knowledge data for our DTA. These global databases are provided through a cooperative set-up of 12 world Database Hosts, like Dialog, Newsnet Data Star, etc.

A sample run of this model is shown in Appendix A5.2.

The model, however, proved to be an expensive one since STD dial up to Delhi had to be carried out and further international PSPDN access costs were also high. Nevertheless, it proved to be a learning point to study and experiment linkages to global database libraries - journals, references, abstracts, etc, as studied earlier in the integration framework.

This approach utilizing GPSS and Easynet Service which proved to be useful as a **Search tool** could not be used for updation operations for the following reasons:

1 Easynet provides one-way information retrieval service

2 Easynet does not provide graphical representation methods or binary file operations. Thus, Map Base files could neither be retrieved nor updated.

3 Although DNIC Zone Codes for various networks were available, lack of information of full DNIC addresses of other networks made it a difficult task to carry further research on other X.121 addressed networks.

The search for a better Cooperative Model had to be continued which is described in the next section.

### 5.2.2 Inet

A model was developed to experiment country-wide Map Base transfer for Updation operations. Here, the approach followed was to use **Inet** [49], India's upcoming Packet Switched Public Data Network (setup by DoT) as the *backbone* for **ISNET**, successfully modelled earlier for local operations. Since Inet has been recently set up and is a fresh hi-tech area, previous expertise was not available and difficulties were faced. The model is shown in figure 5.7(A).

Inet provides high speed connectivity between computers/terminals and could be an ideal backbone for a Digital Thematic Atlas. An Inet user has the advantages of getting connected to:

- any Inet user in the 8 Inet cities,
- any VSAT customer of RABMN, and
- international public data networks by dialling their network user address through GPSS.

Inet provides several facilities which could enable the network to be useful in developing Digital Thematic Atlas applications.

**Reverse Charging** - This may be programmed into a calling DTE for a given call so that the called DTE pays for the call. The called DTE which would be a Digital Atlas Server may accept or reject a reverse charge call, by checking the source Id against a list of Member Digital Information Superhighway users and thus could charge for the value-added map service provided to the user.

**Closed User Group** - This optional user facility can enable Digital Atlas Servers working in a closed group to exchange data amongst themselves.

**Fast Select** - Small messages can be trasmitted instantly in the call set up packet and could help in Id verification of an Atlas User at a fixed cost.

X.28 Dial-up subscribers can use their account number and password, and originate calls from any of a list of specified cities in the region which have STD facility.

### 5.2.3 099 Access :

At the time of writing of this thesis, Phase I of Inet has been made operational with connectivity between computers and terminals covering 8 cities of the country - Delhi, Bombay, Calcutta, Madras, Hyderabad, Bangalore, Pune and Ahmedabad [49]. Inet will subsequently cover 89 cities of India, in phase II. As an intermediate step, Inet is also accessible on Dial-up basis from all over the country. This is called the **099 Access** [49]. The above cities have been categorised on the basis of business activity and demand.

Dehradun which is the headquarters of a number of potential Atlas Server and User Organisations like Survey of India, Wildlife Institute of India, Forest Research Institute, Centre for Minor Forest Products, O.N.G.C., Indian Institute of Remote Sensing, etc has been put under Group C of Phase II of Inet. An effort has to be made by DoT to expedite completion of Phase II and bring Inet connectivity to Dehradun at an early date.

Inet offers the following types of connections : X.25, X.32, X.28 leased, X.28 dial-up and Frame Relay (only in limited cities).

Inet is accessible on a dial-up basis from any place with STD facility. Inet subscribers from non-Inet cities need to make a telephone call using a fixed telephone number i.e., 0992212 or 0992224 using a PSTN Modem. They will be connected through the telephone network to the nearest city where the Inet switch is located i.e., Inet city.

**Tariff Details** :

The cost components include:

1. Long Distance STD Charges to the Inet city are uniform irrespective of the location from where the call is originated. The pulse rate is 36/48/48 sec, i.e., one call for every 36 seconds (0800-1900 hrs) and every 48 seconds (1900-0800 hrs).

2. Volume and duration charges are as per prescribed Inet tariff.

Thus, all subscribers of Inet would be able to communicate with other subscribers at **costs of communications which will be low, volume dependent (amount of data) and independent of distance.**

**Software Design for PSPDN based ISNET**

A Program Object Base Library has been developed for Primitive E-Mail operations which can be integrated in the MFP Query Model for the MFP Atlas, Knowledge Model for the Endangered Species Atlas.

This Base Design for ISNET has been developed and modules such as creation and acceptance of User Id and Password, Login, Audit List, E-Mail functions like Compose, Display, Edit, Binary File Conversion and Attachment etc. have been integrated for operations for Map Base and Data Base file transfer.

Initially, the system waits for a User to give his Id as shown in figure 5.7(B). After getting a valid User Id, the system prompts for the Password. On getting the correct Password, the System checks if any Mail has been received for a particular user. If Mail exists, the user is promptly informed. Thereafter, the Main Menu is displayed.

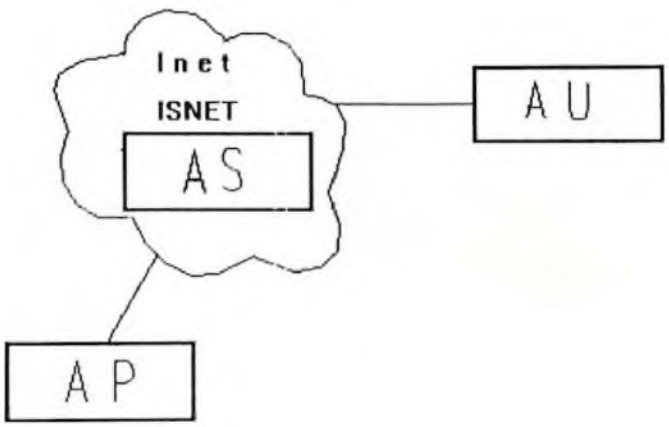



Fig. 5.7(A) CO-OPERATIVE MODELS : ISNET-INET

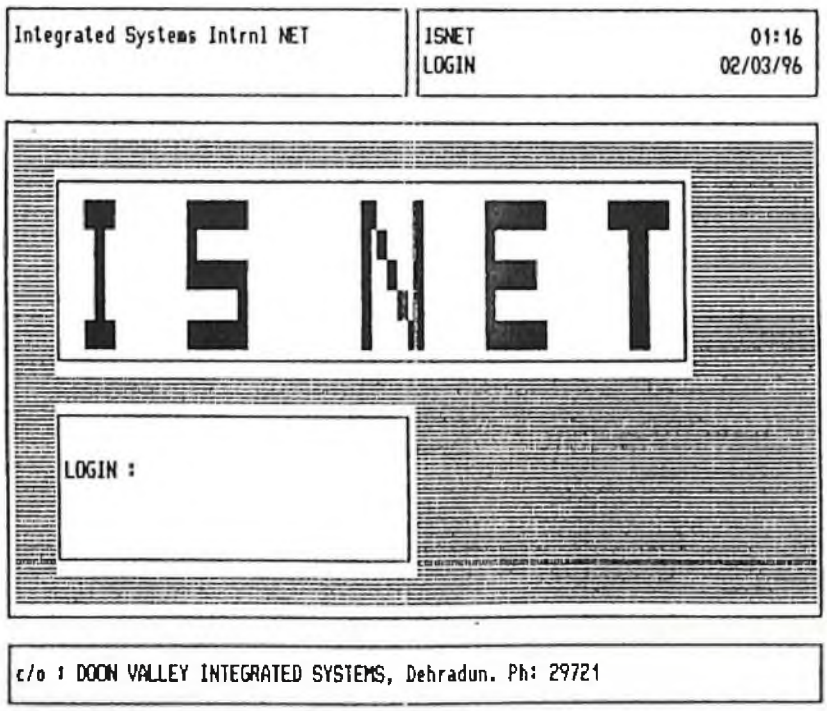



Fig. 5.7(B) ISNET LOGIN SCREEN

From the Main Menu, the User has options to create and compose his Mail, retrieve Mail and attach uu-encoded files for Map and Data Base updations, or perform Housekeeping operations.

PSPDN-based ISNET was modelled to create a new centre to support new network elements and new base services for DTA updation for the P-S-U (Publisher-Storehouse-User) Paradigm, on lines similar to the successful ISNET-BBS Atlas Server Model. It was planned to use Inet as the backbone for ISNET for Atlas Map Base Updation operations and it was desired to have a Network User Id (NUI) account from DoT. 099 access facility was released in Dehradun and it was proposed to 'get into' the Inet PSPDN from Dehradun.

However, Inet access NUIs are not available to date from Dehradun and could not be provided by DoT. Although 099 low cost access is made available there are only two dial-up numbers for the entire Northern India and the connectivity and reliablity is not assured.

It was decided to change existing procedures modelled above and develop another cooperative model with Business India, aXcess, details of which are given in the next section.

### 5.2.4 aXcess

In order to circumvent the problem of non-availability of NUIs from DoT on Inet at Dehradun efforts were made to develop another co-operative model with linkage from Business India aXcess [120] as shown in figure 5.8.

Licensing is required for E-Mail Service operations at present and Business India aXcess is licensed by the Government of India. As aXcess Headquarters are at Bombay, it has its NUIs available from Bombay. aXcess maintains an Internet dial-out through Princeton at New Jersey. The ISNET Atlas User Id gets extended to Internet Id as follows:

xxxxxxx.isnet gets extended to

xxxxxxx.isnet@axcess.net.in

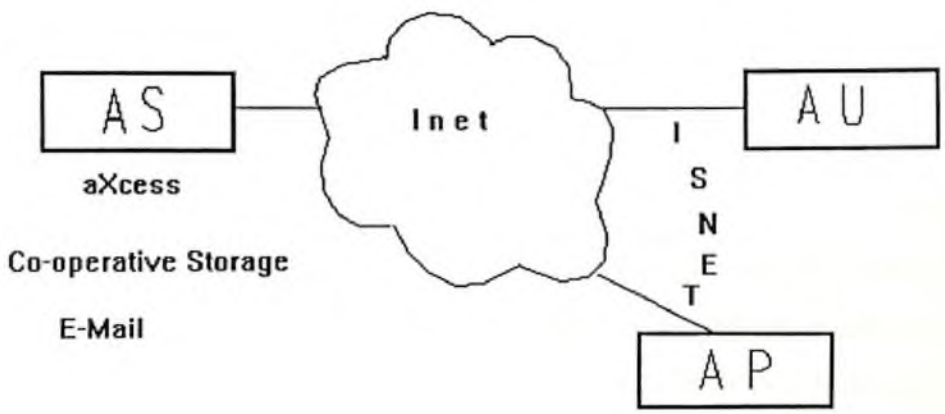



Fig. 5.8 CO-OPERATIVE MODELS : ISNET-INET-AXCESS

In this model NUI usage facility of aXcess was obtained without disclosure of the NUI password over Inet. Instead, the password is programmed through Scheduler Module provided by aXcess so that NUI on Inet provided by DoT to aXcess could be utilised for our file transfer operations. This cooperative model was used to carry out all operations designed under the ISNET model successfully.

Under the reverse charging concept of Inet PDN although calls will be initiated by a user, they are charged to Business India for which a cooperative arrangement has been made. This also supports '099' low cost access and was successful as a PSTN-based linkage.

**Binary File Transfer for Network-based Updation**

A prototype Digital Thematic application file consisting of Thematic Knowledge Data for the Endangered Species Atlas created over Base Map data was transferred from Dehradun to Bombay as a Binary File and received via E-Mail box system. The file is sent as an attachment under a small E-Mail envelope consisting of Destination-ID, Message Title and Message Body. At the other end the binary file attachment is saved and decoded from the text form back to the original format.

Appendix A5.4 shows the uu-encoded UP map converted into a text file for file transfer operations through E-mail system. The same was also uu-decoded into the original file format as discussed above.

Thus, an Atlas User at site A could have E-Mail Attachment based File Updation of Map Base or Database from site B. Test operation was also carried out for Virtual Nodes of ISNET like Bombay, Delhi, Calcutta, Madras. The system could have potential applications in Map Base transfer from one point to another and also a Virtual Training System in which Users can connect to other users through the DTA.

## 5.3 APPROACH III - INTERNET

In order to develop models for Internet-based updations for DTA, it was necessary to be able to do an FTP initially.

It was considered desirable to develop on-line FTP operations for DTA updation. However, one drawback was that on-line Internet access was still not available in the country readily and especially in Dehradun.

On-line Internet access was initially available only through DoE based ERNET [74] or NIC based NICNET [76]. However, at Dehradun, none of the facilities was available, since Dehradun is connected through the normal DoT telephone lines which are not so reliable.

### 5.3.1 Internet Robots

At this stage, therefore, the approach followed was to experiment with different FTP-by-mail operations. The co-operative model developed earlier helped in carrying out E-Mail operations and E-mail requests were sent to various Network Robots to seek Global Updation facilities.

The Network Robots contacted included LISTSERV mailing lists, FTP-by-mail servers, Archie Servers, etc.

Listed below are details of such experiments.

1) **LISTSERV@ntw.org**

A message was sent to the above LISTSERV:

*Subscribe Endangered Species Atlas - Harsh Verma*

Negative reply indicated that there was no existing list of Digital Atlas.

2) **majordomo@world.std.com**

A message was sent to the above mailing list :

*subscribe atlases*

Negative reply indicated that there was no existing list of Digital Atlas.

3) **Electronic Frontier Foundation eff@eff.org**

A message was sent to the above E-mail-based World-wide Conferencing System :

*subscribe*

This resulted in successful subscription to E-mail based conferencing carried out with Electronic Frontier Foundation, which helped in identifying issues regarding global updation.

4) **BITFTP**

BITFTP Server Robot maintained by BITNET proved to be the most 'friendly' robot for carrying out anonymous FTP. This model of Internet access by E-Mail operations is illustrated in figure 5.9.

Two BITFTP servers were contacted :

*bitftp@pucc.princeton.edu* at Princeton University in USA

*bitftp@vm.gmd.de* in Germany

As an economical measure, the BITFTP Server in Germany was used to carry out FTP operations. A Sample FTP operation to receive Updated latest information from INTERNET Network Information Centre (INTERNIC), maintained at INTERNET Headquarters is given below :

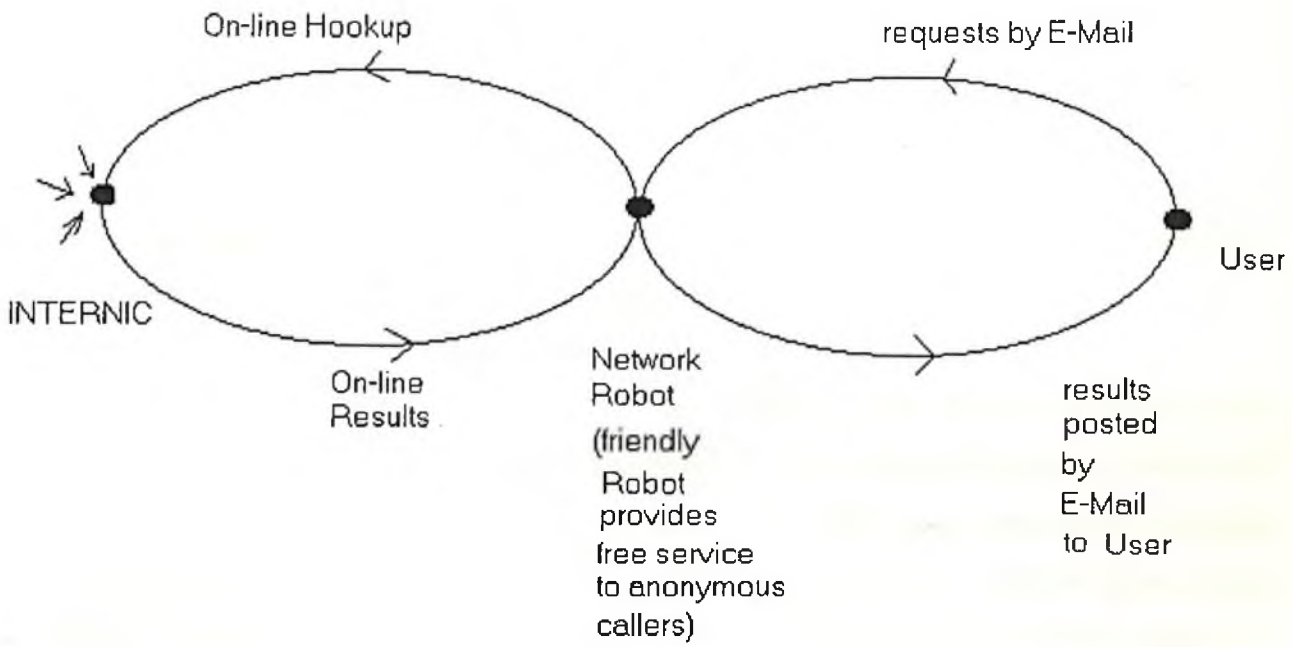



Fig. 5.9 MODEL OF INTERNET ACCESS BY E-MAIL

The commands are sent as E-Mail to *BITFTP@vm.gmd.de*, which carried out the on-line FTP operation from INTERNIC for me and subsequently posted the results back by E-Mail into my Mail Box.

FTP ftp.internic.net

USER anonymous

cd fyi

get fyi-index.txt

quit

To transfer DTA Map Base Files by E-Mail for Updation purposes, a program, **uuencode**, was required to convert the binary files to text.

Since aXcess co-operative Model supports Binary File Attachment only within its domain in India, it was necessary to use **uuencode** for text conversion and **uudecode** to get back the original file. It was possible to retrieve a file called **uuconvert.c** (for encoding and decoding files) from Host **uuarchive.wustl.edu** and the directory **/info/ftp-by-mail** with the help of the robot BITFTP which performed the anonymous FTP operation. The commands sent to BITFTP as E-Mail are given below:

FTP wuarchive.wustl.edu

USER anonymous

cd info/ftp-by-mail

get uuconvert.c

quit

This enabled test exercise and model development for E-Mail-based Anonymous FTP operations. Various global information files which could serve as important tools for Digital Atlas were retrieved at this stage.

In the absence of on-line Internet access, the best possible solution models appear as E-Mail-based Internet access, through Network Robots, for connecting to Servers, searching various Servers, copying and updating files from Servers.

However, to be able to tap the full potential of the Information Superhighway, on-line Internet access was desired. On 15th August 1995, VSNL launched a Gateway Internet Access Service (GIAS) [90] with two types of accounts - 1) Shell account and 2) TCP/IP account. VSNL based GIAS was subscribed to to undertake these research models. However, in Delhi, there are only 16 channels available, with a large number of users. Hence, todate, the heavily overloaded GIAS facility could not be tested from Dehradun.

Because of the above limitations, the experiments had to be carried out at BITS, Pilani, where VSAT system has been installed, providing Internet access at 64kbps.

Different experiments were carried out successfully to test on-line connectivity. It was possible to connect to various Archie and Gopher Servers through Super TCP software. An example of a gopher site visited is given below:

*gopher://veronica.scs.unr.edu:70/00/veronica/how-to-query-veronica*

In general, it was found that a large number of such sites that had sprung up, about two years back had either closed, shifted sites or upgraded to **Hyper Text Transfer Protocol (http)** systems. Tools like Archie and Gopher have become obsolete within two years of their introduction although they seem to have barely been used in India. Even Mosaic, the popular graphic Web-browser, available as Shareware from the World-wide-web, has become less popular as compared to the latest Netscape browser because of speed and other features.

Therefore, rather than exploring the previous tools for DTA system, it was decided to use the Netscape software.

### 5.3.2 World-Wide-Web

The most modern tool of the Information Superhighway is the World-Wide-Web (WWW). The Web was introduced as an online documentation resource by a group of physicists at the CERN European Laboratory for Particle Physics in Geneva, Switzerland in 1991 [88].

The WWW on the Internet utilizes hyperlinks to make immediate network connectivity to any site on the Net. Links are relations between pairs of units which define practical correspondences between them. These are correspondences that otherwise would be known only to the designers of the global schema description [23]. Hyperlinks from one unit to another make it possible for sites on the WWW to allow them to associate with another link and disassociate with a previous one on the network.

Hyper-text Markup language, (HTML) has capabilities to provide Hypertext linking which is also called a hot-link capability. HTML can also include graphical images. As such, this ability can be used along with WWW servers to provide user interface for viewing geographic map data.

