A REPORT ON

"Karnataka State Spatial Data Infrastructure"

Budget: Rs. 2.53 crores (75%:25% share, Government of India share – Rs. 1.92 Crores and Government of Karnataka share Rs. 61 lakhs)

By

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STATUS REPORT - KARNATAKA STATE SPATIAL DATA INFRASTRUCTURE (KSSDI)

Title of the project: Karnataka State Spatial Data Infrastructure (KSSDI)

Budget: Rs. 2.53 crores (75%:25% share, Government of India share – Rs. 1.92 Crores

and Government of Karnataka share Rs. 61 lakhs)

Date of commencement: October, 2007

Duration: Three years

Objective of the Project:

• To develop a web-based Geo Portal to acquire, process, store, distribute and improve the utilization of geo spatial data.

• Data clearing house which would be a gateway of spatial data being generated by various agencies in the State.

Background:

Under a joint project of Natural Resources Data Management System (NRDMS) of Department of Science & Technology, Government of India, and the Government of Karnataka, Karnataka State Council for Science & Technology (KSCST), Bangalore has developed district level GIS databases to support the process of Local Level Planning at the levels of district, taluk and village. Each District Database contains spatial and attribute data sets useful in local level planning processes in the sectors of Natural Resources, Demography, Agro-economy, Socio-economy and Infrastructure facilities. Respective Zilla Panchayaths and Line Departments have been depending upon the databases for meeting their data requirements.

Over the past one and a half decade all the thirty districts of Karnataka State have been covered under NRDMS. With increasing dependence of the Zilla Panchayaths/Urban local bodies, Line Departments and other stake-holders of local level planning on spatial datasets, a need has been felt to speed up the process of discovery of and access to upto-date spatial datasets.

Introduction:

The Karnataka state has a rich "base" of map information in digital format at district level generated/created by various national/state government organizations through topographic surveys, geological surveys, soil surveys, cadastral surveys, various natural resources inventory programmes and the use of the remote sensing images. Now, with the availability of precision, high resolution satellite images, data enabling the organization of GIS, combined with the Global Positioning System (GPS), the accuracy and information content of these spatial datasets or maps is extremely high.

Encapsulating these maps and acquired images and provided by various organizations including government, academic and private sectors in Karnataka into a organized repository and provide access to all users for various developmental needs is the need of the hour. There are new innovative ways of technological innovation in allowing us to capture, store, process and display an unprecedented amount of valuable geographical and spatial information about Society and a wide variety of environmental and cultural

phenomena. It is the vision of National Spatial Data Infrastructure (NSDI) that current and accurate spatial data must be readily available to contribute to local, state and national development and contribute to economic growth, environmental quality and stability, and social progress.

The emphasis is made on information transparency and sharing, with the recognition that spatial information is a national resource and citizens, society, private enterprise and government have a right to access it, appropriately. Only through common conventions and technical agreements, standards, metadata definitions, network and access protocols will be easily possible for this vision to come into existence. In realizing the vision of NSDI and requirements of various state government agencies, Karnataka state through Karnataka State Council of Science and Technology (KSCST) has decided to establish the state level spatial data infrastructure. The Council with the support DST-GoI and DST – GoK initiated to develop a Geoportal and Data Clearing House to discover/ access spatial data sets useful in the local level planning process through Karnataka State Spatial Data Infrastructure (KSSDI) Project. The geo-portal is expected to serve as a centralized hub for other spatial data generating agencies in the State. Web-enabled centralized database of various existing spatial, attribute or statistical data has been generated at KSCST, Bangalore.

About Karnataka Geoportal

Karnataka State Level Spatial Data Infrastructure (KSSDI) called **Karnataka Geoportal** is a centralized single window access mechanism for all the spatial data acquired by various agencies in Government of Karnataka using State's resources primarily to support planning activities of the Panchayath Raj Institutions (PRIs), district/state line departments, Urban Local Bodies (ULBs) and civil society organizations in the State. KSSDI is an Internet based GIS Directory for the state that eventually will be extended for the use of the society in exploring the information related to state geography, demography, agro and socio economy, and infrastructure facilities.

Spatial datasets generated, maintained and provided by various concerned Line Departments of the State Government, academia, private or civil society organizations of Karnataka are proposed to be made accessible through the project data clearinghouse mechanism. In the future the site can also be extended to cater to sale and purchase of data online. All the data would be shared through the Open GIS Consortium (OGC) recommended standards.

