BIODIVERSITY INFORMATICS PROVIDES POTENTIALLY IMPORTANT GEO-SPATIAL DATABASE FOR BETTER PLANNING AND MANAGEMENT OF MELGHAT FOREST.

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ABSTRACT

The term "Biodiversity Informatics" was coined to circumscribe the application of IT tools technology to biodiversity information. It thus deals with the information capture, storage, provision, retrieval, and analysis, focused on individual organisms, populations, and taxa and their interaction. This is an opportunity to apply this technology to develop an information infrastructure that would enable us to unlock the wealth of biodiversity information that exists around the world. Global biodiversity information will bring together people, information, and analytical capabilities that could accelerate the process of knowledge discovery, deliver answer to natural resource management and research questions, and affect the quality of life on earth for the good. In this present research work the objective was to provide potentially important geo-spatial data for better Planning and Management. Biodiversity Informatics is to provide a sound information management infrastructure for biodiversity and Global Change research.

Key Words: Biodiversity, Informatics, Morphodiversity, Information System, Database

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INTRODUCTION

Biodiversity stands for all living things on earth. It refers to the range of variations among a set of entities and is commonly used to describe variety and variability of living organisms in terms of genetic diversity, species diversity and ecological diversity. Plant and animal diversity ensures a constant and varied source of food, medicine, and row material for human populations. In Agriculture, biodiversity provides us with a varied food supply which is needed for balanced human nutrition. Biodiversity is the basis of human survival, and economic development as it provides a large number of goods, and services, that sustain our lives. In the developing world, biodiversity provides the assurance of food, countless raw materials such as fiber for clothing, materials for shelter, fertilizer, fuel, medicines and other necessities. I

The technology of bioinformatics is both versatile and is able to be applied wherever research is being done on genetics, proteins and cells for herbicide-resistant products for crops in agriculture. Bioinformatics and computational biology are rooted in the life sciences as well as computer and information sciences and technologies. Both of these interdisciplinary approaches draw from specific disciplines such as mathematics, physics, computer science and engineering, biology, and behavioral science. Bioinformatics and Computational biology each maintain close interactions with life sciences to realize their full potential. Bioinformatics applies principles of information sciences and technologies to make the vast, diverse, and complex life sciences data more understandable and useful. Bioinformatics derives knowledge from computer analysis of biological data. Biological and ecological data are among the most diverse and complex in the scientific realm, spanning vast temporal and spatial scales, distant localities, and multiple disciplines. Biodiversity Informatics includes the application of information technologies to the management, algorithmic explorations, analysis and interpretation of primary data regarding life, particularly at the species level of organization. Presently, the overriding objective of research and other activities in Biodiversity Informatics is to provide a sound information management infrastructure for biodiversity and global change research.

REVIEW OF LITERATURE

Cotter and Bauldock (2000) presented a paper on Biodiversity Informatics Infrastructure. Biodiversity informatics infrastructures are being called for at national, regional, and global levels, and plans are in place to coordinate these efforts to ensure interoperability. This information is diverse and includes biological specimens, journal articles, videos numeric, data, satellite images, and audio files. Stockwell *et al.,* (2000) commented on an interface between computing, ecology and biodiversity. Environmental Informatics. Biological and ecological data are among the most diverse and complex in the scientific realm, spanning vast temporal and spatial scales, distant localities, and multiple disciplines. The grand challenge for the 21st century is to harness knowledge of the earth’s biological and ecological diversity to understand how they shape global environmental systems. In view of Schnase (2000) the biodiversity enterprise is a vast and complex information domain. There is a need to built infrastructure for that domain, major research thrusts needed to improve its work practices, and areas that could contribute to the advance of the field. The emerging field of biodiversity informatics is attempting to meet the challenges posed by this domain. A fully digital, interactive biodiversity information service would require substantial computational and storage resources. Phattaralerphong and Sinoquet (2005) developed a method for 3D reconstruction of tree crown volume from a set of eight photographs taken from different angles. This photographic method of reconstruction included three steps. They described a fast and nondestructive photographic method, implemented in the Tree Analyzer software, for estimating crown volume made by the photographic method and were compared with values computed directly from 3D-dizitized plants. Kagan (2006) has shed light on challenges and opportunities for applying biodiversity information to management and conservation. It contains comprehensive taxonomy information, provides a set of standardized codes that are used by almost all agencies in United Status for database management. Lobo (2008) analyzed the results of the best comparative study of the performance of different modeling techniques, which used pseudo-absence data selected at random. He provided an example of variation in model accuracy depending on the type of absence information used, showing that good model predictions depend most critically on better biological data.