One of the most suitable tools for advanced hypermedia publications and visualisation is the Editor's Work-bench [34], which also provides maintenance of Knowledge Base System. WWW-based distribution requires developing hyper text linking techniques such as the Uniform Resource Locators (URLs), popular with HTML, Mosaic and Netscape related technologies. A Uniform Resource Locator is used to identify objects accessible through the World-Wide-Web. URL basically defines the protocol needed to access it. URLs can link to dynamic resources as well as static ones.

A well-designed application will access the Digital Thematic Atlas Server information as and when required. From the perspective of the user the location of the information or particular format are of no consequence.

The map, taking the role of the 'home hyperdocument' in a hypermedia GIS, was suggested by Wallin 1990, as reported by Shepherd [15] and could be related to the 'home page' system of WWW using hypertext protocol. World over, with the advent of the World-Wide Web, computing professionals have eagerly pursued the idea of moving from a paper-based technical report service to one that employs networked information systems [81].

On-line WWW access was possible through Netscape. On-line Internet access through Netscape browser provided a quantam jump in research approach. Netscape, the graphical Web Browser developed at Netscape Communications Inc. by Marc Andreesen was used to study and explore the potential of Internet for DTA.

Netscape includes the ability to begin navigating within a Web page even before its contents are completely downloaded, unlike previous browsers like Mosaic and Gopher. Netscape also includes a secure implementation of Hypertext Transfer Protocol (http), active status information, excellent file capture, the ability to rapidly move back to previously browsed pages, multiple window capabilities and a powerful search engine.

To follow links to other Web pages, there are two alternatives - 1) type the http URL 2) select the highlighted hyperlinks.

Netscape has a powerful Search Engine - NetSearch. A Search operation of Netscape displays top 10 hits of a successful search, showing the http location of the WWW link, a score for the identified link, size of the document, a title and description of the searched item. The item with the highest score in the search is displayed on the top of the list. It is possible to connect immediately to any server indicated by the highlighted hyperlink.

The next step was to begin a Netsearch to identify similar work done on Digital Thematic Atlas elsewhere in the world.

The search string *Digital Atlas* retrieved information on the Digital Atlas subject from different parts of the world immediately. a task which seemed very difficult through E-Mail search operations and practically impossible, if done manually. Figure 5.10 displays top 10 items displayed in our search. As seen in the figure, Netsearch located *GEBCO Digital Atlas NCTCOG'S Digital Atlas for North Central Texas, Rat Atlas Image Data Base, CLR-Greater Toronto Area Research Initiative, CD of Mouse Embryology.*

The Search string *Atlas* provided connectivity to the *Brainiac Interactive Human Neuroanatomy Atlas.* The displayed page is shown in Appendix A5.5.

Another page, connected to *The Virtual Tourist*, provides a list of maps and Internet http addresses which act as a resource for digital maps. Figures 5.11 and 5.12 show the picture of the World Map and Asia Map as downloaded from this Internet site and printed on a Dot Matrix printer.

It was also possible to connect to *Xerox PARC Map Viewer* which allows browsing of a Map. This page displays the World Map and some text. The cursor can be moved to any part of the Map, and as it is moved, it displays the Latitude and Longitude also. It also provides zooming facility. It has options to display elliptical, rectangular, sinusoidal projections. Sample pages retrieved are shown in figure 5.13 (A), (B), (C).

The http addresses of some Web Servers *visited* which provide a storehouse for Base Maps are given below:

| | |
|---|---|
| *http://www.cs.ucsb.edu* | Alexandria Digital Library |
| *http://www.esri.com* | Environmental Systems Research Institute |
| *http://atlasinfo.cern.ch1* | CERN |

Obtaining the GEBCO Digital Atlas

-- http://biudc.nbi.ac.uk/bodc/gebco/obtain.html (Score: 76, Size: 2K)
The First Release of the GEBCO Digital Atlas is in three parts: . a CD-ROM containing the Atlas data sets . a 3.5" floppy disk containing the GDA Software Interface . an extensive Supporting Volume describing the activities of GEBCO . and ... (See also Similar Pages)

NCTCOG's Digital Atlas for North Central Texas

-- http://www.nctcog.dst.tx.us/mapbook.html (Score: 73, Size: 2K)
The Digital Atlas for the North Central Texas region has been developed to provide an on-line street map reference guide of the area to the local community. The information used to create these maps includes 1992 Census TIGER file, USPS ZIP+4, ... (See also Similar Pages)

System Requirements

-- http://biudc.nbi.ac.uk/bodc/gebco/requires.html (Score: 72, Size: 1K)
To run the Digital Atlas Software you will need: . an IBM PC (or compatible) with a VGA colour display . CD-ROM drive . 3.5" floppy disk drive . hard disk with at least one Megabyte of free space . DOS 3.0 or later . about 500k of free ... (See also Similar Pages)

GEBCO

-- http://biudc.nbi.ac.uk/bodc/gebco.html (Score: 69, Size: 1K)
Digital Atlas (GDA) has recently been published by BODC on behalf of the International Hydrographic Organisation (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. . It represents the first seamless, high quality, digital ... (See also Similar Pages)

Article on the GEBCO Digital Atlas

-- http://biudc.nbi.ac.uk/bodc/gebco/article.html (Score: 69, Size: 10K)
by Dr Meirion T. Jones of the British Oceanographic Data Centre . Contents . Introduction . The GEBCO System . Creating the GDA . Updating the GDA . Concluding remarks . Back to GEBCO page . Introduction . The General ... (See also Similar Pages)

Fig. 5.10 NETSCAPE SEARCH RESULTS ON INTERNET : TOP 10 HITS (Contd. on next Page)

(Untitled)

Sample Images from the GDA

-- http://biudc.nbi.ac.uk/bodc/gebco/samples.html (Score: 69, Size: 1K)
Sample Images from the GEBCO Digital Atlas . Bathymetry of the World's Oceans (46K) . Distribution of
Echo-Sounding Data held at the IHO Centre for . Digital Bathymetry (24K) . Sample screen shots showing the
GDA in operation . ... (See also Similar Pages)

Features of the Digital Atlas Software Interface

-- http://biudc.nbi.ac.uk/bodc/gebco/features.html (Score: 68, Size: 3K)
Features of the GDA Software Interface . Choice of GEBCO and IBCM charts . Choice of GEBCO, IBCM and
WVS coastlines . Choice of resolution for WVS coastline, including an automatic option . Choice of 5 projections;
Equidistant Cylindrical, ... (See also Similar Pages)

Rat Atlas Image Database

-- http://www.loni.ucla.edu/ratdata/Rat.html (Score: 67, Size: 1K)
UCLA Laboratory of Neuro Imaging . A 3D Digital map of Rat Anatomy . by Arthur W. Toga, Emily M. Santori,
Ron Hazani, Karen Ambach. . Overall description of Digital Rat Atlas . adult male Sprague Dawley rat . perfused
with dye for ... (See also Similar Pages)

CLR-Greater Toronto Area Research Initiative

-- http://www.clr.toronto.edu:1080/SCRATCH/CLR-GTA/intro.html (Score: 67, Size: 1K)
CLR-GTA Research Initiative . Projects Involving the CLR-GTA Research Initiative: . Digital Atlas: DMDUG,
University of Toronto, Digital Map Data Users Group . Regional Analysis: Greater Toronto Area Study,
Conference on Cities ... (See also Similar Pages)

CD of Mouse Embryology

-- http://wwwcivm.mc.duke.edu/civmPeople/SmithBR/documents/MouseCD.html (Score: 67, Size: 2K)
Digital Atlas of Mouse Embryology . What is in the Atlas . A CD disc (for the Macintosh) is available with over
4,000 slice images and 50 QuickTime(r) movies depicting normal mouse embryology. They are organized with a
very intuitive ... (See also Similar Pages)

Fig. 5.10 NETSCAPE SEARCH RESULTS ON INTERNET : TOP 10 HITS (Contd. from previous Page)

GIF Image 700x389 pixels http://www.vtourist.com/webmap/world0.gif

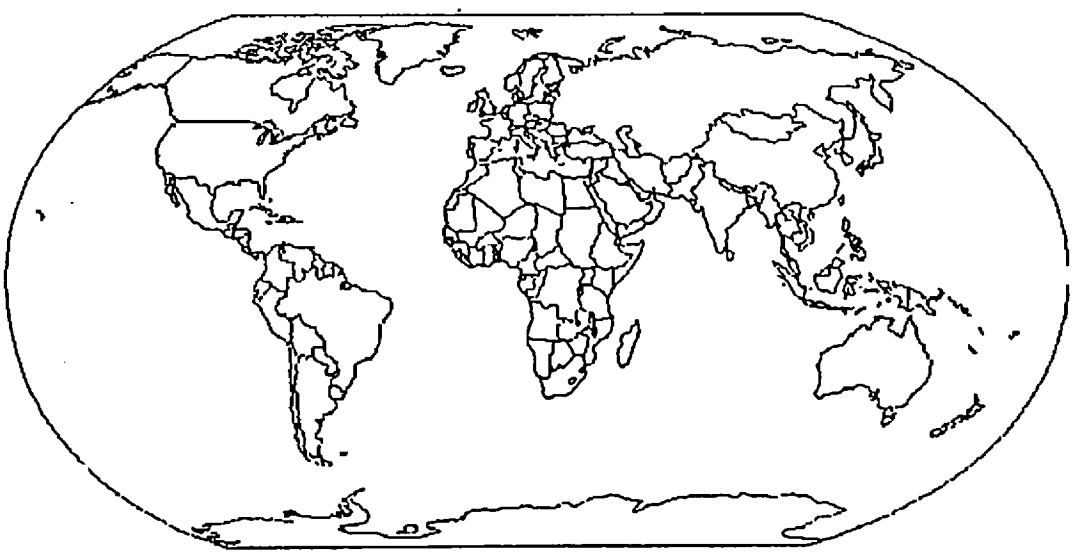


Fig. 5.11 VIRTUAL TOURIST WORLD MAP

GIF image 528x440 pixels http://www.vtourist.com/webmap/asia0.gif

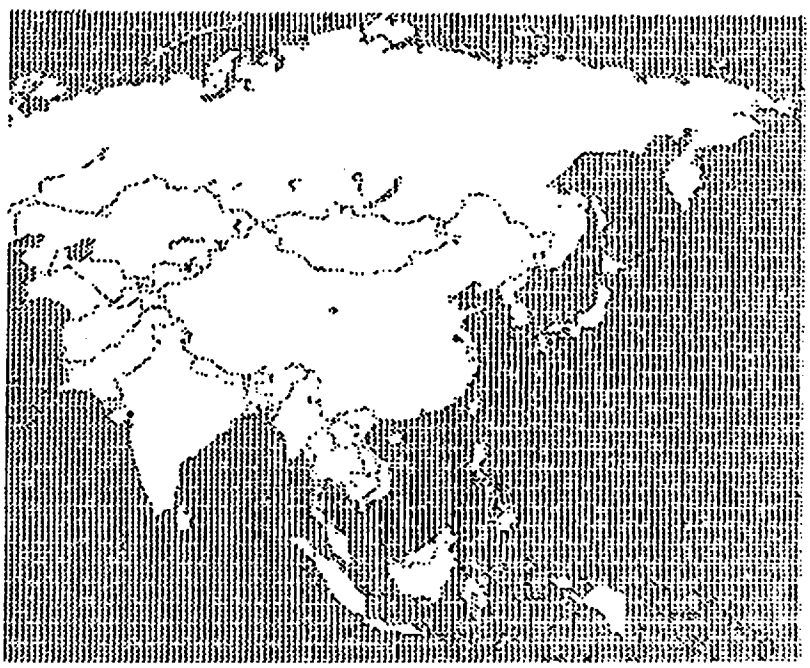
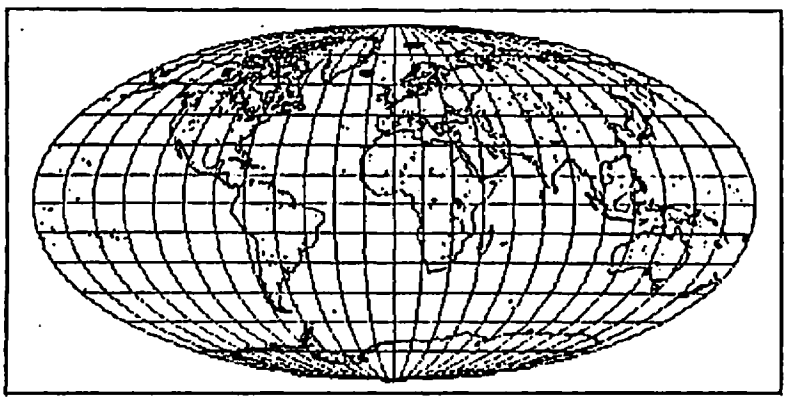


Fig. 5.12 VIRTUAL TOURIST ASIA MAP

# Xerox PARC Map Viewer: world 0.00N 0.00E (1.0X)



Select a point on the map to zoom in (by 2), or select an option below. Please read About the Map Viewer, FAQ and Details. To find a U.S. location by name, see the Geographic Name Server.

## Options:

- Zoom In: (2), (5), (10), (25); Zoom Out: (1/2), (1/5), (1/10), (1/25)
- Features: Default, All; +borders, +rivers
- Display: color; Projection: elliptical, rectangular, sinusoidal; Narrow, Square
- Change Database to USA only (more detail)
- Hide Map Image, Retrieve Map Image Only, No Zoom on Select,
- Place mark at (0.00N 0.00E), Reset All Options

Requested region is 360.00 deg. wide by 180.00 deg. (12420.00 miles) high.

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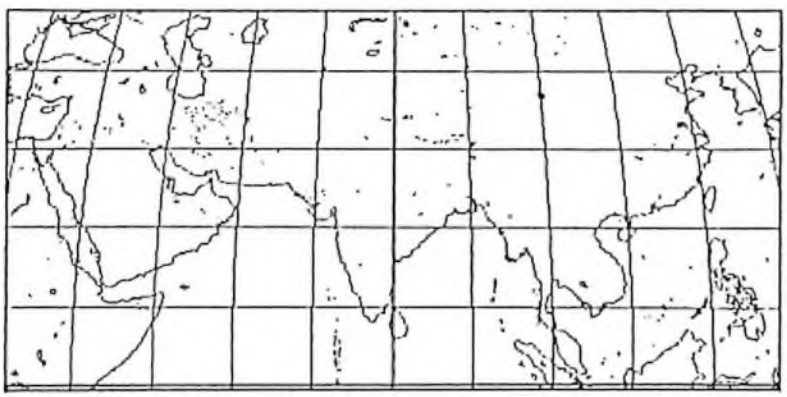
*Map Viewer provided by the Xerox Palo Alto Research Center*

Fig. 5.13(A) XEROX PARC MAP VIEWER

# Xerox PARC Map Viewer: world 23.62N 80.02E (4.0X)



Select a point on the map to zoom in (by 2), or select an option below. Please read About the Map Viewer, FAQ and Details. To find a U.S. location by name, see the Geographic Name Server.

## Options:

- ☐ Zoom In: (2), (5), (10), (25); Zoom Out: (1/2), (1/5), (1/10), (1/25)
- ☐ Features: Default, All; +borders, +rivers
- ☐ Display: color; Projection: elliptical, rectangular, sinusoidal; Narrow, Square
- ☐ Change Database to USA only (more detail)
- ☐ Hide Map Image, Retrieve Map Image Only, No Zoom on Select,
- ☐ Place mark at (23.62N 80.02E), Reset All Options

Requested region is 90.00 deg. wide by 45.00 deg. (3105.00 miles) high.

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*Map Viewer provided by the Xerox Palo Alto Research Center*

Fig. 5.13(C) XEROX PARC MAP VIEWER

| | |
|---|---|
| *http://www.athena.edu* | Virtual On-line user. |
| *http://pubweb.parc.xerox.com* | Xerox PARC Map Viewer |
| *http://www.vtourist.com* | Virtual Tourist |

The search string *Digital Thematic Atlas*, *Endangered Species Atlas* and *Minor Forest Products Atlas* retrieved zero search results.

Next, a search was made to locate only *Endangered Species*. This gave a successful 'hit'. Through this search, it was possible to connect to California Natural Diversity Data Base:

*http://www.econet.apc.org/endangered*

The above page displayed details of the Endangered Species Database at California. However, there was no Atlas to display details on a Map base.

### 5.3.3 Web Pages for Digital Thematic Atlas

After viewing the Internet as an Atlas User, it was necessary to see how an Atlas Publisher could view Internet. For this, Web Pages were designed and developed for the Digital Thematic Atlas in **html** language - Hyper Text Markup Language.

A prototype Web Page Model was designed for the *Endangered Species Atlas* and the *MFP Atlas* and was tested locally to demonstrate link connectivity to internal Pages and also hyperlink with other world-wide Databases like the California Natural Diversity Database. The design of the model is given in figure 5.14.

While prototype data experimentation is carried out by this research work, practical implementation would have to be carried out by the organisations modelled. The DTA model

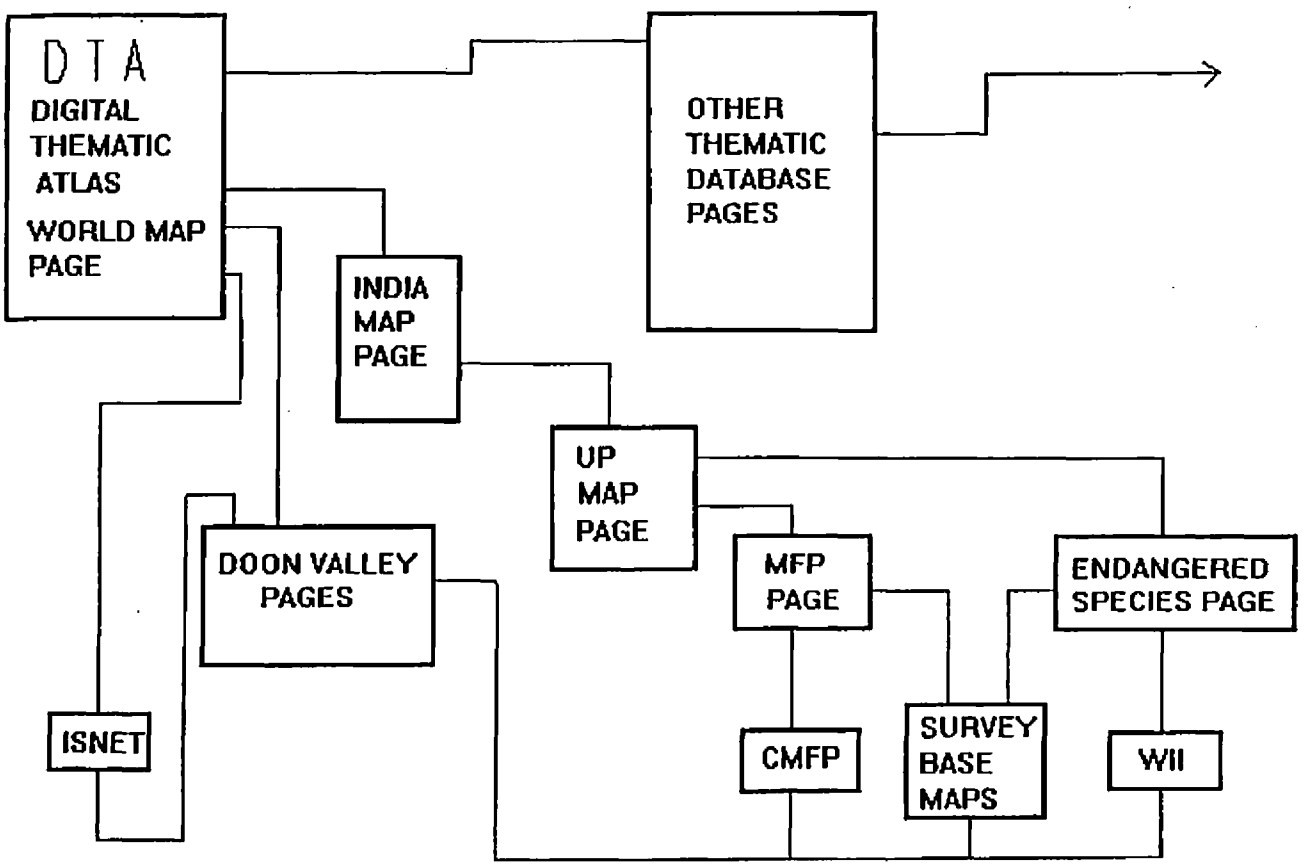
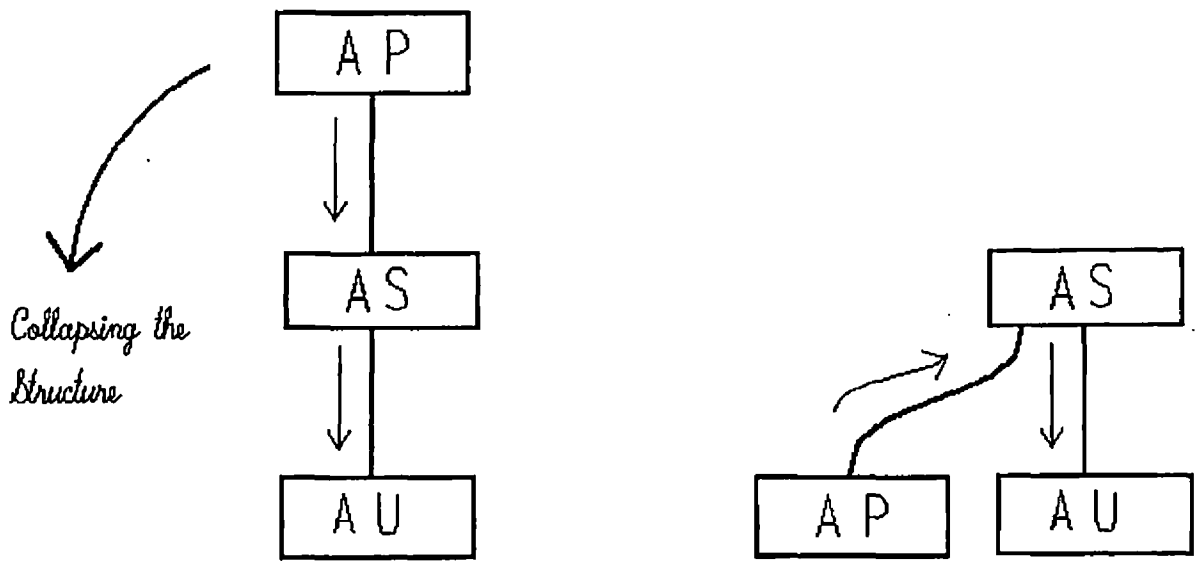



