# Egyptian Survey Authority Geographic Information Management System (ESA GIM)

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**Key words**: GIS, theme, etc.

## SUMMARY

ESA can be regarded as the backbone for supplying data to the Egyptian society. In fact, it is currently the only governmental organization responsible for the coverage of Egypt with base topographic maps of several scales. It also has the responsibility of supporting national cadastre and land registration, in cooperation with the Real Estate Office in the Ministry of Justice. Moreover, ESA is a solid candidate in the Egyptian Geography Network (EGN), Egypt's National Geospatial Infrastructure (NSDI).

In accordance, with its national role comes the establishment of ESA's Geographic Information Management System (ESA GIM). This paper will provide a summary of the main business requirements and challenges that can be overcome with the aid of ESA GIM.

It also gives a detailed description of the system established including the concept of the system, the system architecture, the data model and the different modules from which the system comprises. The proposed system architecture is based on building ESA GIM Data Warehouse, which is the data repository populated from three main data sources: the topographic department, the ECIM (Egyptian Cadastral Information Management) project and the cadastre project in Cairo province. Hence, the solution provides ESA with a tool to convert data coming in from multiple sources.

The system then relies on web services and ESRI's GIS portal toolkit to implement ESA's portal, which acts as a clearinghouse, publishing metadata to the public. The solution also serves ESA internally through a front desk application, which enables ESA personnel of handling incoming requests. Finally, the system also serves top level management, through a web-based monitoring application that allows them to keep track of the performance rate in response to incoming requests.

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## 1. INTRODUCTION

Egyption Survey Authority (ESA) can be regarded as the backbone for supplying data to the Egyptian society. In fact, it is currently the only governmental organization responsible for the coverage of Egypt with base topographic maps of several scales. It also has the responsibility of supporting national cadastre and land registration, in cooperation with the Real Estate Office in the Ministry of Justice. Moreover, ESA is a solid candidate in the Egyptian Geography Network (EGN), Egypt's National Geospatial Infrastructure (NSDI).

In accordance, with its national role comes the establishment of ESA's Geographic Information Management System (ESA GIM).

## 2. ESA'S BUSINESS NEEDS

The following section provides a summary of the main business requirements and challenges that can be overcome with the aid of ESA GIM

Efficient Information Management
- Establish a data warehouse at ESA headquarters to act as a central data repository
- Develop a mechanism for data exchange among ESA headquarters and its various departments
- Avoid the costly process of collecting and organizing data from multiple sources

Establish unified access to Nation-wide Geo-Information
- Provide the mechanism to advertise and disseminate ESA data and services via a web portal
- Integrate ESA information , creating a single , secure node for data dissemination and requests to the public/governmental entities
- Develop a GIS Clearinghouse through which the public/governmental entities can browse the available metadata , search by keywords and even view available samples of data

Business Process Re-engineering
- Apply business process re-engineering concepts to organize data flows between ESA headquarters and departments
- Develop mechanisms to enable top level management of monitoring occurring activities.

System Scalability
- Establish a scalable and sustainable solution that fulfills the needs of ESA GIM in the pilot phase , with the ability to grow simultaneously with future needs.

Improve the competitive power of ESA

- Promote ESA's role as a data provider , enabling it to advertise its services , following advanced business models
- Prepare ESA to become a vital participant in the EGN.

## 3. SYSTEM CONCEPT

The system aims to provide ESA with the mechanisms and tools necessary to build a data warehouse, which hosts topographic and cadastral data, together with their metadata. It enables ESA of building a clearinghouse, which provides various entities, whether governmental or public with a single entry point for the geographic information that it can offer.

The system is based on implementing a number of web services, which allows ESA to develop various applications, empowered with the spatial component. Moreover, a secure cadastral web service is built to allow governmental entities, such as the Ministry of Justice to inquiry cadastral ownership data.

The public can access ESA's metadata via web-based GIS portal, which allows them to browse the available metadata, search by a specific criteria and view available samples of data. Governmental entities can also make use of the portal to browse metadata and they can additionally identify cadastral ownerships. Both, the public and governmental entities can submit requests for unavailable data.

