India Biodiversity Portal: Building a map-based biodiversity and conservation portal

I. Background and Rationale

India is home to an exceptionally high level of biodiversity, and to nearly one-fifth of the world's population. Just 17 of the world's 170-some countries contain 70 percent of its biodiversity, earning them the title "megadiverse." India is one of these megadiverse countries. Unfortunately, India also has four (of about 34) "global biodiversity hotspots" - unique, biologically rich areas which are facing severe conservation threats. The rapid rate of hotspot degradation makes it imperative that conservation science be pursued immediately and vigorously in these habitats, to devise effective measures which curtail the rapidly diminishing biodiversity, and to protect unique biota from the onslaught of humanity.

The value of this biodiversity is immense (including economic, social and cultural) and its potential future value is far greater. To take an example, the ecosystem services from the forested watersheds of the two great mountain chains of the world, the Himalayas and the Western Ghats, indirectly support several million people in India. The economic value of such ecosystem services is immense. The non-timber forest products alone have been estimated to be worth $200 million per annum. The existing biodiversity also has the further potential to add billions of dollars to the country's economy, in new products from its unique species, and from services such as ecotourism. Information about biodiversity combined with India's expertise in information technology and emerging strength in biotechnology has the immense potential to increase the current and future value of the country's biodiversity.

All biodiversity and conservation information is, by definition, spatial in nature, located in a particular geography. Thus organizing, sharing and analyzing biodiversity information is largely and effectively driven by spatial technologies. Most websites related to conservation use some form of map-based web services to deploy and serve spatial data over the Internet.[1, 2] These technologies provide limited functionality in that

[1] Many conservation websites serve map data over the Internet.
http://www.unep-wcmc.org/imaps/IMapS_help.htm
http://www.conservationmaps.org/index.jsp
http://plasma.nationalgeographic.com/mapmachine/conservationmaps.html

[2] Various proprietary and open source web platforms are available for serving spatial data. Many map-based web servers use proprietary software like ESRI's Internet Map Server, MapQuest, Microsoft MapPoint and MapInfo.
http://extranet.mapinfo.com/products/Overview.cfm?ProductID=1825
http://www.esri.com/software/internetmaps/index.html
http://mapserver.gis.umn.edu/

they query and render already available data as a map over the Internet. They have sophisticated rendering capabilities and can zoom, pan, layer and render the map on a canvas. However, all internet map servers are synchronous;[3] heavy on the server; slow in rendering; and provide very limited means to effectively interact with the data behind the servers. Further, all vendor-supported web-services do not provide easy exchange of spatial data. A survey of the websites on biodiversity in the Indian context reveals that some of them are more data driven but provide only a limited geographical and spatial interface.[4] An ongoing international effort which is on similar lines is the Encyclopedia of Life http://eol.org

In general, current map-based conservation websites are centralized, not participative, server heavy and slow. Considering the importance of spatial data for effective conservation monitoring, the current scenario is inadequate in meeting the requirements of guiding policy and democratic participative action. We believe we can eliminate this impediment and expand biodiversity knowledge by developing a web-based, collaborative information network, which solicits broad-based participation from people, government, research institutions and conservation NGOs, interconnects existing databases and makes them readily accessible by all stakeholders interactively.

II. Empowering Eco-Informatics through Web 2.0

Over the last few years two areas and technologies are being redefined that will be leveraged in building eco-informatics: Visualizing geographies and Web 2.0. Today, any geography can be viewed, visualized and annotated freely by anyone on the Internet. The availability of high-resolution imagery and deploying it freely by Internet giants like Microsoft, Google and Yahoo has redefined the space of visualizing geographies. This has sparked off large-scale participation in annotating geographies in an open data model, much like the development of Wikipedia. We propose to leverage the Wiki medium and the free availability of visualizing geographies for conservation monitoring and the participative development of eco-informatics.

