

# National Cyclone Risk Mitigation Project (NCRMP)

National Disaster Management Authority (NDMA)

## Consulting Services for Hazard, Risk and Vulnerability Assessment for 13 states and UT's in India

### IT System Specification Report, Functional Architecture Report, and Development Schedule

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Submitted by

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## Document Control

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## Abbreviations Used

Abbreviation	Expanded Form
Auto CAD	Automatic Computer Aided Design
CSV	Comma separated values
CSW	Catalogue Service for Web
DWG	Auto CAD Drawing format
ESRI	Environmental System Research Institute
GIS	Geospatial Information System
HTTP	Hyper Text Transfer Protocol
MIS	Management Information System
ms	millisecond
OGC	Open Geospatial Consortium
Pgsql	Postgresql
RCC	Reinforced Concrete Building
SDI	Spatial data infrastructure
Shp	Shape file format
SQL	Structured Query Language
SRS	Software Requirement Specification
UAT	User Acceptance Testing
URL	Uniform Resource Locator
UT	Union Territories
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service



# 1 Introduction

## 1.1 Scope of the Document

The purpose of this document is to provide a blue print of the proposed composite risk atlas, which is one of the key deliverable of the Consulting Services for Hazard, Risk and Vulnerability Assessment for 13 states and UT's in India project. It will focus on the IT system specifications, the functional architecture, and time schedule for the development and deployment of the risk atlas.

The report aims to help understand the system functional baseline, software platform that will be adopted for developing the system, the benefits of the selected software platform and how this platform contributes to the project objective, in making rich web mapping applications and their compatibility with mapping engines. This report also details out the functionalities available in the risk atlas and system relationship demonstrated through use cases. It also explains the roles and involvements of States/UTs and various departments in the prototype development, which include performing UAT and testing of the system at client location.

The document comprises of the following seven sections:

**Section 1** (Introduction) provides a brief scope of this document

**Section 2** (Software Platform): provides the review of platform adopted (Geo node and PostgreSQL)

**Section 3** (System Specifications) explains the architecture of the proposed system

**Section 4** (Description of Proposed Functionality) provides details on the functionalities of the proposed system

**Section 5** (Considerations for Phase II) focuses on the specifications that we have considered in this phase to make it compatible for dynamic risk assessment modeling functionalities for phase II

**Section 6** (Schedule) provides the work plan of development, testing and deployment of the composite risk atlas

**Section 7** (Prototype Composite Risk Atlas) describes the UAT process and the role of state/UT in prototype development.

## 2 Software Platform

### 2.1 Review of Geonode

Geonode is an open source platform for managing and publishing the geospatial data on the web. Geonode is built on a stack based on GeoServer, pycsw, Django, and GeoExt that provides a platform for sophisticated web browser spatial visualization and analysis. It can be customized easily to enhance the functionalities and has the capabilities to share interactive maps and geospatial data over the web. Users can make content available via standard OGC protocols such as Web Map Service (WMS) and Web Feature Service (WFS).

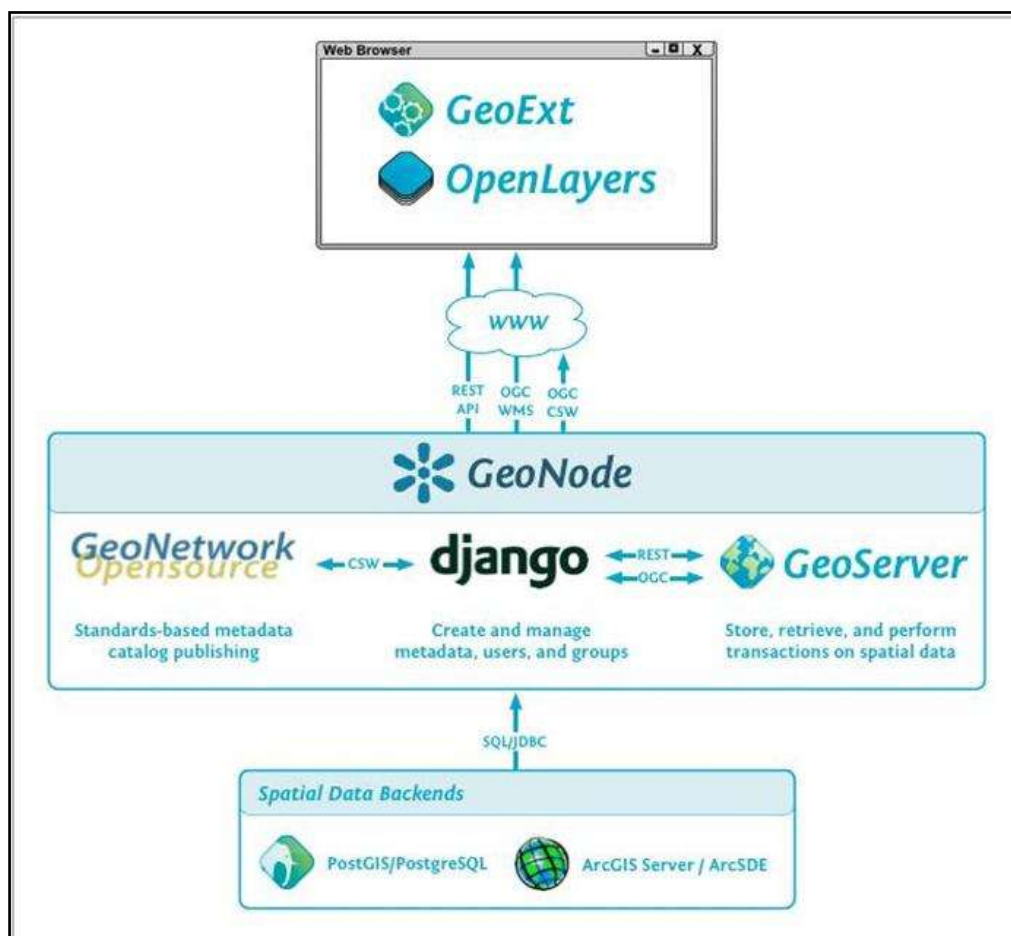
#### 2.1.1 FEATURES OF GEONODE

Following are the functionalities, which makes Geonode a more suitable platform for developing the composite risk atlas for this project:

1. Geonode supports both the vector and raster data including shapefile and Geotiff files
2. It supports all popular open source GIS layers including Open street map, Google satellite and Bing.
3. It re-projects all the layers to web Mercator projection for better display
4. It can be installed on Ubuntu.
5. The look and feel of Geonode can be customized based on user requirements.
6. Geonode is highly secured. Guest users are only allowed to view the maps. However, administrator can give permission to edit a layer or to manage the layer to registered or specific users.
7. Geonode internally uses the GeoServer for map rendering. GeoServer can pick the maps from PostgreSQL database server. The user can take regular backups of the data in PostgreSQL and recover it in case of accidental loss of data. The user can also implement replication of PostgreSQL server, which in turn can be used for load balancing.
8. Geonode supports social network platforms. The maps can be shared using Facebook, Twitter and Google +.
9. All the layers in Geonode can be cached so that layers are rendered faster to the user.

#### 2.1.2 GEONODE ARCHITECTURE

Geonode, being a web-based platform, can be used for developing information systems and for deploying spatial data infrastructures (SDI). Geonode comprises of 'Data management' tools that allow users for integrated creation of data, metadata, and map visualizations. In this process, Geonode allows the user to upload vector (currently only Shapefiles) and raster data in their original projections using a web form. Vector data is uploaded in ESRI Shapefile format and satellite imagery and other kinds of raster data are uploaded as GeoTIFFs. Figure 2-1 shows the architecture and components built in Geonode and the interrelations between them.



**Figure 2-1: Geonode Architecture**

PostgreSQL and PostGIS are the database components that store and manage spatial data and information for django module of Geonode, which is composed of GeoNetwork Opensource and GeoServer. All the tables and spatial data within Geonode are stored in PostgreSQL database. GeoServer uses PostGIS/PostgreSQL to store and manage spatial vector data for each layer, which is stored as a separate table in the database.

Therefore, Geonode is compatible with PostgreSQL/PostGIS. However, it should be kept in mind that Geonode needs to be configured for use with PostgreSQL/PostGIS for storing vector data.

### 2.1.3 GEONODE EXTENSIBILITY

There are several options available to extend Geonode as per user requirements. This section provides a high-level description of what has emerged as “Best Practices” for extending or building on top of the Geonode platform.

#### Prerequisites

- Working experience of Geonode installation
- Familiarity with Django and its project layout scheme

#### Types of Customization/Extension

- Branding
- Geo-processing

## Branding

This customization refers to the look and feel of Geonode i.e. changing the logo, colors and other branding elements in a Geonode site. Since Geonode's style is based on Bootstrap, users can make use of all that Bootstrap has to offer in terms of theme customization.

## Geo-processing

The process extension to GeoServer helps to define custom geo-processing operations against data managed by GeoServer. The operations are exposed via GeoServer RESTlet endpoint. Some processes are included with the process extension. It is also possible to define your own processes.

There are two 'modes' of accessing these processes: interactive and batch. The interactive mode is appropriate for fast-running processes and returns the result of the operation as the HTTP response to the request that launches the process. The batch mode starts a thread on the server and supports polling to find out information about progress until the process is complete.

## 2.2 Review of Database

In order to acquire, manage, and display information, a powerful open source object relational database system PostgreSQL/PostGIS will be used as the spatial database. PostGIS is open source software that adds support for storing geographic objects in the PostgreSQL database. Further, the PostgreSQL/PostGIS database supports relational queries based on SQL query language that could also include GIS operations. This makes spatial querying very easy.

### 2.2.1 FEATURES OF POSTGRESQL/POSTGIS

PostgreSQL/PostGIS provide functionality to store spatial as well as non-spatial (tabular) data on a single platform. This makes it an obvious choice as a backend database for this project.

1. PostgreSQL/PostGIS database server can run on various operating systems such as Ubuntu and Windows.
2. PostgreSQL/PostGIS specifications regarding the data size are shown in the following table:

**Table 2-1: PostgreSQL/PostGIS specifications**

Limit	Value
Maximum Database Size	Unlimited
Maximum Table Size	32 TB
Maximum Row Size	1.6 TB
Maximum Field Size	1 GB
Maximum Rows per Table	Unlimited
Maximum Columns per Table	250 - 1600 depending on column types
Maximum Indexes per Table	Unlimited

3. There are no limitations on the number of hits/queries by concurrent users for read and access to the database. By default, the database allows 100 concurrent users, but this

- can be increased through the configuration settings. PostgreSQL applies intelligent connection pooling mechanism to give optimum performance. If multiple users are concurrently updating the data, then various database isolation levels including serialable, repeatable read, and read committed can be applied.
4. PostgreSQL/PostGIS provide the following command line tools for data interoperability and migration.
    - a. shp2pgsql: This tool can be used to import shape files into the PostgreSQL database.
    - b. raster2pgsql: This tool can be used to import raster format data into the PostgreSQL database.
    - c. pgAdmin3: This tool is a GUI based client, which can be used to manage and export the database. The tables can be exported to SQL scripts or CSV format. CSV files can be viewed in Excel, Notepad or any other text editing tool.
    - d. pgsq2shp: This tool can be used to export the tables in the PostgreSQL database to shape files. These shape files can further be imported in Oracle and MS Sql Server database.
  5. In general, a large spatial query running over the whole database, connecting multiple tables, and involving a set of spatial operations can run in around 10,000 ms.

## 2.3 Summary

The composite risk atlas will be developed in Geonode platform. Geonode is built upon a platform of proven open source components including Django, GeoServer, pycsw, OpenLayers and GeoExt. Geonode implements many Open Geospatial Consortium (OGC) standards, including Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS), KML, and Catalogue Service for Web (CSW).