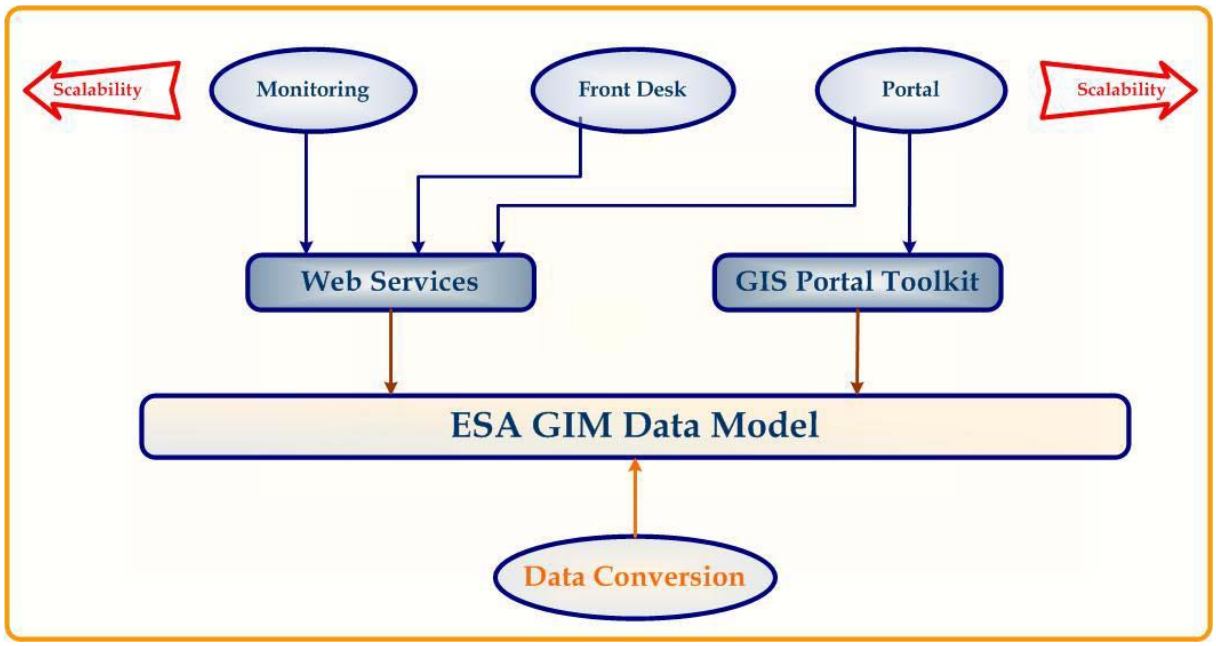
ESA personnel can also access the system via a Front Desk application that allows them to search for metadata and the event of unavailability send a request to the designated department.

Finally, a monitoring application is provided, which enables top level management of monitoring work flows, the status of various requests, as well as generating reports relevant to system performance and response.

As illustrated in the diagram below, the solution encompasses a number of basic building blocks upon which various elements can be added. Hence, the system concept can be briefed as follows:

- Building a central unified data model as the system foundation. As described in the following section , the data model hosts a variety of data entities
- Develop a data conversion application that enables users of converting data inputs from multiple sources to enable storing them in ESA GIM Data warehouse
- Implementing ESA web services in order to empower various applications with GIS functionalities
- Utilizing ESRI's GIS Portal Toolkit , which is a technology for implementing national spatial data infrastructures ( NSDI )

- Develop ESA GIS-based portal , which is built on the GIS Portal Toolkit and empowered by ESA web services
- Build ESA Front Desk and Monitoring applications , which are empowered by ESA web services

