Fire Monitoring Service(FMS)

Project Plan

1 METHODOLOGY

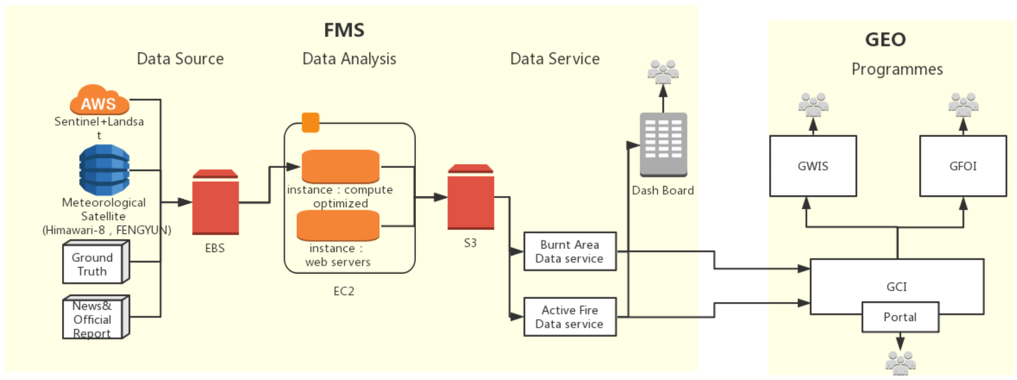

Fig 1. Projects Workflow

The design of this project (Fire Monitoring Service, FMS)consists of three parts: data source integrating, data analysis as well as data service.

1.1 Data Collection

All the data used in FMS are open-access for community future usage. Since web services will be built based on the Amazon Web Service (AWS), most of data will be accessed from AWS open-data. Here is the list of data source for those two products. The sources data will be stored in S3 for one month for user reference.

1. Burnt Area Products(global):
   a) Sentinel data from Sentinel Hub services and AWS open-datathis could be obtained directly from AWS rather than be stored in the EBS, which will occupy the storage size of EBS.
   b) Landsat from AWS open-data: this could be obtained directly from AWS rather than be stored in the EBS, which will occupy the storage size of EBS.
2. Active Fire Products

The source data of active fire products will be updated daily in the EBS individually for those two products, that is, only one day of source data will only be uploaded in EBS for processing and be replaced by the new data in the next day. Those two kind of data will be deleted after processing, leaving room for other input data.

a) Himawari-8 Satellite data from Meteorological Satellite Center of JMA. The study area of it will be east Asian, and the approximate size of it is less than 1GB for one day.

b) Fengyun Satellite data from National Satellite Data Center. The study area of it will be east Asian, and the approximate size of it is less than 1 GB for one day .

3. Ground truth data

a) Third-party products will be used in classification validation e.g. Fire_CCI products, which will be updated according to the frequency of themselves. Since the the ground truth data will be in vector format, it will be less than 1 GB. The ground truth data will be uploaded to the EBS after processing the source data, that is, the source data will no longer

b) News and government reports will also be used to assist classification, which will not updated routinely but according to the events around the world. Since the information will be stored in .txt file , the size will be smaller than 1MB.

The earth observation requirements of data is: the sources data for both burnt area products and active fire products will be the level-1 data after radiometric correction, which is highly desirable for classification.

1.2 Workflow

Sentinel and Landsat images will be directly obtained by the current AWS service and meteorological satellites images will be collected from data centers in real time. All of the source data and the ground truth data will be transferred in the EBS for computing and validation. EB2 is designed to have two instances, one is for applying algorithms to images and validation the quality, the other is for general web servers. The global burnt area data will be classified from Sentinel and Landsat images , while east Asian active fire data on meteorological satellites images. The data processing algorithms will be coded as an automatic data processing components in the EB2. All the algorithm will be the extension of existing algorithms to fit in this programme. Among them, Himawari-8 satellite and Fengyun satellite are good to monitor east Asia area in the real time. Therefore, the active fire data service in FMS will be focused on east Asia. However, the algorithm will be developed in the process to fit in global spatial scales.

Then the near-real-time products will be stored in E3 in data retrieval for developing data service. Finally, the data service will not only visualize those products based on the world map for general users, but also provide GEO GWIS system and GEO GFOI the data access through GCI (GEOSS Common infrastructure) . All the tools and data will be shared within the whole GEO community during this project without AWS services since it could be accessed through the data service itself not just the dashboard .

Additionally, end-user will not only be the scientists in the related field all around the world, but also the officials in disaster management department. On 2018, Ministry of Emergency Management of the People's Republic of China was set up to forestall and defuse serious and major risks and improve disaster relief, including wild fire management. We have actively connected with officials on this departments for involving them in co-design. Other than GWIS and GFOI, users could also have access to both FMS dashboard and GCI portal, which enhances the data utilities. FMS dashboard, which could stand alone,will be open to scientist within GEO community as well as outside of GEO community.

2 REQUIRED CREDITS

2.1 Cloud Computing Credits

According to Amazon Simple Calculator[1]the, AWS Credits Desired for Entire Project(in USD) is $58,615.56 for three years and $1,628.21 for each moth.

[1]https://calculator.s3.amazonaws.com/index.html#key=calc-15B294DE-664F-4D67-9BBD-016D461FBAB6&r=IAD

Amazon EC2 along with EBS and Amzon S3 will be used in FMS projects for both data analysis and data service development. There are wo Amazon EC2 Instance: a computed optimized one is for processing large volume of remote sensing satellites while a web servers is for developing general use of data distribution archive and visualization portal.

