ORMT: A WEB-BASED GIS

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ABSTRACT: The Centre for Remote Imaging, Sensing and Processing (CRISP) has developed the Online Research Mapping Tool (ORMT), as an accessible web-based geographic information system (GIS), or Web GIS, for scientists, researchers and the general public to access and interactively explore remote sensing data and other geographically referenced datasets in general. It also serves as a platform to showcase remote sensing products, such as satellite images received at the CRISP ground station, and research products generated by the research groups in CRISP. A special feature of the ORMT is that it allows the user to add external layers from either the web or a local file on their PC. This enables the user to access GIS functionality to overlay and interact with their data without the need to buy or install specialized software; all that is required is a web browser.

1. INTRODUCTION

In recent years, rapid development of web-based geographic information systems (GIS), or Web GIS, has enabled efficient visualization and analysis of geographic datasets on online platforms. Numerous organizations are nowadays making their geographically referenced datasets available through web-based GIS environments. These datasets are commonly provided in standard geographic file formats like shapefiles and GeoTIFF images. This has dramatically increased the availability of GIS data on the internet, and allows increasingly efficient and fast searching, browsing and analysis of available datasets online.

The Centre for Remote Imaging, Sensing and Processing (CRISP) at the National University of Singapore (NUS) has developed a web portal which we call the Online Research Mapping Tool (ORMT). It is a World Wide Web (WWW) based geographic information system (GIS), or Web GIS, which enables users to access and interactively explore remote sensing data and other geographically referenced datasets in general. It also serves as a platform to showcase remote sensing products, such as satellite images received at the CRISP ground station, and research products generated by the research groups in CRISP. In this paper we describe the system setup, as well as highlight some of the datasets and features available for the users.

2. SYSTEM DESCRIPTION AND USER INTERFACE

2.1 System description

The ORMT system is hosted on a Dell PowerEdge R720 server, which has 2 Intel Xeon CPUs with a total of 16 cores, and 64GB of RAM, and is connected to the Internet via a dedicated broadband line. There is currently 4TB of attached NAS storage, with the option for further expansion in the future.

The software can be separated functionally into the following components: a web server, a map server (or map engine) and a geodatabase (Fig. 1). We are using ArcGIS for Server as the map server, with the local datasets stored in an associated ArcSDE geodatabase.

By definition of a Web GIS, users access the ORMT through the HTTP protocol via a web browser on their device. This device may be a personal computer, a notebook computer, or even a mobile device like a tablet computer or a smartphone (although we do not recommend using the last option as the screen space would be rather limited).