MATERIALS AND METHODS

In the present study especially the tree species were selected because the trees were economically and medicinally important and they show lot of diversity among them. Study of diversity was done up to the family, genus and species level. The whole information was carried over further to computational study. Plants were described according to Bentham and Hooker system of classification by considering parameters such as tree code, local name, family, genera, scientific name, habitat, habit, stem, leaf, flower, calyx, corolla, androecium, gynoecium, fruit, flowering and fruiting periods. Identification of the plants to the level of species, genus, and family was done with help of publish floras.

The biodiversity information was gathered and processed by applying bioinformatics tools. Bioinformatics is more of a tool than a discipline. Information technology makes usage of software, hardware and internet based communication systems for the analysis of Biological Data. The dataset and databases are useful as management information system (MIS) in decision making. Aerial satellite photographic method was useful for mapping large scale forest area. Accurate identification of spot-vegetation potential was done, and topographic situations were well labeled. This modern day technical facility was fully utilized for the study of biodiversity in trees species. Digital Herbarium was developed with the help of MS-Access or MS-Power point software, which was one of the Office tools for its user friendly access.

OBSERVATIONS AND RESULTS

Present study was based on data recording, field survey and collection of specimens. It was seen that at ground level, tree density was quite good, while tree population was sparse with low vegetation growth at upper middle area of the hills where the vegetation was exposed directly to the sunlight. All the required information available with respect to morphodiversity of the species, specimen samples collections, photographs, plant descriptions, illustrations, height and girth recorded and bark morphology was studied. Based on this survey and study it was possible to derive the specific requirement to define the species in the software form with its necessary information. List of tree species was generated with its local and scientific names and their taxonomical identification to make data ready for computation study.

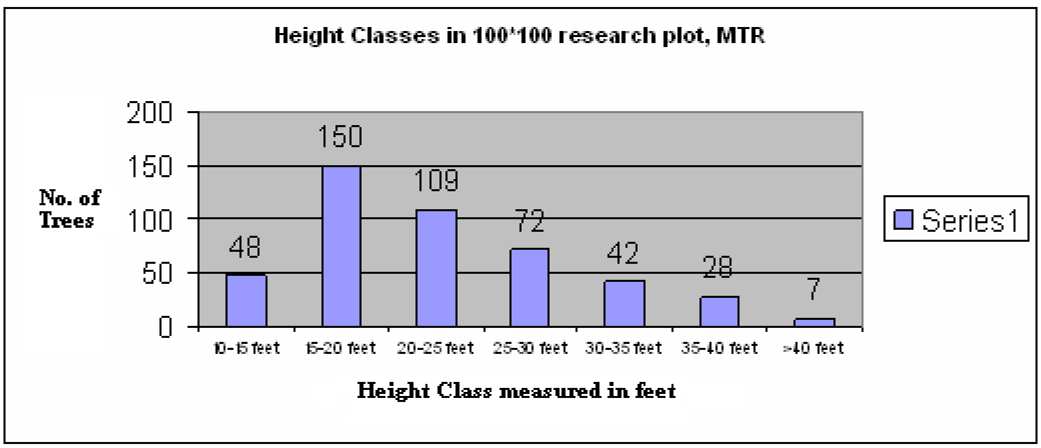

Fig. 1.1. Height measurements (*T. arjuna*)

