

TIME SERIES REPRESENTATION OF WIND VECTOR, SURGE HEIGHT WITH INDIGENOUS WEB MAP SERVER (IGiS) – CASE STUDY OF PHAILIN CYCLONE DATA

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ABSTRACT: Integrated GIS and Image Processing Software (IGiS) is indigenously developed map server – mentored by SAC (ISRO) and developed by SGL. IGiS publisher & server is user friendly. This software is capable of providing web services for operational project/ streamlined approach. A unique feature of this software is its capability to render visualization of time series of spatial (vector) data.

Geostationary meteorological satellites provide data on state of the atmosphere and ocean with very high temporal frequency. This capability is used to derive various geo-physical parameters. To understand evolution of a natural process, particularly of an episodic and / or natural extreme event, it is required to view high frequency geo-physical spatial data in an automated way through animation using web map service. IGiS has an ability to cater to such a request.

This capability of animation service, along with components like publisher, web server, of IGiS is illustrated by taking a case study of Phailin cyclone data (in Bay of Bengal during 2013) for wind vector and storm surge height. The case study aptly demonstrates that IGiS software is capable of animated time series visualization for voluminous data set. This study helps for future uses to provide time-series visualization.

1. INTRODUCTION

The spatial data through web map service consists of various components like map, web tools, OGC standards and most important is metadata of maps. The traditional representation (Yuan et al., 1998) of map service is to display map with nominal web tools, whereas recent trend is to produce interactive, user friendly, informative and customizable map service. Various applications using remote sensing data are available for societal requirement, especially in the field of disaster management and natural resource management. The data captured at different point of time at particular location stores information about the features and its behavior (evolution, path and progress) over a period of time. These create the series of maps / spatial information for a period and are known as time series maps. Time series and change analysis are part of remote sensing (Johnson, 2004) and the time as integral part of GIS (Johnson, 2004). The ubiquitous nature of spatial change through time (Johnson, 2004) is an important for weather forecast, understanding pattern of spatial features at particular period of time while working with time series data.

This paper illustrates an application of the Time series service approach to the Phailin cyclone which occurred in 2013 in Bay of Bengal (BOB). The applications of time-variant processes at global level are very less (Johnson and Nelson, 1998). The time series analysis using various open source and COTS (Customised Of The Shelf) packages for spatial data helps to produce a scenario to identify the natural process at different interval. The simulations using such data also help as a before-hand expectations and preparedness for disaster management can be planned.

To develop such applications, researchers often need easy, customizable and applicable software in order to demonstrate the Time series maps. However, researchers often disagree about the correct solution /software to use for such application development due to computational limitations (Johnson and Nelson, 1998) on image time series analysis. In such a context, this study may be considered as a solution to map services and the usefulness of its indigenous components. It focuses on time series using vector data.

The paper consists of four sections. Section2 provides an overview of the Phailin Time series data. Section 3 describes different relevant modules of IGiS software. The methodology and application proposed is presented in section4. The last section describes salient observations and conclusions.

2. OVERVIEW PHAILIN TIME SERIES DATA

Very severe cyclonic storm Phailin originated from a residual cyclonic circulation from the South China Sea. With

due course of time, the cyclonic circulation was identified as a low pressure system in the North Andaman Sea on 7th October 2013. Moving west-northwestwards, the system intensified into a deep depression and successively into a cyclonic storm 'Phailin' on 9th October. With further intensification Phailin becomes very severe cyclonic storm (VSSC) and crosses central part of Bay of Bengal on 10th October. Cyclone induces a surge or storm surges (Chakraborty et al., 2015) are useful when to represent the time series map for further study. Forecast of storm surge height, surface waves and other parameters work were carried out at SAC during Phailin cyclone period, where for storm surge prediction Advanced circulation (ADCIRC) model was used.

2.1 Data

The forecast cycle analysis was available for 15 days from 1 October 2013 till 15 October 2013, in this study only 5 day i.e., from 10 October 2013 to 14 October 2013 are used because Phailin became very severe cyclonic storm and crossed central Bay of Bengal on 10 October and on 12 October, the cyclone hit the Indian coastal states of Odisha and other states as described (Chakraborty et al, 2015). The initial model conditions were improved by assimilating track observations from three contemporary Altimeters (e.g., Jason-2, SARAL/AltiKa and Cryosat) by using Deterministic Ensemble Kalman Filter (DenKF) and for wind vector have been taken from the National Center for Environmental Prediction (NCEP) (Chakraborty et al, 2015).