The web GIS atlas will be developed in Geonode platform, which consumes the Web Mapping Services of Geoserver. Geonode will be used for its data sharing capabilities. All the risk assessment engine's codes will be written at the backend server in Postgre/PostGIS. Geonode will only be used to display the outcome of the analysis.

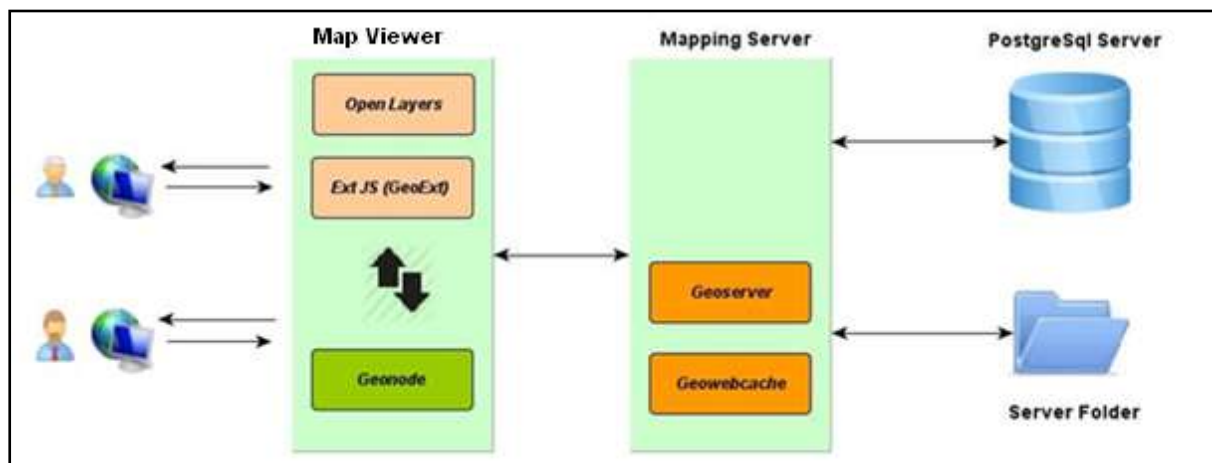
The platform will be suitable for distribution and future use. The proposed platform will be designed as a set of modular components for incorporation in a larger risk analysis system to be developed in future. The user interface will be simple and uncomplicated to help ease of use. Outputs will be presented in the form of printable reports, maps as well as datasets that can be used in subsequent modeling systems. Open Source models will be used in the development to the extent possible.

### 3 System Specifications

#### 3.1 Proposed Architecture

##### 3.1.1 FUNCTIONAL ARCHITECTURE

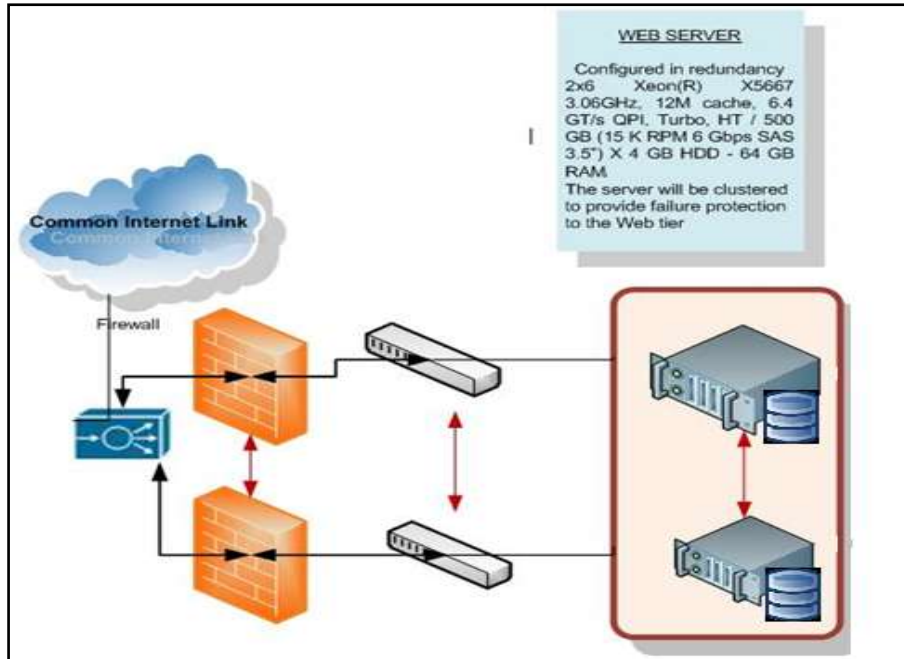
The composite risk atlas will be web GIS based and will be developed in Geonode platform. It will also use Ajax based Javascript libraries called Open layers and GeoExt to give additional functionality to users. Geonode will internally connect to GeoServer and GeoWebCache to render maps on the composite risk atlas. The map data will be stored along with its attributes in PostgreSQL database. GeoServer will connect to the PostgreSQL database to get the map data and return the map to the user.



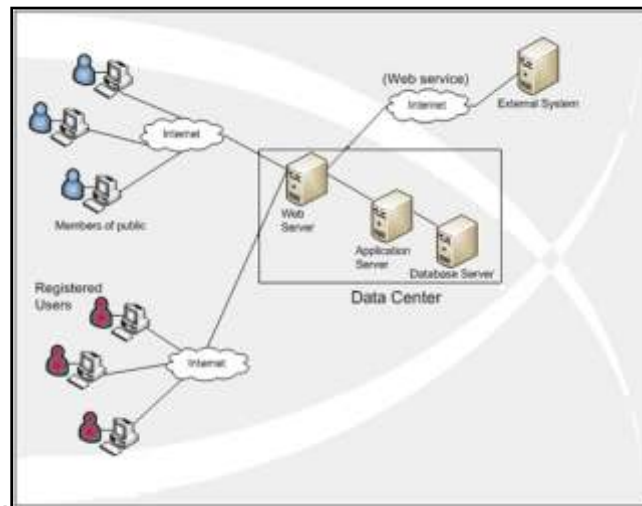
**Figure 3-1: Functional Architecture**

##### 3.1.2 SYSTEM ARCHITECTURE

The system architecture will consist of two redundant web servers clustered to provide failure protection along with the firewall. Geonode will be installed on both these servers. Data from PostgreSQL will be replicated in both these servers. The application architecture will be a centralized and web-based application with high-availability architecture with mirrored servers at each of the tiers. To ensure high availability of the system, load balancing will be done at each of the tiers that help in maintaining the service levels of application in situations of peak load. Database Server and Web Server will be configured and connected via Network Load Balancer for high availability. The proposed system architecture is shown in Figure 3-2.



**Figure 3-2: System Architecture**



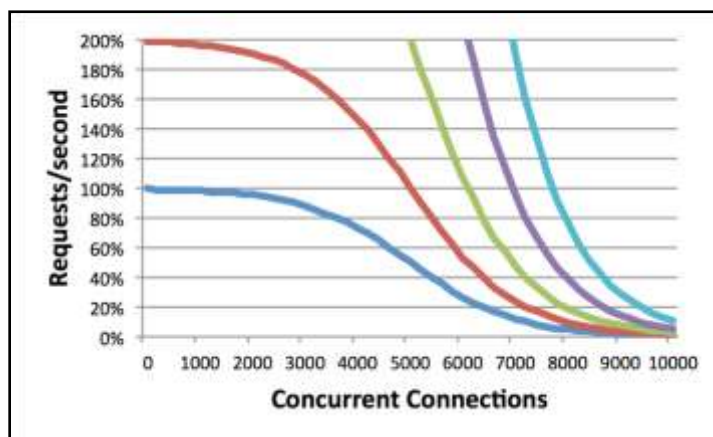
**Figure 3-3: Network Architecture**

It will also help in achieving:

**1. High scalability**

The application architecture can be scaled up to growing future usage in terms of transactional volumes and number of users.





**Figure 3-4: Load on the web server**

**2. Interoperability**

It possesses the ability to support spatial data interoperability and multiple browsers. (IE, Chrome and Mozilla Firefox)

**3. Integration with existing systems**

Due to flexible and scalable architecture of the application, it is easy to integrate any existing system with it.

**3.2 Hardware and Software Specifications**

**3.2.1 HARDWARE SPECIFICATIONS**

**Table 3-1: Hardware Specifications**

Component	Recommended Specification	Qty
<b>Web Server</b>	Rack mounted server with the following configuration: Processor: Similar to dual quad core Xeon X5667(3.06 ghz, 12 MB L3 cache, 6.4 GT/s QPI) or higher latest services, RAM: 64 GB 1333 MHZ DDR3 RAM Hard Disk: 1 TB SAS drive Raid Hardware Controller: RAID 5	04 <sup>1</sup>
	Monitor	01
	Keyboard and Mouse	01

<sup>1</sup> 4 servers are required, of which 2 will be redundant servers to provide failure protection and load balancing. More details regarding this are provided in section 3.1.2



### 3.2.2 SOFTWARE SPECIFICATIONS

**Table 3-2: Software Specifications**

Component	Description (Minimum Specification)	Qty
<b>Operating System</b>	Ubuntu 10 (Open source)	2
<b>Database</b>	PostgreSQL (Open Source)	NA
<b>Internet Browser</b>	Internet Explorer 7 or Higher, Chrome 25 or higher, Mozilla FireFox 20.0 or higher	NA

## 4 Description of Proposed Functionality

### 4.1 Functionality

The web based composite risk atlas will be developed by customizing the Geonode to suit the requirements of NDMA and other State/UT level stakeholders.

- Data sharing – this will ensure that most up-to-date information about buildings, infrastructure, critical facilities, population and demographics are available at a centralized place to facilitate the disaster risk reduction efforts country wide
- Sharing outcomes of the study – this will ensure that individuals, researchers, planners, disaster management specialists, first responders, professional engineers, school authorities etc., have access to the different types of vulnerabilities due various types of hazards that exist throughout the country and they could use that information in their respective work areas
- Provide a platform for deterministic risk assessment that could be later extended for dynamic probabilistic risk analysis
- Assistance in disaster planning, preparedness, response and recovery – this is the dynamic aspect of the application that will allow the users to see the impact of imminent or just occurred disaster on various assets of the country thereby helping in response activities. The application will also provide ground truthing abilities to support recovery operations, followed by inputs for improving planning and preparedness.
- Bring all the agencies involved in disaster management under one common platform so that data and information sharing is made easy
- Contains all the maps related to Hazard, Exposure, Vulnerability, hotspots and realistic disaster scenario maps for training and decision support where user can create different scenarios and choose hazard levels.
- Administrator will be able to create partitioning sub system for different states and perform processing on that partition for the planning and mitigation.
- Option for user to share the data and maps with other users.
- System will be scalable and compatible for Phase II modeling and dynamic decision making.
- User should be able to find the shortest route for evacuation using the application