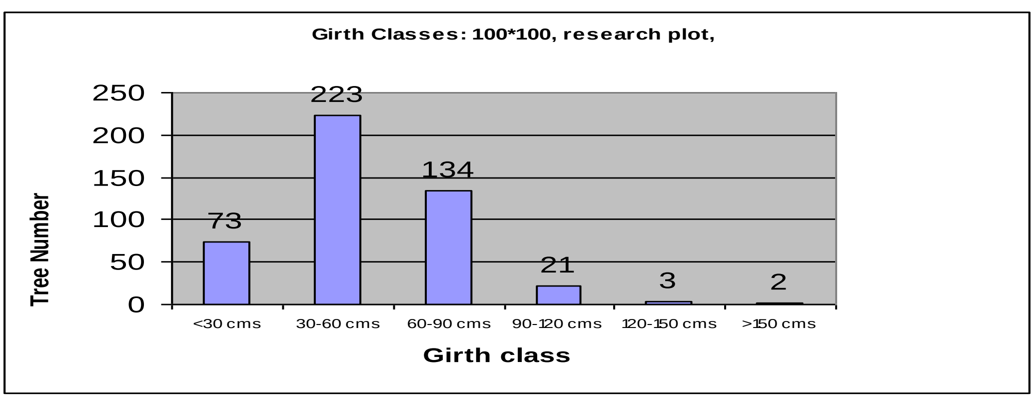

Fig. 1.2 Girth measurement, (*T. bellirica*)

Species diversity, height and girth i.e. growth of the trees was dependent primarily on age of the individuals and truly on ecological conditions of the forest area of research.

Ethnobotanical survey of the medicinal plants was conducted to collect the information regarding medicinally important plant species and its use on various human health problems such as bone fracture, acidity, injury, worm control, body power, blood impurity, antidote to snake poison, cough, dysentery, skin and fever etc.

In the present study ethanobotanical uses of 25 plants species were described. Information on medicinally important plant species and its traditional usage by the residents supported in understanding the value of forest species and its conservation.

Morphological features were studied and recorded. Collected samples were carried to work place and properly identified, labeled and classified on the basis of external features. The 'Digital Bark Library' was prepared. Scanned images of the barks were arranged properly with the help of computer software for further study.

Fig. 1.3 Bark types: Smooth, Furrowed, Scaly, Warty, and Shaggy

The bark served to protect a tree, without bark there would not be the survival of trees. Some tree bark found affected by beetles and used to cause damage to the external surface of the trunk. The tree bark was broadly classified on the basis of morphological characters, colour and texture whether it was smooth, scaly, furrowed, warty or shaggy. From this study it was evident that the diverse natures of the barks the forest trees pave way for identification of species. The tree bark was traditionally used for medicinal purposes by the local residents and ethnobotanical knowledge was descended from older to young generation. bark having many more chemical features, resulting positively on the tree growth. So, this nutritive quality of the bark was the notable feature that could be properly utilized in the nursery practices.

Fig. 1.4 Aerial Satellite Maps

The study was carried out with the help of computer and Internet. The satellite maps were downloaded to understand the area broadly. The study site was located in Satpura mountains ranges. Satellite photographs of different views of the research area were prepared and studied. This data was useful for identify the forest category as tropical dry deciduous type. The satellite map indicated small visual patches of forest vegetation cover comprising dense forest, open forest and non forest areas which were well labeled showing thereby the topographic situation of the area. This data images used to solve the information in handling large complex spatial data.

The main intension of using this digital image processing system was to provide current status of forest with its potentially important data for monitoring, planning, conservation and management of the forest. It showed overall picture of forest, recognizing field patches under cultivation, water resources, river, bandhara/dam, stream, rocky land, open area, dense forest, core area of forest, forest fire affected locations, villages, shady places, directions, hills and slopes, roads and flow of river water**.** These are the usage of new technology in monitoring forest cover which describes relationship in between real world and its computer representation. Aerial digital satellite maps provided accurate and real picture of geographical distribution.

The Specimen Browser System was developed for easy access. Firstly, all the specimen images were stored in the directory and subdirectory in listing format which were further linked with the data table using hyperlink option, just by single click on it, the system could be operated and implemented in a very simple way.

The databases on plant description, botanical terminology, medicinal plants, herbarium field information and also of height and girth were developed with the help of MS-Access database software. The different morphological characters such as tree code, local name, family, genera, botanical name, habitat, habit, stem, bark, leaf, flower, calyx, corolla, androecium, gynoecium, fruit, flowering and fruiting period of the individual species were stored in the prepared database.

The database tools as designing database table, running query, designing data entry form and report generation were utilized. Structured Query Language (SQL) was used for data extraction for searching the tree code, local name, species name, genera, family name with their associated characters, sorting different flowers and fruits types. The forest Melghat has large forest vegetation area, and having very rich diversity. The prepared data could be now handled as soft and hard copy that could serve for scientific study, identification and constructing a database on forests. So, this information could easily share among many users.