Fig. 5.14 WEB PAGE DESIGN FOR DTA ON WWW




(a) Collapsing the structure as above

(b) The resultant structure - INTERNET becomes the vast Storehouse

FIG. 5.15 P-S-U PARADIGM ON INTERNET

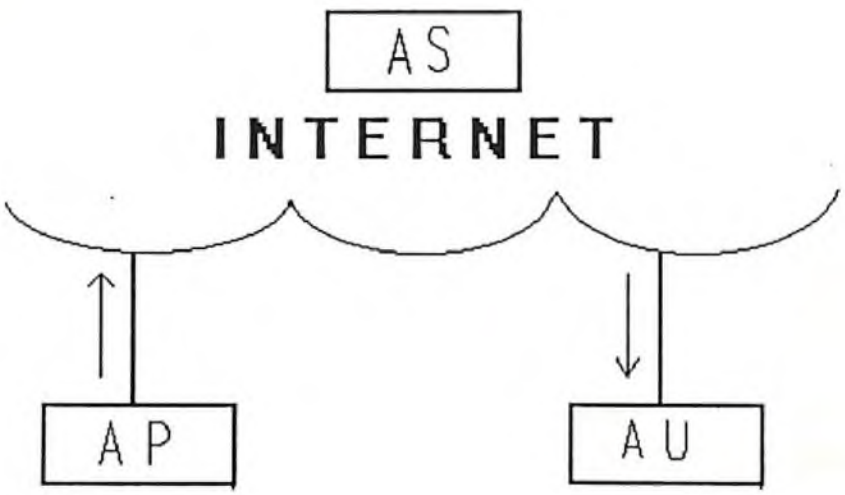



FIG. 5.16 INTERNET AS THE ATLAS STOREHOUSE : THE WWW MODEL

may be put up on the World-Wide-Web as a Home Page using a Web Server for Global connectivity through Netscape. Simple basic maps are available for download operation from Internet for an Atlas User and could also be uploaded onto Internet by an Atlas Publisher very easily.

We return to our Atlas Publisher-Storehouse-User (P-S-U) paradigm and observe that if the structure is collapsed, i.e., if the Publisher is moved from the top-of-the-line in the hierarchical organisation we get the structure as shown in figure 5.15.

It is observed that Internet becomes the Atlas Storehouse in our paradigm and any Atlas User on Internet could become a Publisher. Thus, a free flow of information takes place on Internet and Atlas Publishing through the WWW would be a very successful model as shown in figure 5.16.

Netscape has become the most popular tool for WWW- based applications. Since this is provided as shareware downloadable software, it has made all other leading softwares, in a way, obsolete and outdated. It was found that many Archie/Gopher Servers had shifted their sites or changed to Netscape-based operation.

The model utilising Web Pages proved to be the best method for Atlas Client-Server-based Updation applications on the Information Superhighway.

Our Atlas P-S-U paradigm suggests a methodology for a future paper-less Atlas in which an Atlas Publisher or *Author* would simply compile and dump his maps on Internet and similarly an Atlas User would retrieve his maps from Internet which becomes the Atlas Storehouse.

With powerful computers being installed as Host Web sites that will be the storehouse of the future Global Atlas, maps may need not reside with a Publisher or a User; they could be stored anywhere on the Internet. Radical changes will occur in Atlas publishing processes when people learn to use the aid of powerful DTA techniques as also to collaborate through them on distributed work. With electronic publishing and distribution as soon as the atlas is updated and catalogued it would be available on the World-Wide-Web.

# Chapter Six

## 6 CONCLUSION

### 6.1 SUMMING UP

In **Chapter One**, we saw that Information Technology is going to take the centrestage of our activities of a varied nature. One way of managing the spatial and aspatial information of a multi-disciplinary nature which helps us in planning, decision-making and effective utilisation of various natural resources is through the use of maps. Maps, which have played a significant place in our lives since early days of history, have been compiled into Atlases by different methods.

Advances in the techniques of surveying, data collection, map printing and associated technlogies have made it possible to have computer-generated maps. While digitised maps have become quite popular in the advanced countries, in India, so far only pilot projects have been carried out by Survey of India (SOI) to develop a working model for following a digital approach to produce colour-separated scribed negatives for printing topographical maps on a production line basis successfully.

While using digitisation techniques for creating negatives and printing maps on paper is a step forward in the right direction, this process also creates a Cartographic Database for which SOI has brought out a National Standard Exchange Format using Digital Vector Data (DVD) for topographic maps on 1:25,000, 1:50,000 and 1:250,000 scales which would be useful in the raw digital form as digital Base Maps. By standardising data formats, we should be able to have compatibility with other countries which have also introduced formats like Spatial Archive and Interchange Format, (SAIF) in Canada, Spatial Data Transfer Specification (SDTS) in the US, Australia etc. In addition, it was also seen that a number of standard packages and data exchange formats allow scanned digital images of paper printed maps to be used for simple applications like the Tag Image File Format (TIFF), PC Paintbrush (PCX), Bit

Map (BMP) and Graphical Interchange Format (GIF) for Raster Data and Windows Metafile (WMF), Corel Draw (CDR), Computer Graphics Metafile (CGM), Drawing Exchange Format (DXF), Run Length Encoded (RLE) for Vector Data.

We also came to appreciate that, in addition to basic topographical maps being generated by organisations like SOI, what we need are "Value-added" or resource-specific maps for specialised subjects of study, such as forestry, soil, industrial layout, wildlife etc. Such maps containing information about a single resource or theme, called "Thematic Maps" will be required for Planned Development methodology. We also studied the basic steps involved in developing base maps and value-addition in creating thematic maps, including concepts like interactive Map-Walking.

We identified and formulated the **statement of problem** as follows: (i) the compilation, publication and application of paper thematic atlas is a complex and time-consuming task (ii) there is no nation-wide networking of data banks for thematic maps and information (iii) updation of paper thematic atlas is not taken up at regular intervals thus making it a static entity (iv) India has yet to develop digital thematic maps for a wider use by different interested user groups.

This motivated us to identify the concept of a **Digital Atlas** which would provide users with opportunities for accessing Map-based Information in flexible computer-oriented formats which could be viewed as a **dynamic** networked collection, **composed and printed on-demand** and utilised in different ways for better and effective interaction, as opposed to a Paper-based Atlas of today which is oriented towards static information. We referred to two large projects undertaken in the US and the UK - "The California Environment" and "Doomsday 2000", with a view to developing computer models, aerial and ground photography, maps, videos and databases of the natural environment in these countries.

We then formulated the **aims and objectives** of the research work. The basic aim was to integrate and complement research and development methodologies for a future visualised system of a **global** digital thematic atlas with facilities for regular updation, between the

user and the publisher, incorporating the potential of the Information Superhighway. The objectives formed for the research were: (i) to identify the basic design issues of a conceptualised Digital Thematic Atlas; (ii) to develop a framework for integrating various components of DTA and their inter-relationship, with a view to developing a Back-end for the Publisher and a Front-end for the User; (iii) to demonstrate the framework developed under (ii) above by the use of selected case applications; (iv) to identify the methods of networked updation techniques and various Search Tools for global operations; and (v) to develop Solution Models for networked compilation and updation of DTA for local, country-wide and world-wide approaches, utilising the Information Superhighway potential.

Thereafter, the **scope and limitations** were identified. Particularly, the scope was limited to designing a framework for integrating spatial databases and traditional attribute data with map base, design of query and reporting system and creating an environment for exploring such models and testing the concepts developed with the help of two case applications for study: (a) an Endangered Species Atlas (b) A Minor Forest Products Query System. The models would be tested for local, country-wide and global operations to resolve the various requirements that such a global digital thematic atlas could derive from computer networks and the Information Superhighway. A **methodology** to carry out the research was developed and illustrated at the end of the chapter.

In **Chapter Two**, we identified the **Basic Design issues** of a Digital Thematic Atlas (DTA). To do this, we first depicted the **Atlas Consultation Process** with the help of a flowchart. This gave a user-oriented approach, identifying different steps in using an atlas, which helped us to focus on the design issues. The design issues were classified into two broad categories :

1. Issues of the Integration Task

2. Issues of the Updation Task

The issues of the Integration Task were identified in order to see whether a single, global schema representing all components of a Digital Thematic Atlas could be integrated

into a framework incorporating a method of query system. Issues of various design components of a Digital Thematic Atlas were identified as:

i. Geographic Information System

ii. Data Base Management System

iii. Multimedia Technology

iv. Knowledge-based System

v. Virtual Reality

The above issues were discussed in detail in this chapter. It was felt that GIS is a very powerful system and would provide the basic skeletal base for the integration of a Digital Thematic Atlas. To provide core processing operations and a highly user-friendly atlas, GIS will have to go into the background and provide ***back-end support*** for the entire system. With the globalisation of databases, DBMS would be required to develop sophisticated relationships between data entities which would provide Knowledge linkage with the GIS and help formulate queries in Digital Thematic Atlas. The DBMS would need to be closely coupled with the GIS at the back-end and also provide front-end Query support for the User. With dropping costs, it is possible to integrate Multimedia Technology with GIS which would provide the ideal ***front-end*** for the Digital Thematic Atlas. Multimedia images and Sound can be linked with thematic database records and separate viewer programs could also be executed through system calls. The issue of deciding which spatial features could lead to which particular images was also discussed. An important offshoot of multimedia - **hypermedia** on a parallel to **hypertext** was also discussed. Present techniques employ loose-coupling amongst data units, although tight linkages would be required in the future. We emerged with the key idea that all information and knowledge on the Digital Atlas could be inter-connected and users should be able to browse it by using appropriate associations. This further led to the issue of Knowledge based system which provides three approaches to the use of information intelligently - Relational Query Development, Logic-based Approach and Object-oriented Approach.

The final issue was Virtual Reality being integrated in the Digital Atlas in the future to provide an environment in which the user, after browsing the Atlas, takes a 'decision' and interactively carries out an 'action' by modifying this artificial or virtual world which is fully three dimensional, represented naturalistically and in which changes occur in real time thus providing multisensory feedback as a result of taking the action.

Next, the issues of the Updation Task were identified in order to see what methods could be provided for regular Updation of component and global data, in order to move a Paper-based Atlas to the Information Superhighway. The limitations of Manual Updation were identified and therefore *the need was felt to have Networked Updation utilising an Integrated Systems Network.*

Three methods identified for networked updation were :

i. ON-LINE

ii. E-Mail

iii. INTERNET

The issues related to each of these methods have been discussed with reference to topics like Electronic Data Interchange (EDI), Bulletin Board Systems (BBS), Fax Systems as well as the status of E-Mail and Internet activities in India where the potential of applications for the Digital Thematic Atlas can be of greater value where we are in the process of developing mature computer-based information systems.

In **Chapter Three**, a framework has been developed for the integration task. First a paradigm was proposed which would transport the functions of today's paper-based atlas to a digital atlas. This would consist of three major building blocks :

1. Atlas Publisher (AP)

2. Atlas Storehouse (AS)

3. Atlas User (AU)

The roles of the Atlas Publisher, Atlas Storehouse and Atlas User have been conceptualised and their inter-relationships defined. Thereafter the flow of information has been brought out. We appreciated the use of **author services** or **map compilers** for the development and publication of an Atlas. We also saw that the Atlas User is basically a customer or **client** of the Publisher or the Storehouse and would like to have interactive views of his desired maps along with various queries for information retrieval.

On the basis of the above paradigm a detailed framework was developed. The framework provides an environment for 1) Map Base, 2) Knowledge Base, 3) Query System, and 4) Network Updation.

Thereafter we elaborated upon the development of the **Map Base, Knowledge Base** and a **Query System** and took up illustrated examples of the two **case applications** envisaged.

To fulfil the role of Atlas Publisher, a Map Base was developed by creating digitised Base Maps for World Map, Country Map of India, State Maps e.g., Himachal Pradesh and Uttar Pradesh, cross-section of Dehradun Map etc. A Knowledge Base was designed for an Endangered Species Atlas for its integration with the Map Base by developing Object-oriented Class Structures for Species Database and Protected Area Database, and a Linkage Structure for the above Knowledge acquired from Wildlife Institute of India.

For Atlas User participation, an Information Access Query Model (IAQM) was developed as a ***Front-End Query window***, which displays information as a "**page**" of thematic textual data on the DTA along with a Menu at the bottom of the screen. The user can either go through the results page-by-page or browse again, querying for specific records or make a refined search. The user may then locate a particular record and display its Summary Page. The Model was tested with a case example of the Minor Forest Products system, which would be

overlayed on the Map Base. The Knowledge Database was acquired from the Centre for Minor Forest Products under their copyright.

The two case applications were further discussed to fulfil the role requirements made by the framework for Map Base, Knowledge Base and Query System.

In **Chapter Four**, details of **Network Updation Techniques** have been studied on the basis of the Client-Server Model which has become a *de facto* standard in Networking Systems. The Client-Server Model works in a manner that the Clients access data by sending requests over a network to the address of a well-known destination - the Server, which carries out the work and sends back the replies. The close similarity of our Atlas Publisher-Storehouse-User Paradigm with the Client-Server Model was noted.

By studying the client-server model, we visualised the concept of an *Atlas Server* which would be an *Atlas Publisher* and would provide the Atlas Storehouse with Map Base and Thematic information for storage. The Atlas Storehouse, playing the role of an "**intelligent Atlas-Agent**", would perform the task of going through massive amounts of GIS data from diverse sources like Atlas Publishers or other Servers and retrieving thematic information that is relevant for the user's application. In such a case, the *Atlas Storehouse* would also need the functional capabilities of the Atlas Server.

With a view to provide updated Map Base and Knowledge Base information between the Atlas Server and Client Subsystems, it was realised that the first task that needs to be carried out is the File Transfer Protocol (FTP). File Transfer methods could be categorised as On-line file transfer and E-Mail based file transfer. Both types of FTP methods were discussed. To solve the various needs of Mail-based File Updation, we studied about Network *Robots* like Autoresponders, Listservs, Majordomo and other world-wide *helpful* sub-systems. We further appreciated that to carry out global File Updation, we require Searching Tools and Servers. We studied about Internet Servers and Tools, and methods of accessing them like Archie, Gopher, World-Wide-Web and Softwares like Mosaic, Netscape etc.

In **Chapter Five**, we developed various **Solution Models** based on the Network Updation Techniques, as studied in Chapter Four, for Digital Thematic Atlas. Three approaches were taken up :

- build-your-own network
- use service-providers
- Internet

In the first approach, i.e., *build-your-own*, we developed the concept of an Integrated Systems Network (ISNET) which would support the framework built for the DTA and provide facilities from the Atlas User's point-of-view like Map Download and File Transfer, Updation of Map Information by reading the status or 'Notices' of Map Base, an on-line support for Query System etc. We further designed the ISNET and prepared a Model prototype and the **ISNET Bulletin Board System** (ISNET BBS) for local connectivity to user members of the ISNET model.

We also conceptualised that the Client-Server approach could be modelled into a concept that has been named as **Father-to-Son**. Under the Father-to-Son approach, the server takes a parental attitude and filters the system to provide only useful and relevant information while removing extraneous and unnecessary data. This approach also gives a **friendly** attitude which is a very important concept in the realm of BBSs, and would lead towards building a **trusted-network approach**.

Here, we also used the *Domain Name System, DNS* of **Internet** to develop an electronic address of Atlas User Members. A DNS Internet Model was created under **ISNET** and various member users were given ISNET Identification (Id) and Password. A model member id was made up as follows - xxxxxxx.isnet, e.g., *wii.isnet, cmfp.isnet* etc.

A discussion of the activities under ISNET BBS has been taken up in this section, including the File Transfer Protocols for Map File Transfer.

In the second approach, i.e., *use service-providers*, we developed a number of cooperative models, to provide inter-city Updation for the DTA, using experimentation of three Service Providers.

1 Gateway Packet Switching Service (GPSS) offered by Videsh Sanchar Nigam Ltd. (VSNL)

2 Packet Switched Public Data Network (PSPDN) service offered by the Department of Telecommunications (DoT), Government of India

3 E-mail Services offered by nXcess, Business India licensed by the Department of Telecom.

A cooperative model to utilise international PSPDNs for DTA updation was built using GPSS through dial-up system. Further, work was done to connect on X.121 address and subscribe to a collaborative arrangement with Easynet located at Philadelphia through VSNL. The experiments undertaken and the results achieved have been described in this chapter. We came to the conclusion that this approach utilizing GPSS and Easynet Service which proved to be useful as a Search tool could not however be used for updation operations of the DTA.

The next Co-operative model was built around Inet, India'a upcoming Packet Switched Public Data Network as the backbone for ISNET. The particular design features that helped in interfacing to Inet like STD 099 low-cost dialling etc were discussed in this chapter and a Software Program Object Base Library was developed for Primitive operations which can be integrated in the MFP Query Model for the MFP Atlas, Knowledge Model for the Endangered Species Atlas.

We saw that the PSPDN-based ISNET was modelled to create a new centre to support new network elements and new base services for DTA updation on our P-S-U paradigm, on lines similar to the successful ISNET-BBS Atlas Server Model. However, since Inet access NUIs are not available to-date from DehraDun and could not be provided by DoT, it was

decided to change existing procedures modelled above and develop another cooperative model with Business India, aXcess.

A final co-operative model was developed with the use of Business India aXcess, in order to circumvent the above problem of non-availability of NUIs from DoT on Inet at DehraDun. We stated the stages by which the previous problems were eliminated. Particularly, the DNS Ids created for the Atlas User members by the first approach using the ISNET BBS were extended to Internet Ids as follows:

*xxxxxx.isnet* extended to *xxxxxx.isnet@axcess.net.in*

Using the above model, we discussed how prototype Base Map Files for the Endangered Species Atlas were transferred as attachment from Dehradun to Bombay as a Binary File and received back via E-Mail box system.

Next, we discussed the third approach for developing the solution models - the Internet. After we had developed local models for intra-city updations, co-operative models for inter-city operations, it was considered necessary to seek global updation methods on the Internet.

We discussed the problems faced in executing a File Transfer Protocol - FTP. Firstly, we saw that it was desirable to develop on-line FTP operations for DTA updation, but the constraints were that on-line Internet access was still not available in the country readily, especially in Dehradun. So the initial approach followed was to experiment with different FTP-by-mail operations. The *ISNET-aXcess* co-operative model developed earlier helped in sending E-mail requests to various Network Robots to seek Global Updation and Search facilities.

The Network Robots contacted included LISTSERV mailing lists, FTP-by-mail servers, Archie Servers, etc. Discussion on each of these has been taken up in this section. It was seen that in the absence of on-line Internet access, the best possible solution models

appear as E-Mail based Internet access, through Network Robots, for connecting to servers, searching various servers, copying and updating files from servers.