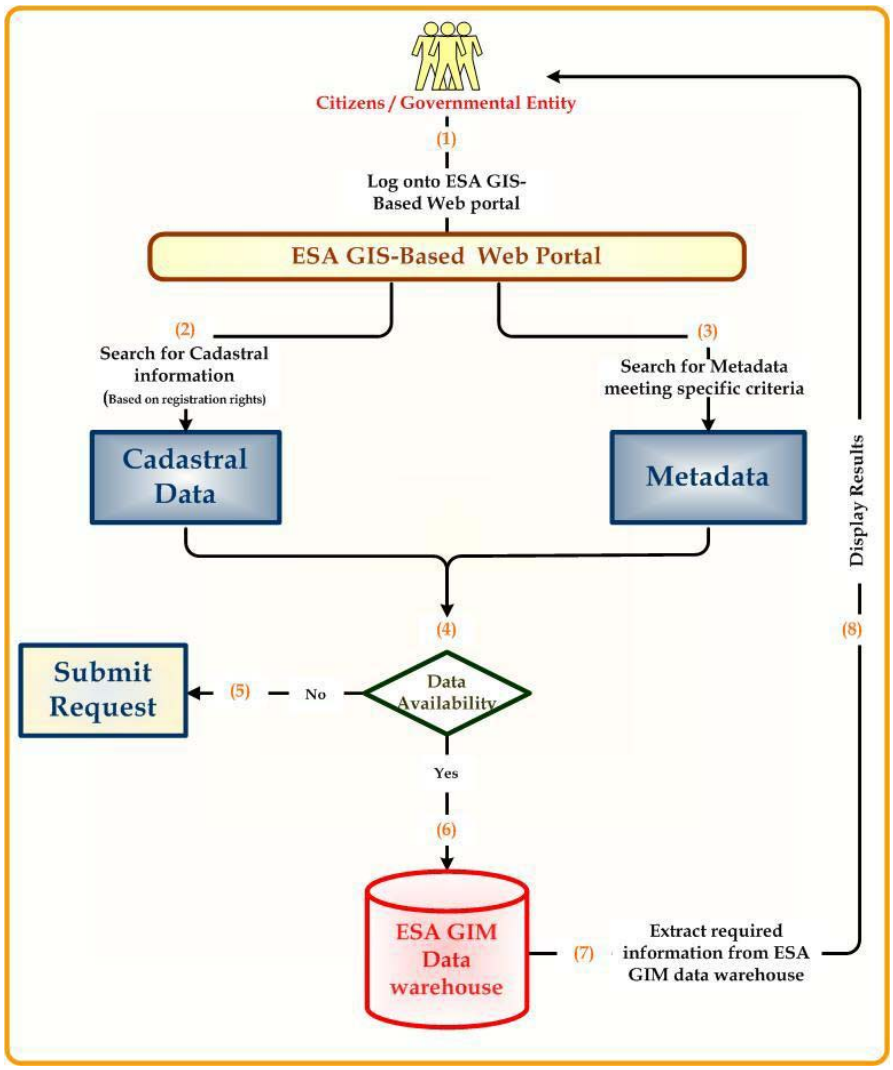



System Concept

## 4. SYSTEM DATA FLOWS

The following section provides a thorough description of the proposed ESA GIM data flows. Data flows are as follows:

## 4.1 ESA GIM Web Portal Data Access Flow



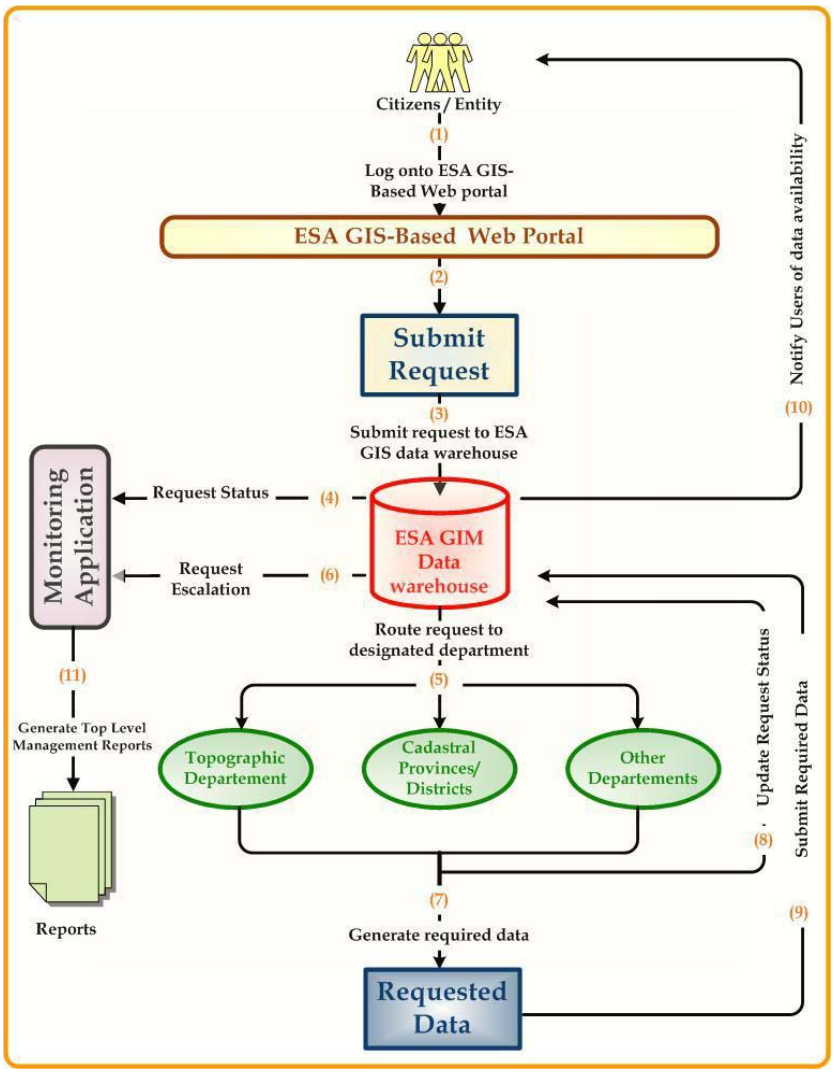

ESA GIM Data Access Flow

- Users represented by either the public or governmental entities, such as the Ministry of Justice log onto ESA
- Governmental entities can access and search cadastral and ownership data, based on privileges granted by ESA

- The public can search metadata , specifying certain criteria to base their search upon
- If required data isn't available a spatial request is generated*
- If required data is available the request is submitted to ESA GIM data warehouse
- Required data is extracted from ESA GIM data warehouse
- Results are displayed to users via ESA's GIS based portal

*Kindly referrer to Spatial Requests Data Flows

## 4.2 Spatial Requests Data Flow




ESA GIM Spatial Requests Data Flow

- Users represented by either the public or governmental entities, such as the Ministry of Justice log onto ESA
- Users submit requests for data that wasn't available
- Received requests are submitted into ESA GIM Data warehouse, where the request status is adjusted to pending. The pending status indicates that a status has been made and is waiting for the designated department to provide details on it. Time interval for the pending status is an adjustable parameter that would depend on ESA's requirements define during the analysis phase
- Request status can be viewed by the monitoring application , which allows top level management to have an insight of ongoing activities and track performance
- Requests are routed to the designated department , whether topographic or cadastral , in addition to other departments , which might be added to ESA GIM in the future.

- If departments don't provide details to requests , such as the availability of required data and estimate date of reply , an alert can be displayed via the monitoring application as a means of request escalation
    - Departments generate the required data
    - Request Status is updated and submitted to ESA GIM data warehouse
    - Requested data is submitted to ESA GIM data warehouse
    - Users are notified via a suitable means of communication , such as e-mail of the availability of requested data.
- Top level management reports about system request response performance can be generated.