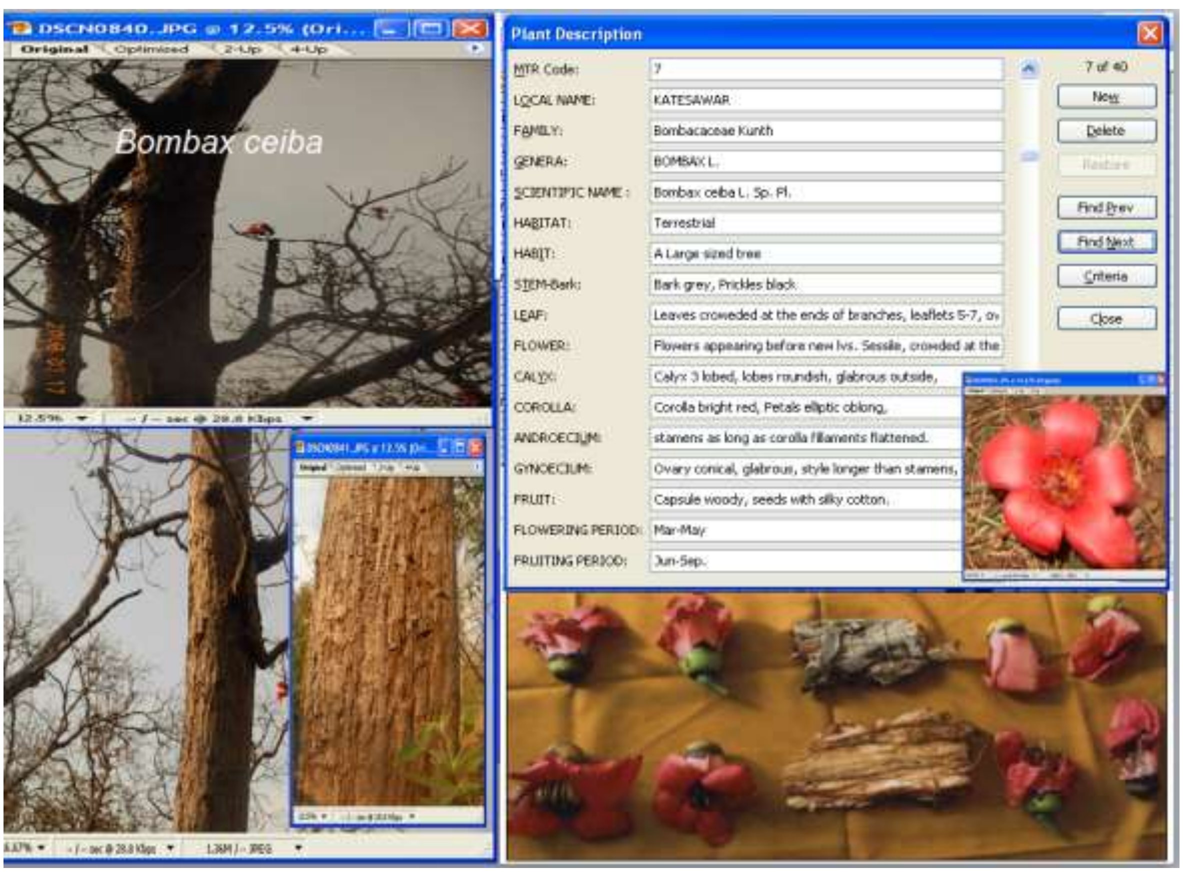

Fig. 1.5. Digital Plant Images as Specimens

Tr. Code	L. NAME	FAMILY	GENERA	SCIENTIFIC NAME	HABIT	FRUIT	FLOW. PERIOD	FRU. PERIOD
1	Charoli	Anacardiaceae Lind	BUCHANANIA Spre	*Buchanania lanzan* Spreng. J.	A middle sized tree	Drupe, 1 cm long,	Jan-Mar	May-Jun
2	Moyen	Anacardiaceae Lind	LANNEA A. Rich.	*Lannea coromandelica* (Houtt.) Merr.	A middle sized tree	Drupe	Feb-Apr	May-Jun
3	Amba	Anacardiaceae Lind	MANGIFERA L.	*Mangifera indica* L. Sp. Pl.	A Large sized tree	Drupe	Feb-May	May-Jun
4	Biba	Anacardiaceae Lind	SEMECARPUS L.f.	*Semecarpus anacardium* L. f.	A middle sized tree	Drupe 2.5 cm long,	Dec-Apr	Apr-Aug
5	Sitaphal	Annonaceae Juss.	ANNONA L.	*Annona sqamosa* L. Sp. Pl.	A small sized tree	Globose, yellowish	May-Jul	Sep-Oct
6	Dudhi	Apocynaceae Juss.	WRIGHTIA R. Br.	*Wrightia tinctoria* R. Br. Var rothii (G. D	A small sized tree	Fruit of 2 follicles u	Mar-May	Dec-Feb
7	Katesawar	Bombacaceae Kunt	BOMBAX L.	*Bombax ceiba* L. Sp. Pl.	A Large sized tree	Capsule woody, s	Mar-May	Jun-Sep.
8	Salai	Burseraceae Kunth	BOSWELLIA Roxb.	*Boswellia serrata* Roxb. ex. Coleb.	A middle sized tree	Drupe, bony, surr	Jan-Apr	Apr-Jun
9	Bhosa	Caesalpiniaceae R.	BAUHINIA L.	*Bauhinia racemosa* Lamk.	A small sized tree	Pod , 12-25 cm lon	Mar-Jun	Nov-Jan
10	Kachnar	Caesalpiniaceae R.	BAUHINIA L.	*Bauhinia variegata* L. Sp. Pl.	A middle sized tree	Pod, 15-30cm long	Sept-Nov	Jan-Apr
11	Amaltas	Caesalpiniaceae R.	CASSIA L.	*Cassia fistula* L. Sp. Pl.	A middle sized tree	Pod	Mar-Jun	Dec-Feb
12	Chinch	Caesalpiniaceae R.	TAMARINDUS L.	*Tamarindus indica* L. Sp. Pl.	A Large sized tree	Pod 8-20 cm long,	Oct-Jan	Apr-May
13	Dhawada	Combretaceae R. Br	ANOGEISSUS (DC.)	*Anogeissus latifolia* (Roxb. ex DC.) Wa	A middle sized tree	Drupe dry, yellowis	May-Jul	Dec-Feb