However, to be able to tap the full potential of the Information Superhighway, on-line Internet access was desired. For this an initial subscription to VSNL based Gateway Internet Access Service (GIAS) was made, however, we saw that the GIAS facility, available only at Delhi and Bombay, was heavily overloaded and could not be tested from Dehradun as described in Chapter Five.

However, the experiments were carried out at BITS, Pilani, where VSAT system has been installed, providing Internet access at 64kbps. Different experiments were carried out successfully to test on-line connectivity to Archie and Gopher Servers through Super TCP software. Subsequently, we discussed the most modern tool of the Information Superhighway - the World-Wide-Web (WWW) and the latest software to access it - Netscape via the Hyper Text Transfer Protocol (http).

We discussed the Search engine capability of Netscape and the various sites visited and enlisted other Digital Atlas prototype development elsewhere. It was observed that some Web Servers displayed maps and we downloaded these maps from various sites, which fit in our paradigm as an 'Atlas Server' site. Next we searched for *Endangered Species* and could connect to servers providing this information. These, however, had no Atlas to display details on a Map base.

After viewing the Internet as an Atlas User, it was desirable to view the Internet model as an Atlas Publisher. *Web Pages* were designed and developed for the Digital Thematic Atlas in **html** language - Hyper Text Markup Language. A prototype **Web Page Model** was designed for the *Endangered Species Atlas* and the *MFP Atlas* and was tested locally to demonstrate link connectivity to internal Pages and also hyperlink with Databases like the California Natural Diversity Database. The design of the model has been fully discussed in this chapter. Prototype data experimentation was carried out by this research work.

Simple basic maps could be downloaded from Internet for an Atlas User and may also be uploaded onto Internet as an Atlas Publisher. We observed from our Atlas Publisher-Storehouse-User (P-S-U) paradigm that if the structure is collapsed, i.e., if the Publisher is moved from the top-of-the-line in the hierarchical organisation we get the Internet model.

It was seen that Internet would become the Atlas Storehouse of the future and it would be much easier to publish a Digital Thematic Atlas via a Web Server which we call as **Atlas Server.** The Atlas Server provides support for an Atlas Publisher as well as the Atlas Storehouse.

It was also seen that the future Digital Thematic Atlas could be easily put up on the World-wide-web in which an Atlas Publisher or author would simply compile and dump his maps on Internet while an Atlas User would retrieve his maps from Internet which becomes the Atlas Storehouse.

It is analysed that three kinds of methods emerge for Network-based Updation for the Digital Thematic Atlas :

(i) developing a BBS with the Father-to-Son concept at the local city level.

(ii) co-operative linkages to work at the country-wide level.

(iii) Internet using the WWW to work on a global world-wide level.

As the spread of Internet develops, which is inevitable, the models developed for Digital Thematic Atlas demonstrate an integrated front-end based on multimedia, hypermedia and querying systems (subsequently a virtual reality system) with a back-end GIS base linked with heavily distributed DBMS and AI-based systems.

## 6.2 RECOMMENDATIONS

The following recommendations are made:

1. A networked Digital Thematic Atlas should be developed on the basis of models proposed in the study.

2. The networked Digital Thematic Atlas should incorporate:

   a) Integration of 5 major Information Technology components viz., Geographic Information System, Data Base Management System, Multimedia Technology, Knowledge-based System, Virtual Reality.

   b) GIS as the backbone along with DBMS and KBS which shall together form the back-end support for processing and analytical functions at Atlas Publisher sites on the network.

   c) Multimedia along with Virtual Reality as the front-end for Atlas User sites on the network.

   d) Intelligent linkages between the back-end and the front-end to provide the user an environment of (i) Map Base (ii) Knowledege Base and (iii) Query System.

3. Compilation and updation should be incorporated utilising an Integrated Systems Network at the Publisher site and making it available to Atlas Users through the use of Atlas Storehouse Servers on the Information Superhighway and on the basis of a combination of the three following models:

   a) Bulletin Board System at a local level within a city or town, to develop and support an Atlas User community. For specialised applications, a trusted-network should be built with the server filtering selected information and taking

a parental attitude towards the User Base under a suggested, concept named as 'Father-to-Son'.

b) Country-wide network with the help of Service-providers like Inet, aXcess or other such agencies for national linkage of Atlas Publishers and Users.

c) World-Wide-Web-based System for World-Wide connectivity to Internet.

4. Suitable agencies - government or non-government - may be asked to take up the task of setting Atlas Servers for Atlas Storehouse functions which could be available for use by Atlas Publishers as well as Atlas Users (the global atlas user community). An initiative needs to be launched in the country for Digital Atlas development. Small independent systems could be operating and co-operating with each other.

5. Internet may become the Atlas Storehouse of the future, with Publishers simply dumping their Atlas pages through the use of Atlas Servers on the W-W-W and Atlas Users would need to simply plug in their computers to download any map or information when required.

6. Recommended Hardware and Software specifications for Atlas Server in the current period are :

Minicomputer or Supermicro

Netscape Server Software

ISNET BBS Atlas Server Software

VSAT System

Ethernet LAN with 3 Pentium Workstations, Laser Printer etc.

UPS

## 6.3 SCOPE FOR FUTURE WORK

The basic objectives of the research have been thus met with the final concluding solution model using WWW. It is anticipated that this model would emerge in the near future as a *de facto* method of Atlas Publishing. Web-based Atlas distribution would be faster than producing or distributing the Digital Atlas in the form of a paper book or CD-ROM. This makes it good for time-sensitive material such as forestry and movement of endangered wildlife species which may alter fast according to global weather conditions and a host of other applications like Pollution Control, Petro-Chemicals, Geo-sciences, Archaeology etc.

The Map contents that traditionally have been conveyed by paper-based drawings can now be captured by computer-based methods - digital representations of technical objects, which can be shifted from site to site via network connections, as routinely as drawings were in the past [21].

It would be possible to generate a large number of scanned maps and images for future work, which would form the Map and Thematic Base for the Digital Thematic Atlas. At this juncture, it is important to identify the limitations of our present work and the scope for future research.

Digital Vector Data (DVD) from Survey of India which could become a standard for data exchange in the country was not available for recording a study report since the policy of making the data available in digital form has yet to be finalised by the government.

Looking back at the framework for the integration task, it may be pointed out that Virtual Reality (VR) which emerged as an important component while identifying the issues of the integration task of the DTA has not been incorporated because of the high costs and non-availability of VR equipment. It is visualised that the future Digital Thematic Atlas would be able to incorporate VR techniques, and the cost of VR equipment would also come down. Once VR equipment becomes commonly available at low-cost, it would be possible to exploit fully this component in the DTA.

In the integration of the multimedia component, basic models have been developed to demonstrate linkage of image with spatial features. Further work is required to link a single image with several types of features. In order to strengthen the linkage of an image with other spatial data, special techniques will be required to be taken up.

With possibilities of a global Digital Thematic Atlas used world-wide, with Atlas Publishers dumping Maps on Internet through Atlas Storehouse Servers at the local, country-wide and world-wide levels, there will be a need for important work to be done in some of the following areas.

First and foremost is the need to maintain high-quality standards for Digital Atlas Publication and its dissemination over the Information Superhighway. In this context, Quality Assurance and Quality Control is of utmost importance. Periodic checks of archived data and a Quality Control procedure will have to be developed [63]. It may also be necessary to have implementation of Total Quality Management Standards.

Another important issue is that of Security of Information. While information transferred through the Network and Mailbox systems has high security because of Password Control, it is definitely susceptible to *hackers* who have often broken into the most secured of networks. Sensitive information which needs to be transferred over the Net would need to be encrypted. New methods of Data Encryption need to be continuously developed to prevent patterns from being recognised to keep data secure.

Restricted Area information which could be sensitive to the country's security may be allowed for access on Local Mode Operations on internal networks, called as an Intranet rather than directly putting up information on Internet.

It would be important to identify the role that the government would play in providing public access to Map Data at a minimal cost of dissemination. Presently projected costs are too high. Through the Network medium, certain basic information of fundamental national importance should be provided at reasonable costs to Users so that it is available for Value-

added developers, Planners and Decision-makers. Free public access to government-held GIS data has been provided in certain areas of the U.S. like Iowa Department of Natural Resources, the Montana National Resource Information System, and the Montana State Library with success [122].

The policy of electronic publication and licencing has to be re-defined. Distribution via the Internet should NOT be interpreted as meaning that the information may have been placed in the public domain [123]. Publishers may, at their liberty, provide certain information at a no-charge, royalty-free license and still retain their copyright of the material. Atlas Users may re-distribute material to others who may benefit from its use. New ways for monitoring re-use of original material will have to be developed such that an initial *digital signature* integrated with the map would be retained and be non-erasable during further editing or updating operations or network transactions.

Further, Atlas Publishers may provide their Maps to Users while charging on a transaction basis, which could reduce costs substantially on large volume scales. It would be necessary to study and tailor the design of 'CyberCash Secure Internet Payment System' [124] which proposes a secure networked financial system to enable a user to securely conduct Credit Card purchases over the Internet. Atlas Publishers and Users may take the benefit of this system if Digital Map information transfer is linked with the digital cash on the network.

Another area for future development to make the digital atlas more realistic is the automatic scene interpretation techniques developed for industial robots and autopilot systems.

While the network-based updation for the DTA was modelled initally using dial-up modems at 2400 bps and subsequently at 14.4 kbps before shifting to VSAT based equipment at 64 kbps, in the future it would be possible to work at much higher speed as seen by the following examples.

Advanced technology like Fast Fax i.e., Group IV Fax would have benefits like high transmission speed of 64 kbps to 2 Mbps, high quality colour images for output of maps and thematic images and faster transmission of map/text outputs over networks.

Using ISDN, an Atlas User could directly see Base Maps and thematic images on the computer using a telephone connection without using a MODEM. Introduction of Hi-speed ISDN at data networking speeds upto 1.544 Mb/s and ATM-based switching at user speeds upto 622 Mb/s [33] will be a boon to the Digital Thematic Atlas.

With a view to identifying the potential for future work in this area, a study was made of the North Carolina Information SuperHighway [33], [38], [39] in the USA. Called as NCIH - North Carolina Information Highway [33], [38], [39], it has paved the way to migrate services from the existing North Carolina Research and Education Network - NC-REN, which is a video and data network, to Superhighway based services.

NC-REN is a 45-Mb/s backbone network incorporating high-quality video and audio to closely approximate the dynamics of face-to-face operations, which would automatically introduce the concept of a Virtual Digital Atlas. The NC-REN with video and advanced inter-network Support Services has been able to provide the research and education community with access to emerging technologies and applications.

NC-REN has become a prototype for the Information Superhighway and one of the first implementation of an Information Highway in US [38]. The connectivity to Internet at 45Mb/s is being upgraded to 155 Mb/s.

With such high operational speeds, a Digital Thematic Atlas could find place in every communication package that works on a GUI point-and-shoot method. While pointing to a desired resource a user would require a Digital Thematic Atlas in one form or another. The computer being used itself disappears in the background with real-life applications developing on electronic notebook and digital atlas systems.

TITAN's Delphi survey suggests that services with the highest potential are (i) Video on Demand, (ii) Video Telephony and (iii) the simple Home Office [93]. Widespread take-up of video on demand is expected to occur. The Digital Thematic Atlas combined with video on demand would be a source for connectivity.

Margaret Hopkins et al have worked on forecasting demand for advanced telecommunication services and networks in the period to 2010. According to Margaret Hopkins et al [91], T. Modis, Predictions, has said that "forecasting growth in a new technology can be assumed to focus on defining an S-shaped logistic curve". It could be said that Digital Thematic Atlas is at the beginning of the curve. Though it is hard to predict what the popularity of this technology will be, it can be said that there would be multiple problem-areas where desired applications of Digital Thematic Atlas could be found. With new Video On-demand Services becoming available Digital Thematic Atlas could become a medium for transporting a user to a virtual world.

Another aspect is the single-server concept used in ISNET BBS system for Atlas Server. This does not scale to truly large distributed systems [15]. A single server system requires centralized efforts to make the information available and keep it uptodate and can do only a partial job of finding and correctly analysing data [81], since there are no standards or policies universally adopted or quality measurement metrices.

As the Digital Thematic Atlas servers on a network increase and higher-end system performance is desired for end-users, it is proposed to study the applications of **NOW** (Networks of Workstations) [92]. These Networks of Workstations which are poised to become the primary computing infrastructure for science and engineering may dramatically improve virtual memory and file system performance; achieve cheap, highly available and scalable file storage. The University of California, Berkeley NOW project tries to harness all the computers in a building to satisfy the needs of both desktop computing and applications that require supercomputing [92]. The NOW project is addressing these problems building a completely Serverless network file system called xFS. In place of a centralized server, client

workstations cooperate in all aspects of the file system storing data, managing metadata and enforcing protection [92].

The challenge would be to provide an Atlas User with the features of a dedicated atlas workstation, while performing background functions of updation over the Information Superhighway.

As this research goes for submission, a new programming language is emerging - Java, which is a new technology that is reported to allow its users to pull down special programs for playing sound or video at the same time as web page is being down loaded.

Java is a new computer language with new techniques for software development - it is anticipated that in future users may not install software on their own computers but simply pick them up from Internet using a programming language like Java.

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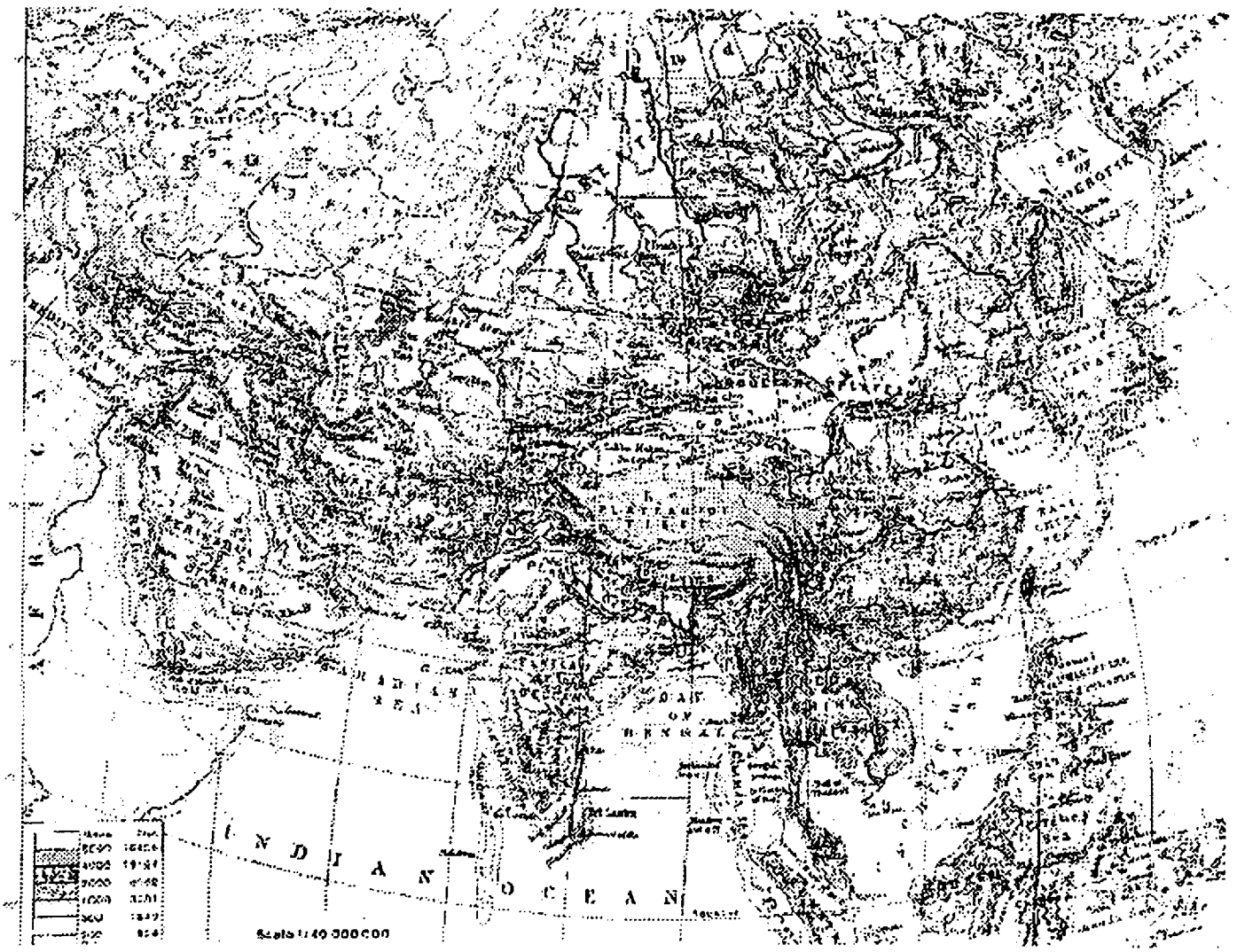
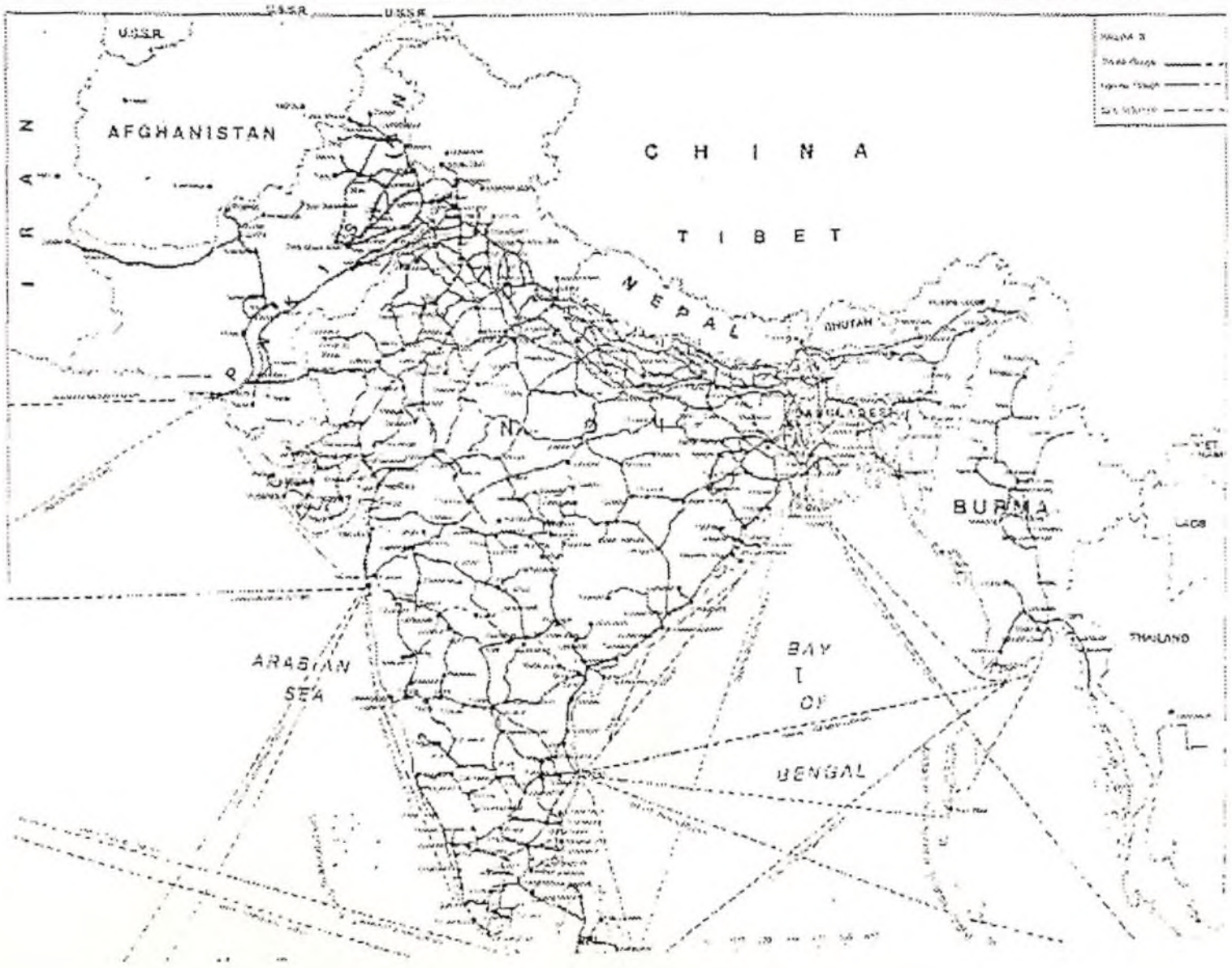
# SAMPLE MAPS CREATED DURING STUDY PROCESS