The parameters identified for this study are Time stamp, Node id (vertices of the triangular mesh used in ADCIRC model), wind speed, wind direction, surge along with Latitude, Longitude.

2.2 Organization of Data

As described the five day data were organised hourly for smooth operation within IGI software. The DEM was generated from point (location-wise) data sets of individual hour. Image files generated using above process is utilized for representation of storm surge in vector. Time stamp was appended to label above vector data. An IGI project was created for analysis. Publisher project lineage with IGI project and common symbology was generated and utilized as a reference to these datasets.

2.3 Analysis

The raw file for Phailin data contains wind vector values. The data organized as described above was used to perform computational work and DEM generation. The raw file was split into sixty files with header information for individual fields and subsequently converted for IGI usage. The overall operations described here below are for one file and repeated for all required data sets.

The point data were converted to Spatial Theme (using create theme using x, y coordinate). The projection information and time stamp were added. The output generated was used as a base vector layer and used further for wind direction/speed presentation. Next, the Symbology for wind vector (as per wind speed) was generated and applied on base vector layer.

The base vector was used to convert point to image (Advance module - Terrain analysis – DEM from point / line – Linear). The generated image was classified and converted to polygon using Raster to Vector method. The Symbology for surge (as per height) was generated and applied on vector file generated in this process.

3. DIFFERENT MODULES OF IGI SOFTWARE

3.1 Overview of IGI

IGI is a Geomatics application software that gives the power to visualize the spatial data (Raster & Vector) geographically and to manipulate data (raster and vector) for standard analysis (www.scanpointgeomatics.com). It facilitates the end user to create maps, images and provides tools needed to put data on a map and display it in an effective manner. It helps to solve the geo-location and attribute based queries, present the results of work in the form of publication-quality maps and to create interactive displays that link reports, graphs, tables, drawings, photographs, and other elements to the data.

3.2 The basic structure

IGiS web application modules: IGiS server, IGiS publisher, IGiS widget and Publish Project were used in this study.

3.2.1 IGiS server

IGiS server is a tool to share, manage and distribute your geographic information system (GIS) data on Intranet and internet. IGiS Server provides the facility for managing GIS services over the web by providing sharing and distribution facilities of maps to web and desktop users. IGiS server supports and provides OGC web services like WMS, WCS, WFS, SLD, etc that user can use anywhere. IGiS Publisher can be used by the user to create services for making the GIS data available anywhere over the intranet and internet. It will be a COTS product and can be measure up to other product available in the market. Also, it is developed to handle national level project and have huge data integration and handling capability. IGiS server and IGiS Publisher are the components of IGiS enterprise suite. The development is based on IGiS Technology which is a highly scalable Geo-Spatial platform.

3.2.2 IGiS publisher

The IGiS Publisher is a tool to publish and manage maps over the web portal. Data created using IGiS desktop can be published using the IGiS publisher tool to make the data easily accessible to users for the purpose of viewing and analyzing the map. Publisher can also be used to publish PostgreSQL/PostGIS data.

3.2.3 IGiS widget

A widget is a small application with limited functionality that can be installed and executed within a web page by an end user. It is a relatively simple and easy-to-use software application or component made for one or more different software platforms. Widgets may be considered as downloadable applications which look and act like traditional apps but are implemented using web technologies including JavaScript, Flash, HTML and CSS.

A widget is an element of interaction in a graphical user interface (GUI), such as a button or a scroll bar. Controls are software components that a computer user interacts with through direct manipulation to read or edit information about an application. Each widget facilitates a specific type of user-computer interaction, and appears as a visible part of the application's GUI as defined by the theme and rendered by the rendering engine. Some widgets support interaction with the user, for example labels, buttons, and check boxes. Others act as containers that group the widgets added to them, for example windows, panels, and tabs.

IGiS Widget is developed to view and analyze the published project or GIS data of IGiS. The Publish Widget tool is developed in the IGiS publisher for publishing the widget of a project published at the server. This tool is used to create, design and configure a web interface of widget to display the map. User has to provide the server Host, Port, User Name and Password for publishing the widget. These credentials are provided by the server administrator to the user for publishing the widget. User can generate an application at the server to display the map in the widget. User can publish the widget as per his choice by specifying the controls like toolbar, map panel, scale, graticules, etc. along with the layers required in the map.