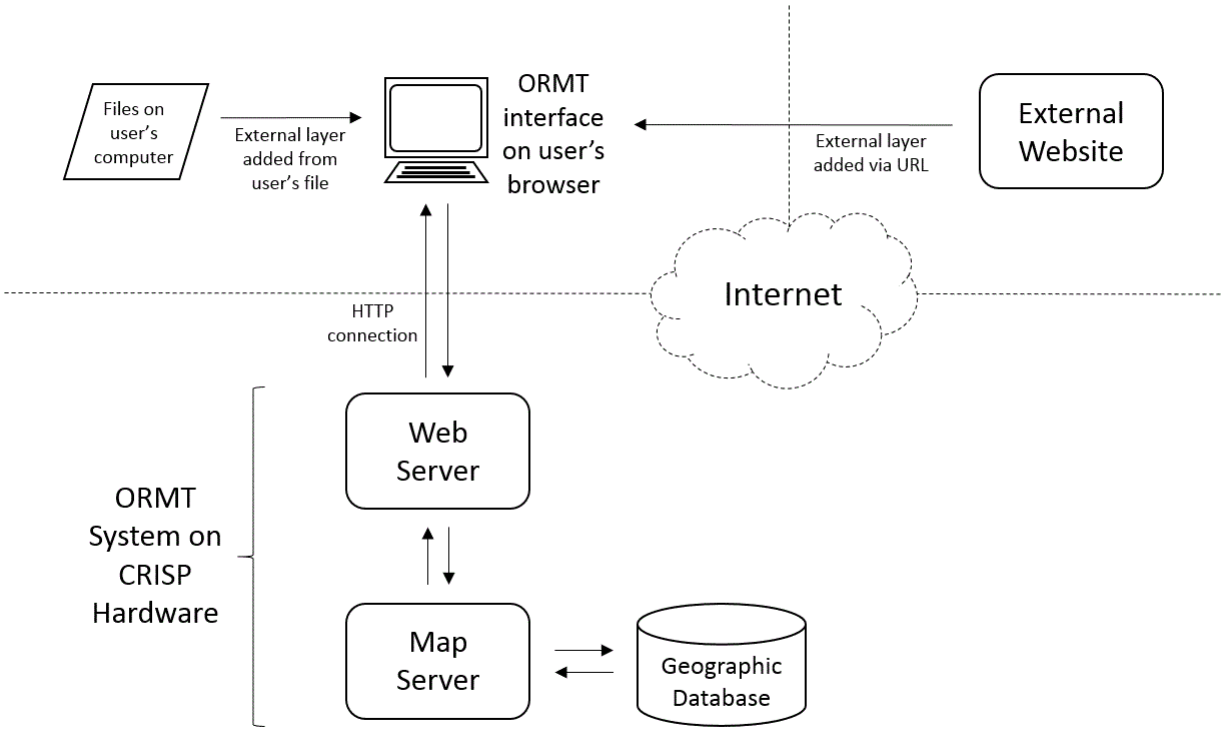

Figure 1. Outline of the ORMT system. When the user accesses the ORMT via web browser, the user interface is loaded onto the browser. Users may add external layers by specifying a URL, or by selecting a file on their computer. Datasets provided by the ORMT are stored in the geographic database and served by the map server to the user's browser via HTTP.

2.2 User Interface

Users can access the ORMT at http://ormt-crisp.nus.edu.sg through their web browser. Users will have to log in (i.e. key in a username and password) to access the ORMT. Any new user can just go through a simple and automated registration process to obtain a free account.

The main ORMT interface (Fig. 2) after logging in is arranged in a way which should be familiar to users of conventional GIS software as well as users of free web maps like Google Maps: Most of the interface is taken up by an interactive map on the right side, while a side pane on the left serves as a display for information like the available local datasets and the currently active layers, as well as a control panel for various GIS tools which the user can select.

The user can choose one or more data layers from a collection of local datasets (described in Section 3 below) and add them as GIS layers to display on the interactive map. A special feature of the ORMT is that it also allows the user to add external layers from either the web or a file on their computer (Fig. 1). The current version of ORMT supports adding zipped shapefiles from the web via a URL, or from a file. In addition, users can also add a GeoTIFF file from their computer as a layer.

The ORMT also provides a selection of GIS tools for the user. These include a Measure Tool for measuring distance and area on the map, and a Draw Tool which allows the user to draw lines and polygons on the map, as well as add text to the map.

