NEAR-REAL TIME RAINFALL MONITORING IN THE CARAGA REGION, MINDANAO, PHILIPPINES USING OPENLAYERS API AND JAVASCRIPT

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ABSTRACT: We developed an online tool for near-real time monitoring of rainfall intensity and accumulated rainfall in various localities in the Caraga Region, Mindanao, Philippines. The web map interface was built using Openlayers API where the locations of all rain gauge stations installed by ASTI DOST are plotted. For each station, a JavaScript is used to extract and analyze 24-hour rainfall data from the ASTI DOST. Based on extracted data, the current rainfall intensity at each rain gauge location is plotted on the web map according to a color scheme that signifies no rainfall, light, moderate, heavy, intense, and torrential rainfall intensities. Clicking on the points of a rain gauge will also show a graph of the rainfall intensities and accumulated rainfall in the last 24 hours. The application is available at http://rainmonitoring.csulidar1.ccgeo.info which can be utilized by Local Government Units (LGUs) and residents of Caraga Region, for rapid rainfall monitoring and as a tool for flood disaster preparedness.

1. INTRODUCTION

Near-real time rainfall monitoring is an important activity that must be undertaken especially in flood-prone areas. Determining how much rain has fallen in the last few hours, including its current intensity can aid disaster managers, Local Government Units (LGUs) and the communities in determining whether flooding is expected in the next hours, and how severe it will be if it will occur. In large river basins, information on the volume and intensity of rain falling in the mountains that are upstream of a river can be utilized as inputs into numerical simulations models to predict if this volume and intensity can increase water levels in the downstream portion (i.e., floodplains), cause overflowing of the river, and inundate the nearby communities. In this respect, access to updated rainfall information can be considered as a flood disaster early warning system. If we are able to determine the rainfall intensity and accumulated rainfall volume in near-real time, it will be great tool to anticipate the severity of the upcoming flood event and possibly avoid casualties.

In the Philippines, the Project Nationwide Operational Assessment of Hazards (NOAH) website at http://noah.dost.gov.ph has been providing near-real time rainfall information (among several sets of information including water level) in various localities (Lagmay, 2012). Through a web map interface, users can access latest rainfall information by selecting a rain gauge location. Once clicked, a graph will pop-up showing a time series plot of the rainfall depth (in mm) for the last 24 hours. The use is also informed on how intense the rainfall is because the timer series plot is overlaid on a color-code background indicating rainfall intensity classification (e.g., light, moderate, heavy, intense, and torrential). Rainfall information displayed in Project NOAH is extracted in near-real time from data recorded by rain gauges installed by the Advanced Science and Technology Institute of the Department of Science and Technology (ASTI DOST) in various locations throughout the country. Aside from Project NOAH, rainfall (and other hydrometeorological information) are also available through the Philippine Real-time Environment Data Acquisition and Interpretation for Climate-Related Tragedy Prevention and Mitigation (PREDICT; http://fmon.asti.dost.gov.ph/weather/predict/), a nationwide system that is meant to complement the existing observation capability of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

Although the rainfall information provided by Project NOAH and PREDICT is sufficient for the purpose of rainfall monitoring, the manner at which information is being displayed takes time and needs examination and analysis from the end-user. For example, the current rainfall intensity can only be determined once the user has clicked on the rain gauge location and examine the graph. Also, some relevant information is lacking such as the total accumulated rainfall depth in the last 24 hours. By the also getting this information (aside from the rainfall depth), the users can be more informed of how intense and how much rain has been falling in their localities. Moreover, the nationwide coverage of Project NOAH sometimes limits the rapid access of rainfall information of a specific area since there is a need to focus and zoom-in the map to a desired area. For disaster managers and LGUs, rapid access to rainfall information to their area of concern is important.

In this paper, we prepared a site-specific online near-real time rainfall monitoring system for the Caraga Region, Mindanao, Philippines. The system uses web-accessible data recorded by ASTI DOST rain gauges installed in Caraga Region (Figure 1), and was primarily designed to provide the necessary rainfall information such as its intensity and the accumulated rainfall in the last 24 hours in a graphical representation for rapid monitoring and as a tool for flood disaster preparedness. The development of the system is based on OpenLayers and JavasScript technologies.