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[3] The importance of asynchronous servers will be discussed in a later section. The synchronous nature of these servers means that the major task of creating and rendering the map will be done on the server. The client (the browser) submits a request to the server and waits patiently for the server to provide the map, meanwhile displaying an hourglass to keep the users interested.

[4] There are websites that focus on biodiversity in the Indian context. They are often narrowly focused and while some of them do provide a geographical and spatial interface, they often allow only limited functionality and participation. Examples include:
http://www.ecoinfoindia.org/
http://wgbis.ces.iisc.ernet.in/biodiversity/
http://www.nbaindia.org/about.htm
http://www.ncbi.org.in/
http://www.eicinformation.org/default.asp
http://www.ibin.co.in/

Outlined below are the main features of such a system:

- Geography and thus spatial technology will provide the rubric and platform for organizing all biodiversity and conservation information.
- We will deploy conservation databases on a public platform, interfacing with visualizing geographies that are built on public Internet sites.
- We will allow active participation from one and all over the Internet. People situated in local geographies can contribute by adding data, notes, case studies, images, success stories and comments.
- We will develop a framework to allow such participation. (Such frameworks are fast developing and leading the Internet to Web 2.0). This will provide tools in the hands of the people. In the early stages much of such publicly contributed information could be random noise. We expect this to mature very quickly and achieve the same kind of efficiency and reliability like Wikipedia.
- We will develop a protocol of aggregation and authentication of publicly contributed data.
- We will initiate moderated discussion forums and provide opportunities for blogs which will also enhance public participation.
- Relevant policy documents and legislation will be collected and placed on line for easy access.
- We will hyperlink conservation and biodiversity related websites, thereby building and expanding the intelligent Web 2.0
- We will introduce a versioning system for conservation data, where all publicly contributed data will be verified and authenticated. Thus at any time there would be a bleeding edge version and a verified and authenticated version.
- While data will be freely accessible on the Internet, we will design to protect the data from illegitimate use and protect intellectual property.
- We will leverage the highest quality IT skills available in India that build cutting-edge IT technologies for the global market. This manpower has not been hitherto exploited to its full potential to develop quality portals in the Indian context.
- We will provide global leadership in building a platform for participative biodiversity and conservation websites.
- We will develop and deploy a beta version of such a system with all the available data within one-year of initiation.

Case Scenarios

A. Bird-distribution data for many countries, including India, are very poor. If we look at the distribution maps in any bird book on India, many species seem to be seen in Delhi and Bharatpur, and nowhere else! By allowing users to add their sightings it will be possible to quickly build up much more comprehensive data on the geographic ranges of bird species, and on their rarity/abundance. If we make it really easy for bird-watchers to upload their daily bird lists, it will be possible to build up a picture of species population fluctuations over time.

B. The field officer in a protected area perambulates the protected area and is a storehouse of information on the conservation status and dynamics of the protected area. For each protected area, the field officer should be able to easily upload and deploy information on zoning, closed and open seasons, different habitat types, location specific annual fire occurrences and a host of other information. In each protected area animal censuses are conducted. Planning and execution of censuses can be better done if this location specific data can be easily uploaded onto the portal. The portal will provide valuable information for managers, planners, eco-tourists and researchers to make more informed decisions. Each protected area must be hyper-linked to websites that contain more detailed information on the protected area including research studies and reports on the area.

C. A naturalist interested in butterflies frequently visits several sites to pursue her interest. She records her observations on the occurrence, abundance and habitats and several related aspects of the natural history of the butterflies. She has a collection of photographs and drawings of butterflies that will help in identification. She keeps meticulous records of the changing seasons and its impact on the butterfly populations. She uploads the data on to the portal pegged on a geographic location, with tags for the genus and species. She provides hyperlinks to the umpteen butterfly conservation websites over the world. Any one user searching for the identification and distribution of different species of butterflies will find this portal and discover a treasure trove of well organized, easily accessible, current and reliable information.

