9.1. General

The development of intranet based GIS, which totally resides on local remote server, allows users to access and analyse the dynamic geospatial information through a web browser or equivalent, thus requiring no user installed software. The system provides enough core GIS capability and allows the creation of GIS data layers but is user friendly enough to provide access to users who are not GIS specialists. Web-based GIS could provide interactive mapping and spatial analysis capabilities reducing the problem of data ownership as data providers could open their sources for online mapping and analysis. Web-GIS is the latest advances in GIS technologies that bring spatial information and non-spatial information via Internet. Access to data over the Internet is growing rapidly and Information sharing through Web GIS Server is important as it reduces cost of data, provide standard data, conformity of data and data interoperability.

This chapter deals with the development and applications of a web based coastal GIS for the quantitative analysis of coastal landform dynamics. The web based coastal GIS (Intranet) for the study area (coast between Tuticorin and Kanyakumari) using ArcIMS server has wide applications. The chapter deals with the concept, architecture and advantages of ArcIMS technology. The integration of spatial and non-spatial database for the study area has been discussed. The effective dissemination of geospatial information and research findings through intranet have also been discussed and analysed.

9.2. Development and Applications of Web-GIS

The web based coastal GIS provides excellent opportunity for the dissemination of up-to-date spatial and non-spatial information of all coastal features, wave climate shorelines modifications, wave processes, sediment transport, land-use and land-cover
maps, land-use plans and landform dynamics etc. through the internet. Also we can perform advanced GIS analysis of various coastal landform features and analyse the related coastal processes. Zhong-Ren and Ming-hsiang (2003) states that the distributed coastal GIS provides an ideal mechanism for geographic data sharing and exchanges over the internet.

9.2.1. Development of Network based GIS

There is a need for a wider dissemination of knowledge relevant to the importance of coastal and marine areas to the world’s well-being, and a reevaluation of societies. There are several Coastal and Marine Monitoring (CMM) networks in the world. Most of them are involved in obtaining real-time quantitative indicators that impact on coastal and marine health such as water temperature, water level and meteorological conditions (wind speed and direction, temperature, barometric pressure), together with qualitative indicators such as visual images of the beach and near-shore. Others are involved in collecting quantitative and qualitative indicators of coastal environmental quality. The networks involve government, academic and environmental NGO institutions. They consist of huge repositories containing databases of archival and current material. They vary in scope—from local to regional to national and international networks.

GIS technology has historically been developed and deployed on monolithic (i.e., 1-tier) systems, such as ESRI's ArcInfo™ software (Morehouse, 1989) that have applications and geographic data installed on them. On such systems, if users want to view a map or make a query, they need to walk to the host machine. Network file servers enabled the sharing of data between machines on LANs within an enterprise. Geographic data is usually massive, expensive, requires powerful computers to host it, and requires its management by GIS experts. The above methods of hosting geographic data on a stand-alone machine or on an LAN are suitable only for GIS-centric high-end users.
The ability to distribute and view spatial information has quickly shifted from a desktop application (fat client) to a browser-based architecture (thin client). This latter architecture is referred to as thin client since the user only needs a web browser to access services and information on the web (Fitzgerald, 2000). The web lets data provider make spatial information available to a wider audience. The data provider can therefore provide a virtually centralised repository of resources without having to change the physical location of the data. This prevents any problems that might arise from maintaining or updating duplicate data sources, such as limited space or corrupt data. The web therefore makes it easy to provide the most up to date spatial data (Fitzgerald, 2000).

Russell et al. (2001) states that the Client/Server (i.e., 2-tier) architecture offers a separation between GIS users and GIS hosts. For example, ESRI's ArcSDE™ software (http://www.esri.com/sde) allows clients to access spatial data both from machines other than the Server machine and from different networks. The separation makes such systems more distributed than 1-tier systems, but they still may not be well suited to occasional users of geographic information, whose users need to have custom client applications on their machines. Later on the three-tier architecture has been introduced. Combs (1996) states that, the three-tier architecture has significant performance and improvements over the 2-tier architecture. Later on an n-tier tool (e.g. ArcIMS) is designed as to provide high scalability, fail over/recovery, and load balancing. Ramesh and Sandeep (2004) have proposed a web-based system based on an n-Tier architecture with external and internal interfaces interacting with the main sub-system for real-estate.