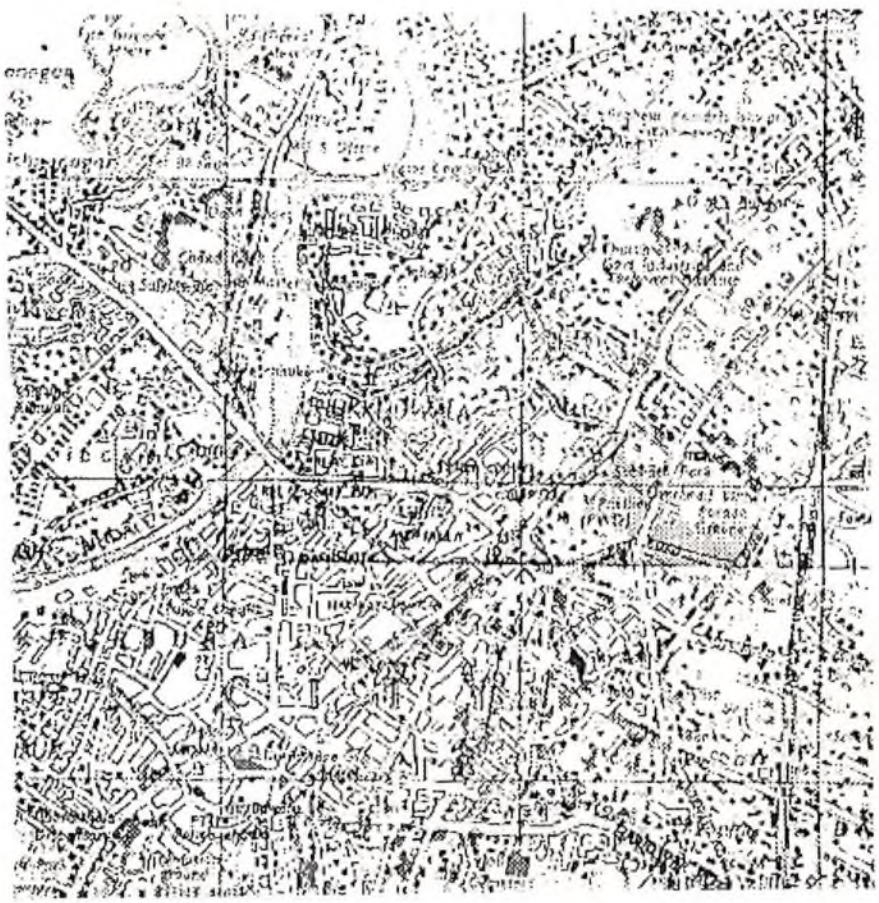



Sample Map No. 1 : WORLD MAP

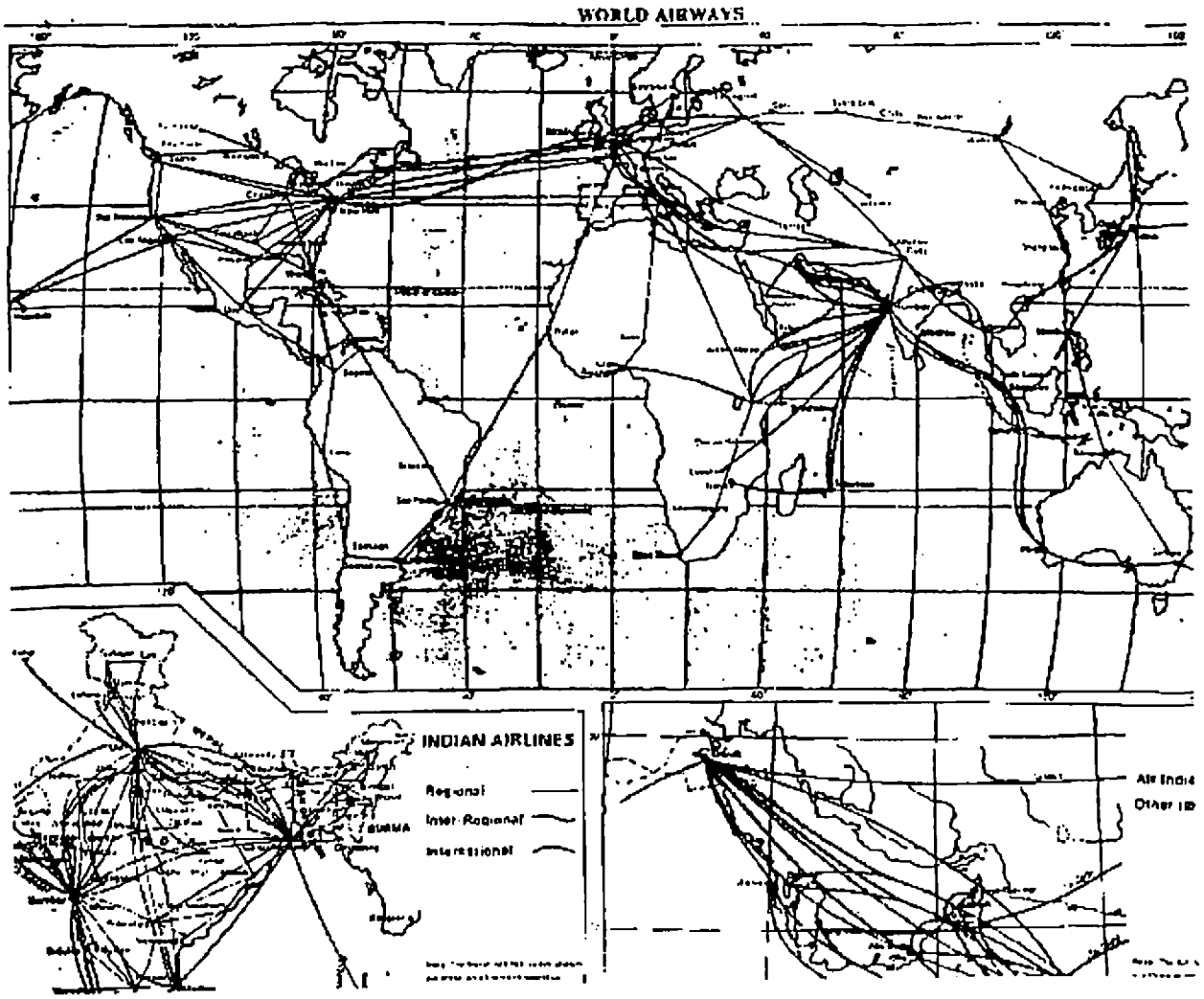
INDIA, BANGLADESH, BURMA, PAKISTAN AND SRI LANKA – RAILWAYS AND SEA ROUTES



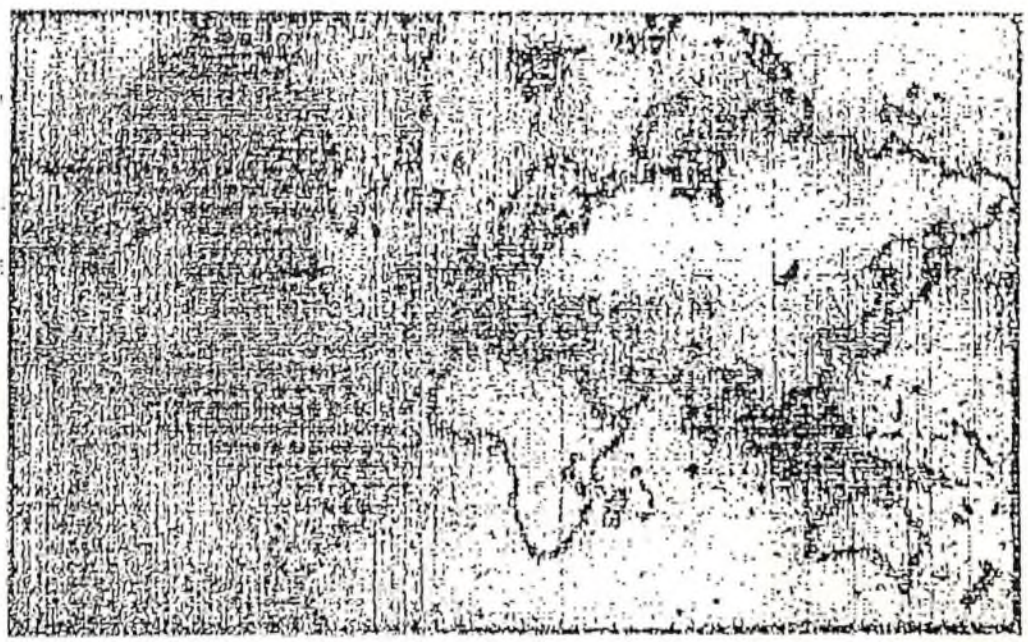

Sample Map No. 2 : INDIA MAP SHOWING THEMATIC INFORMATION - RAILWAYS AND SEA ROUTES



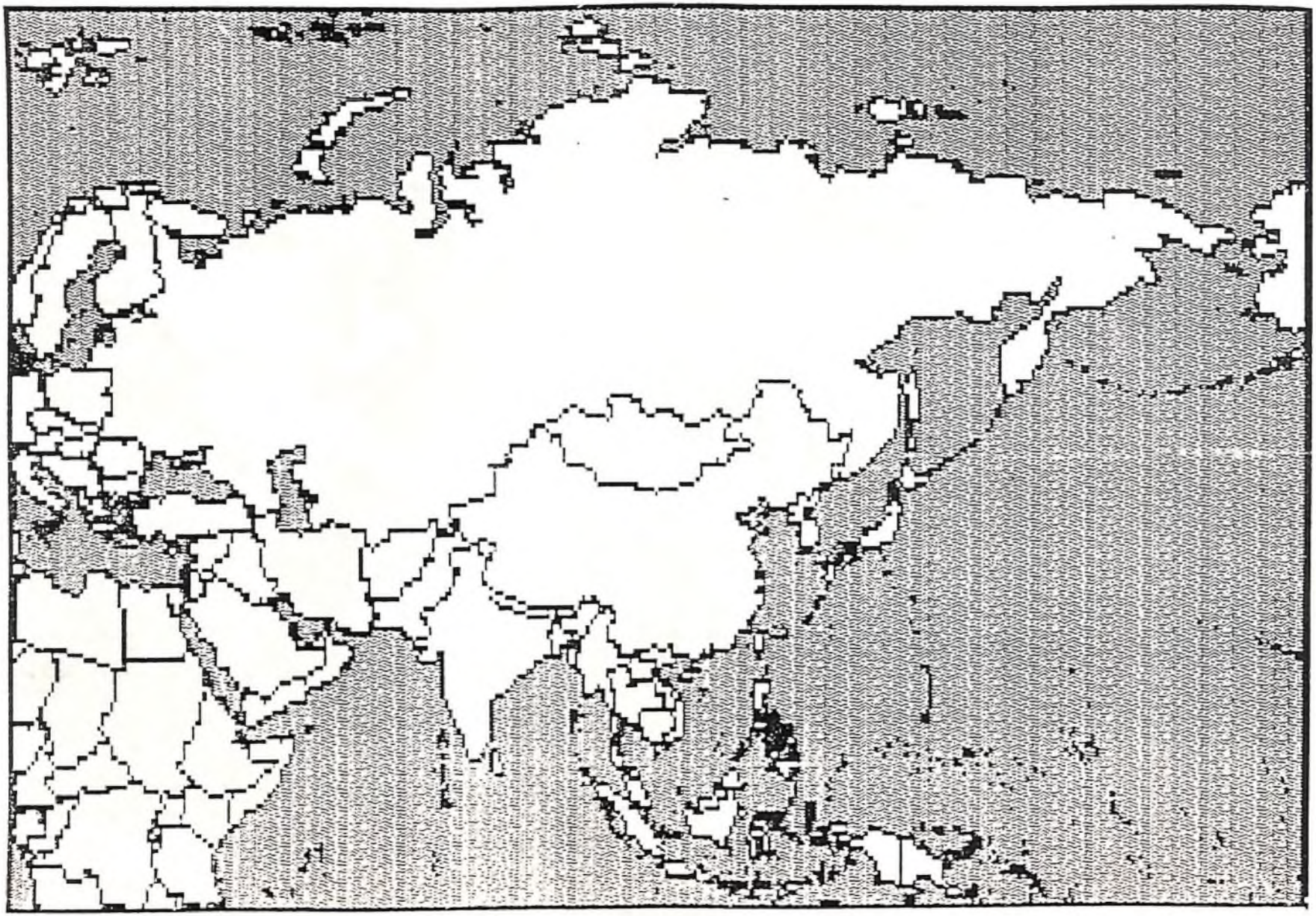
Sample Map No. 3 : DEHRADUN MAP (PART OF)



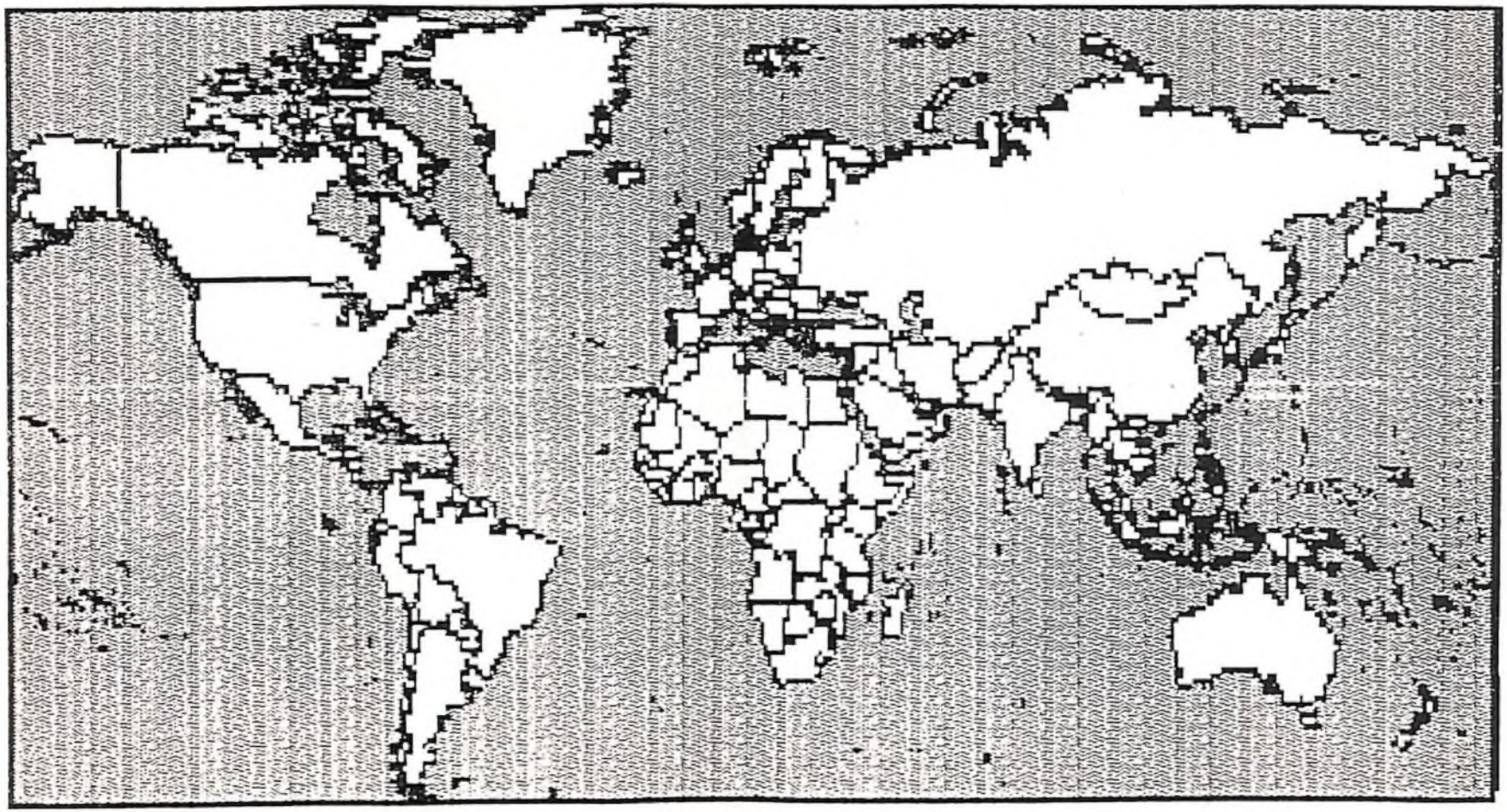

Sample Map No. 4 : NOISE IN A MAP



Sample Map No. 5 : NOISE IN A MAP CAN RESULT IN
FURTHER DEGRADATION OF OUTPUT QUALITY



Sample Map No. 6 PRINTED OUTPUT OF PACKAGES WHICH PROVIDE DATA EXPORT FACILITY AND COULD BE USED FOR VALUE-ADDED COMPILATION - ASIA MAP ( SOURCE - PC GLOBE)



Sample Map No. 7 : PRINTED OUTPUT OF PACKAGES WHICH PROVIDE DATA EXPORT FACILITY AND COULD BE USED FOR VALUE-ADDED COMPILATION - WORLD MAP (SOURCE - PC GLOBE)

APPENDIX A3.2

# EXAMPLE ENDANGERED WILDLIFE SPECIES KNOWLEDGE BASE

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

STATUS SUMMARY FOR Elephas maximus Indian Elephant

DISTRIBUTED IN BIOUNITS :- ,02D,09A,09B,07A,05B,06B,06C,06E,

OCCUPIES HABITATS :- ,SBH,TWE,TMD,TSE,TDD,SPF,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 1037212 | 0 | 0 | 72798 | 7.0 | 7590 | 0.7 |

| | |
|---|---|
| % original habitat lost = | 100.0 |
| % original habitat protected = | 7.0 |
| % original habitat proposed = | 0.7 |
| % remaining habitat protected = | **** |
| Expected protected population = | 27183 |
| Expected total population = | 20387 |
| %age population protected = | 133 |
| Red Data Book Status = | Endangered |
| Computer assigned status = | Endangered |
| Species listed on CITES appendix | 1 |
| Species protected in countries : | ,IN,SL,NP,BH, |

Indian Elephant IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| ARALAM WS | IN | KER | 55.00 | * | 5 |
| BANDIPUR NP | IN | KAR | 874.00 | * | 5 |
| BANNERGHATTA NP | IN | KAR | 104.27 | * | 5 |
| BUXA NP | IN | WBL | 117.10 | * | 5 |
| BUXA WS | IN | WBL | 251.89 | * | 5 |
| CHINNAR WS | IN | KER | 90.44 | * | 5 |
| CORBETT NP | IN | UPR | 520.82 | * | 6 |
| D'ERING MEMORIAL (LALI) W | IN | ARU | 190.00 | * | 5 |
| D'ERING NP | IN | ARU | 100.00 | * | 5 |
| DUDHWA NP | IN | UPR | 490.00 | * | 4 |
| Dr.J.JAYALALITHA(MUDUMALA | IN | TNA | 103.24 | * | 5 |
| Dr.J.JAYALALITHA(MUDUMALA | IN | TNA | 217.76 | * | 5 |
| HAZARIBAGH WS | IN | BIH | 186.25 | * | 5 |
| INDIRA GANDHI (ANNAMALAI) | IN | TNA | 117.11 | * | 5 |
| INDIRA GANDHI (ANNAMALAI) | IN | TNA | 919.95 | * | 5 |
| ITANAGAR WS | IN | ARU | 140.30 | * | 5 |
| KAUNDINYA WS | IN | APR | 357.60 | * | 5 |
| KAZIRANGA NP | IN | ASS | 430.00 | * | 5 |
| MANAS NP, | IN | ASS | 500.00 | * | 4 |
| MUKURTHI NP | IN | TNA | 78.46 | * | 5 |
| MUNDANTHURAI WS | IN | TNA | 567.38 | * | 5 |
| NAGARAHOLE NP | IN | KAR | 643.39 | * | 5 |
| NAMDAPHA NP | IN | ARU | 1985.23 | * | 5 |
| NEYYAR WS | IN | KER | 128.00 | * | 5 |
| PALAMAU (BETLA) WS | IN | BIH | 747.60 | * | 5 |
| PARAMBIKULAM WS | IN | KER | 285.00 | * | 5 |
| PERIYAR NP | IN | KER | 350.00 | * | 5 |
| PERIYAR WS | IN | KER | 777.00 | * | 5 |
| RAJAJI NP | IN | UPR | 820.03 | * | 4 |
| SIMLIPAL NP | IN | ORI | 845.70 | * | 5 |
| SIMLIPAL WS | IN | ORI | 1354.00 | * | 5 |