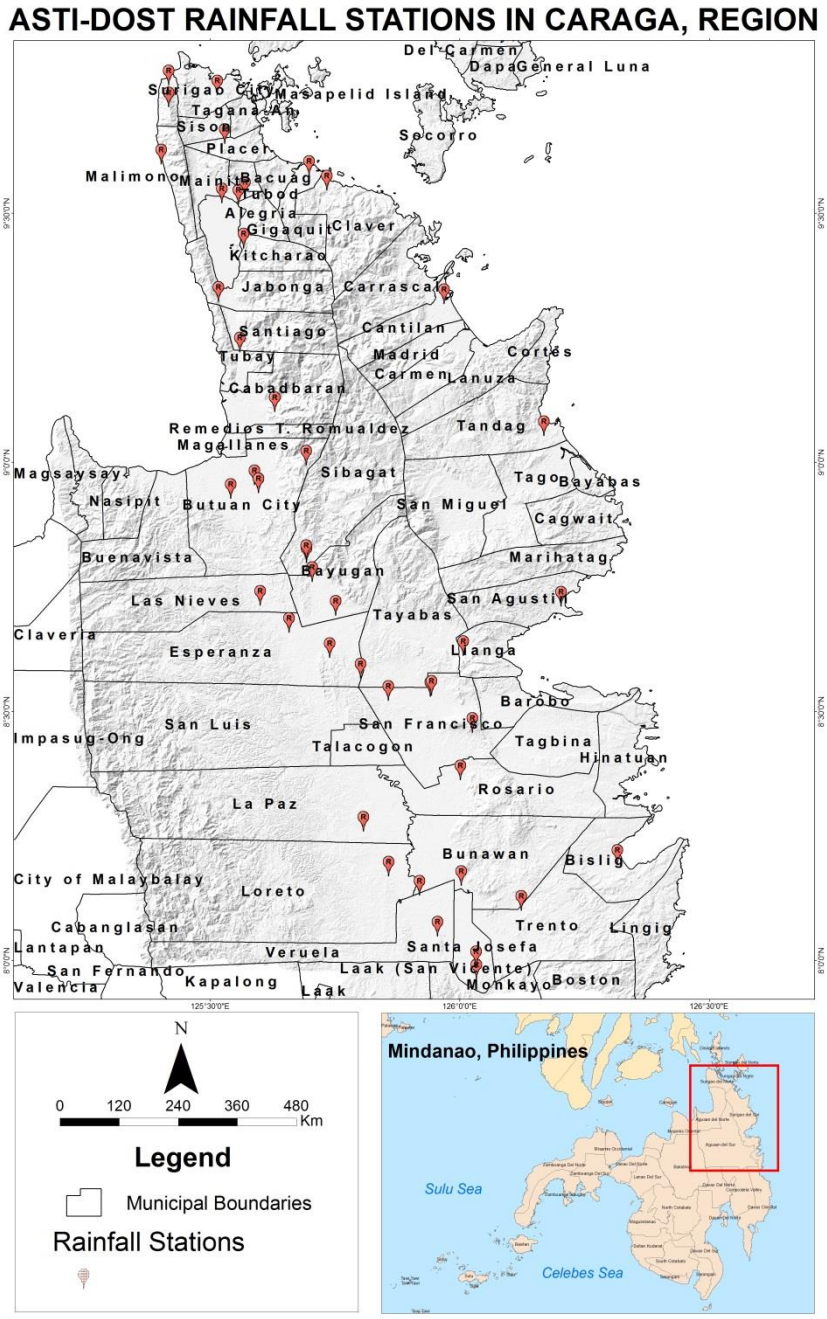

Figure 1. The rain gauge stations installed in Caraga Region by ASTI DOST

2. MATERIALS AND METHODS

2.1 Conceptual Basis

The conceptual basis for the development of the Caraga Region Near-Real Time Online Rainfall Monitoring is the need to rapidly access the following information:

- The current (latest) rainfall intensity in a particular location
- The time series of rainfall intensity in the last 24 hours
- The accumulated rainfall depth in the last 24 hours

In order to access this information, a user must first have access to a web map interface where he/she can view the various locations of rain gauges, with each rain gauge color-coded according to how intense the current rainfall is. The user will then click a specific rain gauge location, and make a request to display the time series plot of rainfall intensities and accumulated rainfall in the last 24 hours. From the graph, the user can further examine it to display in detail the rainfall intensity and accumulated rainfall values.

The framework for the above concept is technically illustrated in Figure 2. Essentially, the user's need for the information through the web map interface is handled on the background as a request that is processed by a web proxy. This web proxy then access the rainfall data server's application programming interface (API) to extract the rainfall information needed by the user. The data server's API will then give a readable response which is then interpreted by the web map interface, generates a graph, and display this to the user.