3.2.4 Publish project

This tool is useful in publishing the project along with the required data to the server for further use. User has to provide the server host, Port, User Name and Password for publishing the project at the server. User can create own workspace for a particular project at the server.

4 APPLICATION OF PROPOSED METHOD

To better understand cyclones, visualization is very important (MacEachren, 1992). Some researchers have developed customised applications for cyclones and their track (Grigoriev, 2000; Wang, 2005). Time series with a spatial reference and computer technology enables researchers to use software SDK for representation of spatial datasets (Kamarianakis, 2005). IGiS facilitates such efforts.

4.1 IGiS desktop work

The Phailin data are acquired as described in section 2, as a text file has been used. The text files generated, is further organised as per described below for IGiS database creation:

The attribute header used as field for column name and converted in xls format. The file creation for individual hours generated for minimizing load on software processing part. The data received is for five days hour-wise, hence 60 text files generated.

The individual file imported in IGiS software using import table option, subsequently point theme created using creates point from x, y option. The generated point map project defined using define projection option.

This point map consider all parameters like wind speed, surge height, node id etc., where timestamp is required as one of the field details as shown in Figure1. Using database tool "phailin_time" filed added with type timestamp and default value given as dd-mm-yyyy hh:mm:ss format as described in Figure2.

Figure 1: Field menu to add timestamp

nodeid	long	lat	surge	wspeed	wdir	ascii_id	phailin_time
1.000000	72.714828	22.315622	-0.000179	1.818080	121.412963	0	2013-10-10 00:00:00
2.000000	72.586463	22.303459	0.009823	1.690557	110.819274	0	2013-10-10 00:00:00
3.000000	72.700759	22.168298	0.006949	1.702094	121.368606	0	2013-10-10 00:00:00
4.000000	72.469070	22.308906	0.022710	1.642260	100.122406	0	2013-10-10 00:00:00
5.000000	72.584777	22.161689	0.005290	1.593279	109.853012	0	2013-10-10 00:00:00
6.000000	72.347412	22.302028	0.021314	1.649466	88.506317	0	2013-10-10 00:00:00
7.000000	72.230484	22.319646	0.031805	1.720599	78.650115	0	2013-10-10 00:00:00
8.000000	72.126350	22.298988	0.036433	1.829143	69.459396	0	2013-10-10 00:00:00
9.000000	72.111076	22.179842	0.037954	1.899770	63.776474	0	2013-10-10 00:00:00
10.000000	72.484161	22.138404	0.010521	1.547740	98.514175	0	2013-10-10 00:00:00
11.000000	72.254180	22.157220	0.015240	1.698559	74.858856	0	2013-10-10 00:00:00
12.000000	72.084526	22.062366	0.029975	2.017289	57.711151	0	2013-10-10 00:00:00
13.000000	72.055831	21.945798	0.000000	1.671939	48.945205	0	2013-10-10 00:00:00
14.000000	72.447769	21.915605	0.094980	0.840659	107.851058	0	2013-10-10 00:00:00
15.000000	72.215881	21.944229	0.037697	1.293855	63.691055	0	2013-10-10 00:00:00

Figure 2: Illustrative representation of Phailin parameters

To use surge height for DEM generation, linear interpolation and subsequently image generated classified by slicing method was used. The image to vector operation helps to create polygon layer and used further for time series animation process using timestamp and proper symbology, the overall methodology is shown in Figure3. The time-stamp added for vector generated and attribute table as shown in Figure 4