### 4.2 Key aspects of User Interface

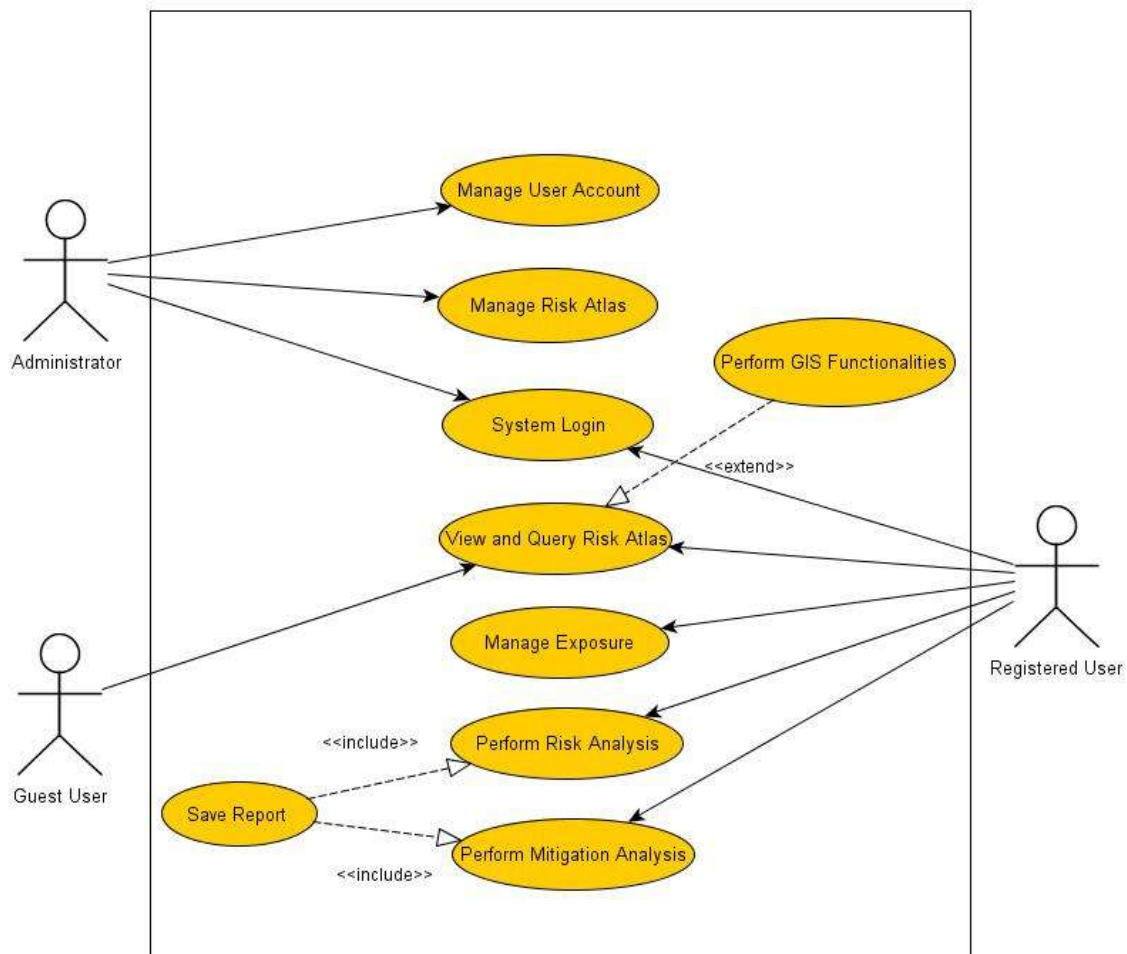
1. **Clarity:** There would not be any ambiguity and it would be achieved by making everything clear through language and flow for visual elements.
2. **Navigation:** Users will be able to easily navigate around and use the atlas with minimum clicks.
3. **Focus order:** Focus order of the controls will be set in order to preserve meaning and operability.
4. **Readability:** Text content will be readable and understandable.
5. **Label or instructions:** Labels or instructions would be provided wherever content requires user inputs.

### 4.3 Use Cases

This section describes various use cases that will help identify, clarify and organize system requirements. It will comprise of possible sequence of interactions between the system and the users. Below is the table specifying the description of each use case and a use case diagram that portrays the different types of users of a system and the various ways they can interact with the system.

**Table 4-1: Table showing list of various use cases and their description**

Use Case	Description
System Login	Allows users to login to the system
Manage user account	Allows administrator to create, update or delete user account.
Manage Risk Atlas	Allows users to upload maps in Risk Atlas
View and Query Risk Atlas	Allows users to view the exposure, risk and vulnerability maps and perform query operations
Perform GIS functionalities	Allows users to perform various GIS functionalities such as pan, zoom in query information etc.
Manage Exposure	Allows users to update or delete exposure
Risk Analysis	Allows users to perform Risk and vulnerability analysis
Mitigation Analysis	Allows users to do preparedness planning and hot spot risk analysis
Save Report	Allows users to save the reports in pdf format



**Figure 4-1: Use case diagram**

### 4.3.1 SYSTEM LOGIN

#### 4.3.1.1 Brief description

This use case describes how a user logs into the composite risk atlas.

#### 4.3.1.2 Actors

The following actor(s) participate in this use case.

Administrator and Registered user

#### 4.3.1.3 Pre- condition

All users must have a user account (i.e, user id, password and role) created for them in the system except for guest users

#### 4.3.1.4 Post condition

If the use case is successful, the actor is logged into the system. If not, the system state is unchanged.

## 1.1 Flow of events

### 1.1.1 Basic flow

This use case starts when the actor wishes to login to the web based risk atlas.

1. The system requests that the actor enters his/her name, password and role.
2. The actor enters his/ her name and password.
3. System validates the entered name and password and logs the actor into the system.

### 1.1.2 Alternative flow

#### 1.1.2.1 Invalid name/password/role

If in the basic flow, the actor enters an invalid username, password or role, the system displays an error message. The actor can chose to either return to the beginning of the basic flow or cancel the login at which point the use case starts. Figure 4-2 shows the login interface.



Figure 4-2: Login screen

## 2. Manage user account

### 2.1 Brief description

This use case allows the actor with 'Administrator' role to maintain user accounts. This includes adding, changing or deleting user account information from the system.

### 2.2 Actors

The following actors interact and participate in this use case.

Administrator

### 2.3 Pre- condition

Administrator must be logged into the system before this use case starts.

### 2.4 Post- condition

If the use case is successful, the user account information is added, updated or deleted from the system.

## 2.5 Flow of Events

### 2.5.1 Basic flow

This use case starts when the administrator wishes to add, change and/or delete user account information from the system.

1. The system requests that the administrator specify the function he/she would like to perform. (either add, update or delete user account information)
2. Once the administrator provides the requested information, one of the following sub flows is executed.
  - If the administrator selected “add a new user account”, the add a user sub flow is executed.
  - If the administrator selected “modify user account”, the modify user sub flow is executed.
  - If the administrator selected “delete user account”, the delete a user sub flow is executed.

#### 2.5.1.1 Add a user account

1. The system requests the administrator to enter user information. This includes user name that should be unique, password and role/group.
2. Once the administrator provides the requested information, user account information is added to the system and an appropriate message is displayed.

#### 2.5.1.2 Update a user account

1. The system requests the user to specify the function administrator wishes to perform:
2. Once the administrator specifies the requested information, one of the sub flows is executed.
  - If the administrator selects “change password” option, the change password sub- flow is executed.
  - If the administrator selects “change group” option, the change group sub- flow is executed.

##### 2.5.1.2.1 Change password

1. The system requests the user to select the name of a user whose password is to be changed.
2. Once the administrator selects the user, system requests the administrator to enter the old password of the user, the new passwords and re enter the new password to confirm change.
3. The administrator makes the desired changes. Once the changes are made, the system updates the user account information record with the updated information.

##### 2.5.1.2.2 Change group

1. The system requests the user to select the name of a user whose role/group is to be modified.

2. Once the administrator selects name of the user from the list of names, the system retrieves and displays the user account information.
3. The administrator makes desired changes.
4. Once the changes are made, the system updates the user account record with updated information.

#### 2.5.1.3 Delete a user account

1. The system requests the user to select the name of a user whose account has to be deleted.
2. Once the administrator selects the user from the list of names, the system prompts the administrator to confirm the deletion.
3. System deletes the user account record.

### 2.5.2 Alternative flow

#### 2.5.2.1 Update canceled

If in the update user account sub flow, the administrator decides not to update the user account information, the update is canceled and the basic flow is restarted at the beginning.

#### 2.5.2.2 Mismatch in password

If in the change password flow, the administrator specifies the wrong old password or new password differs with the confirm the new password entry, the system displays an error message. The actor can choose to either return to the beginning of basic flow or cancel the login, at which point use case begins.

**Figure 4-3: shows the user interface for managing user account.**



**Figure 4-3: Manage user account window**

## 3. Manage Risk Atlas

### 3.1 Brief Description

This use case describes how the user can search and upload maps in the Risk Atlas.

### 3.2 Actors

Administrator

### 3.3 Precondition

User must be logged into the system and the map generated from the atlas is saved.

### 3.4 Post –condition

If the use case is successful, the administrator can upload various default maps or the maps generated by running analysis in the Risk Atlas

### 3.5 Flow of events

#### 3.5.1 Basic Flow

This use case starts when the administrator wishes to upload maps in the Risk Atlas.

1. System requests the administrator to select the maps from the list of saved maps.
2. Once the maps are selected, the system provides user with the option to upload the map in the Risk Atlas.
3. If the user selects the button to upload it, map is added in Risk Atlas.

### 3.6 Alternative flow

None

Figure 4-4 shows the user interface for managing risk atlas



Figure 4-4: Manage Risk Atlas window

## 4. View and Query Risk Atlas

### 4.1 Brief description

This use case describes how the user can view various information related to building infrastructure including roads, bridges, railway lines, inland water transport and embankments, critical infrastructure details, locations of shelter and vertical



evacuation, utilities, social data etc. for 13 state and UTs for cyclone risk. In addition, it also allows the user to perform query operation on the maps.

## 4.2 Actors

The following actors interact and participate in the use case:

Registered user and guest user

## 4.3 Precondition

User must be aware of the URL of the Risk Atlas

## 4.4 Post-condition

If the use case is successful, the user can view various information related to cyclone risk and can perform various GIS functions.

## 4.5 Flow of events

### 4.5.1 Basic flow

This use case starts when the user is interested in viewing the various hazard layers and performing various GIS functions.

1. The system requests the user to specify the URL of the risk atlas.
2. Once the URL is specified, one of the following sub-flows is executed.
  - If the user wishes to “view the risk maps”, view risk maps sub-flow is executed.
  - If the user wishes to perform “GIS functionalities”, performing GIS functionalities sub-flow is executed.
  - If the user wishes to perform “spatial and non- spatial query” the Query Risk Atlas sub-flow is executed.

#### 4.5.1.1 View Risk Maps

1. User selects the layer(s) from various lists of layers such as building infrastructure, land use, land cover, social data etc.
2. Once the user selects the layer(s) their thematic map is generated in the Map window.

#### 4.5.1.2 Performing GIS functionalities

1. The system allows the user to select one of the various GIS functionalities in the risk atlas.
2. Once the user selects any GIS functionality/functionality as shown below, their corresponding flows are executed.
  - **Pan map:** User selects this functionality to pan Map window.
  - **Zoom in:** User selects this functionality to zoom in to a part of a map by clicking or by drawing a region.
  - **Zoom out:** User selects this functionality to zoom out to a part of a map by clicking or by drawing a region.
  - **Previous view:** User selects this functionality to go to the previous view.