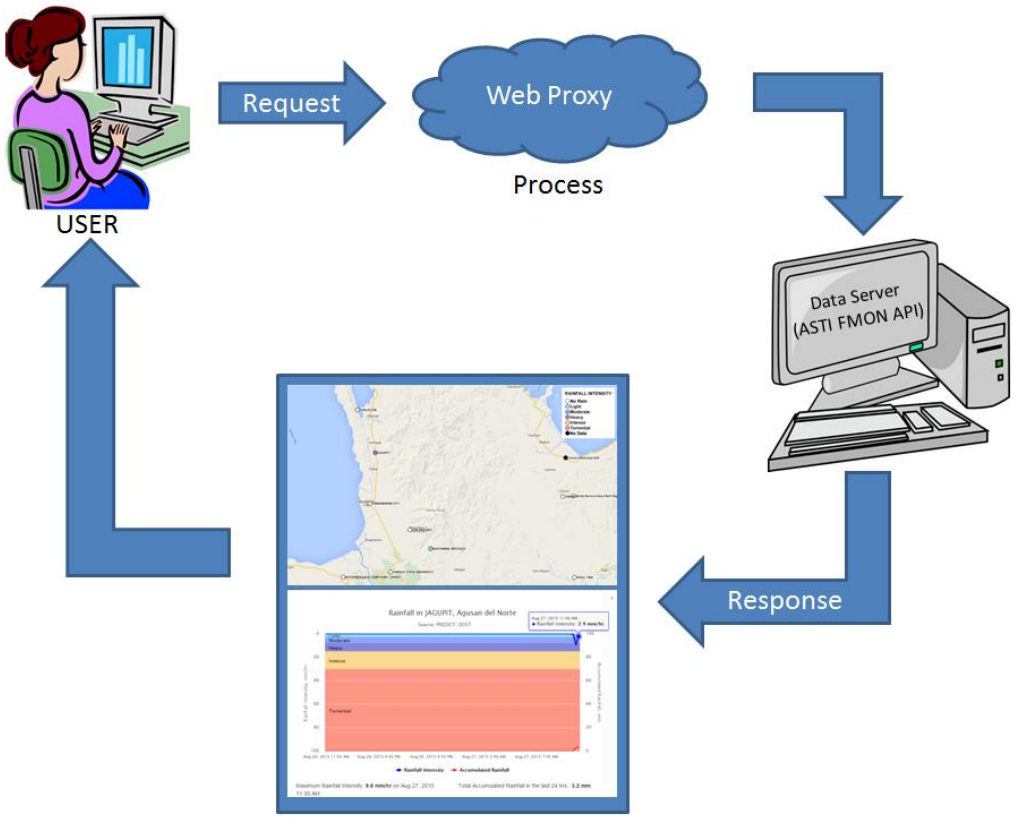

Figure 2. Conceptual Framework

2.2 System Development

2.2.1 Rainfall Data Access: We utilize the publicly-available API of ASTI DOST (http://fmon.asti.dost.gov.ph/home/index.php/api/data/) for rainfall data extraction. In the Caraga Region, there were 58 rainfall stations (as shown previously in Figure 1), and each station has unique identification (ID) number. This ID number is supplied to the API to extract rainfall data in JavaScript Object Notation (JSON) format.

The rainfall data access was done using JavaScript and through a web proxy. Instead of directly requesting the data from the server (e.g. direct access to the JSON file), web proxy was utilized to act as an intermediary every time the application takes request from the server. It will add Cross-origin Resource Sharing (CORS) header to the response so that the web map application can process it. CORS is a mechanism that allows restricted

resources (e.g. JavaScript, etc.) on a web page to be requested from another domain outside the domain from which the resource originated.

Figure 3 shows the flow in acquiring the data from the ASTI DOST data server. For each rainfall station, the rainfall data is in mm, and is recorded every 15 minutes. The extracted data is then multiplied by 4 to convert into intensity (mm/hr). The computed values are then used as the basis to identify the current rainfall intensity at each rain gauge station according to an official color scheme adopted by PAGASA (Official Gazette, 2015) that signifies no rainfall (0 mm/hr), light (< 10 mm/hr), moderate (>2.5mm/hr, ≤7.5mm/hr), heavy (<7.5mm/hr, ≥15mm/hr), intense(>15mm/hr, ≤30mm/hr), torrential(>30mm/hr), and in some cases no data.