The available data would be catalogued and the search for availability of any particular dataset would be made available through specially customized metadata (data about the data) utility. In this architecture, KSSDI Gateway and its user interface allow a user to query distributed collections of spatial information through their metadata descriptions. This spatial information may take the form of "data" or of services available to interact with spatial data on the different data server, described with complementary forms of metadata. A user interested in locating spatial information uses a search user interface, fills out a search form, specifying queries for data with certain properties. The search request is passed to the database Server, which shall search the Metadata repository on its end. The datasets fulfilling the search criteria will

be displayed to the user, on users request the same can be accessed from the Agency Server.

The KSSDI Data clearing house and geo-portal would act gateway for various data generating agencies to share the information across various government departments, NGOs, academies, industries and scientific organisation. It will be a Single window system for discovery, view and access state geo-spatial data sets along with attributes. The individual departments and KSCST would be able to add and update the state geo-spatial data sets thereby providing the up-to-date spatial data dictionary and map directory for the state and facilitate decision support system and helps in local level planning. Thus, KSSDI would provide scientific approach to the decision makers, planners and administrators to facilitate common man usage of valuable Geo-spatial data. Also, the proprietary data prepared by department can also be used for the data sale and purchase, which can be part of the state revenue generation.

The complete KSSDI portal is developed using the ERDAS Apollo Software, an OGC compliant with facilities to share the vector and raster datasets through WMS, WFS and WRS web services along with the solutions and products from IBM for server hardware, storage, backup and retrieval systems, CISCO for the Networking components and Oracle for RDBMS requirements, respectively.

KSSDI - Service Oriented Architecture

There are a large number of users interested in the visualisation and analysis of the data organized and maintained by different sources, without having to install the specific applications or data on their terminals. They want to be able to connect to data services in real time and create different data combinations, and ultimately publish/share the contents and services to third parties and application developers.

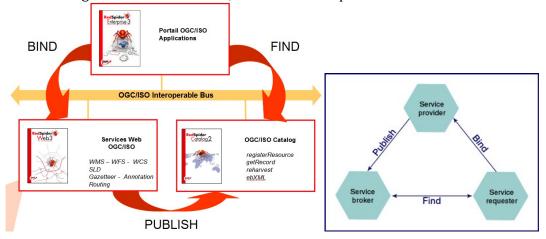
This goal is possible with the help of Service Oriented Architecture **(SOA)** applied to spatial information. An SOA can be implemented with Web services. Web services consist of XML based transport protocols and open standards designed to exchange data between different applications. Software developed and written in different programming languages for different platforms can all use Web services to exchange data using the Internet and HTTP protocol. This interoperability is made possible by the use of open standards.

One of the key elements of an SOA is the Service Registry: a record and description of all available services. It allows users not only to find and discover which services could be useful in providing solutions to their needs but also to integrate them into their business applications.

The methodology can thus be described as follows:

- « service providers » set up Web Services;
- they then publish these Web Services in the service registry : « publish »;
- « consumers / users» then discover these services by means of queries... « find » ;
- ... and integrate them into their applications « bind »;

Service Oriented Architecture, implemented by means of Web Services is particularly useful for setting up spatial data infrastructures for geographic information systems. *The SDI* provide the means for regulators, planning committees, managers, individuals and their organisations to discover, access and use spatial data.



The basic components of KSSDI are:

- Content storage: geographic data, i.e. Local alphanumeric data, data models and associated documentation, metadata;
- Geographic data Library;
- Business processing services: « geo-services » for the purpose of, for example:
 - accessing data;
 - o finding both data and services;
 - Sharing toponymic indexes;
 - webmapping queries;
 - o coordinate transformation services :
 - o finding the quickest path;etc.

Users of Karnataka Geoportal

In line with the SOA, the users of the KSSDI Geo Portal are classified into three main categories:

- a) **General User:** Any internet user/ General public wanting to access the portal must register (sign up) online to access the map services.
- b) **Data Provider:** User or representatives from the State or District level Line Departments, and District NRDMS centres participating in the data sharing with KSCST or members within KSCST itself. This user group based on the roles and privileges is sub-categorized further into two: Data Provider and Data Manager.