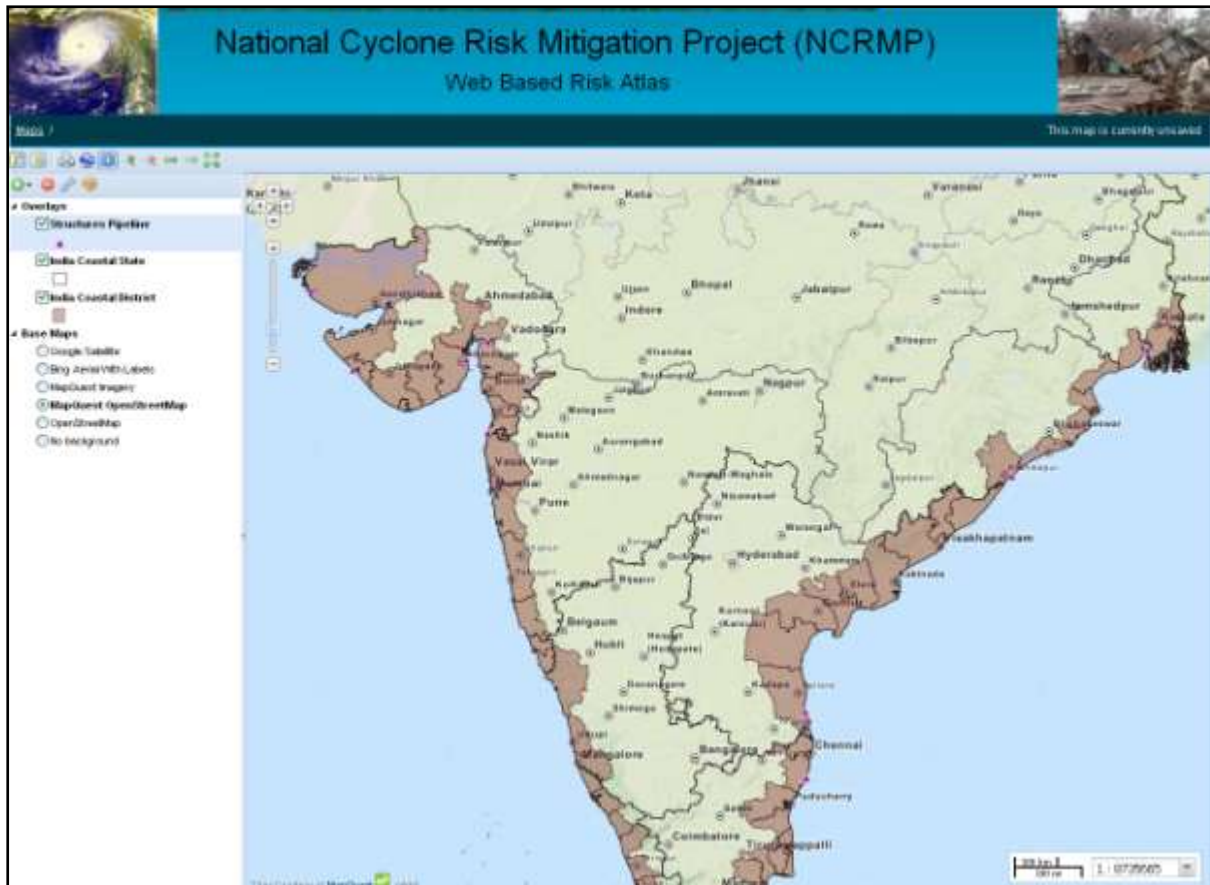
- **Next view:** User selects this functionality to go to the next view.
- **Attribute information tool:** User selects this functionality to view information related to a geographical location in the Map window and the selected layer in the Map tools window.
- **Distance measurement:** User selects this functionality to measure distances on the map. Marking the two points on the Map and double-clicking gives the distance.
- **Measure area by circle:** User selects this functionality to measure the area of any region. Marking the area calculates the area of the circular region.

#### 4.5.1.3 Query Risk Atlas

1. User selects the query tool to perform a search on the map.
2. User activates the layer for which information is required.
3. Once the layer is activated, only the attributes of the active layer are displayed in the query tool.
4. The user selects the attributes and performs the query by selecting different parameters (data of the attribute).
5. Once the query is made, the user executes the query.
6. Once the query is executed, the result is shown in the map window.

#### 4.5.2 Alternative flow

None



**Figure 4-5: View Risk Maps**

## 5. Manage exposure

### 5.1 Brief description

This use case describes how the user updates or modifies the default exposure as per user's needs.

### 5.2 Actors

The following actors interact and participate in this use case.

Registered user and administrator

### 5.3 Pre –condition

User must be logged into the system.

### 5.4 Post –condition

If the use case is successful, exposure value is updated. If not, the system state is unchanged.

### 5.5 Flow of events

#### 5.5.1 Basic flow

This use case starts when the user wishes to update the exposure values.

1. The system requests that the user specify the function user would like to perform.(either to modify building and infrastructure exposure, replacement value aggregated exposure or replacement value site specific exposure)
2. Once the user specifies the function, one of the following sub-flows is executed.
  - If the user selects “Replacement value aggregated exposure”, modify aggregated exposure sub-flow is executed.
  - If the user selects “Replacement value site specific exposure”, modify site-specific exposure sub-flow is executed.

#### 5.5.1.1 Modify aggregated exposure

1. The system requests the user to choose the following criteria:
  - System requests the user to select area type, state, district and village for which exposure is to be updated.
  - System gives user the option to select whether to view exposure at village level or for the selected village.
2. Once the user provides this information, list of all villages or a selected village with all buildings and infrastructure type are displayed, which can be modified by performing click operations.
3. Once the user provides all the information, exposure is updated in the system and an appropriate message is displayed.

Figure 4-6 shows the user interface for Modifying aggregated exposure.

#### 5.5.1.2 Modify site-specific exposure

The system requests the user to choose the following selection criteria:

- System requests the user to select the site-specific category and the type for which exposure is to be updated.
- Once the user selects the criteria, list of selected site-specific type at village level with default exposure is displayed, which can be modified by performing click operations.
- Once the user provides all the information, exposure is updated in the system and an appropriate message is displayed.

Figure 4-7 shows the user interface for Site-specific exposure.

### 5.5.2 Alternative flow

#### 5.5.2.1 Invalid exposure

If in a basic flow, the actor enters a negative value or text for exposure, the system displays an error message.

#### 5.5.2.2 Cancel exposure

If in the basic flow, the user decides not to update the exposure, the update is canceled and the basic flow is restarted at the beginning.

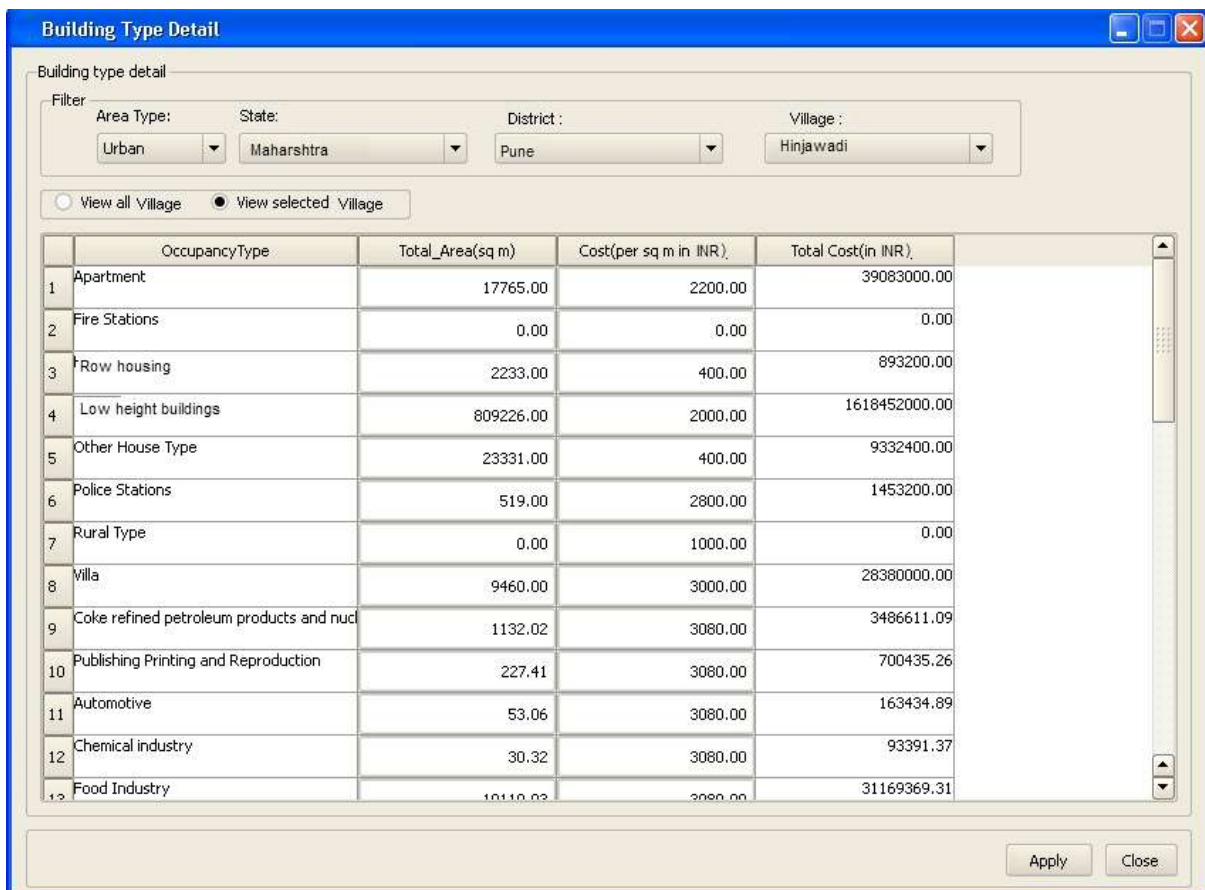
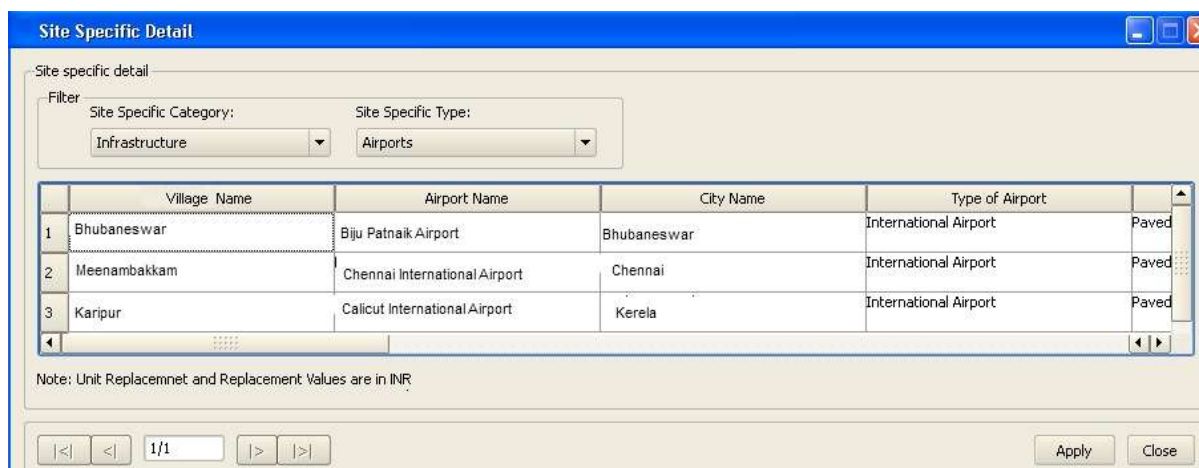


Figure 4-6: Modifying Aggregated Exposure



**Figure 4-7: Modifying site-specific exposure**

## 6. Risk analysis

### 6.1 Brief description

This use case describes how the actor carries out the risk analysis.

### 6.2 Actors

The following actors interact and participate in this use case.

Registered user and administrator

### 6.3 Precondition

User must be logged into the system.

### 6.4 Post-condition

If the use case is successful, system generates a report that displays tables and graphs showing the losses in monetary terms and their distribution over a region based on the choice user made.

### 6.5 Flow of events

#### 6.5.1 Basic flow

This use case starts when the user wishes to perform a risk analysis and loss estimation activity due to changes in exposure or vulnerability.

- System requests the user to select the function the user needs to perform.(either vulnerability analysis or risk analysis)
- Once the user selects the function, one of the following sub-flows is executed:
  - If the user selects to perform vulnerability analysis, vulnerability analysis sub-flow is executed.
  - If the user selects to perform risk analysis, Risk analysis sub-flow is executed.

