# Webgis based Decision Support System for Disseminating Nowcast based Alerts: Opengis Approach

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## Abstract

WebGIS is a kind of distributed information system which holds the potential to make geographic information available worldwide. It is cost effective and provides an easy way of disseminating geospatial data. This paper outlines the design and development of a WebGIS based Decision Support System (DSS) for disseminating Nowcasting of Extreme Orographic Rain events generated at regular intervals from (NETRA) model. Dissemination of events include heavy rainfall alerts all over India and cloudburst alerts over Western Himalayan Region every half an hour. In India, natural calamities like flood and cloudburst results in lot of causalities. If any early Heavy rain alerts dissemination system is developed then it will protect several lives and mitigate damage of property or infrastructure in affected areas. The development of such WebGIS based decision support system originates from this concept. Objective of this paper is to describe the near real time WebGIS based Decision support System developed for disseminating rainfall alerts to the general public and administrators about heavy rain (all over India) and cloud burst (over Western Himalayan region) using interactive maps. Users can also get non spatial information like number of affected cities and their names, district level population (census 2011), forecast date and time, Radius of influence etc. This WebGIS based decision support system can help government agencies, NGO?s and general public in planning to save lives, properties and can be used for decision making to reduce economic and material loss from the resulting floods. This paper also illustrates use of open source technologies for developing such WebGIS -DSS at low cost. The principal development component includes: GeoServer, Java, PostgreSQL, OpenLayers, and GeoExt. The framework of the system can be divided into two categories:(1) Dissemination system which includes visualization of centroid and precise locations of Heavy Rain all over India and clo

***Index terms***— web gis, open source, geoserver, openlayers, cloudburst, spatial decision support system, postgresql database.

## 1 I. Introduction

ecent advancements in internet and interactive content of the World Wide Web (WWW) have made them a powerful means for people to access, exchange and process information (Peng and Tsou 2003). The fast growing technology like Internet provides an ideal platform to empower the general public with the GIS technology through WebGIS. WebGIS (also known as Internet GIS) denotes a type of Geographic Information System (GIS), whose client is implemented in a Web browser **??**Yang C. et. al 2004). It combines the power of the Internet and GIS. It refers to the use of WWW as a primary means to exchange data, perform GIS analysis, and present

results. Also the increased popularity of web mapping in recent years has sparked the development of many Open Source WebGIS projects with the similar aim of bringing GIS technology to the general public at little or no cost **??**Caldeweyher et. al 2006, Sharma andMishra 2012).

The open source softwares are developed in collaborative manner and are available with source code for reuse, modification and redistribution as per technology-neutral published license (Karnatak et. al 2012). This study illustrates a method of using Open Source technology to design this WebGIS based DSS. It analyses the Web Map Service (WMS), Styled Layer Descriptor (SLD) features of GeoServer platform and builds the framework for publishing spatial information over web. We have comprehensively utilized the advantages of WebGIS techniques to design a Webbased system for disseminating near real time forecast alerts. Previously the half hourly forecast was presented as static maps in pdfs hosted in MOSDAC as shown in Figure_1. Adding collateral information in terms of Administrative boundaries, Roads, Rivers, District headquarters etc in this type of map would result in a cluttered or un-interpretable map. GIS Functionalities like zooming, panning, measuring distance/area, querying or searching back dates events was not possible in such static maps. Hence, it was proposed to develop WebGIS based application where visualization is supported with a choice for the decision maker to add or remove the layers of interest. The value added information has been implemented through overlay of different layers. User can also search back date forecast events for more analysis. This WebGIS based DSS is a tailored GIS application whose purpose is to interactively visualize and disseminate NETRA alerts. This near real time WebGIS based forecast dissemination system not only provide very simple way of getting forecast information but can also be used by decision makers to mitigate casualties andeconomic losses. The users of this system include those ranging from general public, professionals or administrator making spatial decisions to Government Agencies or NGO's.

# 2 a) Input for WebGIS based Spatial Decision Support System

This application disseminates the NETRA model output at 8 km spatial resolution. The output predicts location of severe rainfall and has also tried to improve relationship between topography and rainfall intensity.

# 3 b) Web-based Architecture of the System

Figure_2 shows the basic architecture of the system. This system uses an extension of the client/server concept, known as Multi-tier architecture. It consists of the client (Web Browser), Web Server, Map Server and Data Server or Database. A Client is typically a Web Browser which allows users to interact with spatial objects and analysis functions in WebGIS based system. It is also the place to present output to the users (Peng and Tsou 2003). When user requests map or data through application, an HTTP request is sent to the Web Server. In present system, Apache Tomcat 7.0.41 Server is used as Web Server. Apache Tomcat Server recognizes the request and passes it to the Map Server. Map Server also called spatial server, is a major component designed for map rendering and spatial analysis. Here, GeoServer is used as a Map Server for processing spatial requests. The output of the map server can be a feature data or map image in graphical format. This output is then delivered to the Web server and ultimately to the user in his/her Web browser. GIS Database or Database server is also an important component which store spatial and non spatial data in spatially enabled relational database management system.