### 4.3 Front Desk Activities Data Flow

- Users represented by either the public or governmental entities, such as the Ministry of Justice visit ESA headquarters
- Requests are submitted to ESA front desk , which uses a web based application to search for required data
    - If data is available results are reported to requesting visitors
    - If data isn't available spatial requests are generated
    - Received requests are submitted into ESA GIM Data warehouse, where the request status is adjusted to pending. The pending status indicates that a status has been made and is waiting for the designated department to provide details on it. Time interval for the pending status is an adjustable parameter that would depend on ESA's requirements define during the analysis phase
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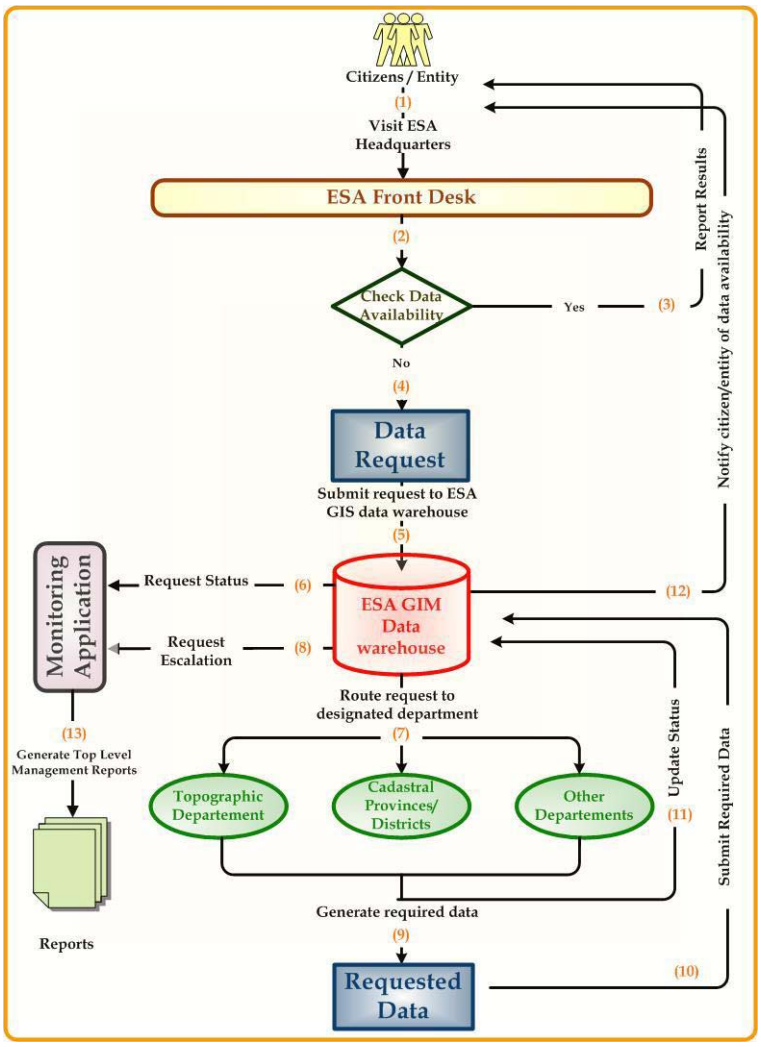
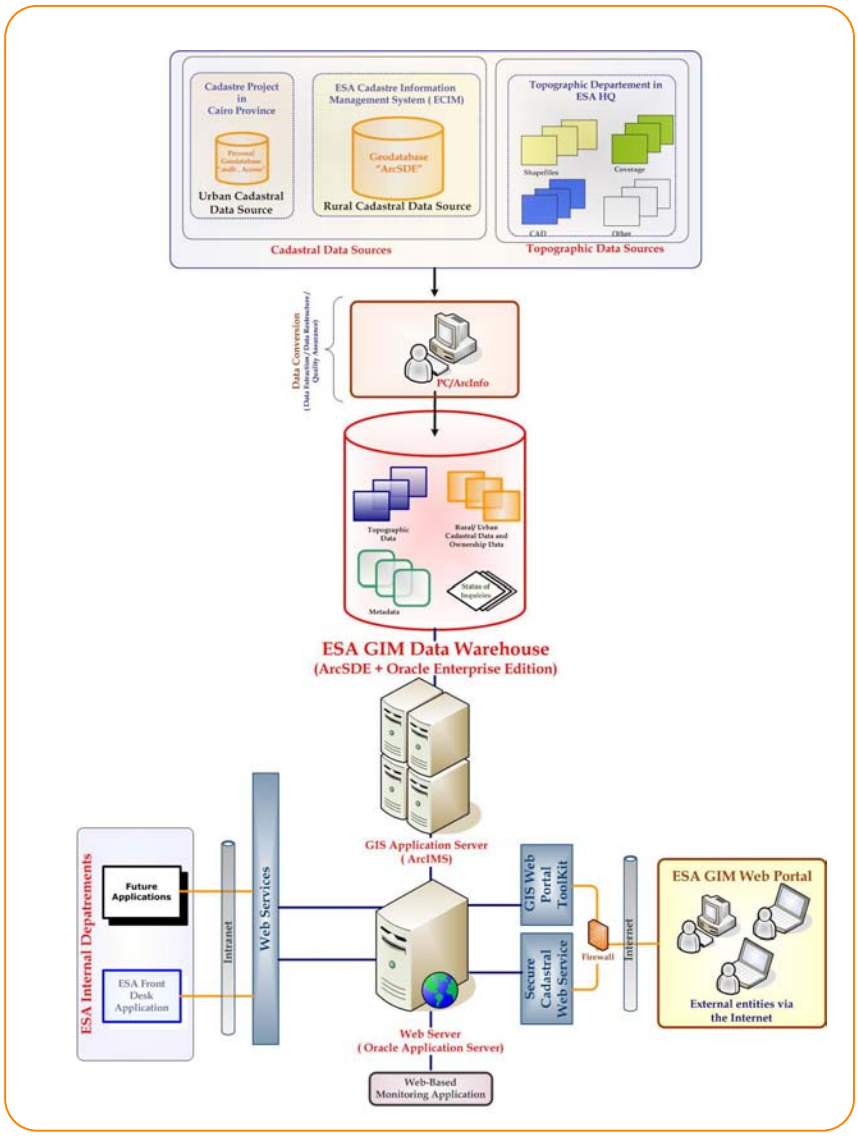