#### 6.5.1.1 Vulnerability analysis

1. The system requests the user to specify the operation, (either generate map or update vulnerability function) that the user wishes to perform.

2. Once the user specifies the operation, one of the following sub-flows is executed.
  - If user selects the “Generate vulnerability map” option, generate vulnerability map sub-flow is executed.
  - If user selects the “Update vulnerability function” option, the update vulnerability function, sub-flow is executed.

#### **6.5.1.1.1 Generate vulnerability map**

1. The system requests the user to select state, district and village.
2. Once the user selects state, district and village, the system requests the user to select the type of vulnerability to generate the map. The various vulnerability types include:
  - i. Population vulnerability mapping
  - ii. Building vulnerability mapping
  - iii. Infrastructure vulnerability mapping
  - iv. Crop vulnerability mapping
3. Once the user selects the type of vulnerability, corresponding map can be generated.
4. Once the map is generated, it can be saved.

#### **6.5.1.1.2 Update vulnerability function**

1. The system requests the user to select one of the following vulnerability types to update the vulnerability function.
  - Population vulnerability mapping
  - Building vulnerability mapping
  - Infrastructure vulnerability mapping
  - Crop vulnerability mapping
2. Once user selects the type of vulnerability, system displays the vulnerability details for the selected vulnerability type, which can be easily modified by performing click operations.
3. Once the user enters the values, vulnerability function is updated in the system and an appropriate message is displayed.

Figure 4-8 shows the user interface for updating vulnerability functions and Figure 4-9 shows the user interface for generating maps.



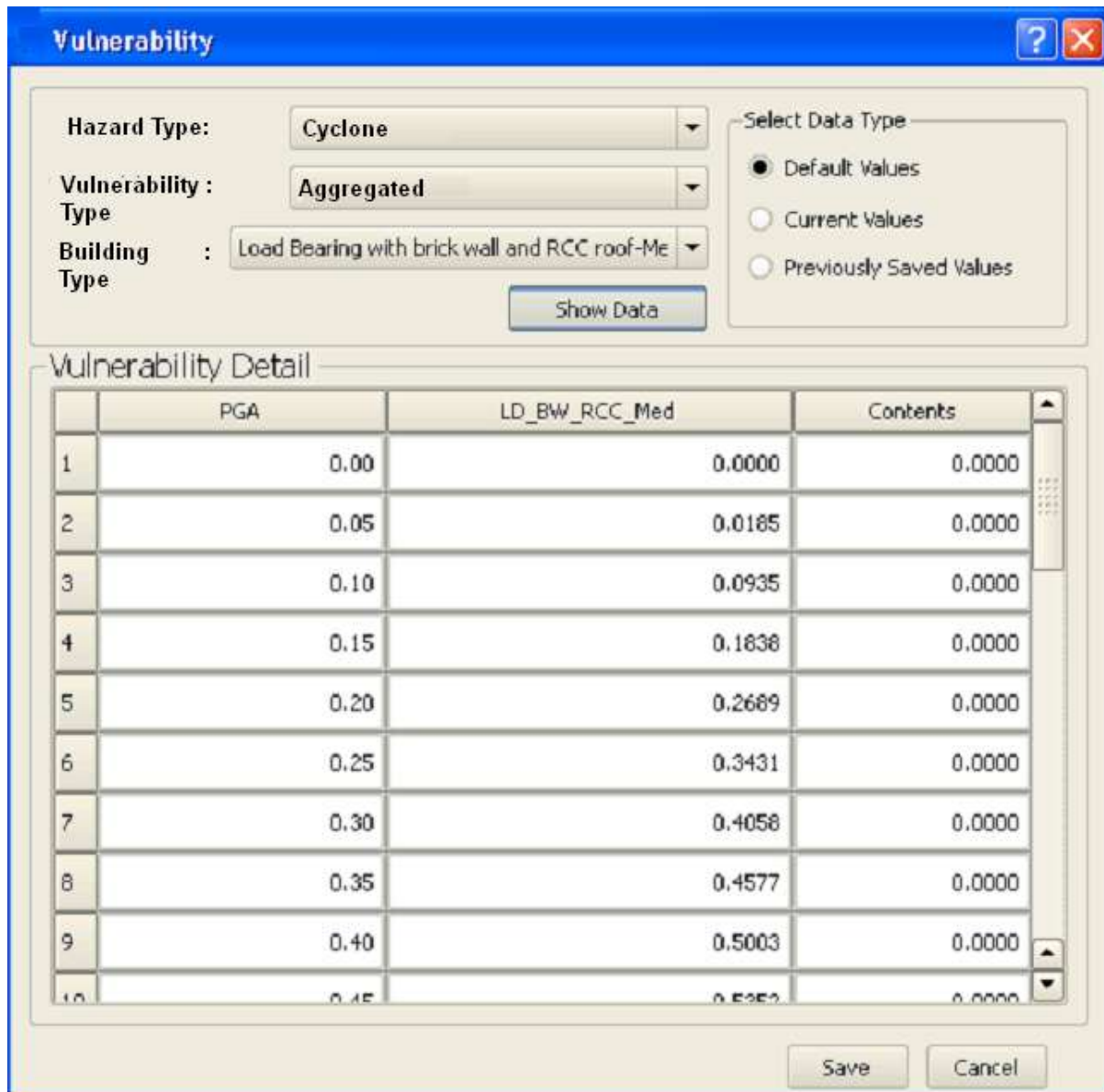
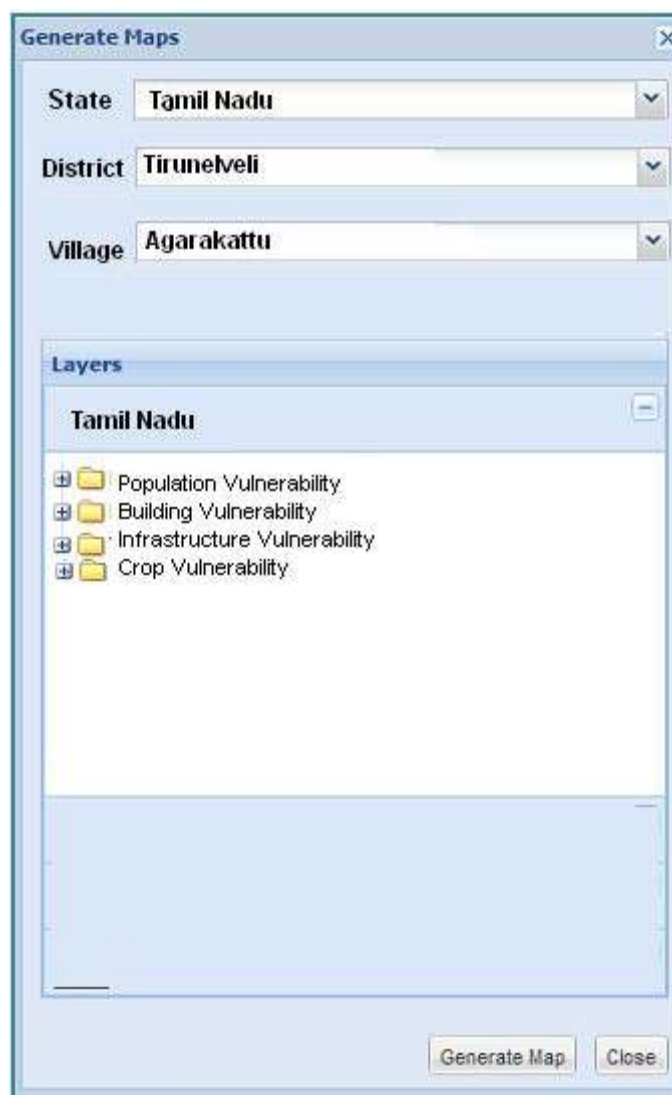


Figure 4-8: Update vulnerability function





**Figure 4-9: Generate Map window**

#### 6.5.1.2 Risk analysis

1. The system requests the user to provide the analysis name, select a hazard (Cyclone or surge), state, district, and village.
2. Once the user provides these details, system requests the user to select historic/deterministic cyclone events and available exposures (population, buildings, infrastructure, and crops) to analyze the impact of cyclone on these exposures.
3. Once the user provides the above details, system provides details of various exposures at village level (agriculture, infrastructure, buildings, critical facilities etc.) to perform analysis.
4. Once the user specifies all the above details, user can run the analysis.
5. Once the analysis is performed, a report and risk maps are generated.
6. Once the risk maps are generated, administrator can replace the risk maps generated for this scenario in the risk atlas.

## 6.5.2 Alternative flow

### 6.5.2.1 Cancel analysis

If in the risk analysis sub-flow, the user decides not to run the analysis, the analysis is canceled and the basic flow is restarted at the beginning.

Figure 4-10 and Figure 4-11 show the screens for running Risk analysis

Figure 4-10: Selecting hazard to perform risk analysis

Figure 4-11: Selecting exposure to perform risk analysis

## 7. Mitigation analysis

### 7.1 Preparedness planning

#### 7.1.1 Brief description

This use case describes how the user can prepare for a disaster by providing the user the ability to define, view, and query the following information based on user-selected area at the available resolution.

- Evacuation planning
- Shelter planning
- Contingency planning

#### 7.1.2 Actors

The following actors interact and participate in this use case.

Registered user and administrator

#### 7.1.3 Precondition

User must be logged into the system.

#### 7.1.4 Post-condition

If the use case is successful, it will help the user in evacuation, shelter and contingency planning.

#### 7.1.5 Flow of events

##### 7.1.5.1 Basic flow

This use case starts when the user is interested in viewing and querying the information for evacuation, shelter and contingency planning to protect against disasters before they occur.

1. System requests the user to select the type of preparedness planning required.
2. Once the user selects the type of planning activity, one of the sub-flows is executed.
  - If the user selects "evacuation planning", the evacuation planning sub-flow is executed.
  - If the user selects "contingency planning", the contingency planning sub-flow is executed.
  - If user selects shelter Planning", the shelter planning sub-flow is executed.

##### 7.1.5.1.1 Evacuation planning

1. System requests the user to select state, district, and village for which safe exit route is required.
2. Once the user selects the state, district and village, system allows the user to generate a route map.
3. Once the user selects to generate a route map, a map showing the existing road connectivity, and existing and proposed shelters and hospitals will be overlaid on a map showing flood inundation areas to pinpoint the shelter of potential roads.