# 4 Global Journal of Computer Science and Technology

Volume XVI Issue VII Version I To visualize the data obtained from various sources, we require a platform that represents the data in visual forms like WebGIS enabled maps for better understanding and analysis. This WebGIS decision support System provides an intuitive interface for decision-making. The system is developed in Java/JSP platform as it is platform independent. This system is built using Open Source softwares and components including:

? Apache Tomcat 7.0.41 (http://tomcat.apache.org) as Web Server ? GeoServer 2. The Jakarta Tomcat server is an open source, Java-based Web application container that was created to run servlet and JavaServer Page Web applications. It is very stable and has all of the features of a commercial Web application container.

# 5 GeoServer

GeoServer allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. GeoServer is the reference implementation of the Open Geospatial Consortium ). GeoServer is used to publish raster and vector data, it supports Vector data sources such as Shapefile, PostGIS, Web Feature Server and Raster data sources such as Arc Grid Coverage Format, GeoTIFF, Gtopo30, ImageMosaic and other spatial data storage format, so it is easy to implement web publishing and sharing of spatial data.

OpenLayers is client side JavaScript library for making interactive web maps, viewable in nearly any web browser. Since it is a client side library, it requires no special server side software or settings. The only thing required to make OpenLayers work is the OpenLayers code itself and a web browser. OpenLayers is also defined as an API (Application Programmer Interface) which provides users with tools to develop their own web maps **??**Hazzard E. 2011).

# 6 Geospatial Extension (GeoExt) and ExtJS

GeoExt is a rapidly-developing library for building rich, web-based GIS applications. The library is built upon Ext JS (Extended Java Script) and OpenLayers. The former provides User Interface (UI) components for building web applications along with solid underlying data components, the later is the defacto standard for dynamic web mapping. Encoding Standard defines an encoding that extends the WMS standard to allow user-defined symbolization and coloring of geographic feature and coverage data. SLD addresses the need for users and software to be able to control the visual portrayal of the geospatial data. It has ability to define styling rules that both client and server can understand. uDIG is open source desktop GIS development platform used for SLD generation.

# 7 Spatial Database Management System

GIS is the principal technology motivating interest in Spatial Database Management Systems. Before a GIS can carry out any analysis of spatial data, it accesses that data from Spatial Database Management System (SDBMS). An efficient SDBMS can greatly increase the efficiency and productivity of a GIS (Shekhar S. and Chawla S. 2003). For thisapplication, PostgreSQL database is used for storing both spatial and non spatial data. PostgreSQL is a powerful, open source object-relational database system. It is fully ACID (Atomicity, Consistency, Isolation, Durability) compliant, has full support for foreign keys, joins, views, triggers, and stored procedures (in multiple languages). PostGIS add support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS), much like ESRI's SDE or Oracle's Spatial extension.

# 8 System Design

The framework of the developed system can be divided into two parts: (i) Fetching NOWCAST based output and storing same in database. (ii) WebGIS based Data Dissemination.

# 9 Data Download and Organization

Data Downloading: Text files containing location of Heavy Rainfall and cloudburst alerts and related information like number of cities affected with their names, radius of influence, forecast date and time are received at predefined Server at thirty minutes interval. Automatic Script is developed for downloading these files to server where database resides whenever files arrive.

Data Organization: Script written for downloading text files also contain one module for extracting locations of alerts and related information. This script is also responsible for inserting data into PostgreSQL database.

The purpose of physical database design is to translate the logical description of data into the technical specification for storing and retrieving data. Database organization for present system requires spatially enabled database, capable of storing and managing both spatial (location of heavy rain and cloudburst alerts) and non spatial data (number of affected cities, their name, forecast date and time, radius of influence etc ). For this, PostgreSQL database is chosen which is capable of handling both Spatial and Non Spatial data in efficient way. GeoServer can be connected to database by creating data store and specifying the database connection parameters i.e. database name, host, port, user name and password etc. After establishing connection between GeoServer and PostgresSQL database, spatially enabled tables having alerts information get published through GeoServer as WMS layers that can be displayed in a browser application. The WMS defines the interface for accessing geospatial data uniformly from remote servers in a standard format, such as Portable Network Graphics (PNG) and Graphics Interchange Format (GIF), through HTTP. Three WMS operations are defined and used in the following sequence: (1) 'GetCapabilities' requests the service metadata; (2) 'GetMap' requests a static map according to given geospatial and other parameters; and (3) 'GetFeatureInfo' requests data of selected features (Li Wenwen et. al 2010). Information contained in published layers automatically gets updated with new dataarrival. Other thematic layers such as State, District and Taluka Boundary, Rivers, National Highways and other roads, District Headquarters, Airports, Railway Tracks and Digital Elevation model (DEM) have been published through GeoServer as WMS layers. All Shapefiles have been taken from Natural Resources Data Base (NRDB) (www.nnrms.gov.in) having GCS WGS84 projection. In order to display Geospatial data, it must be styled. Styled Layer Descriptor is used for visual portrayal of the geospatial data.