D. A researcher studying the behavior of the lion tailed macaque in the rain forest in southern India has finished his three season data collection and observation. He would like do a survey of the distribution of the lion tailed macaque. He would be able to search for any reports of the sightings of the lion tailed macaque on the portal. He would then retrieve the distribution of lion tailed macaque habitats and overlay them on the reported sightings of the lion tailed macaque. With the overlay he will be able to authenticate the sightings data and identify similar locations where there could be possible troops of lion tailed macaque.

III. Technology

The word, Web 2.0, was first coined in a conference planning session by Dale Dougherty around 2004. Since then it has attracted a lot of attention and discussion in many blogs and public places.[5] Although not clearly defined, it is born out of the realization that there was something "qualitatively different about today's web."[6] In the blogs and articles

[5] For a definition and description of Web 2.0 refer to http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html

[6] Reacting to criticisms against the phrase, this article argues that there is something special about today's Internet. http://radar.oreilly.com/archives/2005/08/not_20.html

describing and theorizing on the Web 2.0, Google maps and geographical visualizations are extensively cited as a case in point for what the Web 2.0 represents.[7] It is thus important to look at the elements of Web 2.0 while designing a conservation monitoring map-based portal. For further details on the elements of Web 2.0 refer to various articles on the Internet.[8] We discuss two elements of Web 2.0 in the following sections that will be leveraged in building a biodiversity and conservation map-based portal.

The Web as an Inclusive Platform

This is the age of creating web applications. The gap between the web and the desktop is closing and web-based applications can now be made to work like desktop applications.

While the first wave of the web was based on the browser, the second wave is based on the browser being an interface between the desktop and complex applications running on the server. Take the example of Orkut, Gmail, Google Maps, Google Suggest, Double Click, BitTorrent, Wikipedia and many more. These are based on complex applications running on servers, with the browser providing an interface to these applications. Two main technologies that have made it possible for the web to be a platform is the Ajax[9] and Flash technology.

The Ajax recipe is a combination of technologies (Asynchronous java script and XML) coming together in meaningful ways, to provide server-based applications on the desktop. They facilitate an asynchronous method of interacting with the server which provides a rich user experience for complex applications. Google Earth and Google Maps was the first full application to use the Ajax Engine. Since then there has been a spurt of activity on using the Ajax Engine and a whole new generation of software is being produced at break-neck speed.[10] The core of Ajax technologies is mature, stable and well understood. There is adequate trained human resource in India for the development and deployment of such applications. Development can be quick and since the deployment is server based, deployments can be easy and quick. The challenge is in the design of applications that will appropriately and effectively use Ajax for innovative expansion of the Web.

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[7] "Google Maps set the world on fire because of its simplicity, .. the way Google Maps was implemented left the data for the taking, and hackers soon found ways to creatively re-use that data."

[8] For more details refer the hyperlinks below. A good participative definition from collective wisdom is available on Wikipedia.
http://en.wikipedia.org/wiki/Web_2
http://www.paulgraham.com/web20.html

[9] The Ajax recipe is well articulated by the person who coined the word in the following article. Ajax came to be noticed in early 2005, when Google deployed Google Maps.
http://www.adaptivepath.com/publications/essays/archives/000385.php

[10] New applications, from inclusive instant messengers to rich user experience based applications are being developed and deployed at speeds never before seem in software development.
http://online.wsj.com/public/article/SB113098635587487074.html?mod=todays_free_feature
http://wwwl.meebo.com/index-en.html

Flash technology has been advantageously used to provide animation on websites. The GapMinder initiative is a relevant case in point where the intent was to use the enormous amount of public data available and provide attractive animations to visualize trends. The site has Human Development Trends and other UN reports animated and presented.[11]

A map-based biodiversity and conservation portal is an ideal application to use the Ajax recipe. GIS applications are heavy and visualization intensive. They have mainly been desktop applications providing very limited functionality for web-based manipulations. Current web-based map servers use the browser client and a synchronous mode of deployment that make it inadequate and unsatisfying to the end user. The Ajax recipe could be used advantageously to provide rich geographical visualization and interaction with the map portal. Over time we could add animation with the use of Flash technology making it an attractive, intuitive, addictive and a user friendly site for biodiversity and conservation.