14	Ain	Combretaceae R. Br	TERMINALIA L.	*Terminalia alata* Heyne ex Roth,	A Large sized tree	Fruit 4-6 cm long,	Apr-Jun	Feb-Apr
15	Arjun	Combretaceae R. Br	TERMINALIA L.	*Terminalia arjuna (Roxb.)* Wt. & Arn. Pr	A Large sized tree	Fruit 2-5 cm long,	Apr-May	Dec-Feb
16	Behada	Combretaceae R. Br	TERMINALIA L.	*Terminalia bellirica (Gaertn.)* Roxb. Pl C	A Large sized tree	Fruit 2.5 cm lon, gl	Feb-May	Feb-Apr
17	Tendu	Ebenaceae Gurke	DIOSPYROS L.	*Diospyros melanoxylon* Roxb. Pl. Cor.	A middle sized tree	Fruit yellow whe ri	Feb-Apr	Apr-May
18	Aola	Euphorbiaceae Juss	PHYLLANTHUS L.	*Phyllanthus emblica* L.s Sp. Pl.	A small sized tree	Fruit 4 cm in diame	Feb-Apr	Oct-Apr
19	Palas	Fabaceae Lindl.	BUTEA Roxb.ex Wil	*Butea monosperma* (Lamk.)Taub.	A middle sized tree	Pod, silky, 1 seede	Jan-Mar	Feb-May
20	Tiwas	Fabaceae Lindl.	DESMODIUM Desv.	*Desmodium oojeinensis* (Roxb.) Ohas	A middle sized tree	Pod 5-8 cm. long b	Feb-May	May-Jun
21	Karanj	Fabaceae Lindl.	PONGAMIA Vent.	*Pongamia pinnata* (L.) Pierre.	A middle sized tree	Pod, thick, woody,	Apr-Jun	Jan-Dec
22	Kumbhi	Lecythidaceae - Poi	CAREYA Roxb.	*Careya arborea* Roxb. Pl. Cor.	A middle sized tree	Fruit 6-8 cm. globu	Mar-Apr	Jun-Jul
23	Lendia	Lythraceae J. St. Hil	LAGERSTROEMIA L	*Lagerstroemia parviflora* Roxb. Pl. Cor	A Large sized tree	Capsule, seeds wi	Mar-Jul	Aug-Sept
24	Rohan	Meliaceae Juss.	SOYMIDA A. Juss.	*Soymida febrifuga* (Roxb.) A. Juss.	A Large sized tree	Capsule, woody, s	Mar-Apr	May-Jul
25	Umber	Moraceae Link.	FICUS L.	*Ficus racemosa* L. Sp. Pl.	A Large sized tree	Fruit globose, becc	Feb-Mar	Apr-Jul
26	Wad	Moraceae Link.	FICUS L.	*Ficus benghalensis* L. Hort. Cliff.	A Large sized tree		Mar-Apr	Apr-May