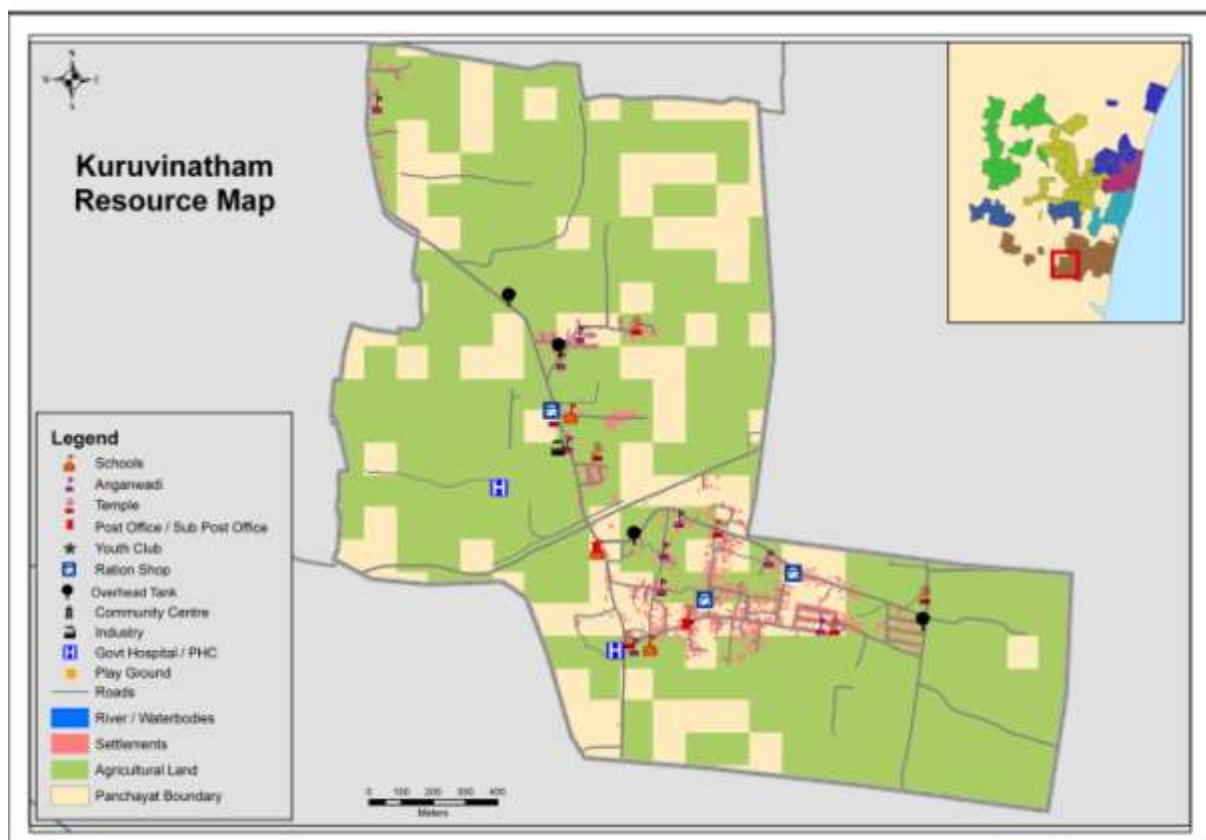
### 7.1.5.1.2 Contingency planning

1. System requests the user to select state, district, and village for which contingency planning is required.
2. Once the user selects the state, district and village, map showing proposed shelters as per the capacity of households in a community is displayed.
3. Once the details are displayed, the user is given the option to save it in the system

### 7.1.5.1.3 Shelter planning

3. System requests the user to select state, district, and village for which shelter planning is required.
4. Once the user selects the state, district, and village, the system allows the user to generate a map.
5. Once the user selects to generate a map, a map is displayed that pinpoints the locations that could be used as shelters at the time of disaster.

Figure 4-12 shows the preparedness map.



**Figure 4-12: Preparedness map**

## 7.2 Hot-spot risk analysis

### 7.2.1 Brief description

This use case describes how the user can carry out hot-spot risk analysis.

## 7.2.2 Actors

The following actors interact and participate in this use case.

Registered user and administrator

## 7.2.3 Pre-condition

User must be logged into the system.

## 7.2.4 Post –condition

If the use case is successful, hot- spot risk analysis report is generated.

## 7.2.5 Flow of events

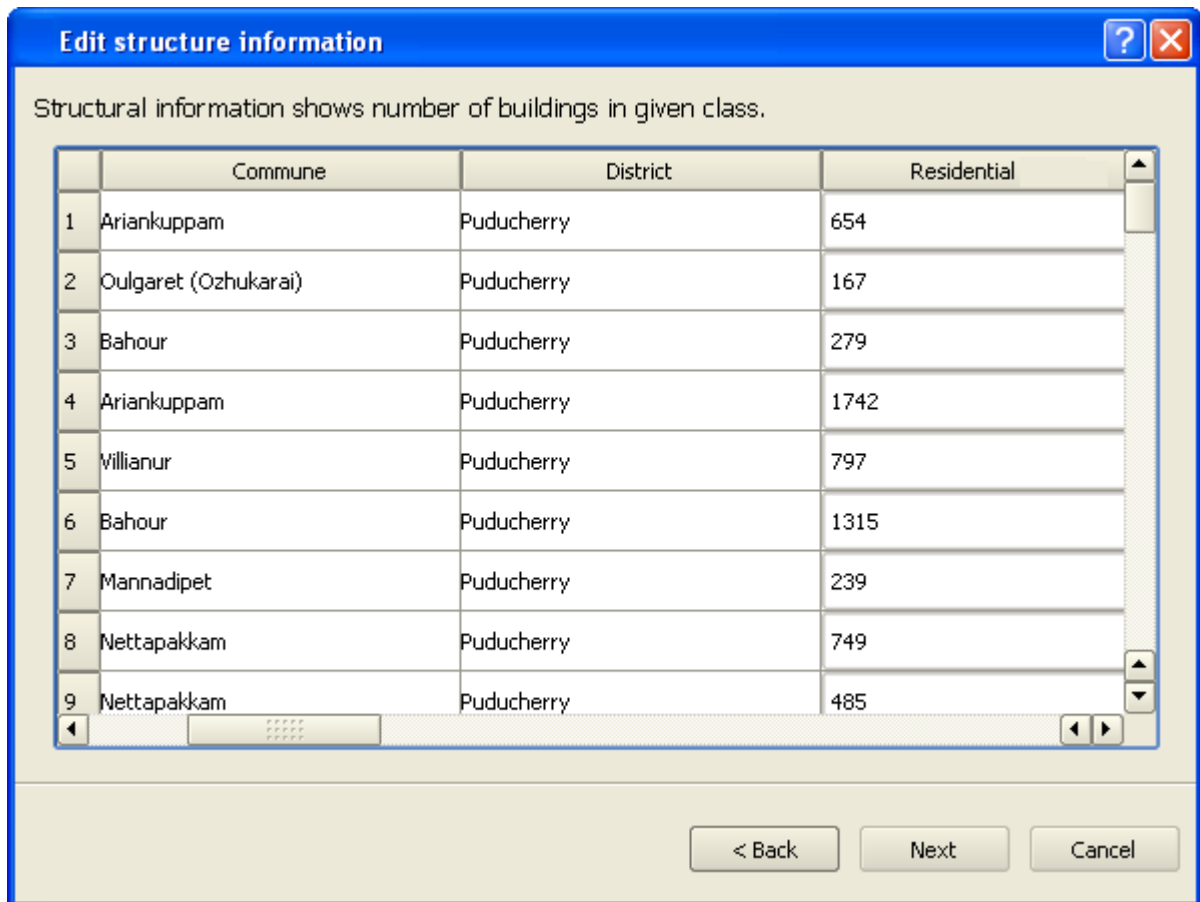
### 7.2.5.1 Basic flow

1. The system requests the user to provide the analysis name, select a hazard (cyclone, surge), state, district, and village.
2. Once the user provides these details, the system requests the user to select historic/deterministic cyclone events and available exposures (population, buildings, infrastructure, and crops) to analyze the impact of cyclone on these exposures.
3. Once the user provides the above details, the system provides details of various exposures at village level and the optional ability to modify the exposure just for the current scenario.
4. Once the user specifies all the above details, the user can run the analysis.
5. Once the analysis is performed, a report and risk maps are generated. After the analysis is run, the changed exposure values are not reflected the next time analysis is performed.
6. Once the maps are generated, the administrator can replace the risk maps generated for this scenario in the risk atlas

## 7.2.6 Alternative flow

### 7.2.6.1 Invalid exposure

If in the basic flow, the user enters a negative or text value for exposure, the system displays an error message.

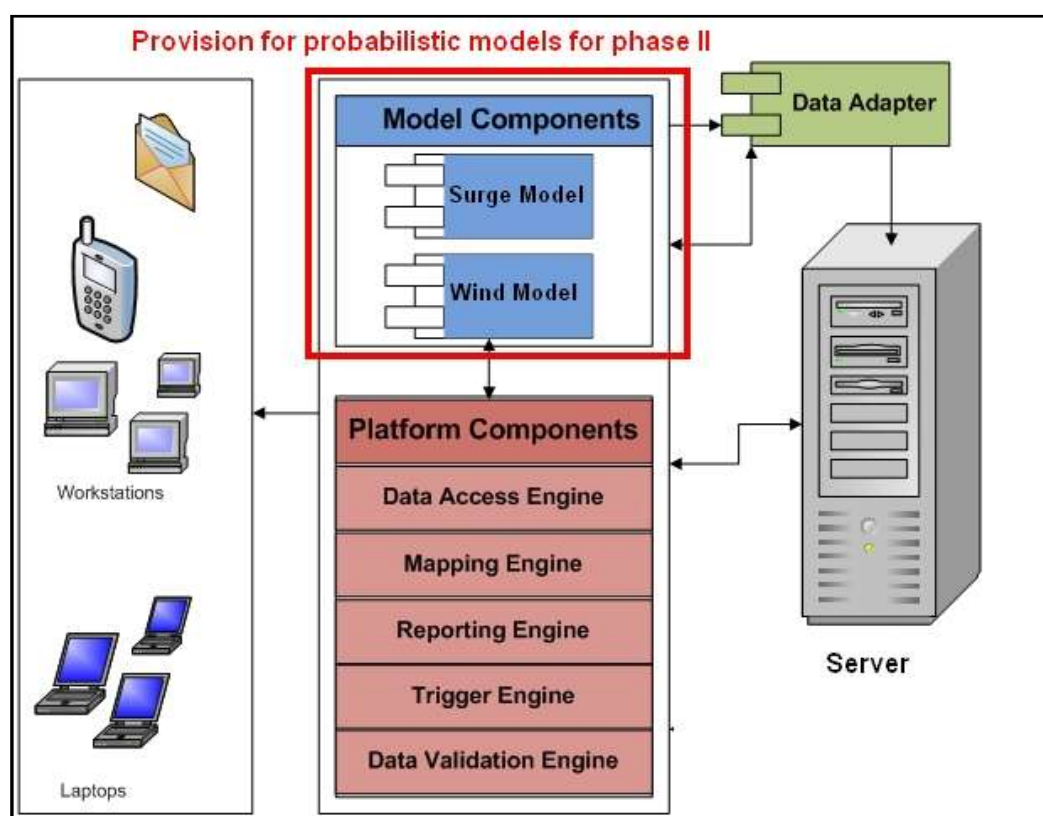


**Figure 4-13: Editing structural information to perform hot spot risk analysis**

## 5 Considerations for Phase II

The present system will be designed keeping in view future requirements such as developing a platform with dynamic risk assessment modeling functionalities that will be taken up subsequently under Phase II of the NCRMP Project. This may include implementation of probabilistic risk modeling in the system. This will be achieved using:

- Loose coupling between the various tiers – presentation, business and data
- Ease of development and deployment
- Allow optimum re-use of code when upgrading the system
- Future upgrade will be easier, subject to staying within the same technology and same vendor(s) platform
- The complete Hazard, Vulnerability, and Loss models will be implemented as pluggable components thereby creating a framework for plugging in models so that future probabilistic models can be easily added as shown in the Figure 5-1 below:



**Figure 5-1: Architecture diagram with provisions for probabilistic models as pluggable components for phase II**

### 5.1.1 Model Components

Model components form the Business Logic tier and are responsible for integration of third party probabilistic storm surge and wind models as shown in the architecture diagram (above) for the proposed solution. The Data Adaptor is the component that provides functionality for supplying data to and retrieving data from the models and triggering the execution of the models. These components transform the data in the data warehouse to meet the input requirements of various models and extract the information for the output of these models to save the outputs in the data warehouse.



To integrate any new models to the system, additional Data Adaptors will have to be developed and integrated into the system.

### **Number of Models Managed Simultaneously:**

The proposed solution can manage any number of models provided Model components exist for those models. The system will provide an ability to specify the model components that take care of input-output reformatting and analysis execution through an Interface.

### **5.1.2 Platform Components**

Platform components represent the Application Tier. These components focus on the application logic for all data access, mapping and reporting. These generic components operate directly on the data warehouse and present the data in different views to the user.