# 10 WebGIS based Data Dissemination system

User interface of system was designed in such a way that it provides a very simple and interactive way of visualizing heavy rainfall and cloudburst alerts along with related information. Currently Cloudburst forecast is provided for Western Himalayan Region and Heavy Rainfall alerts are provided for All India and surroundings. To disseminate these forecasts, separate frontend applications are designed. In both applications, basic information related to the locations of points of heavy rain and cloudburst is depicted through separate Furthermore, District and Taluka boundaries maps use selective labeling. That is, as the user zooms into the detail of the map, the name of the district and taluka will be shown on the map. This makes it easy to browse around the map to find more information about the surrounding area and region. User Interface of application along with functionalities present in the application are shown below from Figure **??** to 7.

better decisions. GIS functionalities like panning, zooming, on/off layers, print map, measure distance/ area have been incorporated. User is also provided with functionality to search back dated forecast events for Webgis based Decision Support System for Disseminating Nowcast based Alerts: Opengis Approach users. These value additions will help users in making overlay layers for providing more information to the Similar technique has been adopted to provide information on heavy rain events using INSAT3D data; the same is available and updated at every half hour.

The current implementation of the GeoServer based depiction of heavy rain and or cloud burst events will be enhanced through implementation of probable impact assessment and depiction of the same. [1]

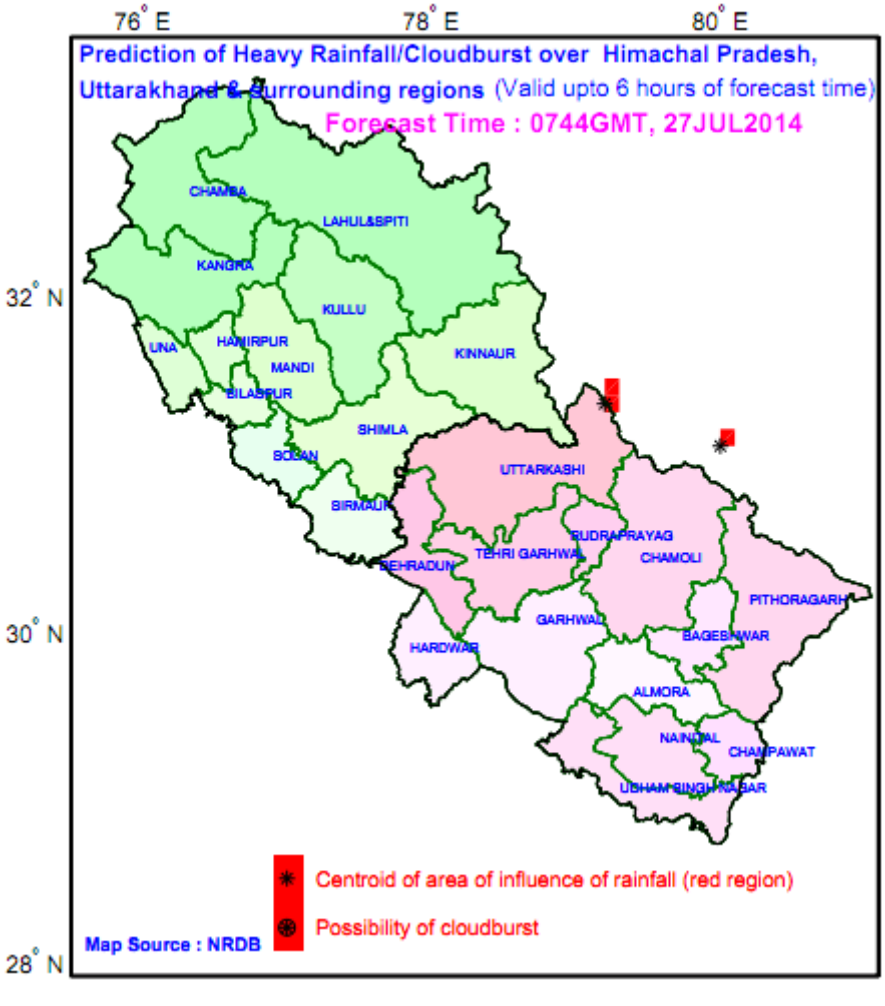


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Figure 1: Figure 1 :