27	Fefri	Moraceae Link.	FICUS L.	*Ficus microcarpa* L. f. Suppl.	A middle sized tree	Achenes, dark bro	Oct-Jan	Feb-May
28	Jamun	Myrtaceae Juss.	SYZYGIUM Gaertn.	*Syzygium cumini* (L.) Skeels	A Large sized tree	Berry, Dark purple	May-Jun	Jun-Jul
29	Mokha	Oleaceae Hoffm. ex	SCHREBERA Roxb.	*Schrebera swietenioides* Roxb. Pl. Cor	A middle sized tree	Capsule, 5-12 cm.	May-Jun	Oct-Mar
30	Ghatbor	Rhamnaceae A Jus	ZIZIPHUS Mill.	*Ziziphus xylopyra* (Retz.) Willd. Sp.Pl.	A small sized tree	Fruit woody	Jan-Apr	Apr-May
31	Bor	Rhamnaceae A Jus	ZIZIPHUS Mill.	*Ziziphus mauritiana* Lamk.	A middle sized tree	Fruit globose, flesh	Sept-Nov	Dec-Feb
32	Lokhandi	Rubiaceae Juss.	IXORA L.	*Ixora pavetta* Andrews	A small sized tree	Berry, Fruit a 2 se	Mar-May	May-Jun
33	Kadamb	Rubiaceae Juss.	MITRAGYNA Korth.	*Mitragyna parvifolia* (Roxb.) Korth.	A Large sized tree	Capsular, seeds n	May-Jul	Mar-Apr
34	Bel	Rutaceae Juss.	AEGLE Corr.	*Aegle marmelos* (L.) Corr.	A middle sized tree	Fruit globose, yello	Apr-Jun	May-Jun
35	Kusum	Sapindaceae A. Jus	SCHLEICHERA Willd	*Schleichera oleosa* (Lour.) Oken, Allg.	A middle sized tree	Fruit Dry, pointed,	Mar-Apr	Aug-Sep
36	Moha	Sapotaceae Juss.	MADHUCA Gmel.	*Madhuca longifolia* (Koen.) Macbr.	A Large sized tree	Berry	Mar-Apr	Jun-Jul
37	Maharukh	Simaroubaceae DC.	AILANTHUS Desf.	*Ailanthus excelsa* Roxb. Cor. Pl.	A Large sized tree	Fruit a 4-6cm. Poin	Feb-Mar	Apr-May
38	Dhaman	Tiliaceae Juss.	GREWIA L.	*Grewia tiliifolia* Vahl var. leptopetala Co	A middle sized tree	Drupe, black	May-Jul	Sept-Oct
39	Shivan	Verbenaceae J. St.	GMELINA L.	*Gmelina arborea* Roxb. Pl. Cor. t	A middle sized tree	Drupe 2 cm long, y	Mar-May	May-Jun
40	Sagwan	Verbenaceae J. St.	TECTONA L. f.	*Tectona grandis* L.f. Suppl.	A Large sized tree	Drupe, globose hai	Aug-Sep	Dec-Feb