Several types of Web-GIS can be found in the literature, in some cases it was used for tracking development of disease, (Kelly et al., 2003; Guo-Jing et al., 2005), land use monitoring (Mathiyalagan et al., 2005), location management of wireless internet
structures (Bonier et al., 2002). Sam Ng'ang'a Macharia (2005) states that the emergence of web-GIS technology is providing the catalyst for easier collaboration, integration and cooperation among organizations with a stake in good governance and sustainable development. This is done by providing an environment for data sharing and integration over the Internet, sometimes without organizations having to make any major changes to the structure and formats of the data they maintain. The full range of analytical capabilities available in most contemporary desktop GIS however is not available on the web browser (or WebGIS client) since they are built on the thin-client concept. To include more functionality at the client end would seem to defeat the concept of the low cost and convenience of utilizing only a web browser to access spatial data.

Traditional mapping issues still pose challenges to web mapping. Some of these new technologies support different data formats (e.g. ESRI shape files, CARIS, MapInfo files etc.), projections, scales, datums, etc., with conversions and visualization being done "on the fly." Certain web-GIS technologies now facilitate the transmission, integration, visualization and analysis of spatial information stored in geographically dispersed locations. A user with permission to access the geographically dispersed data sets need only have access to a web browser in order to view, query, and analyse the data sets. On the CMM front in Canada, Fisheries and Oceans Canada, Environment Canada, the Defense Department, Transport Canada and the Canadian Space Agency are already collaborating on a program called Integrated Satellite Targeting of Polluters (I-STOP), to use the satellite of Radarsat International to identify ocean slicks (Calgary, 2002).

The use of Web-GIS makes geographic information available to larger audiences than conventional GIS packages (Guo-Jing et al., 2005.) or data files stored in a simple server (Hess, 2002) it also enables the integration of geospatial datasets of land and water
resources or other spatial information (Mathiyalagan et al., 2005). This allows real-time access to a high volume of data for all users that need it (Kraak, 2004). The geospatial information has to be easily accessible to all participants of the CALTER project independent of the user's platform or equipment used to access such data. Yank et al. (2007) used web GIS for disaster management in Taiwan. They states that by providing real-time and correct information for response actions, rescue plans, and rehabilitation programs, the utility of Web-GIS techniques will be widely noticed in the future establishments of disaster prevention and rescue information systems. In order to enhance the comprehension of the Web-GIS information system, it will remain to be updated and extended the current GIS maps in the future.

9.2.2. Applications of Web-based Coastal GIS

Web GIS is very useful for coastal zone management that deals with geographic information for decision support on a distributed environment. It becomes more important when the location-specific information is dynamic and decisions have to be made on real time basis. An highly cost-effective way to make geographic data and analyses more widely available and more accessible across an enterprise is to develop web applications. This permits visualization and simple query of spatial information, but also complex spatial operations such as geocoding and route networking. Gillavry (2000) state that, the combination of easy access to data and visual presentation of its location some of the primary difficulties in performing geosciences evaluations. The development of Web based GIS provides several capabilities that can greatly help the geoscientists work in any location. The web application allows the user for visual interaction with the geographic data and to produce interactive maps of dynamic coastal features such as shorelines and landforms. Since these data are frequently updated, the clients can immediately view these updates, which help to speed up the evaluation and analysis process.
9.3. Architecture and Advantages of ArcIMS

9.3.1. Architecture of ArcIMS

ArcIMS can be divided into three parts on the basis of their functionality namely Spatial Server, Middleware, and Client-tier (Figures 9.1, 9.2 and 9.3). Russel et al. (2001) extensively illustrated the components and the functions of ArcIMS network.

a) Spatial Server: The ArcIMS spatial server is composed of Container, AXL Parser, Data Access Manager, and five standard components such as Image Server, Feature Server, Query Server, Geocode Server, and Extract Server (Figure 9.4). A Container is launched by a Monitor and managed by the Application Server. After starting, the Container creates two controlling threads, which keep it connected to the Monitor and application server during the whole session. Container's communications with Application server and Monitor are realized in an XML-based protocol and performed via the web link module. The main tasks of the Container are to register, start, and stop server components. Every instance of each server component is launched within the context of a separate thread inside Container and works independently of all other threads. All the components use Data Access Manager to access ESRI's shape (SHP) files, ArcSDE databases, and Raster databases.