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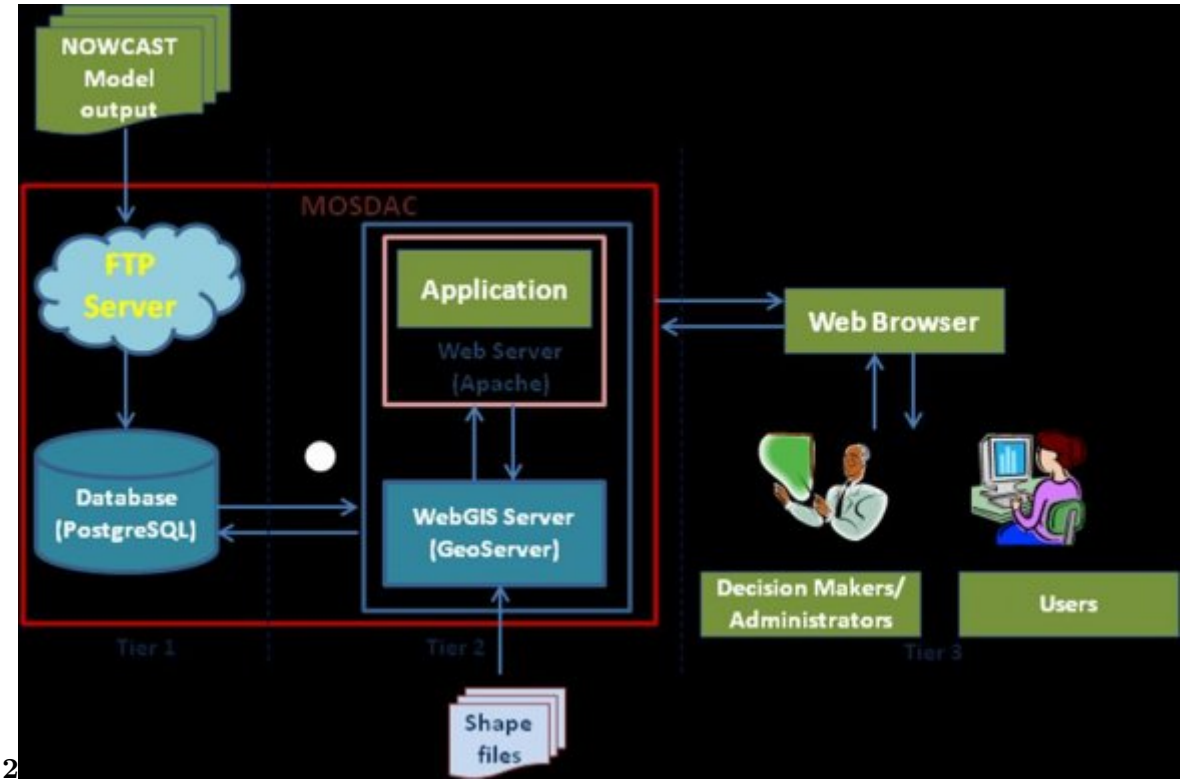