ESA GIM Front Disk Activities Data Flow

## 5. SYSTEM DESCRIPTION

### 5.1 System Architecture

As illustrated in the following diagram, the system architecture is based on establishing the ESA GIM Data Warehouse, which is the data repository, hosting data input from the topographic department, the ECIM project and the cadastre project in Cairo province.




ESA GIM Proposed System Architecture

The system is composed of the following components:

### 5.1.1 ESA GIM Data Warehouse

The ESA GIM Data Warehouse encompasses a spatial component, which allows for storing ESA's tabular and spatial information in a single data repository. As elaborated in the description of the data model, below, the data warehouse hosts the following data:

- Topographic spatial and tabular data coming form the topographic department
- Urban and rural cadastral data coming from the ECIM project and Cairo province
- Metadata describing the available topographic and cadastral data
- Status of inquiries made either through the web portal or ESA front desk

ESA GIM Data warehouse is composed of the following elements:
- Oracle Enterprise Edition.

This is the data repository storing ESA's data. Further details can be found in the Database Tools section.
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- ArcSDE

The Spatial Database Engine that spatially enables the database, allowing spatial data to be stored with its associated tabular data, in a single data repository**.**

### 5.1.2 Geo Application Server

The Internet Mapping Server (ArcIMS) is responsible for handling requests and serving requested spatial and tabular data. It enables building enterprise wide solutions that are secure, reliable, and easily adaptable to increased demand.

### 5.1.3 Oracle Application Server

This is the web server responsible for receiving client requests and transferring them to the ArcIMS. The web server also hosts the proposed web applications.

### 5.1.4 ArcInfo

The GIS tool, which allows maintaining and administrating the spatial and tabular data stored in ESA GIM Data Warehouse. It's customized to enable ESA users of converting data coming from a variety of sources. The data conversion process takes place over three main steps, which are:
- Data Extraction
- Data Restructure
- Quality Assurance

## 5.2 Data Model

The backbone of ESA GIM is in fact building its data warehouse and populating it with data from various sources, hence availing a single integrated data repository for topographic and cadastral data. Hence, building a data model becomes the foundation of developing the system.

The data model of ESA GIM isn't merely a replica of the existing cadastral and topographic data models. In fact, it is a rather simplified data model that is designed in a manner to simplify data access and inquiring.

A good data model results in a well-constructed, functionally and operationally efficient Geodatabase that:
- Satisfies objectives and supports application requirements.

- Contains all necessary data but no redundant data in a well structured integrated design
- Organizes data successfully for multi usage in Enterprise applications
- Appropriately represents and organizes geographic features with all its related relationships.

Data modeling provides the following benefits:-
- Increased flexibility of data retrieval and analysis, applications.
- Facilitated data that supports many different uses.
- Maintained data that supports many different users.
- Extensibility that readily accommodates future functionality.
- Minimized data redundancy.

## 5.3 System Modules

Several bilingual modules, both desktop and web-based are developed to deliver services offered by ESA GIM. The following section provides a detailed view of these modules.