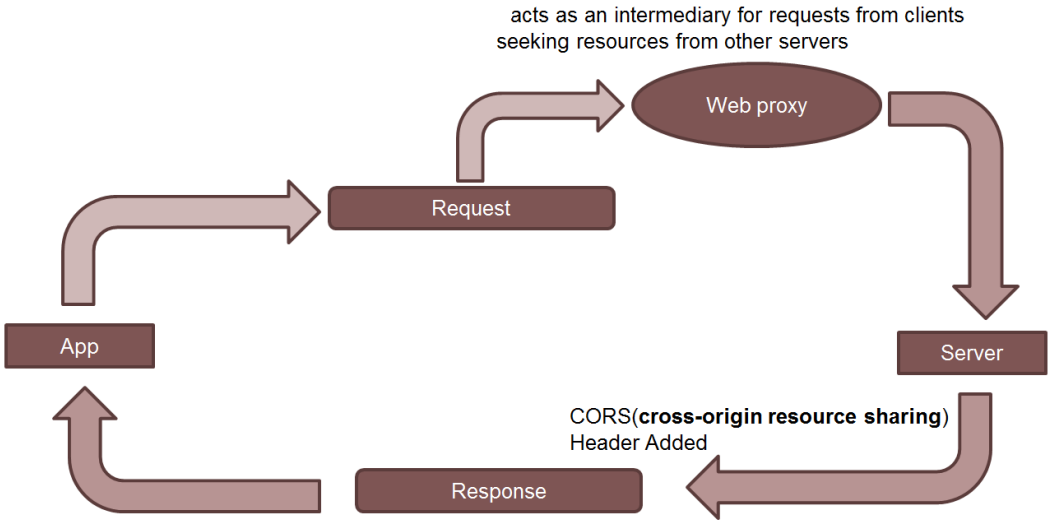

Figure 3. Flow in acquiring data from the server

2.2.2 Technologies Used

The following technologies were used in the development of the online near-real time rainfall monitoring system:

- Bootstrap (http://getbootstrap.com/) – a popular HTML, CSS, and JS framework for developing responsive, mobile first projects on the web.
- OpenStreet Map – used as base map of the application.
- JavaScript - a high level, dynamic, untyped, client-side scripting and interpreted programming language of HTML and the Web.
- Openlayers (http://openlayers.org/) - An opensource JavaScript library to load, display and render maps from multiple sources on web pages.
- Highcharts (http://www.highcharts.com/) - interactive JavaScript charts for web pages. This was used to generate the graphs/time series plots of rainfall intensity and accumulated rainfall
- Web Proxy (CORS Anywhere) - a NodeJS proxy which adds CORS headers to the proxied request.

3. RESULTS

The Caraga Region Near-real time Rainfall Monitoring System is available at http://rainmonitoring.csulidar1.ccgeo.info. Alternatively, it can be accessed at http://tinyurl.com/csulidar1v2.

Once accessed, the user will be provided with a web map interface as shown in Figure 4. On page load, rain gauge stations (points) will be individually plotted and rendered using Openlayers API according to its location (latitude and longitude). The user can easily see if it is raining in a certain locality as the rain gauge locations are colorized by its current rainfall intensity. Additionally, the user will be informed also if the rain gauge station is not providing rainfall data. Currently, there are 58 stations present in Caraga Region.

An example time series plot of rainfall intensity and accumulated rainfall when a user click on a rain gauge location is shown in Figure 5. The user can see the rainfall records for the last 24 or more hours by hovering the

mouse on the plots. Other necessary information such as date and time the maximum rainfall intensity occurred is also shown in the graph.