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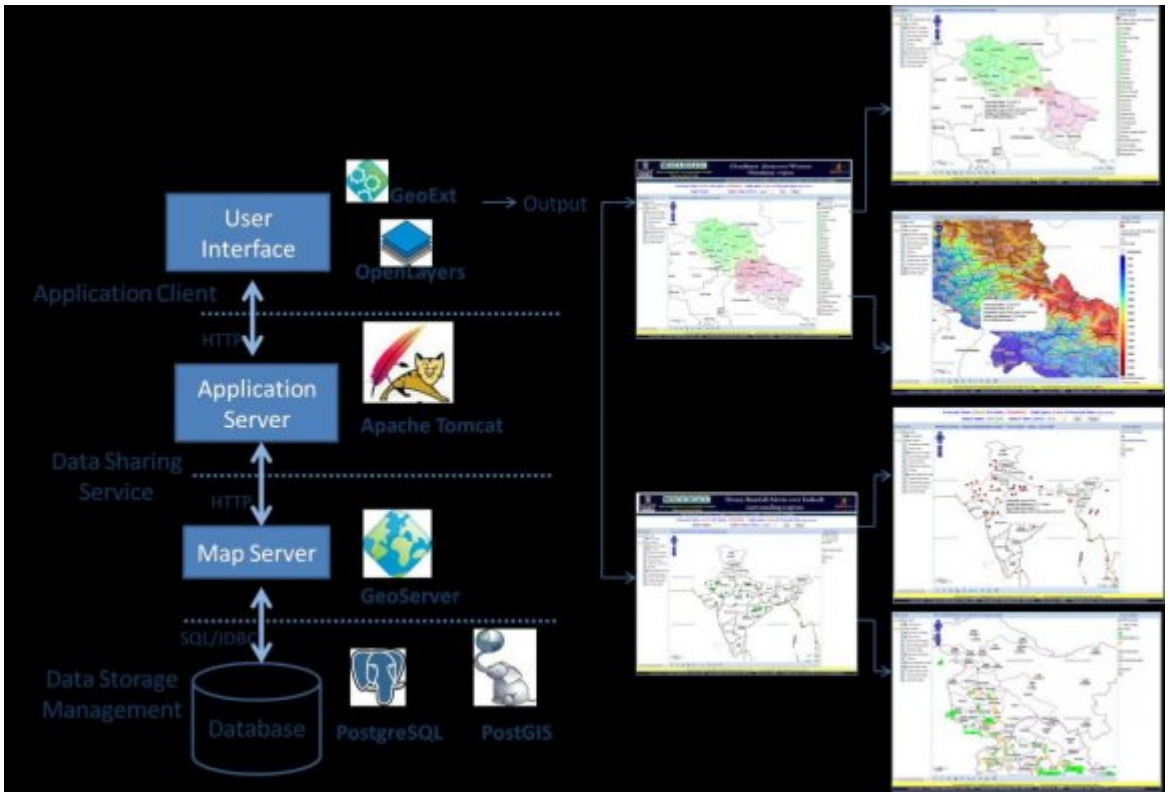
Figure 2: Figure 2 :

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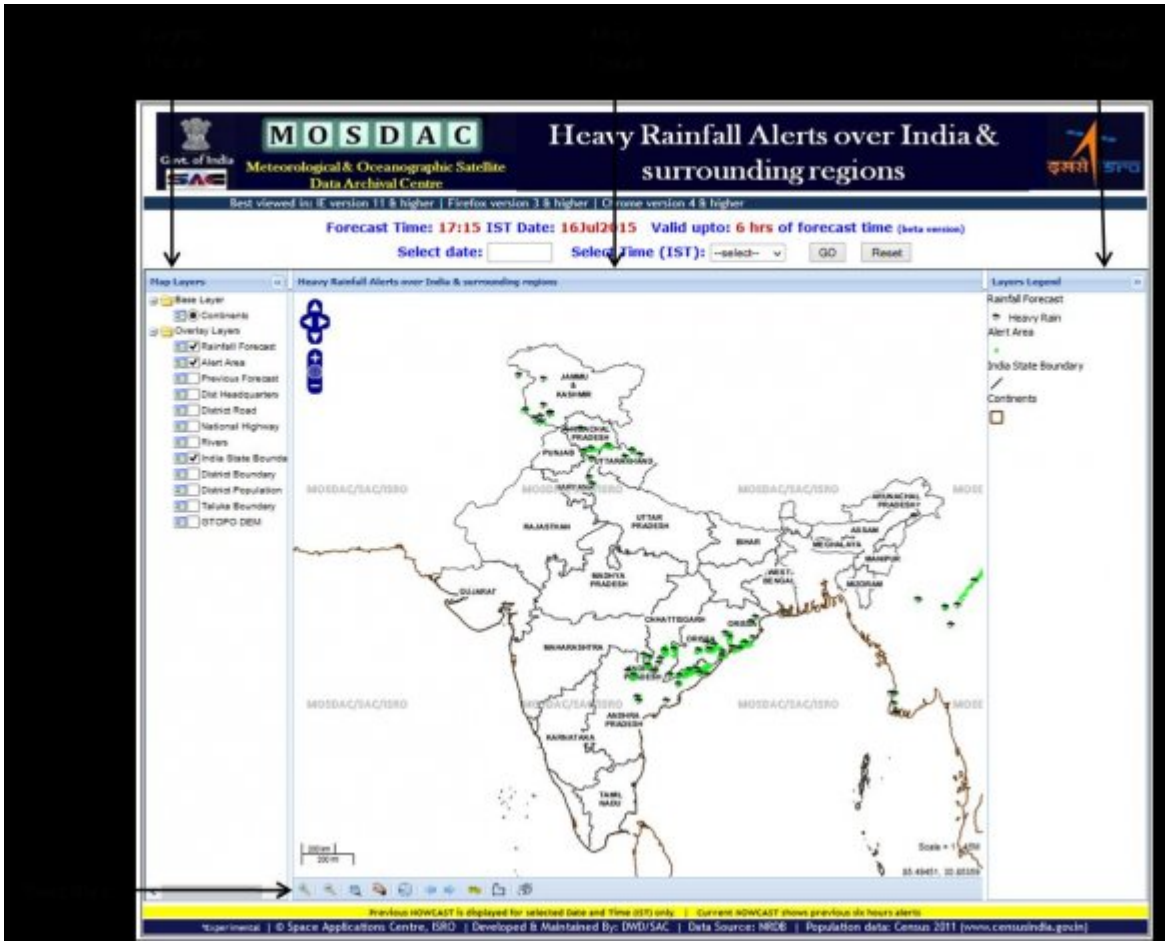