<u>Data Provider:</u> Will be representing their respective line departments and are authorised to make changes to the data pertaining to their department only. <u>Data Manager:</u> Will be a member of the KSCST staff who is authorised to perform overall data operation across all departments under the guidance of the Administrator of the KSSDI system.

c) **Administrator:** The administrator is considered as the super user of the system with the sole privileges to administer the complete system. They are further sub categorised as: System Administrator and Super Administrator

<u>System Administrator</u> – who is an authorised KSCST staff to perform administrative operations of the system that includes Managing Users, Roles and Privileges, application resources, system auditing and reports

<u>Super Administrator:</u> who has the sole authority over the system setup and its resources. He would be responsible for the data uploaded/update, modification of data format, define/modify and managing privileges for all user groups, administrative user profile, login, IP, security etc.

KSSDI Geo Portal – Identified User's General User Data Provider Administrator Categories **✓** J User Data Provider Super Administrator Roles System Administrator Data Manager KSCST/ NRDMS Departments

The overview of the user categorisation is given below

FUNCTIONS OF KSSDI GEOPORTAL

KSSDI Geo Portal provides an OGC framework for accessing spatial data across organizations or group of users in an efficient and flexible manner. This has the following components

- I. <u>Map Viewer</u> is an internet based interactive map viewing applications, which allow a user to view the spatial data. Map Viewer also facilitates map discovery, querying, analysing and update.
- II. <u>Map Catalogue</u> is list of map services available as a map directory. It allows the user to browse the directory of spatial datasets that are available as map layers. It facilitates an authorized data provider to publish map data as service that can be accessed remotely.

<u>Metadata</u> is information about spatial data. This would enable a user to view the descriptions of the metadata before actually accessing/working with the data. The authorised users would be able to Create, Update, Remove and Export Metadata is provided.

III. <u>Product Catalogue:</u> facilitate spatial datasets as maps to be listed as products and hosted for online sale and purchase with the payment details. Registered users can search for map products, select and download by making online transaction.

- IV. <u>Service Request:</u> allows users to post their requests via the portal to publish data as map services or make available as a product. The request can be made to the KSSDI Administrator or to a specific Line Department.
- V. **KSSDI Applications:** KSSDI Applications are prepared based on the currently identified needs of the line departments.

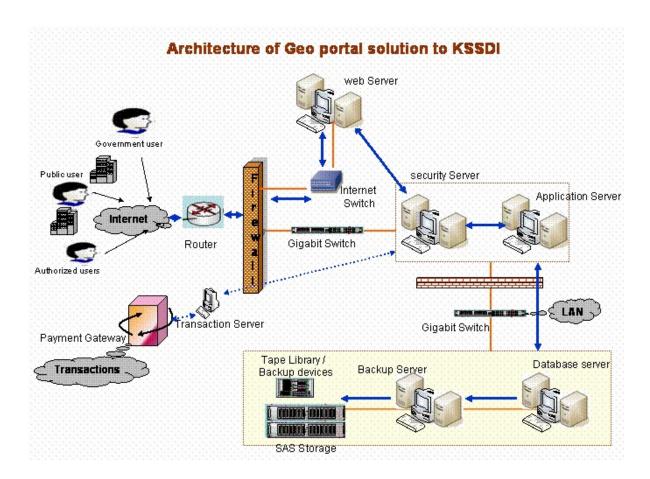
The applications are categorized based on the department name or a search keyword. These applications will help the Users in taking decision making process. A indicative list of application requirements are given below which would be available as part of KSSDI Geoportal for various users