Table Fig.. 1.6 Database of Trees of Melghat Forest (DBMS)

The database tools as designing database table, running query, designing data entry form and report generation were utilized. Structured Query Language (SQL) was used for data extraction for searching the tree code, local name, species name, genera, family name with their associated characters, sorting different flowers and fruits types. The forest Melghat has large forest vegetation area, and having very rich diversity. The prepared data could be now handled as soft and hard copy that could serve for scientific study, identification and constructing a database on forests. So, this information could easily share among many users.

DISCUSSIONS

The Specimen Browser System was developed for easy access; all the specimen images were stored in the directory and subdirectory in listing format which were further linked with the data table using hyperlink option; just by single click on it, the system could be operated and implemented in a very simple way. The herbarium, bark specimens along with field maps were linked to the table. The specimen browser provided specified image and table data in its desirable form rapidly. Schneider *et al.,* (1998) pursued the more specific project of transferring the field information into electronic form. Specimens collected within Texas were used by the Specimen Browser. For each of those, the following items have been recorded: accession number and source herbarium, collector’s name, a collector-specific number for the specimen, data of collection, country of collection, and scientific name. Future revisions to the Specimens to be used as they were entered; future data-gathering passes were anticipated to input data from annotations and images of the plants themselves. Cotter and Bauldock (2000) assumes that information technology provides us tools to digitize information and store it in accessible systems; discover and retrieve data pertinent to the issue at hand; analyze data from diverse distributed databases input and promote interactions among colleagues through collaboratoria, internet-based communication facilities which enable discussions, document development and revision, and decision making in real time.

In view of Kagan (2006) Biodiversity informatics has to provide consensus reference system in structural features (e.g. in database design) and and content definitions (controlled vocabularies, i.e., list of applicable terms). Taxon based information system (or system using taxon names) must find ways to map individual taxon concept reliably. Information on vascular plant taxonomy, as addressed by global biodiversity information facility and key partners, serves as an example of current efforts to integrate information of the plant biodiversity. Efforts of Roderic and Page, (2008) have relied on taxonomic names as the share identifier linking record in different databases. Integrating diverse sources of digital information is a major challenge facing biodiversity informatics. It was an opportunity to apply this technology to develop an IT infrastructure that would enable us to unlock the wealth of biodiversity information that existed around forest of Melghat. Specimen browser system formulated by the candidate on biodiversity of 1016 compartment was one of the tools for accessing botanical specimen collections which was allowing the rapid input of specimens with dynamic zooming facility. It was the easiest and effective way for retrieving the biological data just by pressing the computer keys. A vast amount on biological information existed in the world today. This information was diverse and usually found in assorted form, thus it was the foremost need to greatly increase our computing capacity to process and integrate extensive biodiversity information for conservation, management and decision making purposes by applying informatics tools. Aerial satellite monitoring method helps to understand better the complexity of the forest. The main intension of using this digital image processing system was to provide current status of forest with its potentially important data for monitoring, planning, conservation and management of the forest.

Lertlum and Murai **(**1995) illustrated the use of objected-oriented data model to handle the integration problem of multi-resolution, multi-temporal data sets by defining an object oriented data model that could handle multi-resolution, multi temporal remote sensing GIS data sets. A semi-automated classification procedure was adopted by Meyera *et al.,* (1996) for identification of forest species from digitized large-scale, colour-infrared aerial photographs to simulate imagery from future sensors with high spatial resolution capability. With the help of applied computer-assisted classification approaches involving a tree by tree approach an average about 80% of the trees could be classified. A GIS database of environmental and management data for 40,000 hectare segment of Kinleith Forest, New Zealand, has been built by Hock, *et al.,* (2003). The digital forest provides a stable database to develop and test models, and is accessible for planning new experiments and future research. The database has proved to facilitate research efficiency and capability. The wealth of digital data permitted the development of new approaches in using spatial information for forest management. Joshi *et al.,* (2004) explored the potential of multi-temporal IRS-ID WiFs (Wide Field Sensor) data for characterization of tropical forest in Central India. The WiFS product provided information on forest types, Viz., tropical moist deciduous, dry deciduous and mixed deciduous. In the present work database was developed with the help of MS-Access database software on plant description of 40 trees belonging to compartment number 1016, research plot by giving unique ID codes for unique identification of the record to avoid data duplication. Different database tools such as table, primary key, relationship, query, form, report were applied for data analysis. SQL was used for data extraction for searching the tree code, local name, species name, genera, and family name with their associated characters.

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