Image Server processes data extracted from Data Access Manager and produces map images in JPG, GIF, and PNG formats, which may be downloaded by a thin client such as HTML viewer. Query Server runs in the background of Image Server and handles all spatial and attribute queries. Feature Server streams vector features to the clients of Java viewers, to get raw data in the form of a highly compressed binary stream. It is up to the client to unpack, store, and render the data. Extract Server extracts data and packs it in
the form of zipped SHP/DBF files. The data may be downloaded in the same way as images generated by Image Server. Geocode server can be used with both Image and Feature Servers to find the location for a street address. This component is built on top of the Arc GIS geocoding engine and works with both SHP and ArcSDE data sources. The Container's internal structure makes it possible to use Custom server components.

b) Middleware: ArcIMS Middleware has Connectors, Application Server, Monitor, and Tasker. Application Server receives requests from clients through Connectors; it responds to site-information requests and forwards the requests to the respective service of the Spatial Server. Once Spatial Server sends back the response, it conveys it back to the client that sent the request. A Monitor starts Spatial Servers and makes sure that Spatial Servers are always running. The Tasker cleans up the images generated by Image Server after a predefined time interval so that the Web site does not run out of disk space.

c) Client Tier: The client tier provides a user interface for the end user of the system to interact with the distributed GIS. It displays maps in a web page and manage map services on the server. In ArcIMS, this tier uses ArcXML as the language of interaction with all components within the system over HTTP transport. The significance of ArcXML in ArcIMS is that any application that can read and/or write XML can be a client to ArcIMS. Client tier uses the following applications for accomplishing its tasks.

i) ArcIMS Administrator: It is a Java 2 Application and applet that enables the ArcIMS Administrator to manage map services, Spatial and Virtual Servers, and Folders Creating and managing an ArcIMS site is simplified using this tool.

ii) ArcIMS Author: It is a tool that enables an end user to author an electronic map or the Web. The tool allows a user to visually create a configuration file that can be used by the
ArcIMS Administrator to create a map service. Users can add spatial data, symbolize the data, set scale dependencies, and perform similar operations on a map window using a Java 2 application or applet running inside of the ArcIMS Manager web pages.

iii) ArcIMS Designer: It is a tool that enables a user to generate a "ready-to-run" Web site using a wizard. The Designer is a Java 2 Application and applet that is run after a map service is created. This enables a user to get up and running quickly with a web site that can be modified to suit the project needs. The Designer outputs the three ArcIMS Viewers-HTML, Java Custom, and Java Standard.

iv) ArcIMS Manager: It is a web site designed for enabling a user to quickly begin using and managing an ArcIMS site. The Manager consists of the ArcIMS Administrator, Author, and Designer.

v) HTML, Java Standard and Custom Viewers: There are three ArcIMS viewers-HTML, Java Custom, and Java Standard—use a Web site template to provide the functionality and graphic look of a Web site. Since these viewers are implemented as a template or a starting point, they can be modified to behave and appear according to the requirements of a project.

9.3.2. Advantages of ArcIMS

The distributed architecture of ArcIMS offers the separation between clients and data sources across the local webs or Internet, which makes it feasible to host expensive, high-accuracy, and up-to-date data. One can gradually add machines for additional Web servers to handle increasing client load. One can easily customize servers to serve route maps, weather data, traffic data, and so on. They ArcIMS have excellent advantages like Fail Over/recovery, Platform Independent and Multi-site (Mirror-sits) options.
9.4. Integrating Geospatial Data for Web based Coastal GIS

9.4.1. Integration of Spatial Data

The coastal landforms are highly dynamic in nature. Frequent monitoring and analysis are required to validate and update the geospatial database. Most geographic information users, experts, scientists, individuals and organizations have access to the Internet Web browsers for their needs. This makes the Web the vehicle of choice to serve people's GIS needs.