Harnessing Collective Intelligence

Participatory websites have been enormously successful at aggregating, sorting, filtering, classifying, and validating information. The India Biodiversity Portal should take full advantage of these strengths and develop them. The engine of harnessing collective wisdom is driven by three factors: the voluntary participation of users; a simple intuitive system of tags and categories; and, a participative system of rating and selection of content.

The Internet now abounds with millions of social and participative websites where users congregate to create content. The Wikipedia is the epitome of such collective wisdom. Wikipedia is already one of the top 100 websites and is expected to become one of top ten very soon. And as they mature, better systems of self-organizing information, mechanisms of weeding out wrong, irrelevant and abusive content are quickly evolving. Structures for conflict resolution, peer reviewing and rating are available if users democratically choose to use them. The evolution and success of Wikipedia is a sociological study in itself.[12]

Along with harnessing collective intelligence a simple and intuitive systems of tags and categories have evolved that allow organizing the chaos of contributed data. Called folksonomy, [13] it is a user-generated taxonomy to categorize web pages and web content. At every site built on such collective participation, special provisions are made for

[11] Refer: http://www.gapminder.org/

[12] Wikipedia is an unimaginable social phenomenon where millions of users contribute to develop widely used knowledge on any topic of interest.
http://meta.wikimedia.org/wiki/Wikipedia_sociology

[13] http://en.wikipedia.org/wiki/Folksonomy

creating and using tags. Tags can also be used to enforce desired categories of information and guide and facilitate the evolution of information along certain axes.

The final aspect of harnessing the wisdom of the crowd is the evolution of a method of aggregating information. User ratings and user recommendations are registered on content pages that have a natural method of weeding out undesirable and irrelevant content by ignoring them; and enhancing valuable content by re-enforcing, promoting and propagating them. Many websites provide such aggregation and valuation features that work wonders in naturally selecting viable and valuable content.[14]

A map-based conservation monitoring portal is ideally suited to harness the collective contribution and intelligence of the crowd to build reliable, authenticated, updated and accurate conservation information. Distributed local residents situated and working in the local geography have an intuitive and experience-based understanding of their geography and environment. Humans, like every life form, have an innate ability to create a mental map of their local environment and resources.[15] The portal will provide a platform to enable the contribution of information on conservation, biodiversity, environment and bio-resources from distributed people situated in local geographies.

Initially much of this contribution may be inaccurate. A monitoring site that does not certify quality will soon become irrelevant. Tagging and rating of information by users would provide the first level of validation and authentication of data. And with more active users, the reliability of data will increase. In addition to this process of natural selection, we may need to add more levels of authentication and verification. We would build three more levels of validation. A locale based validation will look for patterns in the neighborhood to authenticate the data; an expert based validation will co-opt experts in the area or geography to authenticate and validate data; and finally, a versioning system that will automatically and continuously provide a verified and authenticated version and a 'bleeding-edge' version of unauthenticated and freshly contributed data.[16]

[14] Redit is a website providing hyperlinks to other content and allowing users and individuals to rate, promote and demote hyperlinks. The site can also be customized to learn and suit individual preferences. This can apply to news websites, information websites, music websites and whatever.
http://reddit.com/
http://pandora.com/