Fig. (a)

STATUS SUMMARY FOR Panthera tigris Tiger

DISTRIBUTED IN BIOUNITS :- ,02D,05B,06A,06B,06C,06D,06E,04B,02D,07A,07B,09A,09

OCCUPIES HABITATS :- ,TWE,SPF,TSE,TMD,MNV,IDD,IDE,SBH,HMT,MNF,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 1987546 | 0 | 0 | 117588 | 5.9 | 9076 | 0.5 |

| | |
|---|---|
| % original habitat lost = | 100.0 |
| % original habitat protected = | 5.9 |
| % original habitat proposed = | 0.5 |
| % remaining habitat protected = | **** |
| Expected protected population = | 9129 |
| Expected total population = | 6846 |
| %age population protected = | 133 |
| Red Data Book Status = | Endangered |
| Computer assigned status = | Endangered |
| Species listed on CITES appendix | 1 |
| Species protected in countries : | ,IN, |

Tiger IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| BADALKHOL WS | IN | MPR | 104.55 | * | 5 |
| BANDHAVGARH NP | IN | MPR | 448.00 | * | 4 |
| BANDIPUR NP | IN | KAR | 874.00 | * | 5 |
| BETLA NP | IN | BIH | 231.67 | * | 5 |
| BHAHRAMGARH WS | IN | MPR | 139.00 | * | 5 |
| BORI WS | IN | MPR | 480.00 | * | 5 |
| BUXA NP | IN | WBL | 117.10 | * | 5 |
| BUXA WS | IN | WBL | 251.89 | * | 5 |
| CHANDRAPRABHA WS | IN | UPR | 78.00 | * | 5 |
| CHAPRAMARI WS | IN | WBL | 9.60 | * | 5 |
| CORBETT NP | IN | UPR | 520.82 | * | 5 |
| D'ERING MEMORIAL (LALI) W | IN | ARU | 190.00 | * | 5 |
| D'ERING NP | IN | ARU | 100.00 | * | 5 |
| DARRAH WS | IN | RAJ | 265.80 | * | 4 |
| DUDHWA NP | IN | UPR | 490.00 | * | 4 |
| Dr.J.JAYALALITHA(MUDUMALA | IN | TNA | 103.24 | * | 5 |
| Dr.J.JAYALALITHA(MUDUMALA | IN | TNA | 217.76 | * | 5 |
| ERAVIKULAM NP | IN | KER | 97.00 | * | 5 |
| ETURNAGARAM NP | IN | APR | 219.00 | * | 5 |
| ETURNAGARAM WS | IN | APR | 806.15 | * | 5 |
| FOSSIL NP | IN | MPR | 0.27 | * | 4 |
| GORUMARA NP | IN | WBL | 79.45 | * | 5 |
| GUNDLA BRAHMESWARAM NP | IN | APR | 300.00 | * | 5 |
| GUNDLA BRAHMESWARAM WS | IN | APR | 1194.00 | * | 5 |
| HAZARIBAGH WS | IN | BIH | 186.25 | * | 5 |
| INDIRA GANDHI (ANNAMALAI) | IN | TNA | 117.11 | * | 5 |
| INDIRA GANDHI (ANNAMALAI) | IN | TNA | 919.95 | * | 5 |
| INDRAVATI NP | IN | MPR | 1258.00 | * | 4 |
| ITANAGAR WS | IN | ARU | 140.30 | * | 5 |
| JALDAPARA NP | IN | WBL | 100.00 | * | 4 |

Fig. (b) (1 of 2)

| | | | | | |
|---|---|---|---|---|---|
| JALDAPARA WS | IN | WBL | 216.51 | * | 4 |
| KANGER VALLEY NP | IN | MPR | 200.00 | * | 4 |
| KANHA NP | IN | MPR | 940.00 | * | 6 |
| KAWAL WS | IN | APR | 893.00 | * | 5 |
| KAZIRANGA NP | IN | ASS | 430.00 | * | 5 |
| KINNERASANI WS | IN | APR | 635.41 | * | 5 |
| LANJA MADUGU SIVARAM WS | IN | APR | 36.29 | * | 5 |
| MADHAV-SHIVPURI NP | IN | MPR | 337.00 | * | 5 |
| MAHANANDA WS | IN | WBL | 127.22 | * | 5 |
| MANAS NP | IN | ASS | 500.00 | * | 6 |
| MEHAO WS | IN | ARU | 281.50 | * | 4 |
| MELGHAT WS | IN | MAH | 1262.00 | * | 6 |
| MOULING NP | IN | ARU | 483.00 | * | 5 |
| MOULING WS | IN | ARU | 700.00 | * | 5 |
| MUKURTHI NP | IN | TNA | 78.46 | * | 5 |
| MUNDANTHURAI WS | IN | TNA | 567.38 | * | 5 |
| NAGARAHOLE NP | IN | KAR | 643.39 | * | 4 |
| NAMDAPHA NP | IN | ARU | 1985.23 | * | 4 |
| NANDA DEVI NP | IN | UPR | 650.00 | * | 4 |
| NATIONAL CHAMBAL (M.P.) N | IN | MPR | 50.00 | * | 4 |
| NATIONAL CHAMBAL (M.P.) W | IN | MPR | 320.00 | * | 4 |
| NATIONAL CHAMBAL (Raj.) W | IN | RAJ | 280.00 | * | 4 |
| NATIONAL CHAMBAL (U.P.) N | IN | UPR | 50.00 | * | 4 |
| NATIONAL CHAMBAL (U.P.) W | IN | UPR | 635.00 | * | 4 |
| NAWEGAON NP | IN | MAH | 134.88 | * | 5 |
| NEYYAR WS | IN | KER | 128.00 | * | 5 |
| PACHMARHI WS | IN | MPR | 461.85 | * | 5 |
| PAKHAL WS | IN | APR | 879.30 | * | 5 |
| PALAMAU (BETLA) WS | IN | BIH | 747.60 | * | 6 |
| PANNA NP | IN | MPR | 543.00 | * | 4 |
| PAPIKONDA WS | IN | APR | 591.00 | * | 5 |
| PARAMBIKULAM WS | IN | KER | 285.00 | * | 5 |
| PENCH NP (Maharashtra) | IN | MAH | 257.26 | * | 6 |
| PENCH WS (M.P.) | IN | MPR | 449.39 | * | 6 |
| PENCH(PRIYADARSHINI) NP(M | IN | MPR | 293.00 | * | 6 |
| PERIYAR NP | IN | KER | 350.00 | * | 5 |
| PERIYAR WS | IN | KER | 777.00 | * | 5 |
| PRANAHITA WS | IN | APR | 136.02 | * | 5 |
| RAJAJI NP | IN | UPR | 820.03 | * | 4 |
| RAJIV GANDHI(N)(Nagar.Sri | IN | APR | 2221.09 | * | 5 |
| RAJIV GANDHI(S)(Nagar.Sri | IN | APR | 1347.00 | * | 5 |
| RANTHAMBORE NP | IN | RAJ | 392.00 | * | 5 |
| SANJAY NP | IN | MPR | 1938.00 | * | 5 |
| SARISKA NP | IN | RAJ | 273.80 | * | 4 |
| SARISKA WS | IN | RAJ | 492.00 | * | 4 |
| SATPURA NP | IN | MPR | 524.00 | * | 4 |
| SIMLIPAL NP | IN | ORI | 845.70 | * | 4 |
| SIMLIPAL WS | IN | ORI | 1354.00 | * | 4 |
| SRI VENKATESWARA NP | IN | APR | 352.62 | * | 5 |
| SRI VENKATESWARA WS | IN | APR | 506.94 | * | 5 |
| SUNDERBAN NP | IN | WBL | 1330.10 | * | 5 |
| TADOBA NP | IN | MAH | 116.55 | * | 5 |
| UDANTI (WILD BUDDALO) WS | IN | MPR | 247.59 | * | 5 |
| VALMIKI (Extension) WS | IN | BIH | 419.10 | * | 5 |
| VALMIKI NP | IN | BIH | 335.65 | * | 5 |
| VALMIKI WS | IN | BIH | 461.00 | * | 5 |
| VAN VIHAR NP (Madhya Prad | IN | MPR | 4.45 | * | 5 |
| VAN VIHAR WS (Rajasthan) | IN | RAJ | 59.93 | * | 5 |

Fig. (b) (2 of 2)

STATUS SUMMARY FOR Panthera leo persica Asiatic Lion

DISTRIBUTED IN BIOUNITS :- ,04B,

OCCUPIES HABITATS :- ,TDD,TTF,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 385612 | 0 | 0 | 21195 | 5.5 | 924 | 0.2 |

| | |
|---|---|
| % original habitat lost = | 100.0 |
| % original habitat protected = | 5.5 |
| % original habitat proposed = | 0.2 |
| % remaining habitat protected = | **** |
| Expected protected population = | 99 |
| Expected total population = | 49 |
| %age population protected = | 202 |
| Red Data Book Status = | Endangered |
| Computer assigned status = | Endangered |
| Species listed on CITES appendix | 1 |
| Species protected in countries : | ,IN, |

Asiatic Lion IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| GIR NP | IN | GUJ | 258.71 | * | 6 |
| GIR WS | IN | GUJ | 1153.42 | * | 6 |

STATUS SUMMARY FOR Antilope cervicapra Blackbuck

DISTRIBUTED IN BIOUNITS :- ,06A,06B,06C,06D,03A,03B,06E,04A,04B,07A,

OCCUPIES HABITATS :- ,TDD,TTF,TAZ,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 1756662 | 0 | 0 | 80938 | 4.6 | 1935 | 0.1 |

| | |
|---|---|
| % original habitat lost = | 100.0 |
| % original habitat protected = | 4.6 |
| % original habitat proposed = | 0.1 |
| % remaining habitat protected = | **** |
| Expected protected population = | 301524 |
| Expected total population = | 150762 |
| %age population protected = | 200 |
| Red Data Book Status = | Vulnerable |
| Computer assigned status = | Endangered |
| Species listed on CITES appendix | 3 |
| Species protected in countries : | ,IN, |

Fig. (c) (1 of 2)

Blackbuck IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| ABOHAR WS | IN | PUN | 186.00 | * | 6 |
| BAGDARA WS | IN | MPR | 478.90 | * | 6 |
| BANDHAVGARH NP | IN | MPR | 448.00 | * | 6 |
| DUDHWA NP | IN | UPR | 490.00 | * | 5 |
| ETURNAGARAM NP | IN | APR | 219.00 | * | 6 |
| ETURNAGARAM WS | IN | APR | 806.15 | * | 6 |
| FOSSIL NP | IN | MPR | 0.27 | * | 4 |
| GANDHI SAGAR WS | IN | MPR | 368.62 | * | 6 |
| GHATIGAON WS | IN | MPR | 512.00 | * | 6 |
| GUINDY NP | IN | TNA | 2.82 | * | 6 |
| GUNDLA BRAHMESWARAM NP | IN | APR | 300.00 | * | 6 |
| GUNDLA BRAHMESWARAM WS | IN | APR | 1194.00 | * | 6 |
| INDRAVATI NP | IN | MPR | 1258.00 | * | 6 |
| KANHA NP | IN | MPR | 940.00 | * | 6 |
| KARERA WS | IN | MPR | 202.21 | * | 6 |
| KAWAL WS | IN | APR | 893.00 | * | 6 |
| KEOLADEO GHANA NP | IN | RAJ | 28.73 | * | 5 |
| KINNERASANI WS | IN | APR | 635.41 | * | 6 |
| NANDA DEVI NP | IN | UPR | 650.00 | * | 5 |
| NATIONAL CHAMBAL (M.P.) N | IN | MPR | 50.00 | * | 6 |
| NATIONAL CHAMBAL (M.P.) W | IN | MPR | 320.00 | * | 6 |
| NATIONAL CHAMBAL (Raj.) W | IN | RAJ | 280.00 | * | 6 |
| NATIONAL CHAMBAL (U.P.) N | IN | UPR | 50.00 | * | 6 |
| NATIONAL CHAMBAL (U.P.) W | IN | UPR | 635.00 | * | 6 |
| PACHMARHI WS | IN | MPR | 461.85 | * | 6 |
| PAKHAL WS | IN | APR | 879.30 | * | 6 |
| PANNA NP | IN | MPR | 543.00 | * | 6 |
| POINT CALIMERE NP | IN | TNA | 7.00 | * | 6 |
| POINT CALIMERE WS (E) | IN | TNA | 17.26 | * | 6 |
| POINT CALIMERE WS (P) | IN | TNA | 137.78 | * | 6 |
| PRANAHITA WS | IN | APR | 136.02 | * | 6 |
| RAJIV GANDHI(N)(Nagar.Sri | IN | APR | 2221.09 | * | 5 |
| RAJIV GANDHI(S)(Nagar.Sri | IN | APR | 1347.00 | * | 5 |
| RANEBENNUR WS | IN | KAR | 119.00 | * | 6 |
| RANIPUR WS | IN | UPR | 230.00 | * | 6 |
| ROLLAPADU WS | IN | APR | 6.14 | * | 6 |
| SINGHORI WS | IN | MPR | 287.91 | * | 6 |
| SULTANPUR NP | IN | HAR | 1.43 | * | 6 |
| TAL CHHAPPER WS | IN | RAJ | 7.90 | * | 6 |
| VALMIKI (Extension) WS | IN | BIH | 419.10 | * | 6 |
| VALMIKI NP | IN | BIH | 335.65 | * | 6 |
| VALMIKI WS | IN | BIH | 461.00 | * | 6 |
| VAN VIHAR NP (Madhya Prad | IN | MPR | 4.45 | * | 6 |
| VELAVADAR NP | IN | GUJ | 34.08 | * | 6 |
| WILD ASS NP | IN | GUJ | 1000.00 | * | 6 |
| WILD ASS WS | IN | GUJ | 4953.70 | * | 6 |

Fig. (c) (2 of 2)

STATUS SUMMARY FOR Uncia uncia Snow Leopard

DISTRIBUTED IN BIOUNITS :- ,01A,01B,02A,02B,02C,02D,NEP,

OCCUPIES HABITATS :- ,SAF,AMS,AMP,HD1,AAP,ADP,ADS,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 190673 | 74 | 0 | 6586 | 3.5 | 1034 | 0.5 |

% original habitat lost = 100.0
% original habitat protected = 3.5
% original habitat proposed = 0.5
% remaining habitat protected = 8900
Expected protected population = 190

Expected total population = 96
%age population protected = 198
Red Data Book Status = Endangered
Computer assigned status = Endangered
Species listed on CITES appendix 1
Species protected in countries : ,IN,NP,

Snow Leopard IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| ASKOT MUSK DEER WS | IN | UPR | 600.00 | * | 5 |
| CHANG-CHENMO NP | IN | J&K | 500.00 | * | 5 |
| DACHIGAM NP | IN | J&K | 141.00 | * | 5 |
| GOVIND PASHU VIHAR NP | IN | UPR | 472.08 | * | 5 |
| GOVIND PASHU VIHAR WS | IN | UPR | 953.12 | * | 5 |
| GREAT HIMALAYAN NP | IN | HPR | 620.00 | * | 4 |
| GULMARG WS | IN | J&K | 180.00 | * | 5 |
| HEMIS NP | IN | J&K | 3350.00 | * | 5 |
| HEMIS WS | IN | J&K | 3300.00 | * | 5 |
| KHANGCHENDZONGA NP | IN | SIK | 850.00 | * | 5 |
| KISTWAR NP | IN | J&K | 400.00 | * | 5 |
| MOULING NP | IN | ARU | 483.00 | * | 5 |
| MOULING WS | IN | ARU | 700.00 | * | 5 |
| NAINA DEVI WS | IN | HPR | 156.00 | * | 5 |
| NAMDAPHA NP | IN | ARU | 1985.23 | * | 5 |
| NANDA DEVI NP | IN | UPR | 650.00 | * | 5 |
| PIN VALLEY NP | IN | HPR | 675.00 | * | 5 |
| RUPI BHABA WS | IN | HPR | 125.00 | * | 4 |
| SECHU TUAN NALA NP | | | 103.00 | * | 5 |
| SECHU TUAN NALA WS | IN | HPR | 102.95 | * | 5 |
| SHIKARI DEVI WS | IN | HPR | 214.00 | * | 5 |
| VALLEY OF FLOWERS NP | IN | UPR | 87.50 | * | 5 |

Fig. (d)

STATUS SUMMARY FOR Antilope cervicapra Blackbuck

DISTRIBUTED IN BIOUNITS :- ,06A,06B,06C,06D,03A,03B,06E,04A,04B,07A,

OCCUPIES HABITATS :- ,TDD,TIF,TAZ,

EVALUATION OF HABITAT STATUS (areas given in square kms.)

| Unit | Country | Admin Div. | Vegtn. type | Origin. area | Remain. area | Rem.% | Protect. area | Prot.% | Propos. area | Prop.% |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTALS | | | | 1756662 | 0 | 0 | 80938 | 4.6 | 1935 | 0.1 |

| | |
|---|---|
| % original habitat lost = | 100.0 |
| % original habitat protected = | 4.6 |
| % original habitat proposed = | 0.1 |
| % remaining habitat protected = | **** |
| Expected protected population = | 301524 |
| Expected total population = | 150762 |
| %age population protected = | 200 |
| Red Data Book Status = | Vulnerable |
| Computer assigned status = | Endangered |
| Species listed on CITES appendix | 3 |
| Species protected in countries : | ,IN, |

Blackbuck IS CONFIRMED IN THE FOLLOWING AREAS

| Name | Country | Admin. | Total Area | Confirmed | Status |
|---|---|---|---|---|---|
| ABOHAR WS | IN | PUN | 186.00 | * | 6 |
| BAGDARA WS | IN | MPR | 478.90 | * | 6 |
| BANDHAVGARH NP | IN | MPR | 448.00 | * | 6 |
| DUDHWA NP | IN | UPR | 490.00 | * | 5 |
| ETURNAGARAM NP | IN | APR | 219.00 | * | 6 |
| ETURNAGARAM WS | IN | APR | 806.15 | * | 6 |
| FOSSIL NP | IN | MPR | 0.27 | * | 4 |
| GANDHI SAGAR WS | IN | MPR | 368.62 | * | 6 |
| GHATIGAON WS | IN | MPR | 512.00 | * | 6 |
| GUINDY NP | IN | TNA | 2.82 | * | 6 |
| GUNDLA BRAHMESWARAM NP | IN | APR | 300.00 | * | 6 |
| GUNDLA BRAHMESWARAM WS | IN | APR | 1194.00 | * | 6 |
| INDRAVATI NP | IN | MPR | 1258.00 | * | 6 |
| KANHA NP | IN | MPR | 940.00 | * | 6 |
| KARERA WS | IN | MPR | 202.21 | * | 6 |
| KAWAL WS | IN | APR | 893.00 | * | 6 |
| KEOLADEO GHANA NP | IN | RAJ | 28.73 | * | 5 |
| KINNERASANI WS | IN | APR | 635.41 | * | 6 |
| NANDA DEVI NP | IN | UPR | 650.00 | * | 5 |
| NATIONAL CHAMBAL (M.P.) N | IN | MPR | 50.00 | * | 6 |
| NATIONAL CHAMBAL (M.P.) W | IN | MPR | 320.00 | * | 6 |
| NATIONAL CHAMBAL (Raj.) W | IN | RAJ | 280.00 | * | 6 |
| NATIONAL CHAMBAL (U.P.) N | IN | UPR | 50.00 | * | 6 |