The present research has been aided to study the coastal landforms and their dynamics using satellite imageries, topographic maps and meta data. The ArcIMS architecture provides easy and effective handling of massive geospatial data such as Satellite Imageries, Airborne Photographs, Digital Elevation Models and other related raster data sets. In-order-to perform easy data handling, low processing time and security reasons, low resolution JPEG images are uploaded to the personal geo-database of the ArcIMS Site. The classified images of the different coastal landforms are also incorporated with the database. The identified and extracted landforms by using remote sensing and GIS techniques are also exported and saved as ESRI ArcGIS Shape files. The integration of all spatial and non-spatial data is very essential for extensive sharing and analysis of geographic data over internet. So, the shape-file of landform features such as shorelines, sandy beaches and sand dunes etc. have been integrated with the geo-database. In addition to these raster datasets, the secondary data such as local maps, road networks and drainage maps have also been integrated.

9.4.2. Management of Non-Spatial and Meta Data

The advanced ArcIMS technology is fully capable to integrate the RS, GIS, spatial and non-spatial data in a single platform. The non-spatial data of different coastal landforms such as feature ID, feature type, location, aerial extent, perimeter, soil type, etc.
are integrated as attributes with the personal geo-database. This will enhance the GIS analysis capability of the ArcIMS site. Thus the geo-database is discrete representation of geographical reality with sufficient spatial and non-spatial data to compute and perform extensive and effective GIS analysis.

9.5. Development of Web based Coastal GIS

9.5.1. Configuring a Map

The client-tier of ArcIMS provides the facility to create a map for the web map for the service. The ArcIMS ‘Author’ has been used for the purpose. Both spatial and non-spatial information can be added with map. The raster layers of satellite images, aerial photographs, topographical maps, road networks can be integrated with map. The vector layers such as shorelines, settlements, landforms and other vector feature can be added with map. In addition to this spatial information, the non-spatial information like length, and area of coastal feature, type of soil, vegetation, land use-land cover type and other meta-data can also be integrated with the map. The properties of these raster and vector layers can also be modified with in this Author service. The projection type, map units, layer drawing order, legend and symbols type and colour etc. can be added with the map. Finally the map is saved as Arc AXL format.

9.5.2. Creating a Web Map Service

The web map service such as feature service or image service is required for the incorporating the map. The web map service can be created by using the ArcIMS Administrator (Figure 9.5). It provides tools to create a web map service. The developed ArcIMS map in Arc AXL format or mxd format can be used to produce the map service. The type of image data (such as jpeg, png etc.), output directory, website directory and html location can also modified by the ArcIMS Administrator.
9.5.3. Development of Graphical User Interface (GUI)

The ArcIMS Designer (Figure 9.6) provides tools to produce interactive websites for publishing the map. The name of website directory, title of web page, ArcIMS hostname can be specified in the designer. The type of viewers such as html, Java custom and Java standard can be selected and integrated. The extent of all feature layers, data source units, scale bar units can also be modified. The designer also helps to incorporate various functional tools such as zoon, pan, query etc. with the website. Thus the ArcIMS designer provides an interactive graphical user interface (web page) for the service.

9.5.4. Client Viewer Tools and Controls

The ArcIMS browser interface supplies the user with a number of tools to view, select, and search spatial data. These tools allow the user to zoom in or out, pan, measure, select, find, create custom map views, and buffer or query spatial features and their associated attributes.

9.5.5. Publication and Management of Coastal Geographic Data

The developed website namely ‘SNCOAST-GIS’ (Figure 9.7) has been launched through the local intranet. It is incorporated with major coastal landform features along the study area with more interactive GIS tools. The developed site has been modified and managed by the ArcIMS Administrator.
Figure 9.7 Graphical User Interface of STNCOAST-GIS (ArcIMS Intranet Website)
9.6. Summary

This chapter analysis the history, development and applications of web based coastal GIS. The architectures of ArcIMS and its advantages have been reviewed and analysed. The chapter also discusses the development of web based coastal GIS for the study area. The integration of various geographic data and their attributes has been dealt with proper care and attention. The Web GIS development processes faces new challenges such as technology innovations, voluminous data transfer rate, and non-specialist users.

The development of Web based GIS for the study area provides several capabilities that can greatly help the students, researchers and geoscientists. The web application allows the user for visual interaction with the geographic data and to produce interactive maps of dynamic coastal features such as shorelines and landforms. Since these data are frequently updated, the clients can immediately view these updates, which help to speed up the evaluation and analysis process.

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