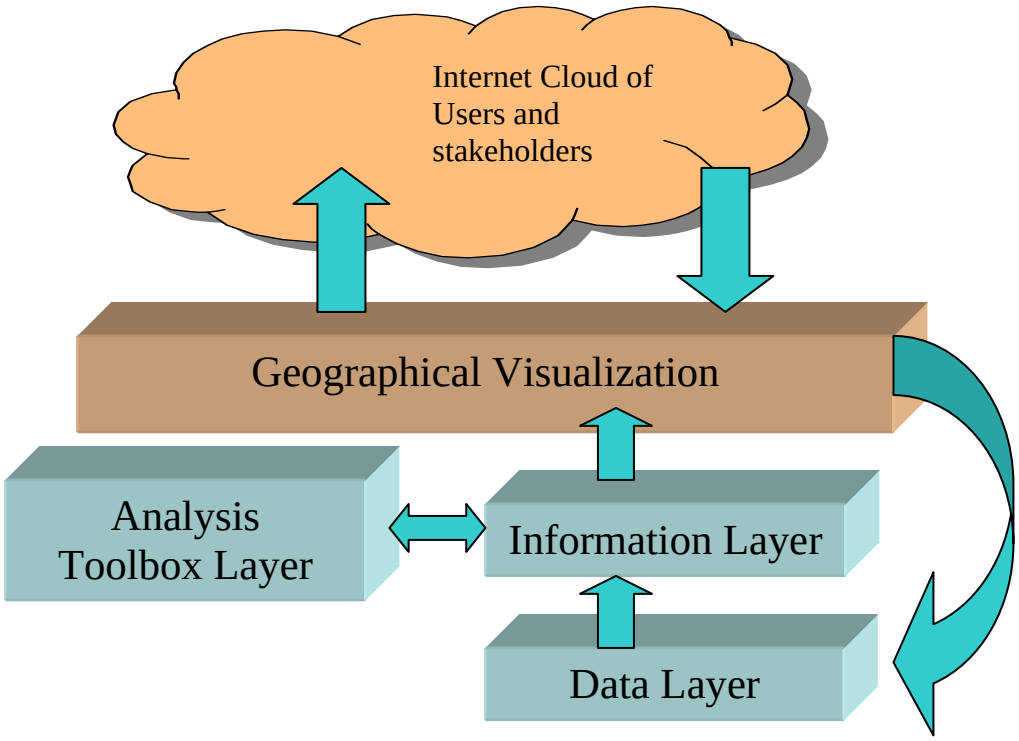
[15] This mental map and understanding is independent of the education and technical expertise of the individual. Participatory Rural Appraisal methods developed by Robert Chambers (IDS, Sussex), and extensively used by development agencies around the world amply illustrate the fact that these maps are effective and true representations of local environments. In addition researchers, activists, environmentalists and local residents are a valuable source of information about the environment.
http://en.wikipedia.org/wiki/Participatory_rural_appraisal

[16] These versioning systems are very common in open source software development projects where large groups participate and contribute to build complex software systems. The versioning decisions are taken by a small group of leaders of the project.

IV. Design Elements of the Portal

The quality, extent and reliability of the portal will directly depend upon public participation on the portal. Only if the portal has anything to offer will users participate and contribute data. To inspire participation from the public, the portal must be attractive and have adequate biodiversity data to attract users. Thus, the portal must be built and deployed with some basal data and adequate biodiversity information to evince interest among users.

The map-based portal that we build will conceptually consist of four levels that interact and relate with each other. This section outlines these levels.



The Data layer

The Data layer will be participatory and will draw on the intelligence of the crowd. It will provide a platform to facilitate the contribution of data. A set of base layers like topography, climate, biogeography and population density will be deployed on the portal. In addition biodiversity themes where we would like contribution would be built with the current data available. This will encourage users to visit the site, participate and jump-start the map portal.[17] The elements of the data level should enable the following:

- Create and deploy basal data.
  - Topography data from Shuttle Radar Topography Mission (SRTM)[18]
  - Climate data
  - Integrate biodiversity data from all available government and non-government sources e.g., IBIN, WII, SACON, BNHS, ATREE, NCBI, WWF-I and other participating institutions

- Enable collaborative contribution of data from various public sources
  - Thematic collection of data from conservation and biodiversity related agencies (e.g., from various ENVIS nodes and botanical gardens)

- Enable participative contribution of data over the web
  - Built on an architecture of participation
  - Intuitive user interface for contributions over the Internet
  - Means to provide location, annotation and tagging of data elements
  - Intuitive means to provide and annotate geographical topologies of points, lines and polygons