#### **Database Access Engine**

Data Access Engine provides access to all spatial and non-spatial data that is stored in the Data Warehouse. This includes data viewing and editing capabilities. In addition, it also provides data import and export capability from and to Microsoft Excel and text files.

#### **Mapping Engine**

Mapping engine provides all mapping capabilities to the application. The major component in the mapping engine is the Map Viewer that loads the spatial data and displays the map and provides all basic map navigation functions like Zoom, Pan, Identify tool and calculate distance. All the layers are loaded with a predefined symbology.

#### **Reporting Engine**

Reporting engine generates all the graphs and tables that can be printed. Based on output of schedulers and triggers, information viz., alarms for any real time cyclones, non-working of any models will be carried in map, graph and tabular formats, where the user can easily understand this information.

#### **Trigger Value' Communication**

The Trigger engine provides the following functionality to the tool

1. Sets user-supplied 'trigger values' for wind and surge values and provides ability to communicate to the user when these 'trigger values' are exceeded.
2. These 'trigger values' shall initially take the form of forecasted values from the Models outputs.
3. Communication from tool to the users will be done in the following formats
  - Text to multiple mobile phone numbers
  - E-mail to multiple accounts

### **5.1.3 Data Management**

Data warehouse represents the Database tier as shown in the architecture diagram of the proposed solution. It stores all the input data to the model, system data and the output results. The data can be categorized as spatial and non-spatial. All the spatial grid data resides in the form of ESRI Grid files. All spatial vectors and the non-spatial data are stored into PostGIS/PostGRES database.



## 6 Schedule

### 6.1 Development schedule

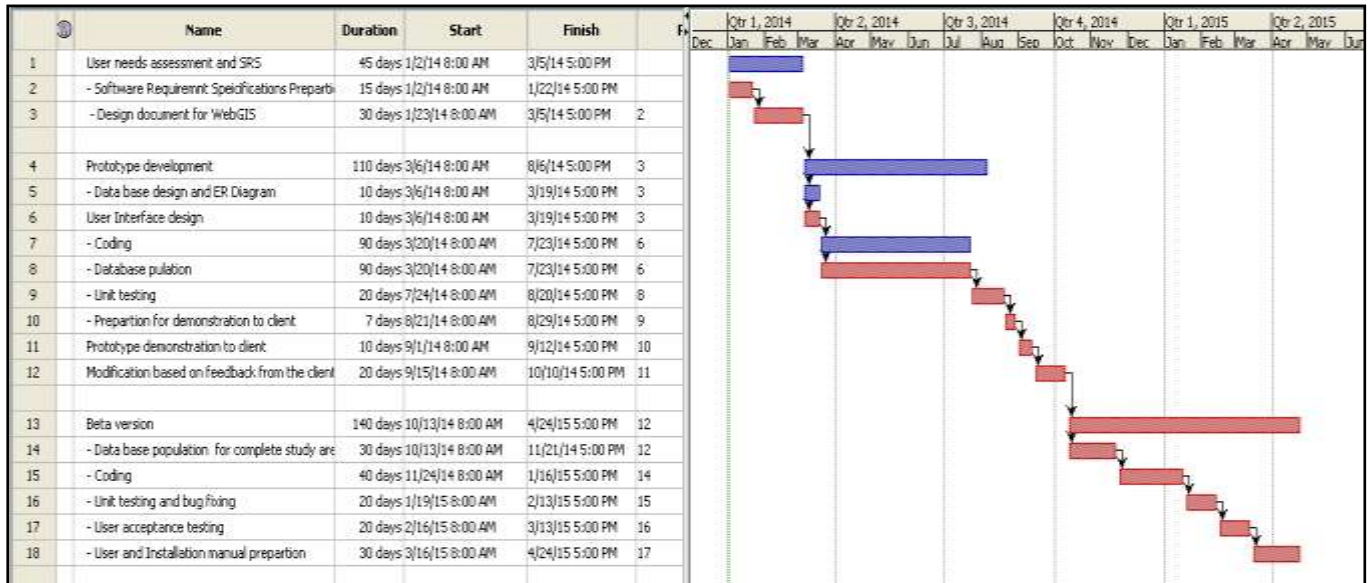


Figure 6-1: Development schedule

### 6.2 Testing schedule

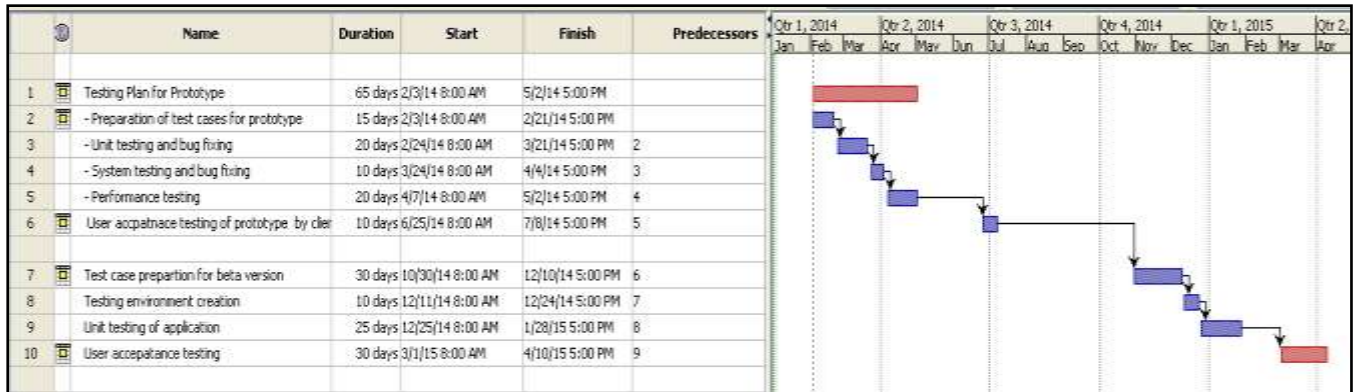


Figure 6-2: Testing schedule

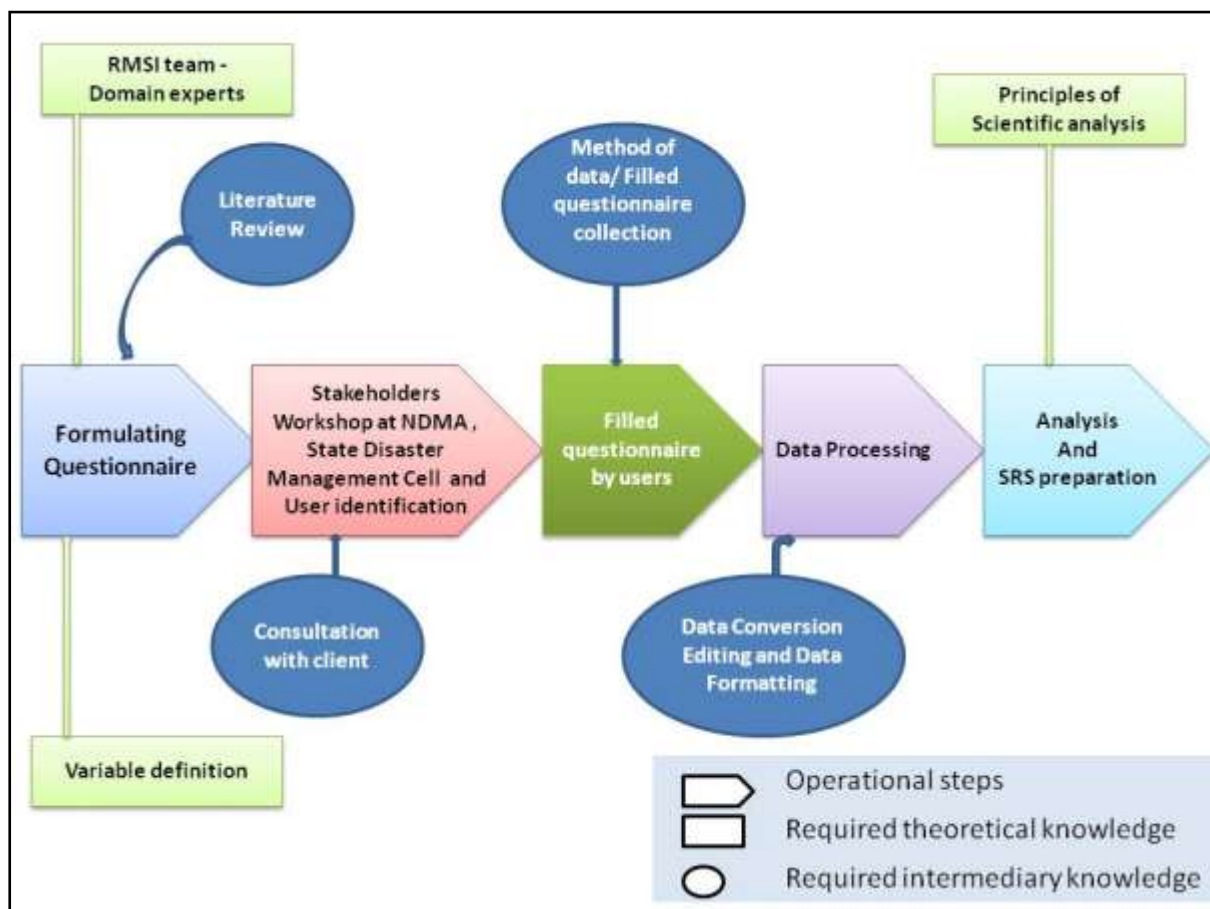
## 7 Prototype composite risk atlas

### 7.1 Role of State/UT in prototype development

RMSI, in close coordination with various states and UT, would identify potential users to carry out the user needs assessment activity to bridge gaps between the existing and required situation and to perform user acceptance testing.

#### 7.1.1 USER NEEDS ASSESSMENT

Preliminary steps for design and development of proposed Web based risk atlas, is to have a detailed understanding of potential users, institutions along with their roles, responsibilities, and requirements, existing business processes and interrelationships, and the existing data and infrastructure. The needs assessment has been carried out through the following steps:



**Figure 7-1: Scheme explaining the process framework for user needs assessment**

### Step 1: Preparation and Planning

**Formulation of Core Team:** The first step in this process was the creation of the Core Requirement Analysis team. The RMSI team worked closely with NDMA for establishing a team to take initiative in designing of proposed Web application. This core team was a joint team between NDMA and RMSI who participated in this exercise.

**Pre-workshop Activities:** Before the actual interviews, RMSI performed the following activities:

- Understand the existing processes, work flows and systems for Cyclone risk related information collection and dissemination
- Review the existing documents and information relevant for designing the web application for cyclone-related risk assessment in India
- Review the existing documentation on existing network, software and hardware
- Identify and understand the responsibilities of user groups and providers

**Questionnaire Development:** RMSI team has prepared a questionnaire for facilitating this exercise and will circulate it to the stakeholders during stakeholder meetings during different state visits. The set of questions has been designed in such a way that required information can be collected in a more effective and structured manner. The questionnaire has been designed keeping in view:

- Information providers
- Administrators such as heads of state disaster management cells and decision makers
- Current and Potential users

The sample questionnaire is given below and the complete set can be seen in appendix A.

**User requirement study**

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**Project** - Consulting Services for Hazard, Risk and Vulnerability Assessment for 13 states and UTs in India under National Cyclone Risk Mitigation Project (NCRMP).

**Product Category** - Web based Risk Atlas/ Disaster Risk Reduction (DRR) Application

**Client:** PMU, NDMA, New Delhi

**Consultant:** RMSI Pvt. Ltd., Noida

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Date: ..... Place: .....

Name: .....

Designation: .....

Department: .....