MOSDAC
Meteorological & Oceanographic Satellite Data Archival Centre
Heavy Rainfall Alerts over India & surrounding regions
Forecast Time: 17:15 IST Date: 16Jul2015 Valid upto: 6 hrs of forecast time
Select date:
Select Time (IST):
GO
Reset
Map Layers
Layers Legend
Rainfall Forecast
Heavy Rain
Alert Area
India State Boundary
Continents
© Space Applications Centre, ISRO | Developed & Maintained By: DWD/SAC | Data Source: NRDB | Population data: Census 2011 (www.censusindia.gov.in)

Figure 4: (

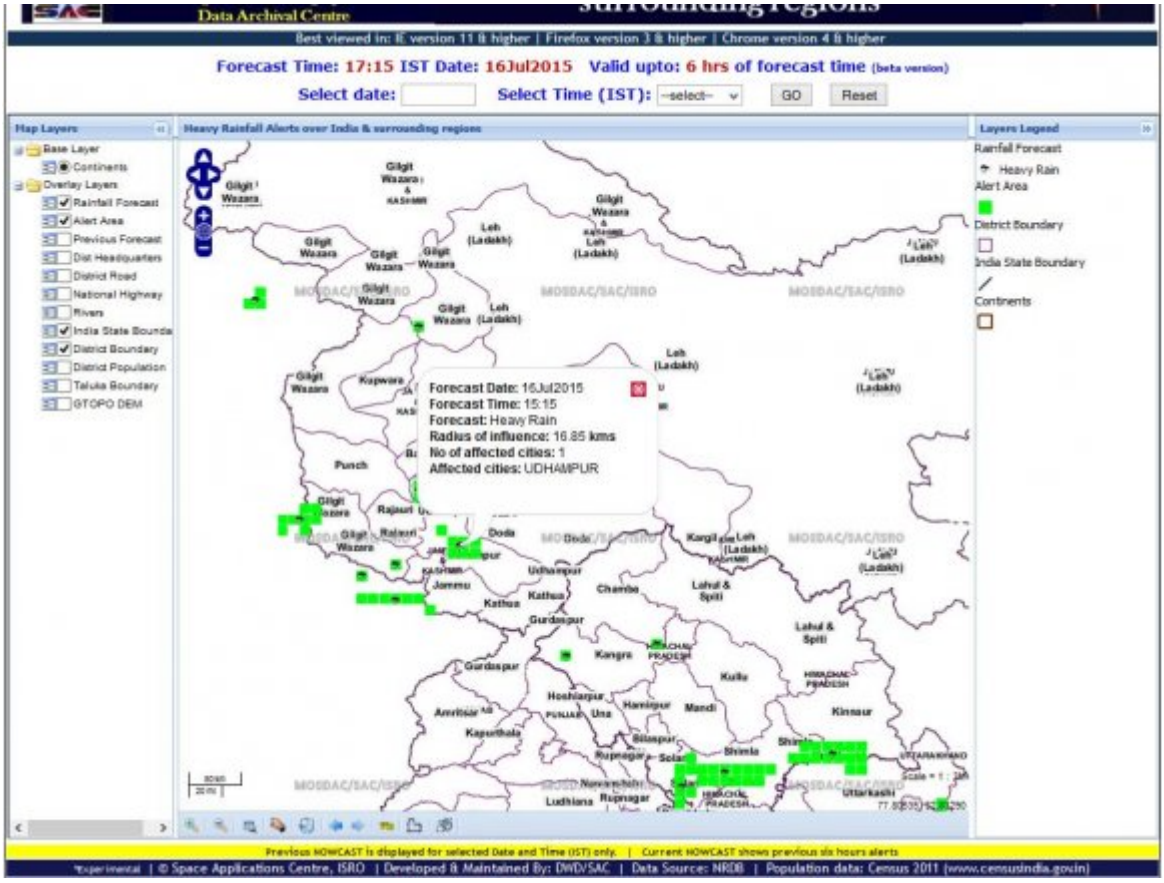
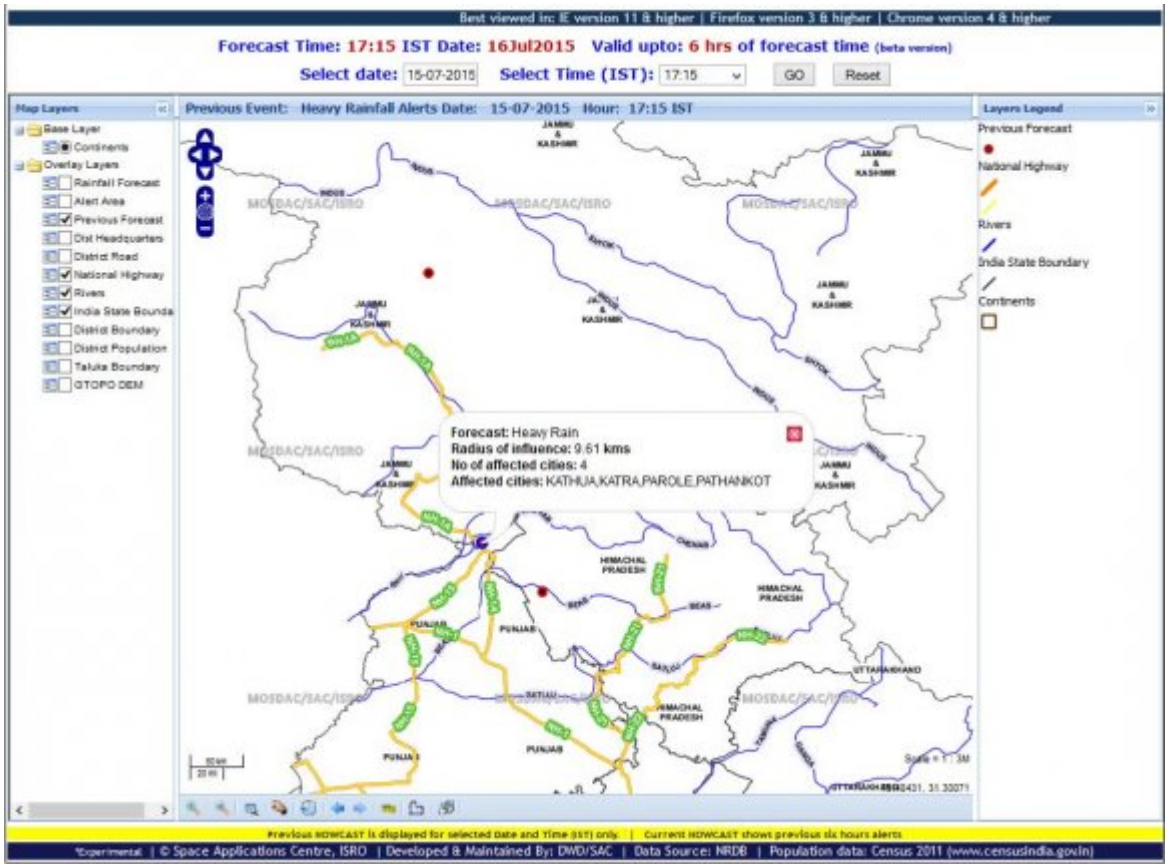