Fig (e) (1 of 2)

| | | | | | |
|---|---|---|---|---|---|
| NATIONAL CHAMBAL (U.P.) W | IN | UPR | 635.00 | * | 6 |
| PACHMARHI WS | IN | MPR | 461.85 | * | 6 |
| PAKHAL WS | IN | APR | 879.30 | * | 6 |
| PANNA NP | IN | MPR | 543.00 | * | 6 |
| POINT CALIMERE NP | IN | INA | 7.00 | * | 6 |
| POINT CALIMERE WS (E) | IN | INA | 17.26 | * | 6 |
| POINT CALIMERE WS (P) | IN | INA | 137.78 | * | 6 |
| PRANAHITA WS | IN | APR | 136.02 | * | 6 |
| RAJIV GANDHI(N)(Nagar.Sri | IN | APR | 2221.09 | * | 5 |
| RAJIV GANDHI(S)(Nagar.Sri | IN | APR | 1347.00 | * | 5 |
| RANEBENNUR WS | IN | KAR | 119.00 | * | 6 |
| RANIPUR WS | IN | UPR | 230.00 | * | 6 |
| ROLLAPADU WS | IN | APR | 6.14 | * | 6 |
| SINGHORI WS | IN | MPR | 287.91 | * | 6 |
| SULTANPUR NP | IN | HAR | 1.43 | * | 6 |
| TAL CHHAPPER WS | IN | RAJ | 7.90 | * | 6 |
| VALMIKI (Extension) WS | IN | BIH | 419.10 | * | 6 |
| VALMIKI NP | IN | BIH | 335.65 | * | 6 |
| VALMIKI WS | IN | BIH | 461.00 | * | 6 |
| VAN VIHAR NP (Madhya Prad | IN | MPR | 4.45 | * | 6 |
| VELAVADAR NP | IN | GUJ | 34.08 | * | 6 |
| WILD ASS NP | IN | GUJ | 1000.00 | * | 6 |
| WILD ASS WS | IN | GUJ | 4953.70 | * | 6 |

Fig. (e) (2 of 2)

# EXAMPLE PROTECTED AREA KNOWLEDGE BASE

Source : WILDLIFE INSTITUTE OF INDIA, DEHRADUN

## Protected Areas of Himachal Pradesh

### Existing Protected Areas

1. Shikari Devi WLS
2. Majathal WLS
3. Kalatop-Khajiar WLS
4. Bandli WLS
5. Talra WLS
6. Chail WLS
7. Shilli WLS
8. Shimla Catchment WLS
9. Darlaghat WLS
10. Pong Dam WLS
11. Renuka WLS
12. Simbalbara WLS
13. Naina Devi WLS
14. Govind Sagar WLS
15. Great Himalayan NP
16. Raksham-Chitkul WLS
17. Lippa Asrang WLS
18. Rupi-Bhava WLS
19. Kais WLS
20. Nargu and Winch WLS
21. Manali WLS
22. Kanwar WLS
23. Khokan WLS
25. Dharanghati WLS
26. Saichu Tuan Nalla WLS
27. Gamgul Siyabhai WLS
28. Kugti WLS
29. Tundah WLS
30. Pin Valley WLS

### Proposed Protected Areas

A Spiti NP and WLS
B Saichu Tuan Nala NP

20-23 to join as Nargu-Khotan

SUMMARY FOR PROTECTED AREA PIN VALLEY NP

| | | |
|---|---|---|
| BIOUNIT | :- | 01B ( Tibetan Plateau ) |
| ADMIN. UNIT | :- | HPR Himachal Pradesh |
| NATIONAL CODE | :- | HPR/NP/PIN |
| LAND-USE CATEGORY | :- | NATIONAL PARK |
| IUCN PA CATEGORY | :- | 2 |
| SPECIAL CATEGORY | :- | Cold Desert |
| DATE NOTIFIED | :- | 09.01.87 |
| TOTAL AREA | :- | 675.00 square kms. |
| ALTITUDINAL RANGE | :- | 3300 -6632 m. |
| AVERAGE RAINFALL | :- | 170 mm. |
| LONGITUDE | :- | 77.45.55 to 78.06.09° E. |
| LATITUDE | :- | 31.44.00 to 32.11.00° N. |
| TEMPERATURE | :- | Min -30 ; Max. 30° Celsius |
| MAPS | :- | Outline |
| DISTRICT | :- | Lahaul & Spiti |
| NEAREST TOWN | :- | Tabo (47 kms) |
| NEAREST RAIL HEAD | :- | Shimla (443 kms) |
| NEAREST AIRPORT | :- | Shimla (458 kms) |
| NOTIFICATION NO. | :- | Fts. (8) F(7)-31/86 dt. 09.01.87. |

THE PROTECTED AREA CONTAINS THE FOLLOWING VEGETATION TYPES :-

| Vegetation Code | Area | Vegetation Status |
|---|---|---|
| AAP | 0.0 | E |

Vegetation Status :- V = Vulnerable, E = Endangered.

Vegetation Description :-

AAP = Alpine Arid Pasture

SPECIES CONFIRMED FROM PIN VALLEY NP

| Scientific Name | English Name | Conf | End | Thr | Abund |
|---|---|---|---|---|---|
| Alticola roylei | Royle's Vole | * | | | 6 |
| Capra ibex sibirica | Himalayan Ibex | * | | | 6 |
| Ochotona roylei | Pika/Him.Mouse Hare | * | | | 5 |
| Uncia uncia | Snow Leopard | * | | E | 5 |
| Vulpes vulpes montana | Red Fox | * | | T | 5 |

Abundance coding :- 4 = scarce, 5 = occasional,
6 = frequent, 7 = abundant
0 = status unknown.

RDB status :- R = Rare, V = Vulnerable, E = Endangered,
I = Indeterminate, T = Threatened,
K = Insufficiently Known.

Confirmed Total Species = 5
% Endemism in Confirmed Species = 0.0
Total Confirmed Species Threatened = 2

MANAGEMENT DETAILS

Fig. (a) (1 of 2)

Management Plan not Completed

| | | | |
|---|---|---|---|
| Current Staff | = | 10 | |
| Current Annual Budget | = | Rs. 610000.00 | |
| Number of Reserve Buildings | = | 15 | |
| Total Tourist Accomodation | = | 0 | Rooms |
| Annual Visitor Level | = | 0 | |
| Number of Reserve Vehicles | = | 0 | |
| The Reserve is Zoned | - | Core,Buffer | |

Fig. (a) (2 of 2)

SUMMARY FOR PROTECTED AREA SHIKARI DEVI WS

| | | |
|---|---|---|
| BIOUNIT | :- | 02A ( North West Himalaya ) |
| ADMIN. UNIT | :- | HPR Himachal Pradesh |
| NATIONAL CODE | :- | HPR/SA/SHI |
| LAND-USE CATEGORY | :- | SANCTUARY |
| IUCN PA CATEGORY | :- | 4 |
| DATE NOTIFIED | :- | 19.09.62 |
| REVISED DATE | :- | 27.03.74 |
| TOTAL AREA | :- | 214.00 square kms. |
| ALTITUDINAL RANGE | :- | 1800 -3359 m. |
| AVERAGE RAINFALL | :- | 1038 mm. |
| LONGITUDE | :- | 77.05.36 to 77.13.41° E. |
| LATITUDE | :- | 31.27.03 to 31.32.16° N. |
| MAPS | :- | Outline |
| DISTRICT | :- | Mandi |
| NOTIFICATION NO. | :- | Ft. 43-51/50-VI dt. 19.09.62 and 5-11/70-SF dt. 27.03.74. |

THE PROTECTED AREA CONTAINS THE FOLLOWING VEGETATION TYPES :-

| Vegetation Code | Area | Vegetation Status |
|---|---|---|
| HMT | 100.0 | |
| SAF | 20.0 | E |
| AMS | 12.0 | E |

Vegetation Status :- V = Vulnerable, E = Endangered.

Vegetation Description :-

| | | |
|---|---|---|
| HMT | = | Himalayan Moist Temperate |
| SAF | = | Sub-Alpine Forest |
| AMS | = | Alpine Moist Scrub |

SPECIES CONFIRMED FROM SHIKARI DEVI WS

| Scientific Name | English Name | Conf | End | Thr | Abund |
|---|---|---|---|---|---|
| Moschus chrysogaster | Himalayan Musk Deer | * | | V | 5 |
| Uncia uncia | Snow Leopard | * | | E | 5 |

Abundance coding :- 4 = scarce, 5 = occasional,
6 = frequent, 7 = abundant
0 = status unknown.

RDB status :- R = Rare, V = Vulnerable, E = Endangered,
I = Indeterminate, T = Threatened,
K = Insufficiently Known.

| | | |
|---|---|---|
| Confirmed Total Species | = | 2 |
| % Endemism in Confirmed Species | = | 0.0 |
| Total Confirmed Species Threatened | = | 2 |

MANAGEMENT DETAILS

Management Plan Written

| | | | | |
|---|---|---|---|---|
| Current Staff | = | | 13 | |
| Current Annual Budget | = | Rs. | 0.00 | |
| Number of Reserve Buildings | = | | 11 | |
| Total Tourist Accomodation | = | | 56 | Rooms |
| Annual Visitor Level | = | | 1000 | |
| Number of Reserve Vehicles | = | | 0 | |

Fig. (b)

SUMMARY FOR PROTECTED AREA GREAT HIMALAYAN NP

| | | |
|---|---|---|
| BIOUNIT | :- | 02A ( North West Himalaya ) |
| ADMIN. UNIT | :- | HPR Himachal Pradesh |
| NATIONAL CODE | :- | HPR/NP/HIM |
| LAND-USE CATEGORY | :- | NATIONAL PARK |
| IUCN PA CATEGORY | :- | 2 |
| DATE NOTIFIED | :- | 01.03.84 |
| REVISED DATE | :- | 30.07.90 |
| TOTAL AREA | :- | 620.00 square kms. |
| ALTITUDINAL RANGE | :- | 1500 -5805 m. |
| LONGITUDE | :- | 77.38° E. |
| LATITUDE | :- | 31.38° N. |
| TEMPERATURE | :- | Min. -20 ; Max. 25° Celsius |
| MAPS | :- | Outline |
| DISTRICT | :- | Kullu |
| NEAREST TOWN | :- | Kullu (60 kms) |
| NEAREST RAIL HEAD | :- | Joginder Nagar |
| NEAREST AIRPORT | :- | Bhuntar (50 kms) |
| NOTIFICATION NO. | :- | 6-16/73-SF dt. 01.03.84 and 6-16/73-SF dt. 30.07.90. |

THE PROTECTED AREA CONTAINS THE FOLLOWING VEGETATION TYPES :-

| Vegetation Code | Area | Vegetation Status |
|---|---|---|
| HMT | 0.0 | |

Vegetation Status :- V = Vulnerable, E = Endangered.

Vegetation Description :-

HMT = Himalayan Moist Temperate

SPECIES CONFIRMED FROM GREAT HIMALAYAN NP

| Scientific Name | English Name | Conf | End | Thr | Abund |
|---|---|---|---|---|---|
| Alticola roylei | Royle's Vole | * | | | 5 |
| Canis aureus | Jackal | * | | V | 4 |
| Canis lupus | Indian Wolf | * | | V | 6 |
| Capra ibex sibirica | Himalayan Ibex | * | | | 6 |
| Caprolagus hispidus | Hispid Hare | * | * | E | 5 |
| Cervus unicolor | Sambar | * | | | 5 |
| Cuon alpinus | Asiatic Wild Dog/Dhole | * | | V | 4 |
| Hemitragus jemlahicus | Himalayan Tahr | * | | K | 6 |
| Hylopetes fimbriatus | Kashmir Fly.Squirrel | * | | | 6 |
| Hystrix indica | Indian Porcupine | * | | | 4 |
| Macaca mulatta | Rhesus Macaque | * | | | 4 |

**Fig. (c) (1 of 2)**

| | | | | |
|---|---|---|---|---|
| Martes flavigula | Himalayan Marten | * | I | 5 |
| Moschus chrysogaster | Himalayan Musk Deer | * | V | 5 |
| Naemorhedus sumatraensis | Serow | * | E | 6 |
| Nemorhaedus goral | Goral | * | V | 5 |
| Neofelis nebulosa | Clouded Leopard | * | V | 4 |
| Ochotona roylei | Pika/Him.Mouse Hare | * | | 4 |
| Paguma larvata | Himalayan Palm Civet | * | | 5 |
| Panthera pardus | Leopard | * | T | 4 |
| Prionailurus bengalensis | Leopard Cat | * | | 4 |
| Pseudois nayaur | Blue Sheep/Bharal | * | | 6 |
| Selenarctos thibetanus | Himalayan Black Bear | * | V | 5 |
| Semnopithecus entellus | Common Langur | * | | 4 |
| Soriculus gruberi | Gruber's Shrew | * | | 6 |
| Sus scrofa | Wild boar | * | | 4 |
| Uncia uncia | Snow Leopard | * | E | 4 |
| Ursus arctos | Himalayan Brown Bear | * | V | 5 |
| Vulpes vulpes montana | Red Fox | * | T | 5 |

Abundance coding :- 4 = scarce, 5 = occasional,
6 = frequent, 7 = abundant
Ø = status unknown.

RDB status :- R = Rare, V = Vulnerable, E = Endangered,
I = Indeterminate, T = Threatened,
K = Insufficiently Known.

| | | |
|---|---|---|
| Confirmed Total Species | = | 28 |
| % Endemism in Confirmed Species | = | 3.6 |
| Total Confirmed Species Threatened | = | 15 |

MANAGEMENT DETAILS

Management Plan Written

| | | | |
|---|---|---|---|
| Current Staff | = | 22 | |
| Current Annual Budget | = | Rs. 2100000.00 | |
| Number of Reserve Buildings | = | 40 | |
| Total Tourist Accomodation | = | 7 | Rooms |
| Annual Visitor Level | = | 100 | |
| Number of Reserve Vehicles | = | 1 | |

Fig. (c) (2 of 2)

# LIST OF AGRO-ECOLOGICAL CODES USED IN MFP SYSTEM

Appendix A3.4 List of Agro Ecological Codes used in MFP System

| AE | DESCRIPTION |
|---|---|
| 01 | Western Himalays,Covering Ladakh & Gilgit districts |
| 02 | Western part of Rajasthan(Marusthal),Southwestern part of the states of Haryana & Punjab,Kutch peninsula & northern part of Kathiawar peninsula |
| 03 | Part of Deccan Plateau includes dist. of Raichur,Bellary of Karnataka & Anantapur in Andhra Pradesh |
| 04 | Parts of Northern Plain,Central Highlands & Gujarat Plain |
| 05 | Western part of MP,Eastern part of Rajasthan & Gujarat encompassing Kathiwar Peninsula |
| 06 | Maharashtra, Northern parts of Karnataka & Andhra Pradesh |
| 07 | Parts of Deccan Plateau & eastern Ghtas,Major part of A.P. |
| 08 | Southern parts of Deccan Plateau,Tamil Nadu Uplands & Western parts of Karnataka |
| 09 | Part of northern Indo-Gangetic Plain,including piedmont plain of the Western Himalays |
| 10 | Part of Central Highland,including dists. of Raisen,Sagar, Bhopal,Sehore,Shajapur & Hoshangalad |
| 11 | Bundelkhand part of M.P & north-eastern part of Vidarbha region |
| 12 | Parts of eastern Plateau comprising Chhatisgarh region of MP & south-west Highlands |
| 13 | Chotta Nagpur Plateau of Bihar,Western parts of W.Bengal,eastern Ghats of Orissa & Bastar region of Madhya Pradesh |
| 14 | Eatern Plains,Covers north-eastern Uttar Pradesh & northern Bihar, including foot-hills of Central Himalayas |
| 15 | Comprising of W.Himalays,Covers J&K,HP&north-western hilly areas of UP |
| 16 | Comprising the Plains of the Bramhaputra & the Ganga river,Covers part of Assam & W.Bengal including Southern pocket of Assam |
| 17 | Encompasses nortern tip of West Bengal,northern part of Assam & most part of Arunachal Prasesh & Sikkim |
| 18 | North-eastern hilly Nagaland,Meghalaya,Manipur,Mizoram & South Tripura |
| 19 | Eastern Coastal plain,extending from Cauvery delta to Gangetic delta |
| 20 | Sahyadris,Western Coastal Plains of Maharashtra,Karnataka,Kerala |
| 21 | Islands of A & N in the East and of Lakshadweep in the West |

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

# LIST OF ECO-FLORISTIC CODES USED IN MFP SYSTEM

Appendix A3.5 List of Eco-Floristic Codes used in MFP System

| EF | DESCRIPTION |
|---|---|
| 01 | Trans-Himalaya in Indus catchment |
| 02 | North-West Himalayan with Mediterranean tendency no tropical regime |
| 03 | Western Himalaya including parts of Jammu, H.P & U.P hills under tropical monsoonic regime |
| 04 | North-East India & Eastern Himalayas from Sikkim eastwords |
| 05 | Indian desert with long dry season, Western Rajasthan & Kutch Peninsula |
| 06 | Deccan desert,Bijapur to Malagaon,North Gujarat plains & piedmonts of Aravalli ranges |
| 07 | Semi-arid Deccan thorny forest Maharashtra |
| 08 | Semi-arid forest of Rajasthan,M.Pradesh&Bundelkhand reg. upto 1000m alt |
| 09 | Semi-arid forest of Coromandel cost |
| 10 | Semi-arid Hardwickia forest on dry plateau of Karnataka,A.P,Satpura, Vindhya & dry plateau of Salem upto 1000m altitude |
| 11 | Semi-arid Sal forests on dry plateau & hills of Bihar & Orissa upto 900m |
| 12 | Semi-arid hill forest of Vishakapatnam,Koraput,Bailadala & Papikonda upto 900m alt. |
| 13 | Sal forests of Puri and Cuttack districts |
| 14 | Sal forest (above 1000m |
| 15 | Miscellaneous forest (Soil & teak mixed) zone on hills of Gujarat, Rajasthan,Madhya Pradesh and Peninsular hills |
| 16 | Teak forest zone of peninsular India to Bundelkhand upto 1000m alt. |
| 17 | Wet evergreen teak forests ecotone |
| 18 | Wet evergreen forest of West and Western Ghat |
| 19 | Wet evergreen,montane Shola forests of West coast-Western Ghats (high hills of Nilgiris,Annamalai,Bababudn,Giri hills above 1500m) |
| 20 | Wet evergreen forests of West coast,W.Ghats with pronounced dry seasons hills from 700-1500m alt. |
| 21 | Wet evergreen forest Western Cost,W.Ghat,C.India (dry season) |
| 22 | Trop Wet evergreen forest of A.N. Islands coast to 800m alt. |
| 23 | Coastal formations of East-West Coast,Godavan,A.N. Islands, mangrove formations |

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

# LIST OF FOREST TYPE CODES USED IN MFP SYSTEM

Appendix A3.6 List of Forest Type Codes used in MFP System

| FT | DESCRIPTION |
|---|---|
| 01 | TROPICAL WET EVERGREEN FOREST |
| 02 | TROPICAL SEMI-EVERGREEN FOREST |
| 03 | TROPICAL MOIST DECIDUOUS FOREST |
| 04 | LITTORAL AND SWAMP FOREST |
| 05 | TROPICAL DRY DECIDUOUS FOREST |
| 06 | TROPICAL THORN FOREST |
| 07 | TROPICAL DRY EVERGREEN FOREST |
| 08 | SUBTROPICAL BROADLEAVED HILL FOREST |
| 09 | SUBTROPICAL PINE FOREST |
| 10 | SUBTROPICAL DRY EVERGREEN FOREST |
| 11 | MONETANE WET TEMPERATE FOREST |
| 12 | HIMALAYAN MOIST TEMPERATE FOREST |
| 13 | HIMALAYAN DRY TEMPERATE FOREST |
| 14 | SUBALPINE AND ALPINE FOREST |
| 15 | SUBALPINE AND ALPINE FOREST |
| 16 | SUBALPINE AND ALPINE FOREST |

Source : CENTRE FOR MINOR FOREST PRODUCTS, DEHRADUN

# PROGRAM LISTING OF MFP IAQM

```
*************************************************************************
*MFP.PRG
*MINOR FOREST PRODUCTS  DATABASE  PROGRAM
*
*
*************************************************************************

*INITIALISE
*********************************************
# include "inkey.ch"
# include "box.ch"
# define MEMOFORMAT  .F.
# define COMPILE(c_expr) &("{||" + c_expr + "}")

COLMON=ISCOLOR()

* Initialize global variables and overall conditions
INITGLOBAL(colmon)
DEVELOP()
SETCOLOR(colstd)
CLEAR SCREEN
SET DELETED ON
SET SOFTSEEK ON
set talk off
set date brit
SET SCOR OFF
SET KEY 22 TO CSRINSERT
SET PROC TO TMFUNC
STORE 'C' TO DRV.
EXTERNAL DBVIEW
EXTERNAL SYSCHECK
*EXTER DVISFUNC
EXTERNAL SYSHELP
set proc to dvisfunc
# For Overlay generation : EXTERNAL REP_FN,REPO,MONTHLY1,MONTHLY2,DISTRIB1,DESP,SHCAL

PRIVATE OBURCH, OBCH
PRIVATE apphelp := 'SYSHELP', fkeySet := 'HOTKEYS'
*
PUBLIC helpfile := "TMSHELP"
PUBLIC helpcode := ""
*
PUBL OPTION,NILL,CHTIS,MCH,CH1,CH2,chmod,CHINF,repfile1,REPPRN,CHBAK
PUBL GUEST,mLOGIN,PASSOK,mACLVL
PUBL LX,LY
PUBL mLNAME,mLGP,mLGPMENU
publ gCO_ORD,gCNO,gGROUP,gYR,gDATE,gDESIG,gCO_DESIG,gORG

PUBL gFA_PX , gSO_PX ,gLNO_PX , gGROUPDES, gPO
PUBL mHEAD1,mHEAD2,mHEAD3,mHEAD4
PUBL PRINTYES
```