- Create data formats and tagging standards for contributing data
  - Build a tagging vocabulary
  - Provide standards for tabular form and free form annotations
  - Facilitate hyperlinks and searches with tags
  - Means to annotate topologies and load images
  - Means to load biodiversity surveys and scientific surveys

The Information Layer

The next level is the information layer, where raw data contributed by users will be processed, cleaned, weeded and organized. This will involve active management by the portal team. Information from this level should be directly useable for a variety of

[17] One project that has exploited the participation of people to build an authentic spatial dataset is the Tracks4Africa project. This solicits GPS surveyed information from amateurs, processes the data and now is the only source of map data in Africa. Recently Google maps have started carrying this data as featured content on Goggle Earth.
http://www.tracks4africa.com/

[18] http://srtm.csi.cgiar.org/

conservation purposes. It should be amenable to analysis in the portal itself as well as for export into various formats. The data and data formats should be open and freely available. The functions at the information level are the following:

- Validate and authenticate data layer
    - Using corroborative and collateral data
    - Using local and expert based authentication.
    - Using analysis (e.g. averages and dispersions)

- Retagging of data
    - Rationalize tags to facilitate searching and retrieval of information
    - Tagging into defined categories for organization and retrieval

- Versioning of layers into two levels
    - Authenticated versioning
    - Bleeding-edge version

- Aggregate atomized data and organize into layers and themes

- Export of spatial data
    - Export data into open GIS formats
    - XML data export formats
    - Export as text data

Analysis Toolbox

The highest level of the portal is an analysis toolbox based upon the conservation data and information available. The portal should allow some manipulation and analysis of the data. Such capabilities are currently only confined to desktop based applications. With current technologies, it will be possible to incrementally and anticipatively provide such analysis capability on the portal. There are some good public open source analysis tools that will be leveraged in providing this capability on the portal. The following GIS analysis capabilities will be built into the portal:

- Basic functions
    - Handling of layers and annotation
    - Query on layers and annotation
    - Overlays and map composition
    - Computation of areas and distances
    - Contouring, enveloping and surfacing algorithms from point data
    - Buffering

- Advanced functions
    - Compute shortest path from connected components
    - Spatial Modelling

- Diversity index computations from sampled data
- Contributed algorithms

Geographical Visualization

The strength and popularity of the site will be governed by the capabilities of geographic visualizations. The popularity of this function will decide its success as a conservation monitoring site. Geography is a visual science and the emergence of Google Maps has demonstrated the feasibility and the attractiveness of geographic visualization. The open format and simplicity of Google Maps have fired the imagination of a huge number of websites built on the Google technology, APIs and data. Some of the public as well as commercial websites are listed in the footnotes.[19] Noteworthy among them and relevant to the current initiative are the public SRTM 90m Digital Elevation Data[20] site, the tracks4africa[21], and the International Polar Year[22] site. The elements of the visualization capability are listed below:

- Attractive map layouts
- Satellite Image links
- Image Links
- Leverage Google Maps visualization using APIs[23]
- Use public map plotting libraries[24]
- Hyperlinks

V. Strategy to Build, Manage and Operate the Portal

This section develops a strategy for building the India Biodiversity Portal: A map-based biodiversity and conservation portal. The portal will provide global leadership in the design and operation of a participatory web-based biodiversity and conservation portal.

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[19] There are many sites that have sprung up that use Google Maps to provide the geographical visualizations necessary. (E.g. The People's Atlas: Platial, Map your Photos: Panoramio, Let's Describe the world: Wikimapia and many others). Some of them are listed here.
http://wikimapia.org/
http://www.panoramio.com/
http://platial.com/splash
http://www.housingmaps.com/
http://busmonster.com/

[20] http://srtm.csi.cgiar.org/

[21] http://www.tracks4africa.com/

[22] http://www.ipy.org/index.php?/ipy/detail/ipy_in_google_earth/

[23] http://www.google.com/apis/maps/

[24] http://matplotlib.sourceforge.net/

Building the Portal Platform

Leverage Open Source

The open source movement has contributed significantly to Web 2.0. Most of the emerging websites are built with open source tools. The map portal will be built as a web-based application portal integrating open source tools like Ajax to serve the data efficiently and PostGIS databases to store the data. It will integrate open source analysis tools as well. This will facilitate stable, quick development and deployment.