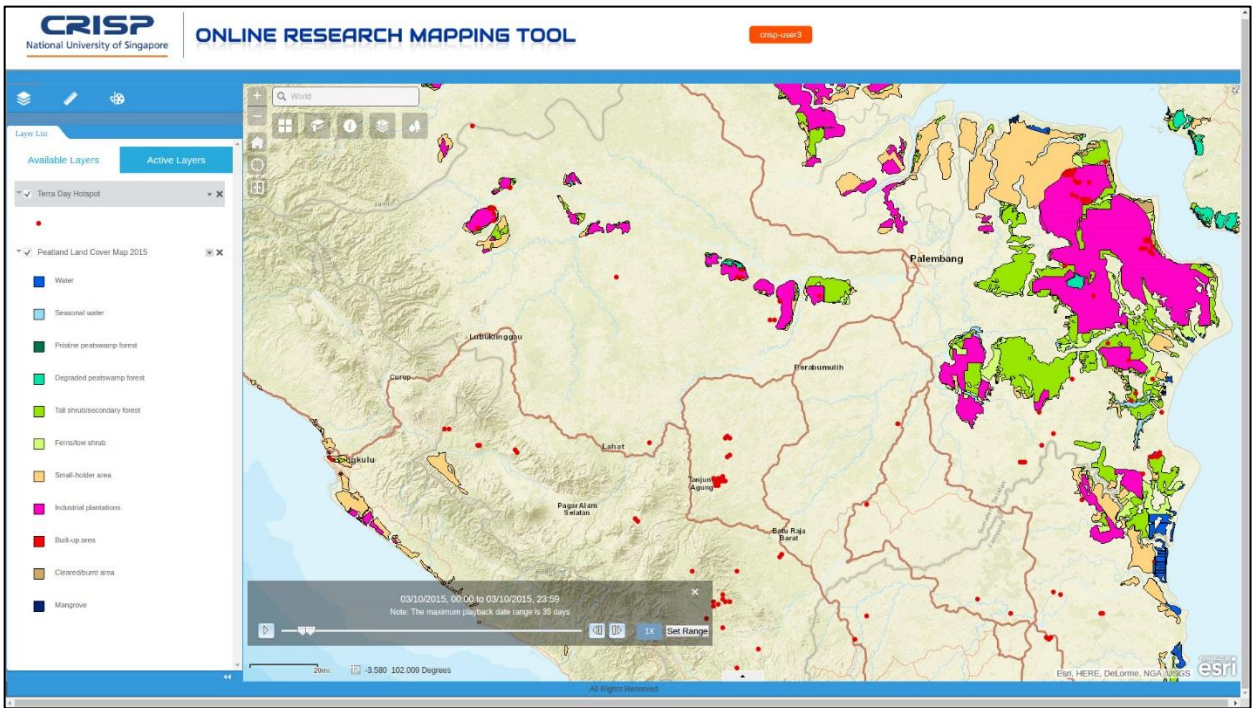

Figure 2. The ORMT user interface. This example shows overlaying of layers. The top layer shows fire hotspots captured by the Terra satellite on Oct 3, 2015 as red dots. This is overlaid on the bottom layer, which is a land cover map of peatland areas. The legend for the land cover map is opened in the side pane on the left.

3. DATA LAYERS

The local datasets served by the ORMT can be divided into two broad categories: Satellite data received and processed at CRISP, and research products generated by the research groups in CRISP.

3.1 Satellite Data

3.1.1 Processed satellite products

The satellite data available in ORMT comprise both visual imagery and also processed satellite products. An example of a satellite product which is not visual imagery is fire hotspot data. The ground station at CRISP receives direct readout broadcasts from the NASA Terra and Aqua satellites; the coverage includes most of Southeast Asia, as well as parts of India and Australia. Moderate Resolution Imaging Spectroradiometer (MODIS) data received from these satellites is run through the NASA MOD-14 algorithm to generate day and night hotspot data for each day. This data is accessible as vector layers in the ORMT; a time slider tool is provided for the user to display hotspots for a specific date, or range of dates.

3.1.2 Visual satellite imagery

The ORMT also provides a selection of visual satellite imagery of interest from satellites which are currently received at the CRISP ground station, as well as archived imagery from retired satellites which CRISP used to receive. These include images captured by IKONOS, GeoEye-1, Worldview-2 and the SPOT series of satellites. Here we describe in more detail the newest addition to the satellite data in the ORMT, namely images from the CBERS-4 satellite which are received at the ground station at CRISP.

CRISP began reception of China-Brazil Earth Resources Satellite 4 (CBERS-4) data from mid-2015. There are four instruments onboard the CBERS-4 satellite: Panchromatic and Multispectral Camera (PanMux), Multispectral Camera (MuxCam), Infrared System (IRS) and Wide-Field Imager (WFI). The PanMux, MuxCam and WFI can provide NIR/Red/Green false-colour images similar to that offered by the SPOT series of satellites. We have found this to be useful as it complements the use of SPOT satellites in CRISP's operational monitoring of vegetation fires in the region (Miettinen et. al., 2013). The CBERS-4 data provided in the ORMT show images of vegetation fires

captured by these sensors.