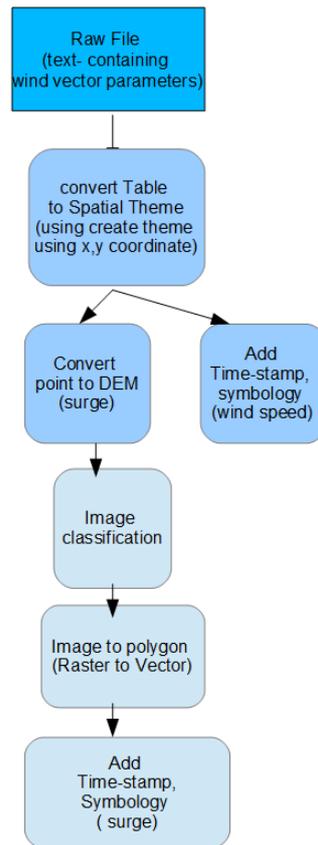


Figure 3: Methodology for Phailin point data to polygon conversion

ogc_fid	id	ColorValue	ascii_id	phailin_time
1	1	50	0	2013-10-10 00:00:00
2	2	50	0	2013-10-10 00:00:00
3	3	50	0	2013-10-10 00:00:00
4	4	50	0	2013-10-10 00:00:00
5	5	50	0	2013-10-10 00:00:00
6	6	50	0	2013-10-10 00:00:00
7	7	50	0	2013-10-10 00:00:00
8	8	50	0	2013-10-10 00:00:00
9	9	50	0	2013-10-10 00:00:00
10	10	50	0	2013-10-10 00:00:00

Figure 4: Illustrative representation of Phailin time stamp

The original point layer used for wind direction presentation where wind speed field used for symbology with 20 classes (high to low). The wind direction layer generated and overlaid with storm surge polygon as shown in Figure 5.

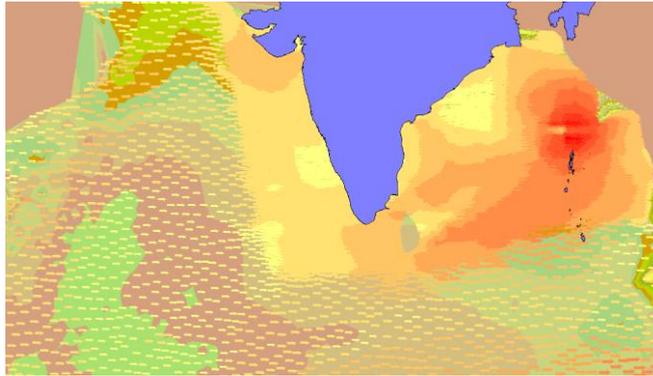


Figure 5: Wind direction over storm surge layer polygon

The above process is repeated for 60 files and IGiS project created to use for further web map publishing.

4.2 IGiS publisher work

This module used to prepare all maps and organize the flow of service like WMS. It uses all project layers with project database connection.

4.2.1 Organize publisher project

The new publisher project created and linked with IGiSproject. The all layers published as WMS using tools add WMS service provided, this tool has option to enable layer with time support against required filed. The phailin_time field used for this option and published WMS layers of project.

4.2.2 Symbology of publisher

The symbology generated in previous part for wind direction shows only scaled images of wind direction with its size according to intensity. To demonstrated wind speed with angle really helps the user to visualize a pattern of cyclone generated with its intensity. This module provides option to provide angle to wind speed field as shown in Figure 6.

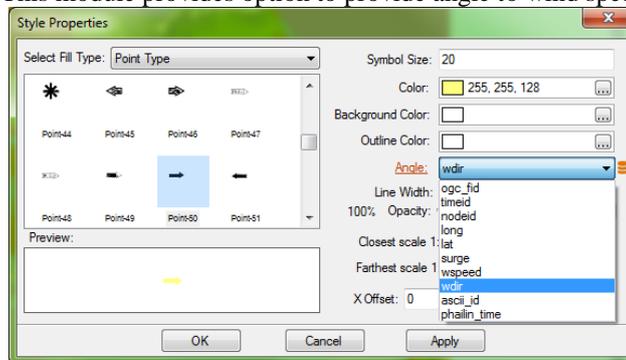


Figure 6: Illustration of defining symbology style

4.2.3 Publish project

The project generated using IGiS publisher module made available to IGiS Server using publish project option. This establish authenticated connection with IGiS server and publish the work, hence all project published, the overall methodology is shown in Figure 7.