Department	Application Requirement	Application Query
Department of Education (Akshaya Yojana Programme)	Opening of new Primary School	Distance of a school from a village doesn't exceed 1.5 kms
(District Primary Education Programme)	Opening of new Primary School	 Population exceed 300 Village with Adult Education Centre
(Akshaya Yojana Programme)	Construction of new school rooms	Select Schools for which additional rooms were constructed Population is in excess of 600 Number of students in excess
(Akshaya Yojana Programme)	Repair to school rooms	Select Schools for which rooms were repaired
	Location of School	Select School in Private land Select School in Govt. Land Select School in Adult Education Centre
Health Services (Malaria Eradication Programme)	1. Identification of High Risk Areas	Select Districts prone to Malaria high risk areas
KSCST	Villages with Primary health centre	Select Villages within a given Taluk that has PHC
	Constituency wise watershed 1000 ha each	Select Constituency within a district that has watershed area 1000ha
	Taluk wise location of M.I tanks having fishing activities	Select Taluk with MI Tank that has fishing activities
	Minor irrigation tank taluk wise	Select Taluk with Minor irrigation tank
	Schools with implementation of Rain water harvesting method	Select Village with schools that has Rain water harvesting
	Schools with drinking water and toilet facilities	Select Village with schools that has drinking water and toilet facilities
	Village with fluoride distribution	Select fluoride distribution map at village level
	Village with adult education	Select Villages with Adult Education facility available

Village with continuing	Select Villages with Continuing
education centre	Education Centres (CEC) facility
	available
Village with veterinary facility	Select villages with Veterinary facility available
Village with live stock	Select Villages with liver stock
distribution	distribution available
SC/ST percentage distribution	Select Taluk wise SC/ST percentage
taluk wise	Distribution
Village with population greater than 600	Select villages with population > 600
Village with number of	Select villages that has borewells and
borewells	the count
Village with Primary health centre	Select villages with PHC facility available
Village with Community Health	Select village with CH facility available
8 kms Buffer around the village locations with PHCs	Select villages with PHCs with 8 Kms Buffer polygon
Villages without PHCs	Select villages having PHCs facility
12 kms buffer around village	Select villages having CHCs with 12 kms
locations with CHCs	buffer polygon
Village location with population 3000 and with SHC	Select villages with population >= 3000 and SHC facility
Villages without Sub centres	Select Villages that do not have (<>) Sub centres

Karnataka Geoportal System Architecture

The diagram provides a schematic representation of the infrastructure and network requirements to host the Geo Portal and the clearing house and provide the system performance as stated in the requirements. The diagram also shows required number of servers, and server types, and how these servers will communicate with existing infrastructure and partner systems



IBM provides the HS21 blade servers for the 5 servers viz, web, security, backup, database and applications servers. The industry-leading flexibility, performance, and investment protection you've come to expect from the IBM servers has been extended even further with the introduction of a new generation of 2 processors, which run at clock speeds as high as 3.3 GHz and are available with a Level 2 cache as large as 6MB.

The Oracle 11g Enterprise Edition along with the Spatial Option gives the industries best RDBMS solution. Oracle Database server with spatial option is an OGC compliant product for storing Spatial and metadata. The unique features of Oracle in storing, retrieval adds value to our solution to KSSDI. The Virtual private database and data encryption adds more to the existing security features.

The Geo-portal solution as per the requirements of KSSDI/KSCST would have a total of 5 servers as shown in the architecture. The LDAP- active directory would be housed in the security server, along with the security module developed for the web portal. Security features will be compatible with LDAP (Light Directory Access Protocol) and Microsoft's Active Directory and would enable the establishment of a single sign-on security and authentication scheme. The application server would be housing the web portal solution, OGC certified WMS, WFS, WRS web services. The portal would also be housing the data conversion software / utilities. The Geo-Portal is also expected to have a transaction module which keeps account of the various transactions. The transaction services are later planned to be connected to a payment gateway of any of the nationalized bank like State Bank of India for payment transactions.

Activities:

- Release of RFP 25 Aug 2008
- Last date for obtaining RFP 05 September 08 (Received 12 requests)
- Clarification for RFP 12 September 2008
- Pre-bid conference 23 September 2008
- Last date for submission 17 October 2008 (Received 8 bids)
- Technical bids opened 31 October 2008
- Evaluation of technical bids & Short listing of bidders 05-01-2009
- Opening of financial bids 19-01-2009
- Evaluation of financial bids 27-01-2009
- Selection of consultant 27-01-2009
- Finalization of contract agreement
- Signing of contract 16-03-2009
- Initiation of Geoportal development 23-03-2009
- Installation of h/w, s/w and networking components September, 2009
- Stages of portal development during 2009 10
 - a) Requirement analysis
 - b) Real world object catalogue
 - c) Conceptual Data Model
 - d) Centralized database
 - e) Publishing metadata
 - f) Creation of Geo-portal
 - g) Customization of software for creation of Geo-portal
 - h) Security system to handle data, identity & network
 - i) Testing of the Geo-portal/database/services
 - j) Final deployment of the complete system
 - k) Training
 - l) User acceptance testing
- Updation of database, fine-tuning, metadata, catalogue etc.- 2011