Of particular interest is the WFI instrument as it is currently unique in providing a wide swath width (866 km) and resolution of 64 m at nadir. This coverage and resolution afforded is intermediate between that of higher resolution imaging satellites like Landsat and SPOT on the one hand, and low resolution, wide coverage earth observing satellites like Terra and the NOAA series on the other. This characteristic is useful for observation and monitoring of large scale vegetation fires such as the ones in Indonesia in the latter half of 2015, where e.g. large fires were spread across several provinces in Sumatra; in this situation, within a single CBERS-4 WFI image, smoke plumes could be seen spread across an area that would have required several SPOT or Landsat passes to cover in full (Fig. 3).

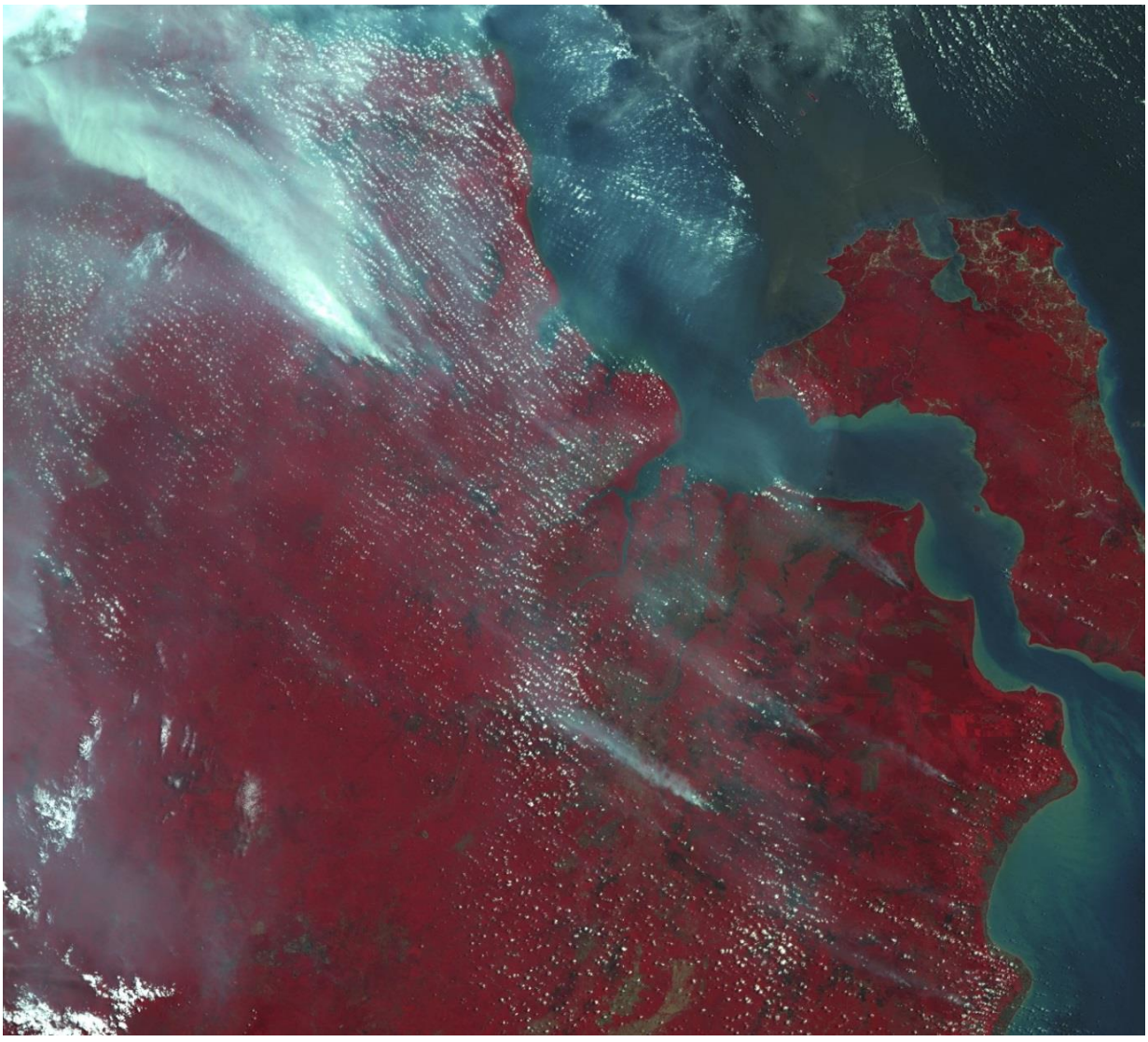

Figure 3. CBERS-4 WFI false colour (R/G/B=NIR/Red/Green) image over the northern coast of southern Sumatra. Smoke plumes can be seen carried by the wind towards the NW and WNW direction. This image, which measures about 380 km × 345 km, was cropped from a full WFI swath image which covers about 866 km in width.

3.2 CRISP Research Products

The ORMT also serves as a platform to publish research products generated by the research groups in CRISP. As an example of this we describe the land cover products available on the platform. Currently available in the ORMT platform are 1) three sets of regional 250 m resolution land cover maps covering insular Southeast Asia (for 2000, 2010 and 2015) and continental Southeast Asia (for 2015) as well as 2) peatland land cover and industrial plantation species maps for the western part of insular Southeast Asia (Peninsular Malaysia, Sumatra and Borneo) for 1990,

2007 and 2015 (land cover and industrial plantation species) plus 2000 and 2010 (only industrial plantation extent and species). Availability of the land cover information in the same platform with the other datasets (e.g. fire hotspots) enables effective visual analysis to be easily performed by combining the various datasets of interest (Fig. 2).