Contribute to Open Source

The portal will raise the required funds for its establishment and operation and will contribute to the public good as open source software. The advantages of open source development are well known. It will quicken and distribute development; it will reduce bugs in the application; and it will be widely deployed. Importantly, it will attract the best talent in the industry at reduced rates because working on open source builds respectability among peers.

Outsource Development

Application development and building the portal must be outsourced for quickness and efficiency. Software development is specialized and is a one-time process. It is not feasible to develop the application in-house. The attractiveness of an open source project and the innovation and uniqueness of the project will encourage favorable terms. The sustainability of the application will be guaranteed by open source contributions and periodic outsourced development.

Quick deployment and frequent update

The portal will be built and deployed in as short a time as possible. Since the application is a web-based application, proto types and beta versions will be created and deployed within a year. The architecture of the application will enable quick development and frequent updates.

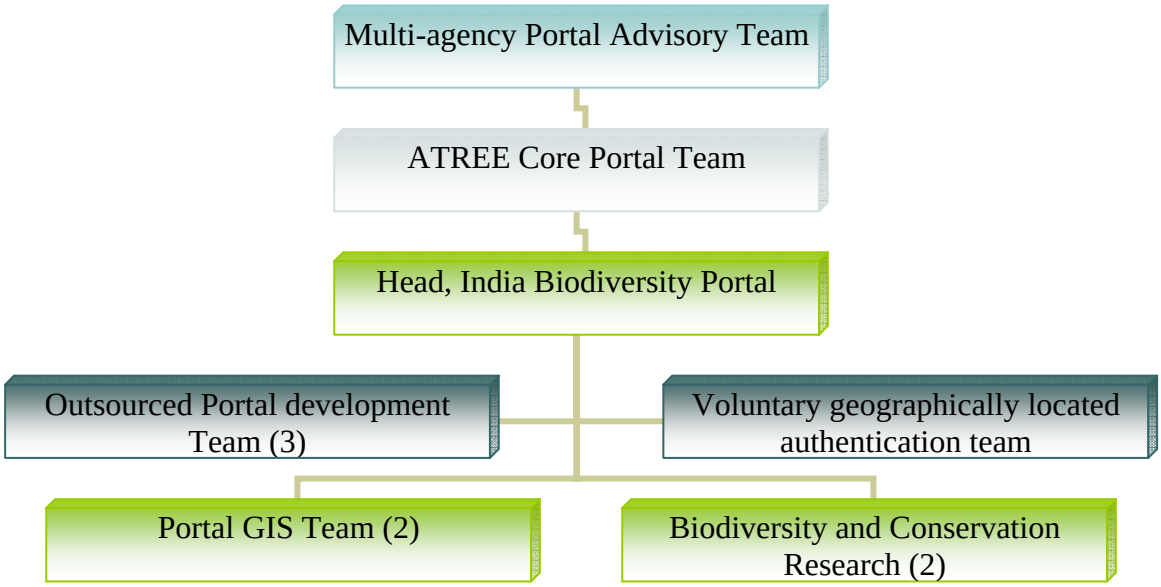
Portal Management and Operation

A multi-agency portal advisory team will advise the core portal team at ATREE during the design, development and deployment phases of the portal. The core portal team will have senior staff and academics including the Head of the India Biodiversity Portal and it will design, validate and drive all aspects of application development. A small and dedicated team of researchers and GIS specialists will work in a dedicated manner for the portal. In-house researchers and collaborators will add value to the data with analysis and derive rational policy guidelines from the data. The team will integrate and build alliances with other specialized databases and link their data on the India Biodiversity portal.