Data Archival Centre
Best viewed in: IE version 11 & higher | Firefox version 3 & higher | Chrome version 4 & higher
Forecast Time: 17:15 IST Date: 16Jul2015 Valid upto: 6 hrs of forecast time (beta version)
Select date:
Select Time (IST): --select--
GO
Reset
Map Layers
Base Layer
Continents
Overlay Layers
Rainfall Forecast
Alert Area
Previous Forecast
Dist Headquarters
District Road
National Highway
Rivers
India State Boundary
District Boundary
District Population
Taluka Boundary
GTOPO DEM
Heavy Rainfall Alerts over India & surrounding regions
Forecast Date: 16Jul2015
Forecast Time: 15:15
Forecast: Heavy Rain
Radius of influence: 16.85 kms
No of affected cities: 1
Affected cities: UDHAMPUR
Layers Legend
Rainfall Forecast
Heavy Rain
Alert Area
District Boundary
India State Boundary
Continents
Previous NOWCAST is displayed for selected Date and Time (IST) only. | Current NOWCAST shows previous six hours alerts
Experimental | © Space Applications Centre, ISRO | Developed & Maintained By: DWDVSAC | Data Source: NRDB | Population data: Census 2011 (www.censusindia.gov.in)

Figure 5:


Best viewed in: IE version 11 & higher | Firefox version 3 & higher | Chrome version 4 & higher
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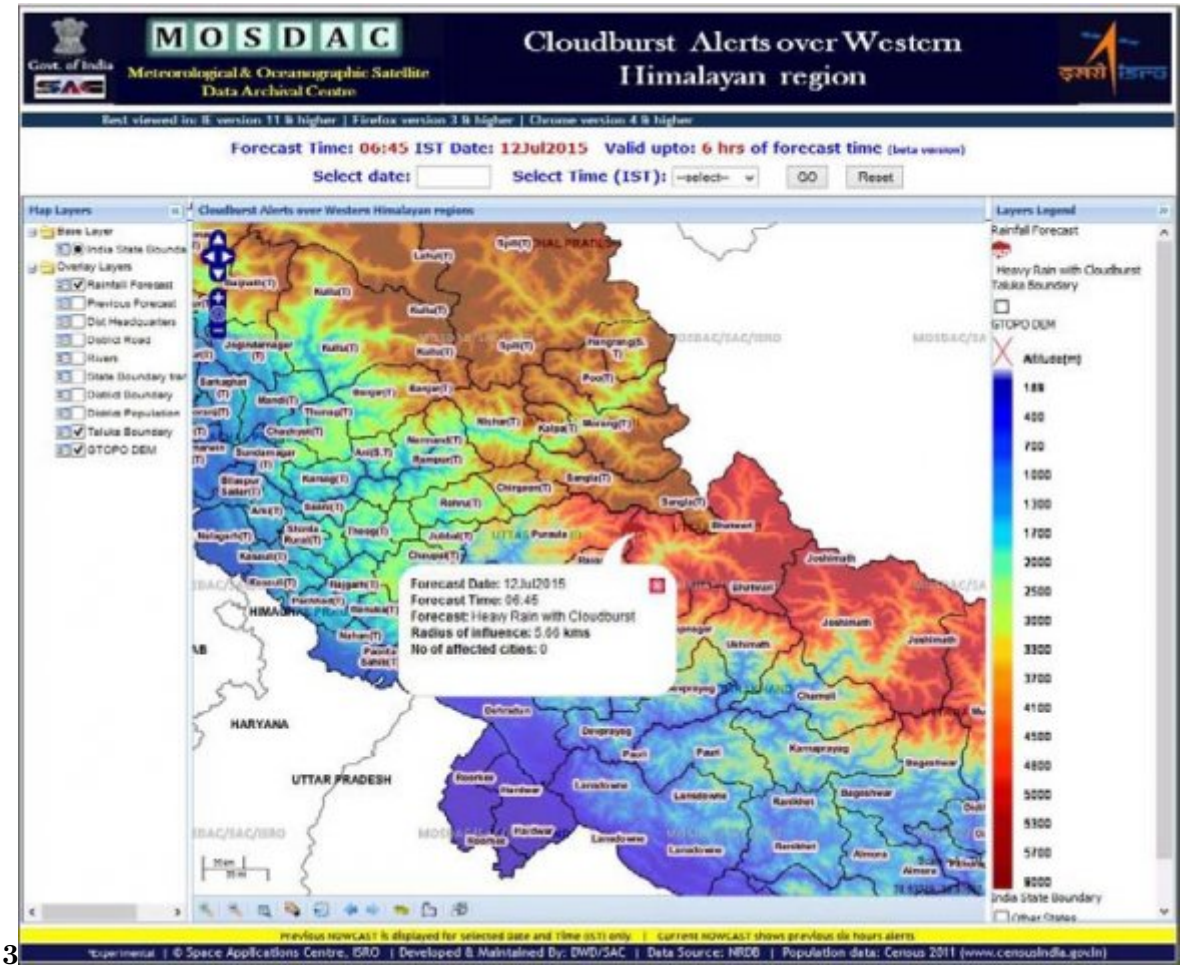
Select date: 15-07-2015 Select Time (IST): 17:15 GO Reset
Map Layers
Base Layer
Continents
Overlay Layers
Rainfall Forecast
Alert Area
Previous Forecast
Dist Headquarters
District Road
National Highway
Rivers
India State Bounda
District Boundary
District Population
Taluka Boundary
GTOPO DEM
Previous Event: Heavy Rainfall Alerts Date: 15-07-2015 Hour: 17:15 IST
Forecast: Heavy Rain
Radius of influence: 9.61 kms
No of affected cities: 4
Affected cities: KATHUA,KATRA,PAROLE,PATHANKOT
Layers Legend
Previous Forecast
National Highway
Rivers
India State Boundary
Continents
Previous NOWCAST is displayed for selected Date and Time (IST) only. | Current NOWCAST shows previous six hours alerts
Experimental | © Space Applications Centre, ISRO | Developed & Maintained By: DWD/SAC | Data Source: NRDB | Population data: Census 2011 (www.censusindia.gov.in)

Figure 6:




3

Figure 7: Figure 3 :

# .1 III. Acknowledgements

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