The regional 250 m land cover maps have been produced using MODIS surface reflectance products in combination with various auxiliary datasets (e.g. peatland maps, radar data, population density information). The classification is based on an unsupervised clustering into 100 classes, followed by visual interpretation and assignment of the original classes into five or six basic classes depending on the part of the region (Water, Forest, Regrowth/plantation, Mosaic, Open and Deciduous forest). The five or six basic classes are then further split using the auxiliary information, forming the final 12-18 land cover classes depending on the year and part of the region. Detailed description of the methodology used to produce the regional maps can be found at Miettinen et al. (2016a).

The peatland land cover and industrial plantation species maps for Peninsular Malaysia, Sumatra and Borneo have been produced by visual interpretation of Landsat (30 m) and SPOT (10-20 m) satellite data. The land cover maps include 11-13 land cover classes depending on the year, including classes e.g. for industrial plantations, small-holder dominated areas as well as pristine and degraded peat swamp forests. The industrial plantation species maps provide additional information to the land cover map through identification of the plantation species (Oil palm, Acacia or other) and by providing two additional time steps for historical analysis. The peatland land cover maps are available for years 1990, 2007 and 2015, while the industrial plantation extent and species information is available also for years 2000 and 2010. Detailed description of the methodology used to produce the peatland land cover and industrial plantation species maps can be found at Miettinen et al. (2016b).