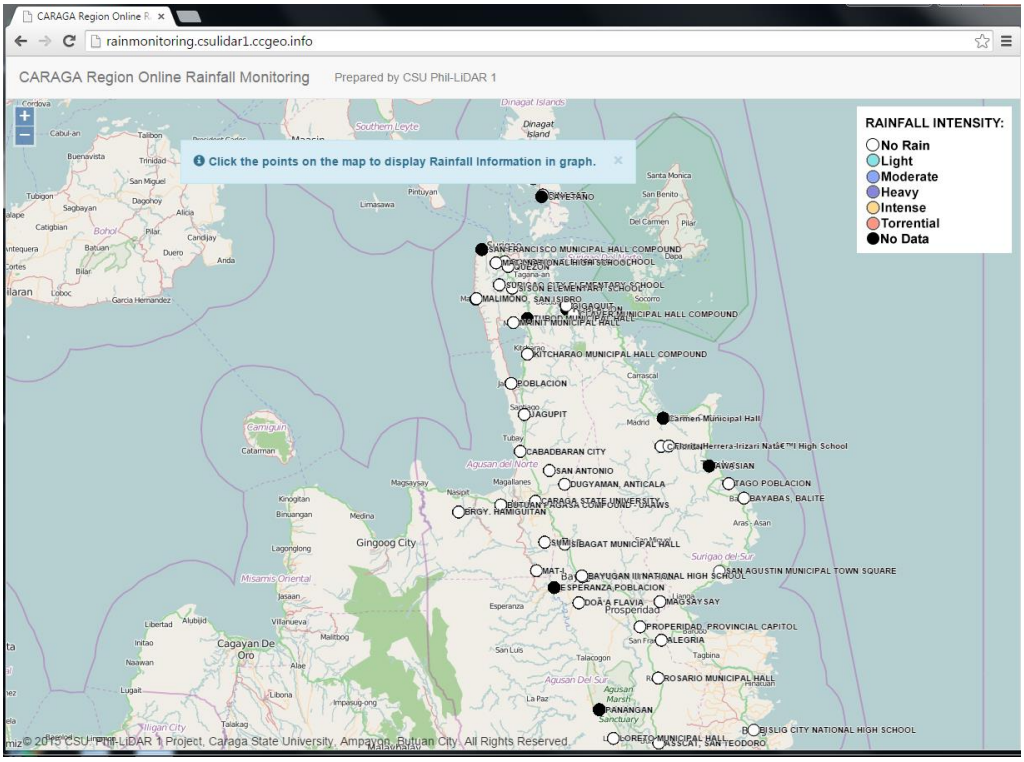

Figure 4. Rain gauge station with its current rainfall intensity (August 27, 2015 11:30 AM)

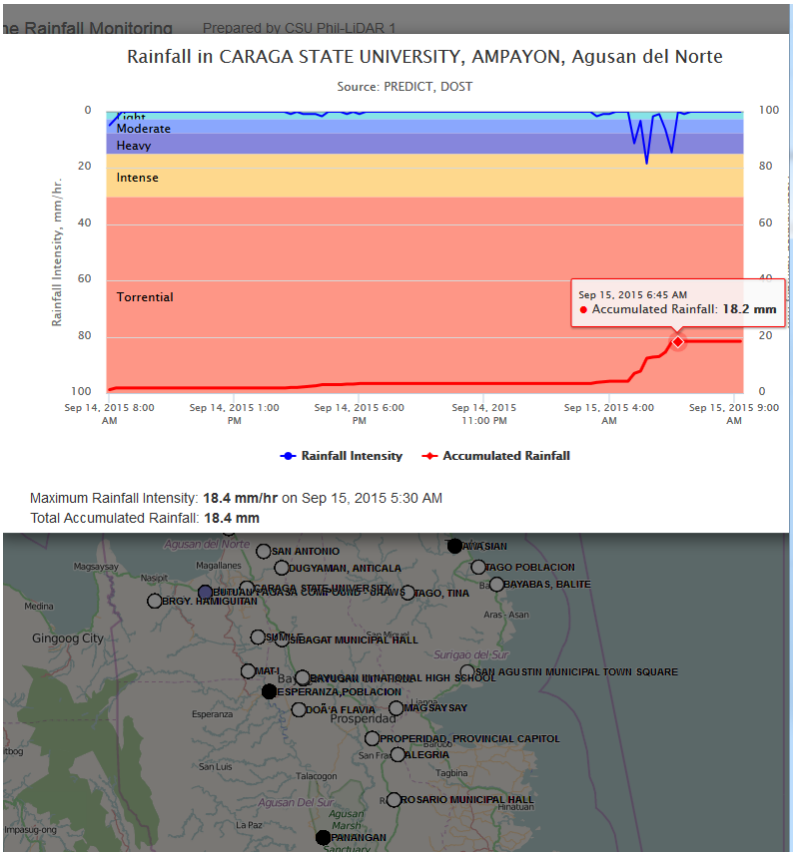

Figure 5. Example time series plot of rainfall intensity and accumulated rainfall for the 'Caraga State University' rainfall station.

4. CONCLUDING REMARKS

In this paper, we presented the development of an online application for near-real time rainfall monitoring in Caraga Region. The application is capable of generating graph based on the rainfall data acquired from the sensors installed by ASTI DOST.

The application can be utilized by Local Government Units (LGUs) and residents of Caraga Region for rapid rainfall monitoring and as a tool for flood disaster preparedness.

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