The KSSDI portal passed preliminary stage of development and was released to users during October, 2009 for portal functionality testing. The release allowed the testing of the portal to undergo usability testing with selected users who provided feedback to the project team. Identified malfunctions were rectified. The Council officially launched Karnataka GeoPortal during December, 2009 at the 9th annual event of National Spatial Data infrastructure by the Honourable Minister of State for Science & technology, GOI, Sri. Prithviraj Chavan. The Council is initiating to set up state level committee to sensitize various departments/agencies of the government of Karnataka on the concept of SDI and the utility of Geo-portal and clearing house in order to secure their cooperation in the utilization/development of portal.

The complete Karnataka Geo Portal is developed using the ERDAS Apollo Software, an OGC compliant with facilities to share the vector and raster datasets through WMS, WFS and WRS web services along with the solutions and products from IBM for server hardware, storage, backup and retrieval systems, CISCO for the Networking components and Oracle for RDBMS requirements, respectively. It is a centralized single window access mechanism for all spatial data acquired by various agencies of the state.

The Karnataka Geoportal has been continuously being fine tuned for some of the issues like search feature enhancement, usability issues, application queries rectification and functionalities. The portal also has long list of pre-canned queries for different type of users as well as the facility for user defined queries. Training of the project staff as well as district project personnel has been completed.

Cataloguing of various data/metadata services available in Karnataka Geoportal has already been taken up and with increasing user awareness, the State will have to frame a policy/ guideline for dealing with user requests for getting access to feature or map data. An open approach at this stage with governmental stakeholders will facilitate better user awareness and promotion of the use of the standardised data sets/ services in governance-related activities. This in turn will help upgrade value of the data/ services for their better marketability amongst stakeholder agencies.

Participation of state level departments/directorates has facilitated in arriving suitable modalities for the data/ metadata using the geospatial tool developed under the project. The KSSDI Steering Committee has also triggered the issue of data sharing as well as data updation process. Under this project a meeting of the stakeholders from the Government sector at State level was held to deliberate on issues related to:

- 1. Online data sharing/updation mechanism
- 2. Metadata/Catalogue of services of participating agencies
- 3. Data standardisation for interoperability
- 4. Data sharing policy

Karnataka Geoportal Services:

Karnataka GeoPortal is envisaged to be a centralized single window access mechanism for all spatial data held and acquired by various agencies/line departments of the state. The modules in the Karnataka Geoportal are categorized into

- Map viewer Web Map Service (WMS),
- Product catalogue/metadata Catalogue Service on Web (CS-W),
- Services specific service/ feature data sets Web Feature Service (WFS),
- Simple Applications (Query based decision support)
- Coverage services/images Web Coverage Service (WCS)
- Help/support

Karnataka Geoportal URL: www.karnatakageoportal.in

Documents attached:

- 1. Need assessment report
- 2. Data migration and data management report
- 3. Conceptual data model report

User Need assessment: User acceptance testing (UAT) is the last phase of the portal/software testing process. During UAT, actual portal was tested to make sure it can handle required tasks in real-world scenarios, according to specifications with the support of State and district NRDMS centre staff, Experts from IIT - Bombay and IISc. The portal was made available for a trial for the both the in-house testing team and other experts.

Following are the steps involved in in-house UAT:

- Planning: The UAT strategy was adopted by the advice of experts from IIT- Bombay.
- Designing test cases: Test cases are designed to cover all the functional scenarios of the software in real-world usage. The access and discovery of data was an important bench marking for testing the portal. They were designed in a simple language and manner to make the test process easier for the testers.
- Selection of testing team: The testing team comprised of real world end-users.
- Executing test cases and documenting: Majority of the test cases were documented and tested randomly for bugs.
- Bug fixing: Responding to the bugs found by the in-house testing team, the vendor made few adjustments to the code to make the portal relatively bug-free.