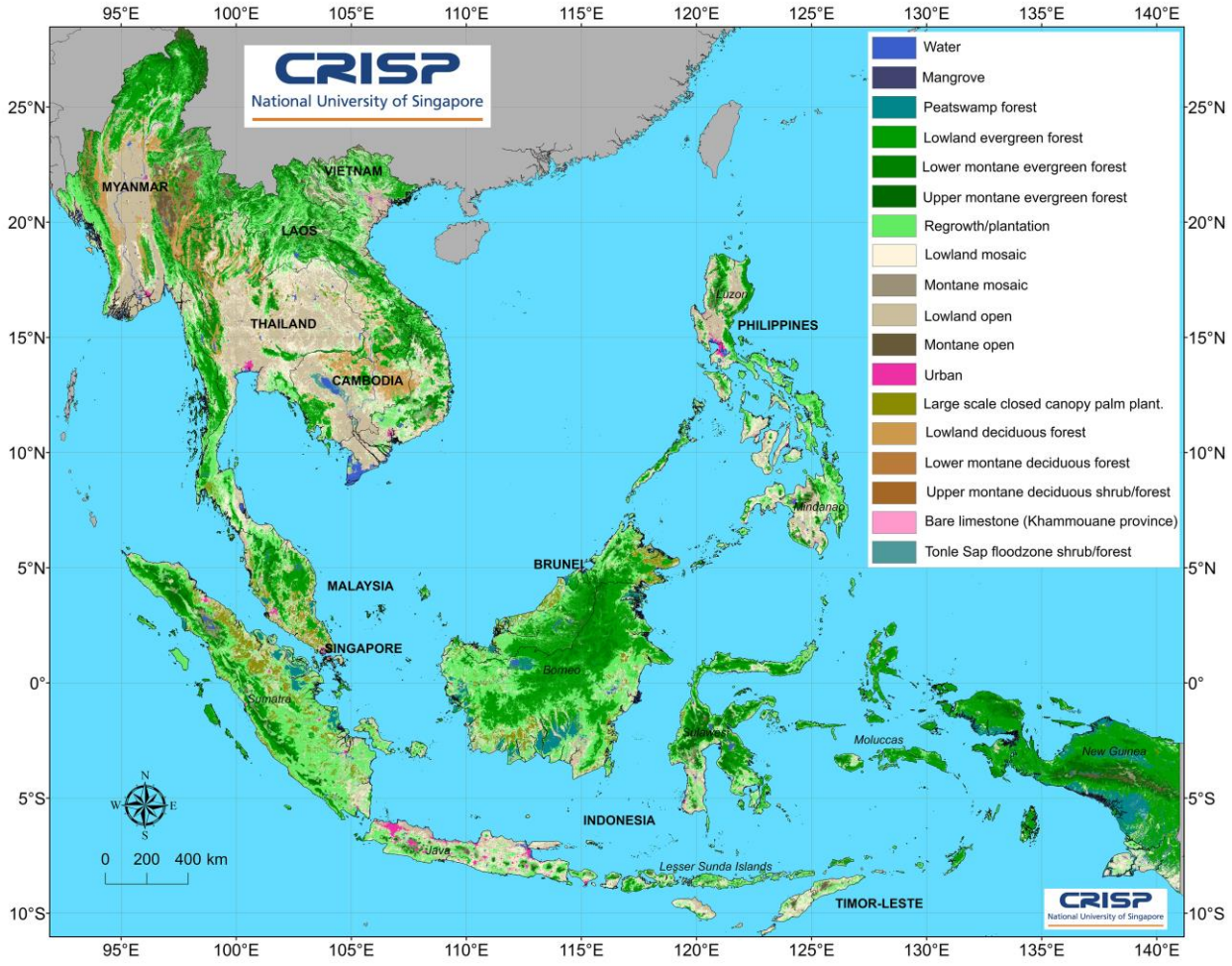

Figure 4. Regional land cover map of Southeast Asia 2015 available in ORMT, covering all Association of Southeast Asian Nations (ASEAN) countries (figure modified from Miettinen et al. 2016).

4. CONCLUSION

In this paper we have described the ORMT, a Web GIS system developed at CRISP which enables the user to access GIS functionality to overlay and interact with local data served by the ORMT, as well as the user's own data, without the need to buy or install specialized software. The only user requirement is internet access and a modern browser, which can be found on a range of desktop and laptop computers, as well as mobile devices.

The aim of the ORMT is to serve as an accessible web portal for scientists and researchers in NUS in particular, and in general anyone with web access, to interactively explore remote sensing data and other geographically referenced datasets. To this end, we intend to continue to add more interesting satellite datasets and research products, as well as develop more GIS tools to explore these data and other user data on the ORMT.

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