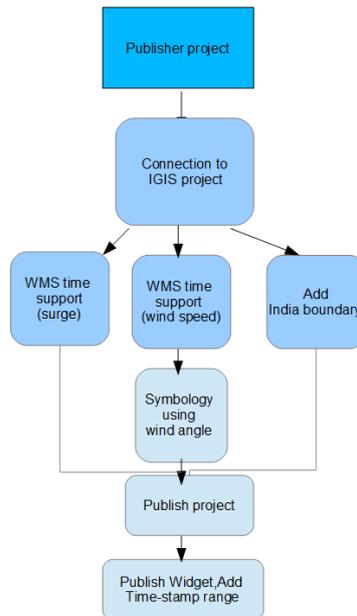


Figure 7: Methodology for IGIS Publisher work

4.2.4 Widget Publisher work

The maps presentation using widget and design of web layout with this tool along with layer sequence work carried out. The time series using time stamp properties defined for Phailin data sets. Hawk window used for India boundary to define the navigation of map.

4.2.5 Web layout

Using URL provided/generated by widget is used to view web map. User gets all layers and may identify features on web layout using identification tool. Time series tool establish the maps display according to the time stamp defined in the widget publisher. With equal interval (i.e. per hour) of time maps changes accordingly. Web User's gets time series maps animation during this process and bring valuable information about the cyclone pattern over the period of time, the same is shown in subsequent Figures 8 (a-c).

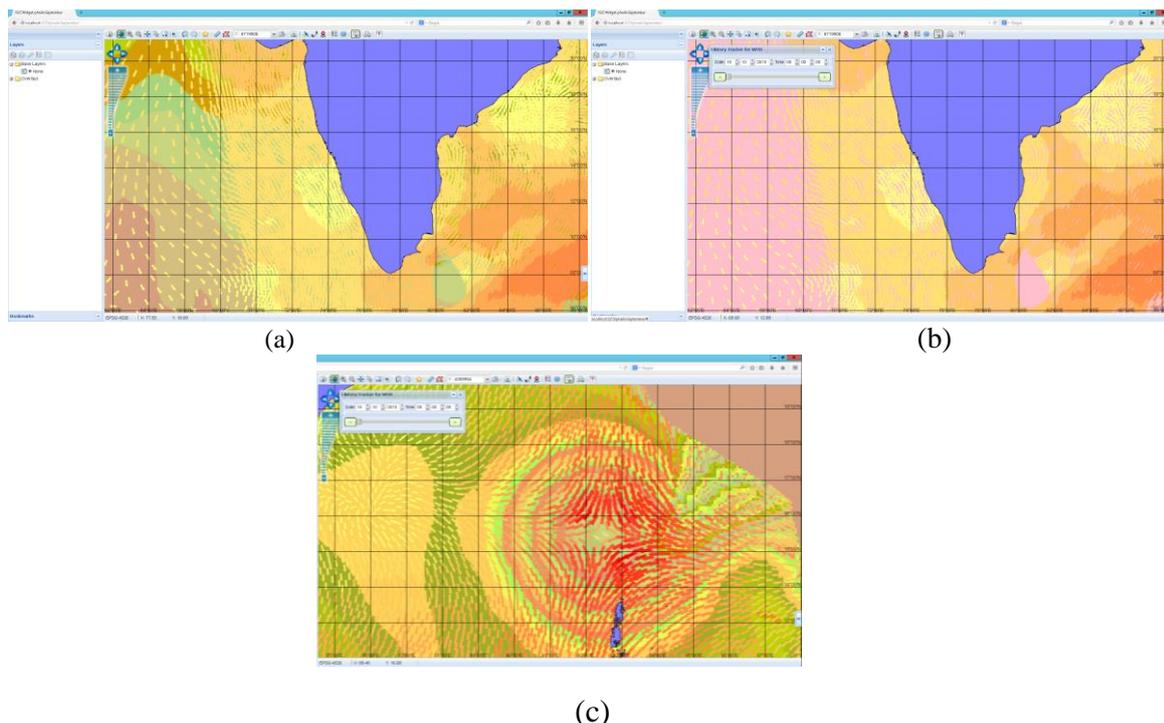


Figure 8: Phailin cyclone (a) wind overlaid with storm surge; (b) Time series menu; (c) Time series zoom portion

5 CONCLUSIONS

The present study demonstrates utility of IGIS software for visualization of time series of data corresponding to Phailin cyclone in BOB during 1 to 15 October, 2013. From the study it is apparent that IGIS server has capability to render the services required to visualize time series of spatial data. Time series visualization of spatial data facilitates interpreting patterns in the processes and can be applied to many other natural or extreme events to discover hidden patterns in time series of spatial data.

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