Proposed future activities:

- 1. Development of web based geospatial applications for Karnataka Watershed Development Department for monitoring and evaluation of IWMP projects and health sector.
- 2. Institutional mechanism for Karnataka Geoportal to facilitate spatial datasets from concerned Line Departments to the monitoring, evaluation and formulation of developmental programmes/ schemes in watershed and health sectors.
- 3. Data sharing by data generating agencies through Karnataka Geoportal
- 4. Development of multi-lingual search facility
- 5. Integration of Ortho-images on geospatial applications for visualization
- 6. Map comparison tool for assessing the quality of crowd-sourced data
- 7. Crowd sourcing of points of interest in Karnataka Geoportal

Karnataka Geoportal - Login Page

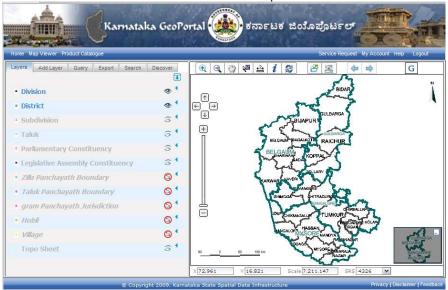


Karnataka GeoPortal's - Home Page



• On Login into the Geo Portal, the user have access to the various modules of the SDI.

Karnataka GeoPortal's – Map Viewer



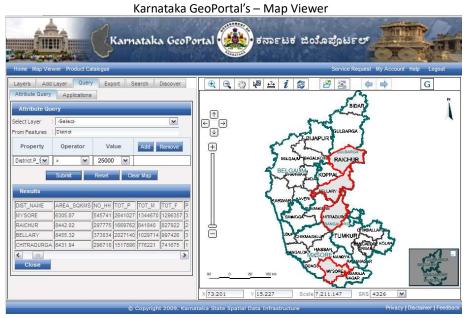
- Geo Portal Map Viewer module by default displays State Division and District Boundaries
- The Layer Tab on the left pane displays the list of layers that can be made visible at various map scales.
- User also have the ability to switch ON or OFF layers by using the Eye icon against each layer.
- The General Map Viewing tools available are: Zoom, Pan, Full view, Previous and next view, Identify, Measure, Refresh and Load context. It also provides the scale bar, X Y coordinates, SRS (Spatial Reference System) and Over View Map display along with Google Map layer display.

Home Map Viewer Product Catalogue Service Request My Account Help Logout Layers Add Layer Query Export Search Discover Search for Layers by Keyword and Spatial Extent Enter Keyword : State Service Type : |Map Services(WIIS) | Map | Map Services(WIIS) | Map | Map Services | Map Services

Karnataka GeoPortal's – Map Viewer

- Add Layer Tab allows user to search for the available services through "Key Word Search" or "Spatial Extent" using the Select Tool from the Toolbar.
- The Resulted services will be displayed and by clicking "View on Map", the selected layer gets displayed on the current Map Viewer.

Note: The current map displays the Division & District boundary with the State National Highway Layer resulted in the search above.



1. The Attribute Query Sub Module provides the ability to select multiple layers with or without spatial join and operators with input values to generate results and view them too on map.

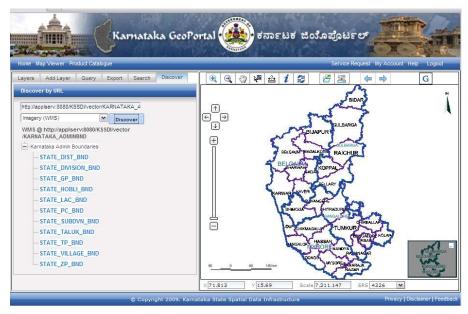
Note: The current map viewer shows the Query on District Layer, Highlighting the Districts with TOTAL ST POPULATION > 25000.



1. The Export module allows the user to select a specific layer for export to GML and SHAPE file format.

Note: The above screen shot shows Export of District layer to GML.

Karnataka GeoPortal's – Map Viewer



1. The Discover Module allows users to discover map services hosted at remote locations for viewing within the current map viewer as an overlay.

Note: The current map viewer shows the discovery of WMS Services from the local server. (Same way can be used to discover services on Remote Servers).



- Product Catalogue allows user to search the Published Web Services (WMS/WFS/WCS) in the KSSDI Data Repository.
- 2. It presents the Metadata of the selected Layer (NSDI Metadata Standard 2.0).
- 3. Also allows a user to all the layers to cart.