List of potential database networks on which the intended mega-portal would feed

S. No.	Name of the Biodiversity related Database / Information Systems	*Name of the Developer / Owner*
1	Species Databases	
	Endemic Trees of Western Ghats	*French Institute of Pondicherry, Pondicherry*
	Flora of Karnataka, Plants of India (website), Database on Indian Ants	*ATREE and University of Agricultural Sciences, Bangalore*
	National Wildlife Database and Zoo Database	*Wildlife Institute of India, Dehradun*
	IndFauna; electronic catalogue of known Indian fauna. IndFungi; electronic catalogue of known Indian Fungi. Invasive Species Information System. ABCDIO; Access to Biological Collections Data of Indian Origin. SaGrIS; Sacred Groves Information System.	*NCL Centre for Biodiversity Informatics, National Chemical Laboratory, Pune*
	Birds of India	*Salim Ali Centre for Ornithology and Natural History, Coimbatore*
	Biodiversity Information System (database of Western Ghats flora and fauna)	*Centre for Ecological Sciences, Indian Institute of Sciences, Bangalore*
	Indian Medicinal Plants Database	*FRLHT, Bangalore*
	Bio-resource related databases	*IBIN-DBT*
2	Vegetation and landscape Databases	
	Biodiversity characterization using RS/GIS (BIOSPEC and BIS)	*Indian Institute of Remote Sensing, Dehra Dun*
	National and State Forest Vegetation maps and National Basic Forest Inventory (NBFIS)	*Forest Survey of India* *ATREE*
3	Environmental Databases related to Biodiversity, climate, soil, geology, and hydrology	*ENVIS Centres, Ministry of Environment and Forests* *Agharkar Research Institute (ARI)*
4	Agricultural Databases	*MS Swaminathan Research Foundation, Chennai*
5	Traditional knowledge	
	National Register of Green Grassroots Innovations and Traditional Knowledge	*National Innovation Foundation*
	People's Biodiversity Registers SAHYADRI: Western Ghats	*Centre for Ecological Sciences, Indian Institute of Sciences, Bangalore*

	Traditional Knowledge Digital Library	*NISCAIR New Delhi*
6	Socio-economic databases	*INDIASTAT, ATREE*
7	Trade and globalization	*Covenant Centre for Development, Madurai*



Campaign for adoption by public agencies

There would be many public agencies that would like to deploy this application. The portal, being in the open source, will facilitate adoption by user agencies. The portal must actively campaign for adoption and wide deployment of the application by providing support to agencies that would be interested in the application.

Integrate with Google Maps as a conservation skin

The data should facilitate integration with Google Maps. This will give end users the ability to easily extract and use the data. Google should be encouraged to integrate and distribute the data as featured content with Google Earth and Google Maps. Much like they have done with other commercial and public websites like Tracks4africa, Panoramio and UNEP.

VI. Resources

Public multi-agency support

There is a recognized need and requirement for good conservation information for planning and development action. While there are a multitude of agencies providing

information and supporting conservation, there is a lack of adequate and efficient web-based application tool. The portal under development will also provide an open source free application to other agencies that may want to serve specialized spatial data. Wider use of the application will also ensure rapid and feature rich development. The portal will solicit national and international support from public and user agencies. This will include ongoing national and state government programmes, academic initiatives and conservation initiatives in the non-government sector.

Corporate Social Responsibility

The project will draw upon corporate social responsibility towards the environment. Support for this initiative will be sought from several Indian companies especially from the IT sector like INFOSYS and WIPRO and international internet companies like Google, Microsoft and Yahoo. This initiative will provide visibility for these companies, good values to associate with and opportunities for image building. Google in particular should be encouraged to support, as the project will directly impinge upon geographic visualization in which Google has shown leadership and innovation. GIS software development corporations would also be interested to support the project and provide back-end data manipulation tools. Other business, like oil companies and automotives could support this project for displaying their concern for the environment.