1. Have you or your office been involved in managing the key activities such as preparedness, response and recovery and/or mitigation activities related to natural disasters caused by cyclones and associated flooding in your State?
  - (a) Yes
  - (b) No
2. If answer for first question is yes, what is your and/or your office's focus in undertaking the above-mentioned activities?
  - (a) Preparedness
  - (b) Response
  - (c) Recovery
  - (d) Mitigation
  - (e) All of above
3. Are these Disaster Risk Reduction activities carried out
  - (a) Routinely by you/your office or
  - (b) When specifically assigned?

Please specify how long you / your office has been engaged in DRR services:

  - (a) Less than 2 Years
  - (b) 2 to 5 Years
  - (c) 5 to 10 Years
  - (d) Longer than 10 Years

## Figure 7-2: Sample Questionnaire

### Step 2: Information and requirement gathering

Specific activities that will be carried out during this phase are:

- Meeting identified stakeholders and documenting the current process and needs as explained by the stakeholders
- Analyzing the current infrastructure setup. This includes studying the present design of the network, server setup, possibility and scope of expansion within the data centre
- Reviewing existing data, applications, documents and work procedures (this includes analysis and understanding of existing infrastructure and designing an optimized connectivity and deployment plan, and the availability of network connectivity. Study of Interface requirements with other applications
- Data Access and Security requirements
- Quality Control and Quality Assurance Issues
- Training requirements and Implementation plan
- Documenting the current systems and future requirements
- User Interface requirements

### Step 3: Compilation and Detailing

Information collected during the workshop will be documented. Various options to address the current challenges will be evaluated and findings of the evaluation will be presented in the SRS report. If there is any impact on the commercial value presented in this proposed risk atlas, this will be brought to the attention of NDMA to process a change request.

The SRS report elaborating the solution will be submitted to the client for approval. Once the solution is formally approved, RMSI team will freeze the solution for development.

#### 7.1.2 PERFORMING USER ACCEPTANCE TESTING

User acceptance testing is the software testing process where system is tested for acceptability and validates the end-to-end business flow. The UAT will be done at the client site at the time of the establishment of prototype version of Atlas by the UAT team. RMSI, in close coordination with NDMA, will demonstrate the functionalities supporting hot spot analysis for two “category-1 higher vulnerability” coastal states/UTs and the full system functionality for selected use cases.

The UAT team would ideally comprise of end users of the software from all stakeholder organizations so that each and every user role can be tested in order to confirm whether the system meets the requirements as per requirement specifications or not.

#### UAT process

RMSI would provide a user manual to give assistance to users who will be using the atlas. With the help of the user manual, user will be able to clearly understand and use the functionality of the atlas. Apart from user manual, UAT document will be shared that will comprise of various test cases designed based on the functionality of the web based GIS atlas. During the testing, users will execute these test cases and as a result of these test cases, actual results have to be written in comparison to the expected results and whether the test cases have passed or failed. Also, if interested, the user can create additional test cases and execute them.

Before the test cases are executed, RMSI in coordination with PMU/NDMA will set acceptance criteria for the web-based GIS atlas.



**Figure 7-3: UAT process**

To carry out the UAT task a proper approach should be adopted, which is mentioned below:

- **Test Plan:** An effective test plan should be created that should outline the testing strategy. It aims to identify the features to be tested, entry and exit criteria to be used, quality goals etc.
- **UAT Test cases:** Once the test plan is done, user needs to create the test cases with respect to the features that have been identified during test plan. The Test cases help the team to effectively test the atlas in UAT environment.
- **Test Log:** After test cases are created, user has to execute the test cases to compare the actual result with the expected result.
- **User Sign Off** – Once all the test cases are executed, RMSI along with UAT team based on the acceptance criterion will decide whether application is delivered to client satisfaction.



# Appendix A: User Requirement Study

**Project** - Consulting Services for Hazard, Risk and Vulnerability Assessment for 13 states and UTs in India under National Cyclone Risk Mitigation Project (NCRMP).

**Product Category** - Web based Risk Atlas/ Disaster Risk Reduction (DRR) Application

**Client:** PMU, NDMA, New Delhi

**Consultant:** RMSI Pvt. Ltd., Noida

---

Date: .....

Place.....

Name:.....

.....

Designation:.....

.....

Department.....

.....

1. Have you or your office been involved in managing the key activities such as preparedness, response and recovery and/or mitigation activities related to natural disasters caused by cyclones and associated flooding in your State?

(a) Yes

(b) No

2. If answer for first question is yes, what is your and/or your office's focus in undertaking the above-mentioned activities?

(a) Preparedness

(b) Response

(c) Recovery

(d) Mitigation (e) All of above

3. Are these Disaster Risk Reduction activities carried out

(a) Routinely by you/your office or

(b) When specifically assigned?

Please specify how long you / your office has been engaged in DRR services:

(a) Less than 2 Years

(b) 2 to 5 Years

(c) 5 to 10 Years

(d) Longer than 10 Years

4. How do you and/or your office execute DRR related activities :

(a) Based on past experience

(b) As per instructions received

(c) Discussion and planning in a core group

(d) Based on professional training

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5. Could you briefly describe how you perform these activities?

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6. What information do you need to perform these activities?

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7. Do you create any reports during these activities or after their completion? What information do you provide in those reports?

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8. Could you briefly describe how you mobilize your resources at the time of disaster?

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9. Have you faced any problems when you perform these activities? What were these?

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10. Do you generate any reports after the disaster and for whom? If possible mention the names/designations of the individuals who receive these reports.

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11. What kind of information do you normally incorporate in these reports at the time of any Natural Disaster?

---

12. How do you get information related to any cyclone or other disasters approaching your area?

- |                                   |  |
|-----------------------------------|--|
| (a) Alerts from Media (Radio/ TV) | (b) Alerts from headquarters           |
| (c) From IMD Web site             | (d) Other sources, please give details |

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13. What is the information you look for related to any cyclone approaching your area?

- |                                    |                                 |
|------------------------------------|---------------------------------|
| (a) Cyclone track                  | (b) Forecasted wind map         |
| (c) Villages likely to be affected | (d) others, please give details |

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14. If there is a system/product which can help you complete this task more efficiently, which information do you expect it would have?

(a) Hazard Information (wind speed, surge height) (b) Building and Infrastructure details

15. (c) Expected loss information (d) All the above

16. What would you like to know about the cyclone and associated flooding hazard?

(a) Maximum wind velocity in your area (b) Likely flood extent and flood Depth at your area  
(c) Expected affected area (d) All the above

17. General classifications of buildings based on their occupancy are shown below:

1. Residential
2. Commercial
3. Industrial
4. Public Buildings

Would you like to add any other classification? Please mentioned below:

---

18. Please select from the list how you would like to classify residential buildings:

- (a) Kuchha tiled huts
- (b) Row houses (G+1 with Masonry construction)
- (c) Apartment (Multistoried with RCC)
- (d) Villas

Would you like to add any other classification?

---

19. Is data available for number of stories, area of construction, cost of construction ?

Which agency can provide such data and what will be the format of data?

- Hard copy literature (Table)
  - Printed maps
  - Data in MS Word or Excel format
  - Maps in Digital format (ESRI shp, Map Info Tab, AutoCAD DWG)
- 
- 
- 

20. What is the importance of shelters ? Are there any cyclone shelters ? If yes, do you know where they are geographically located (latitude, longitude, elevation) ? Is this data





S. No.	Items	Required	Attributes	Source Agency and data format
1.	Administrative Head quarters	Yes/ No	- Location lat/long	
2.	Fire Station	Yes/No	- Location lat/long - No. of Fire Fighters - No. of Fire and Emergency Vehicles and specialized Equipments with details -	
3.	Police Station	Yes/ No	- Location lat/long - No. of Police Personal - No. of vehicles with details	
4.	Medical Facility	Yes/ No	- Location lat/long - No. of beds - No. of vehicles with details	
5.	Cyclone Shelter	Yes/ No	- Location lat/long - Capacity	
6.	Educational Institutes (Schools, Colleges)	Yes/ No	- Location lat/long - Capacity	
7.	Village level evacuation plan	Yes/ No	- Route details -	
8.	Major Hazardous Industries	Yes/ No	- Location lat/long - Capacity - Details about output	
9.	Power plants	Yes/ No	- Location lat/long - Capacity	
10.	Telecommunication towers	Yes/ No	- Location lat/long	
11.	Cultural heritage sites	Yes/ No	- Location lat/long - Details	
12.	Land use map	Yes/ No	- Classification based on land use pattern	
13.	Ecological Assets (Mangroves, coastal	Yes/ No	- Digital Coastal Landuse map	

S. No.	Items	Required	Attributes	Source Agency and data format
	plantations etc.)		- Area and extent	
14.	Social Data	Yes/ No	- Total Population - Density - Age group - Gender - Social Capital hot spot etc - House type details	
15.	Infrastructure <ul style="list-style-type: none"> <li>- Roads</li> <li>- Railways</li> <li>- Bridges</li> <li>- Ports</li> <li>- Inland water</li> <li>- Embankments</li> </ul>	Yes/ No	- Location lat/long - Details of each elements including digital maps	
16.	Economic data <ul style="list-style-type: none"> <li>- Livelihoods classifications</li> <li>- Occupational pattern like farming (per census classification)</li> <li>- People below poverty line</li> <li>- Livestock numbers</li> <li>- GDP/district level if possible</li> <li>- Replacement costs</li> </ul>	Yes/ No	- Location lat/long - Details	
17.	NGO's / Voluntary organizations involved in DRR activities	Yes/ No	- Address - Details including contact numbers	
18.	Contractor's details for Response and recovery activities	Yes/ No	- Address - Details including contact numbers	

Would you like to add any other data layers? Please mention below

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S. No.	Features	Yes/No	Remarks
	<ul style="list-style-type: none"> <li>- Schools</li> <li>- Medical Facilities</li> <li>- Cyclone Shelters</li> <li>- Police Stations</li> </ul> <p>Are in a high risk zone of cyclone or not in high risk zone of cyclone</p> <p>(spatial query)</p>		
3	<p>Finding all the locations (such as</p> <ul style="list-style-type: none"> <li>- Fire Stations</li> <li>- Schools</li> <li>- Medical Facilities</li> <li>- Cyclone Shelters</li> <li>- Police Stations)</li> </ul> <p>which are within a specified distance from a road or affected village</p> <p>(spatial query)</p>	Yes/No	
4,	<p>Selecting Fire Stations/ Schools/ Medical facilities/ Cyclone shelters greater than specified capacity like Medical facilities having 100 beds for the affected victims</p> <p>(attribute query)</p>	Yes/No	
5.	<p>Functionality to add new cyclone shelter or deleting an existing cyclone shelter</p>	Yes/No	
6.	<p>Search a village/gram-panchayat/ taluka/tehsil/ district in identified cyclone hot-spots using search option of software, and software will provide functionality to show all the information available for this village such as its risk profile, no of schools, medical facilities, population etc.</p> <p>It also provides functionality to zoom to this village on map and generate a user friendly report which can be exported in the pdf and word format.</p>	Yes/No	
7.	<p>One comprehensive report showing information about all the villages of a selected state lying in high risk</p>	Yes/No	

S. No.	Features	Yes/No	Remarks
	prone areas (hot-spots)		
8	Generate map functionality – User can select any three layers such as hot-spot Village, Cyclone shelter(s) and road network and generate a user friendly maps which can be exported to pdf and word format	Yes/No	

Please suggest any other features which you may like to see in the proposed software?

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28. Please suggest any other information you would like to provide which will help in satisfying expectations from the proposed web based GIS application for Cyclone Disaster Risk Assessment.

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29. Do you think such a system will help in DRR operations for:

- |                           |                   |
|---------------------------|-------------------|
| (a) Response and Recovery | (b) Preparedness  |
| (c) Mitigation            | (d) All the above |