### 5.3.1 Desktop Module

#### 5.3.1.1 Data Conversion Module

The desktop module is presented through the Data Conversion application, which is built on ESRI's ArcInfo to provide ESA with the tools necessary for converting data coming from a variety of sources into a unified, simple data model.

Data inputs, which will be converted, come from three main sources as follows:
Topographic Department: CAD Data, Coverages, Shapefiles,Scanned maps and photos in TIFF format.
Egyptian Cadastral Information Management Project
This is the rural cadastral data source, which supplies data in Geodatabase format, according to the Finnish project data model.
Cadastral Project in Cairo Province

This is the urban cadastral data source, which supplies spatial data, based on ArcGIS format. Supplied data includes:

- Cadastre maps including the surveyed parcels, administrative boundaries and relevant topographic features (1:500, 1:1000)
- Ownership information

The data conversion, takes place over three main phases, as follows:
- Data Extraction
  This phase covers the extraction of data from its original sources. Data transfer between source and ESA GIM can take place over a network connection or can be done by using CDs in the case of the unavailability of a network connection
- Data Restructure
  Extracted data is restructured to comply with the newly developed data model to facilitate

its processing and handling

- Quality Assurance
  As a final phase of the data conversion, quality assurance tests are performed to ensure the data quality.

### 5.3.2 Web Based Modules

ESA GIM system involves the development of a number of web-based applications that are built upon ESRI's GIS Toolkit and the web services developed. The web-based applications are described in the following section.

#### 5.3.2.1 ESA GIM Web Portal

ESA GIM web portal allows both the public and governmental entities of navigating metadata and sample maps published via the portal, in addition to using a number of functionalities as stated below.Generally, the portal allows users to:

*Search for Data*
Metadata on ESA GIM Web Portal is categorized according to its nature, such as administrative boundaries, cadastral and environment and conservation related. Hence, users can choose to search for metadata based on its category or they can choose to select specific criteria for their search. Users can then:

- Access a detailed view of the metadata from the search results page
- Launch the map viewer if the search results refers to a supported Internet map service
- Access the full metadata from the detailed metadata view.

Criteria for metadata search can be classified into:
Data Location
- Users can Select geographic extent of search by drawing a rectangle
- Users can Select geographic extent of search by the spatial extent of a selected feature

Data Description
- Users can Search by subset of metadata record fields (keyword, data category, scale, content type, publication period, period of relevance)

Date
- User can select a time period during , which the required data was issued
- User can select data that has been updated within a specific time frame.

*ESA Inquiries*
Users can submit inquiries and requests via ESA GIM web portal. Inquiries can either be general or specific requiring map generation, map update or inquiring about the status of a request submitted before.

*ESA Cadastral Data*

Due to its importance and strategic nature, cadastral data needs to be secured and access to it based on certain privileges. Hence, to access ESA's cadastral data, a user needs to have a login name and password. Through the portal users can:

- Submit a cadastral transaction
- Search for live data with its associated ownership information
- Inquiry the status of a transaction.

*ESA Professional Services*

ESA professional services allow users to request customized data that actually serves their business needs. For instance users can submit requests for:

- Terrain analysis
- Integrating cadastral and topographic data.


ESA GIM Web Portal home page, displaying available categories of metadata

5.3.2.2 ESA GIM Web Portal

ESA Front Desk Web-Based application is a spatially enabled application that serves ESA users. The front desk application is responsible for receiving data requests from the public and from governmental entities. It also allows for routing requests to their designated departments
The application encompasses a spatial component, which allows its users to:

- Map display, through the display of geographic and attribute data of the Royal Court properties, using the same interface.
- Map Navigation that allows for interaction with maps through operations that include:Pan,Zoom ( in / out / extent ),Identify

5.3.2.3 Monitoring Web-Based Application

The Monitoring Web-Based application provides top level management with a tool for:

- Following up the progress and status of requests made either to the portal or front desk
- Provides an alert in the event of a problem
- Perform basic analysis , such as selecting areas to which requests have been submitted
- Generate various performance related reports , such as the number of requests submitted within a certain time frame or number of requests submitted to specific departments

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