APPENDIX A5.1

# PROGRAM LISTING OF ISNET BBS ATLAS SERVER IN PROCOMM LANGUAGE

APPENDIX A5.1 PROGRAM LISTING OF ISNET BBS ATLAS SERVER IN PROCOMM LANGUAGE

(SAMPLE PAGE ONLY)

```
; BBSFTS.CMD
; ISNET BBS - FATHER-TO-SON    SERVER PROGRAM
; INSTALLED AT DEHRADUN
; INITIALISE  VARIABLES:
; S1 - ID
; S2 - assigned password of valid user
; S3 - Password received from caller    / name of new caller
; S4 - assigned Name of Person          / phone no. of new caller
; S5 - used later
CLEAR
MESSAGE "*********************************************************"
MESSAGE "*                                                       *"
MESSAGE "*                  W E L C O M E                        *"
MESSAGE "*                                                       *"
MESSAGE "*                      T O                              *"
MESSAGE "*                                                       *"
MESSAGE "*                                                       *"
MESSAGE "*                I S  -  N E T                          *"
MESSAGE "*                                                       *"
MESSAGE "*          B B S -F A T H E R - T O - S O N             *"
MESSAGE "*                                                       *"
MESSAGE "*              A T L A S  S E R V E R                   *"
MESSAGE "*                                                       *"
MESSAGE "*           S Y S  O P   -   C O N S O L E              *"
MESSAGE "*                                                       *"
MESSAGE "*********************************************************"
PAUSE 2
CLEAR
LOCA 3,1
MESSAGE "Enter your ID : "
LOCA 3,20
GET  S1 4
LOCA 4,1
MESSAGE "Enter ISNET Password : "
LOCA 4,25
MGET S2 8
MESSAGE " "
MESSAGE " "
SET ALARM ON
SET CR_OUT CR_LF
SET TRAN ON
GOSUB CHK_OPID
IF NOT FOUND
  LOCA 7,1
  MESSAGE "Sorry, you are not authorised to operate IS-NET BBS FTS"
  PAUSE 5
  quit
ENDIF

EXEC "ASKMODE.CM2"
```

# SAMPLE RUN OF CO-OPERATIVE GPSS MODEL

APPENDIX A5.2 SAMPLE RUN OF CO-OPERATIVE GPSS MODEL

```
ATDP0113747244
CONNECT 1200 RELIABLE

       WELCOME TO GPSN NEW DELHI       07
*NCCDVIDND-31412152931000

COM
Telebase Systems, Inc. KGC-4
ID?VSNL
PASSWORD?********

Welcome!
+-----------------------------------+
|                                   |
|       WELCOME TO EASYNET          |
|                                   |
|  (c) 1992 Telebase Systems, Inc.  |
|    U.S. Patent No. 4,774,655      |
|                                   |
+-----------------------------------+
Logon 1261467 19Aug93 12:40 EST

PRESS   TO SELECT          * Main Menu *

  1 EasyNet selects database
  2 User knows database name
  3 Instructions

  H for Help, C for Commands

Total charges thus far:       0.00 Rs
-> 2
                      * SELECT SEARCH METHOD *

PRESS   TO SELECT

  1 Menu searching
  2 Command searching

  H for Help, C for Commands

Total charges thus far:       0.00 Rs
-> 1

Please enter the database name as you know it.
(Use B to back up.)

-> FOREST PRODUCTS

Searching.....................................................

That database name is not in our index.
```

PRESS  TO SELECT  * Main Menu *

1 EasyNet selects database
2 User knows database name
3 Instructions

H for Help, C for Commands

Total charges thus far: 10.00 Rs
-> 1

* SUBJECT CATEGORIES *

PRESS  TO SELECT

1 Business
2 Science & Technology
3 Medicine & Allied Health
4 Law, Patents, Tradenames
5 Social Sciences & Education
6 Arts, Literature, Religion
7 People
8 News
9 General Reference

H for Help, C for Commands

Total charges thus far: 10.00 Rs
-> 2

* SCIENCE & TECHNOLOGY *

PRESS  TO SELECT

1 Agriculture & Food
2 Biology
3 Chemistry
4 Computers
5 Earth Sciences
6 Engineering & Technology
7 Energy
8 Mathematics
9 Physics

H for Help, C for Commands

Total charges thus far: 10.00 Rs
-> 1

* ENTER AGRICULTURE TOPIC *

SEARCH TIPS: Omit all punctuation and small, common words (examples: the, as, in, on, for, an, of).

SEARCH EXAMPLES: citrus AND export

cattle OR livestock
(grape/ OR vineyard/) AND forecast/

Type H for more help and examples.

ENTER AN AGRICULTURE TOPIC
-> TIMBER AND INDIA

Is:
TIMBER AND INDIA
Correct ? (Yes/No) -> Y

We have no reason to believe that errors exist in the data or services furnished. If there are any such errors the parties hereto have no liability for any consequential, incidental or punitive damages. No warranty, either expressed or implied, including but not limited to those of merchantability or fitness for a particular purpose are made. Any liability is limited to the amount paid by the customer to Telebase.

**********

The scan is now in progress. Your query is being submitted to a selected group of databases.

When the scan is completed, a results menu will display. This special menu will show you which of the databases contains information on your topic. To help you select the appropriate databases to search, the menu will indicate the format of items in each database and the main source of information, such as journals, books, or newspapers. You'll also be able to see database descriptions by typing H. Further assistance will be available from the results menu by typing SOS to access our online reference support facility.

Note that database searches conducted from the scan results menu incur normal search charges. The scan process may take a few minutes. The message "Scanning, please wait..." will repeat until the scan is completed.

Scanning, please wait...

(Use B to back up.)

-> 1137

Searching.....

* GEOARCHIVE *

PRESS TO SELECT

1 by subject words
2 by author name
3 by journal name
4 by publication year

```
  H  for Help, C for Commands

Total charges thus far:       10.00 Rs
-> 1

                    * ENTER SUBJECT WORDS *

SEARCH TIPS:  Omit all punctuation and small, common words
              (examples: the, as, in, on, for, an, of).

SEARCH EXAMPLES:  proterozoic AND crust/
                  argon OR helium

Type H for more help and examples.

ENTER SUBJECT WORDS
-> HIMALAYAN GEOLOGY AND INDIA


Is:
HIMALAYAN GEOLOGY AND INDIA
 Correct ? (Yes/No) -> Y

PRESS    TO SELECT

  1  Narrow your search  (add more fields)
  2  Begin your search now
  H  for Help,   C  for Commands

Total charges thus far:       20.00 Rs
-> 1

                              * GEOARCHIVE *

PRESS   TO SELECT

  1  by subject words
  2  by author name
  3  by journal name
  4  by publication year

  H  for Help, C for Commands

Total charges thus far:       20.00 Rs
-> 4

                    * ENTER PUBLICATION YEAR *

SEARCH  TIPS:  Enter the publication year in YYYY  format.  This
               database covers data from 1974 to the present;
               do NOT enter a pre-1974 date, as it may cause your
               search to fail.

SEARCH EXAMPLES:  1987
```

1988 OR 1990

Type H for additional help and examples.

ENTER THE PUBLICATION YEAR
-> 1987 OR 1988 OR 1989 OR 1990

* * * Search Alert * * *

You are using three or more "OR"s in
a single search statement.

This often leads to searches that
are too broad.

Would you still like to proceed with this search? (Yes/No) -> Y

Is:
1987 OR 1988 OR 1989 OR 1990
Correct ? (Yes/No) -> Y

PRESS TO SELECT

1 Narrow your search (add more fields)
2 Begin your search now
H for Help, C for Commands

Total charges thus far: 30.00 Rs
-> 2

We have no reason to believe that errors exist in the data or services furnished. If there are any such errors the parties hereto have no liability for any consequential, incidental or punitive damages. No warranty, either expressed or implied, including but not limited to those of merchantability or fitness for a particular purpose are made. Any liability is limited to the amount paid by the customer to Telebase.

System is now searching the Geoarchive database, copyrighted 1993 by Geosystems, London, England and is available through Dialog Information Services, Inc.

Accessing Network.....Completed.
Accessing Database Host.....Completed.
Logging on.....Completed.
Logging on (second step)....Completed.
Selecting Database.....Completed.
Submitting Search.\.....Completed.

Occurrence Search expression
---------- ----------

APPENDIX A5.3

# PROGRAM LISTING OF ISNET CO-OPERATIVE MODEL

APPENDIX A5.3 PROGRAM LISTING OF ISNET CO-OPERATIVE MODEL

(SAMPLE PAGE ONLY)

```
*********************************************************************
*ISNET.PRG
*ISNET
*Integrated Systems - Network
*
*Proprietary System by  Doon Valley Integrated Systems,
*              9 Badrinath Chibber Marg,
*              Dehradun
*              ph: 0135-29721
*
*Copyright (c) Er. Harsh Verma, 1994
*
*********************************************************************


*INITIALISE
************************************************
# include "inkey.ch"
# include "box.ch"
# define MEMOFORMAT  .F.

COLMON=ISCOLOR()

* Initialize global variables and overall conditions
INITGLOBAL(colmon)
DEVELOP()
SETCOLOR(colstd)
CLEAR SCREEN
SET DELETED ON
SET SOFTSEEK ON
set talk off
set date brit
SET SCOR OFF
SET KEY 22 TO CSRINSERT

set proc to wasproc
SET PROC TO TMFUNC

STORE 'C' TO DRV

EXTERNAL DBVIEW
EXTERNAL SYSHELP

PRIVATE DBURCH, OBCH
PRIVATE apphelp := 'SYSHELP', fkeySet := 'HOTKEYS'
*
PUBLIC helpfile := "TMSHELP"
PUBLIC helpcode := ""
*
PUBL OPTION,NILL,CHTIS,MCH,CH1,CH2,chmod,CHINF,repfile1,REPPRN,CHBAK
PUBL GUEST,mLOGIN,PASSOK
```

```
PUBL LX,LY
PUBL mLNAME,mLGP,mLGPMENU
publ gCO_ORD,gCNO,gGROUP,gYR,gDATE,gDESIG,gCO_DESIG,gORG

PUBL gFA_PX , gSO_PX ,gLNO_PX , gGROUPDES, gPO
PUBL mHEAD1,mHEAD2,mHEAD3,mHEAD4
PUBL PRINTYES
PUBL DRWHO       && VOICE OUTPUT SYSTEM

DO GPARAMTR

*
gORG='IMD'
public Gdbe_view := ARRAY(1), Gheadings := ''

TRIGGER= ' '

rest from lic.sys addi

*
menulvl=0
gDATE=date()
gYR=SUBSTR(str(year(gDATE),4),3,2)+'-'+SUBSTR(str(year(gDATE)+1,4),3,2)

* EDIT/GET ROW - GR
GRTOP=5

SET KEY K_F1 TO &apphelp
*SET KEY K_F2 TO HOTKEY_2
*SET KEY K_F3 TO HOTKEY_3
*CENTERON(18, 'Press F1, F2, F3 for simulated HOTKEY functions')
*CENTERON(19, 'Press ALT-G, ALT-V or ALT-H for GRID and RULERS')

*help()
helpcode='ISNET01'


*DO TMPASS

wait 'Press a key to continue' to ix
if uppe(ix) = 'I'
 clea
 @ 5,5 say 'Please wait, Indexing Files...'
 do indxfile
endif

 LAN_DIAGNOSE()


 IF .NOT. LAN_WORKING

                STANDALONE_OPNS()

 ENDIF
```

```
*GET_DATE()

DO WHILE .T.
PASSOK=.F.
SETCOLOR(colstd)
*SPEAK("Welcome to IS Net")
do ISNETIT

LX=13
LY=4

*login_scr= savescreen(0,0,24,80)

*               DISP_MESS(" Login :  " )
do login

              &&   (Login :  GUEST / USER_ID)
IF upper(mLOGIN)='EXIT'
* LOOP
 EXIT
ENDIF



IF GUEST
                              NO_PASSWORD()

                              GUEST_MENU()

ELSE

             do lmpass
             IF .NOT. PASSOK
               LOOP
             ENDIF
             do getgrp
  IF mLOGIN = 'SUPER'
     DO MENUSUP

  ENDIF

DONEBEEP()
PAUSE(3)

DO AX

*EXIT
         scrnpush(0,0,24,79)
              scrnpop()

ENDIF
ENDDO

RETU
```

# UP BASE MAP, UU-ENCODED INTO A TEXT FILE

APPENDIX A5.4 UP BASE MAP, UU-ENCODED INTO A TEXT FILE

section 1 of uuencode 5.25 of file up0.pcx by R.E.M.

```
begin 644 up0.pcx
M"@4!'0````!G'CX"@`+@`0```(`````"```("`````@(``@`"`@("`@,#`P/\'
M``#_`/__````__\'_P#_____P`$30```)@$#DQW&Y@$GQQ``)@$&DQW&Y@$
MCQ$!`"!,X`\!````G@2D`$T+.$QQ$@$````!````YO-B"#8(``!_U__!X#C!
MJ\"`;C_!_W_%_P!O`+E`7%@QQQ`2/",(`(,!3PQJ`<+_0!`7``_!Y\`QQ_J_
MU__!X#C!J\"`;C_!_W_%_P!O`+E`7%@QQQ`2/",(`(,!3PQJ`<+_0!`7``_!
MY\`QQ_J_U__!X#C!J\"`;C_!_W_%_P!O`+E`7%@QQQ`2/",(`(,!3PQJ`<+_
MO!`7``_!Y\`QQ__8_\'P?\C_P?C!`\#`R`#!P``#`!_"_Y3$_\'QP<##_\'S
MQ_`_R?_"W\3_P?C'_\``/\'WRQJ\P<Q!P\'K?K#!YQ@`$`$T7(N_/\'_CX`5
MO\'XF<'AP__!_)Q#_\'QQ/_!C\+_Q\G_PM_$_\``Q__!P#_!J\K_?,`+P</!
MZWZPP>4(`!`!-%R+QS_!_X``%;_!`)G!X</_P?R;P__!C\3_P>_"_C_)_\+?

:
:
:

M\#_6_YT%UQ_-_\``S/_!_@8/P?`_UQ`=!=;_V_\/'\'P/J;_P?X#UQ_;_\'Q
MG\``/J?_!J;_V__!CY_!_C_7_P?6_JQ_P>`?P?X_U_\'UQ_=_\'P/`C_W?_!
M_G_N_JW_P?Y_CQ_=_\``?`C____.____SQ___\C____.____SQ_<_\'W\/_<
M_\'W\/_<_\'W\/___\C_W/_!Y_#_W/_!Y_#_W/_!Y_#_W/_!J_#_W/_!Y_#_
MW/_!Y_#_W/_!Y_#_W/_!J_#_W/_!J_#_W/_!J_#_W/_!J_#____.____SQ__
M_\C____.____SQ___\C____.____SQ___\C_QQ_!C___Q__&_\'Q___`_\;_
MP>___\?____._\S_Q___P?_,_C___\'_S/`____!____SQ_/_C_J_\__Q_W_
MS_`__?___\C_YQ_!_G_E_`;_P?Y_Y?_F_\``?`7____._`3_?\'CY__D_W_!
M``^?_Y/J_P?QG____SQ___\C____.____SQ___\C_ZQ`_XQ_J_C_B_`K_Q`+_
M___.____SQ___\C____.____SQ_(_\'Q___%_\C_P>___\7_R/_!C___Q?__
M_\C_T__!J_G_T__!J_G_T__!J_G____.____SQ___\C____.____SQ___\C_
M___.____SQ___\C_P__!_?__RQ_#_\'J___*_\/_P?W__\K____.____SQ__
M_\C____.____SQ_J_\'CXQ_J_\'CXQ_J_\'CXQ___\C_RQJ____#_\K_?___
MP__*_W___\/____._J;_P?WB_\``T__6_\'JXQ_!_M/_UQ_!_>+_P?C3____
HSQ_Y_\``T__Y_\``T__Y_\``T____\C____.____SQ___\C____.___.
`
end
```

sum -r/size 2440/58548 section (from "begin" to "end")
sum -r/size 40187/42475 entire input file

# SAMPLE PAGE OF INTERACTIVE HUMAN NEUROANATOMY ATLAS ON INTERNET

# SAMPLE PAGE OF INTERACTIVE HUMAN NEUROANATOMY ATLAS ON INTERNET

# Brainiac!
# Interactive Human Neuroanatomy Atlas

## Welcome to the home of Brainiac! Developed exclusively by Medical Multimedia Systems

---

## Summary

**Brainiac! is the #1 selling computerized interactive neuroanatomy atlas. Currently in use at universities throughout the US, Europe, Australia, China, Israel, South America, New Zealand and Canada, Brainiac! has taught neuroanatomy to thousands of students.**

### Download the free demo below and see why!

Most people who have taken a course in human neuroanatomy will probably tell you it was one of the most difficult courses they ever took. Ask why, and they will tell you about the hours they spent trying to remember the names and locations of countless neuroanatomical structures.

**Now imagine having a learning aid that reduces your study time by hours and is fun to use!**

Brainiac! is a state of the art interactive human neuroanatomy atlas that goes beyond the pages of an ordinary textbook. The intuitive "point and click" interface allows you to quickly and easily navigate through the central nervous system.

---

 **Features**

 **Program Overview** (screen shots totalling approx. 300k)

 **System Requirements**

 **Free Demo**

 **Pricing**

MEDICAL MULTIMEDIA SYSTEMS Return to Home Page

# SAMPLE PROGRAM IN HTML FOR WEB PAGES FOR DTA

APPENDIX A5.6 SAMPLE PROGRAM IN HTML FOR WEB PAGES FOR DTA

(SAMPLE PAGE ONLY)

```
<html>
<head>
        <title>DIGITAL THEMATIC ATLAS</title>
        <meta name="Author" content="Harsh Verma">
</head>

<body>
<center><img src="dtalogo.bmp" alt="blueline" align="middle">
<h1><img src="mapw1.bmp" align="absmiddle">DIGITAL THEMATIC ATLAS</h1>
<h2> RESEARCH PROTOTYPE</h2>
<img src="world1.bmp" alt="blueline" align="middle">
<h3>Welcome to World Map on Digital Thematic Atlas WWW Server Prototype </h3>
</center>


<center>
<h6><img src="world1.bmp" align="middle" ismap="ISMAP">WWW ATLAS SERVER PROTOTYPE <a href="#Top"></a></h6>

</center>

<p>From this World Map, you can select any country by point-and-click method. Since this is at Conceptual Stage,
   you may only select India, however you have the option to link up to other World Maps through links shown
   elsewhe re.<p>
<p><a href="dtaindia.htm"><img src="go_next_.gif"> Click here to select India</a>,

This page was created on 29 Jan '96<p>

<i>This page was created by Harsh Verma</i>


<p><a href="http://www.econet.apc.org"><img src="go_next_.gif">Click here to linkup to other Thematic
   Projects on WWW</a>
</body>
</html>
```

(SAMPLE PAGE ONLY)

```
<html>
<head>
        <title>DIGITAL THEMATIC ATLAS</title>
        <meta name="Author" content="Harsh Verma">
</head>

<body>
<center><img src="dtalogo.bmp" alt="blueline" align="middle">
<h1><img src="mapw1.bmp" align="absmiddle">DIGITAL THEMATIC ATLAS</h1>
<h2> RESEARCH PROTOTYPE</h2>
<img src="india0.bmp" alt="blueline" align="middle">
<h3>Welcome to India Map on Digital Thematic Atlas WWW Server Prototype </h3>
</center>


<center>
<h6><img src="india0.bmp" align="middle" ismap="ISMAP">WWW ATLAS SERVER PROTOTYPE <a href="#Top"></a></h6>

</center>

<p>From this Map of India, you can select any state by point-and-click method. Since this is at Conceptual Stage,
  you may only select UP.<p>
<p><a href="dtaup.htm"><img src="go_next_.gif"> Click here to select State Map of UP</a>,

This page was created on 29 Jan '96<p>

<i>This page was created by Harsh Verma</i>



</body>
</html>
```