The meteorological satellites images, which will be stored in Amazon EBS along with the Sentinel data and Landsat Data, will be processed in EC2; then the near-real-time products will be stored in S3.

2.2 Sentinel Hub Services Credits

The main function of Sentinel Hub required in this project will be accessing to sentinel-2 and sentinel-3 data as well as Landsat5,7,8 data. Therefore, individual non-commercial use package(13.59 €/month) with the basic support of service will fulfill the needs of projects. Besides, to produce global burnt area data, the geographic region of all the data is global.

3 PROJECT FEASIBILITY

3.1 Data Support

Data sources are the basic elements to support FMS, which could be provided by current AWS service as well as the open public data. Firstly, “Open Data on AWS” program has a large amount of data varying from earth observation to disaster response, which could provide the source data (sentinel1-3,landsat,MODIS) to FMS. Besides, the existing data service supported by AWS, for instance, Sentinel Hub could also be integrated into this project to provide first-hand real-time data. Last, images from used in this study is open-access.

3.2 Algorithms

Applicants are familiar with the processing of producing fire products. The active fire products usually generated by detected using thermal infrared bands (3.6–12μm range) from coarse spatial resolution sensors[1] such as the Advanced Very High Resolution Radiometer (AVHRR), the Along Track Scanning Radiometer (ATSR), or the Moderate Resolution Imaging Spectroradiometer (MODIS)(table1). Thermal emissive power from fires is orders of magnitude more intense than from the surrounding background. Such high contrast allows active fires to be reliably detected even when the fire covers small fractions (for example <0.01%, or 1 ha of a 1 km^2 area) of the pixel.[2] For the meteorological satellites, assessment of fire at sub-pixel level for sensors[3-4]as well as The Automated Biomass Burning Algorithm (ABBA)[5-7] are usually adopted[8]. This project will adopt combined sub-pixel analysis as well as a multi-spatial resolution approach. Additionally, the generated active fire products will also be used in the burnt area products processing.

The previous method used for classifying the burnt area includes indexes classification[9], supervised classification[10], spectral analysis[11-12],regional growth[13] , time series analysis[14]. Indexes classification and supervised classification have been applied to extract global burned area based on certain vegetation indexes or the certain band combination, which cost a lot of time and efforts. The other method for thousands of real-time meteorological satellites scenes requires high computing resources ,which usually results impractical processing time in the previous study. Thanks to AWS strong computing resource, this project will adopt a combined method founded on the time series analysis of the image spectral features during fire events with relatively low processing time.

Table1. Remote Sensing System Relevant To Fire Detection And Monitoring[1]

VIS-MIR, Visible, Mid-Infrared; TIR, Thermal Infrared

Sensor and additional web resources	Temporal resolution	Spatial resolution (km)	VIS-MIR bands (µm)	TIR bands (µm)
Advanced Along Track Scanning Radiometer http://www.le.ac.uk/ph/research/eos/aatsr/	2 days	1.00	0.56, 0.66, 0.86, 1.6	3.7, 11, 12
Advanced Land Imager http://eo1.gsfc.nasa.gov/Technology/ALIhome1.htm	16 days	0.010–0.09	0.44, 0.48, 0.56, 0.64, 0.79, 0.87, 1.25, 1.65, 2.23	
Advanced Spaceborne Thermal Emission and Reflection Radiometer http://asterweb.jpl.nasa.gov/	16 days	0.015–0.09	0.56, 0.66, 0.82, 1.65, 2.17, 2.21, 2.26, 2.33, 2.34	8.3, 8.65, 9.1, 10.6, 11.3
Along Track Scanning Radiometer http://www.atsr.rl.ac.uk/	3 days	1.00	0.55, 0.67, 0.87, 1.6	3.7, 10.8, 12
Advanced Very High Resolution Radiometer http://www.nesdis.noaa.gov/	4 daily	1.10	0.63, 0.91, 1.61	3.74, 11, 12
Hot Spot Recognition Sensor System http://www.itc.nl/research/products/sensordb/getsen.aspx?name=HSRS		0.37		3.8, 8.9
Hyperion http://eo1.gsfc.nasa.gov/technology/hyperion.html	16 days	0.03	[220 bands: 0.38–2.5 µm]	
IKONOS http://www.spaceimaging.com/	3 days	0.001–0.004	0.48, 0.55, 0.67, 0.81	
Indian Remote Sensing-1A,B http://www.isro.org/	22 days	0.036–0.072	0.55, 0.65, 0.83	
Indian Remote Sensing-1B,C http://www.isro.org/	24 days	0.023–0.188		
Landsat 5, 7 http://landsat.gsfc.nasa.gov/	16 days	0.015–0.09	0.48, 0.56, 0.66, 0.85, 1.65, 2.17	11.5
Moderate Resolution Imaging Spectroradiometer http://modis.gsfc.nasa.gov/	4 daily	0.25–1.0	19 bands	16 bands
Quickbird http://directory.eoportal.org/pres_QUICKBIRD2.html	1–5 days	0.001–0.004	0.48, 0.56, 0.66, 0.83	
VEGETATION http://www.spot-vegetation.com/	1 daily	1.15	0.55, 0.65, 0.84, 1.62	

3.3 GEO Programmes

The PL of this FMS project, Dr. Yuqi Bai, has participated in the design, implementation, maintenance, and upgrade of GEOSS system since the beginning of 2007.

In particular, he was the technical lead for the Component and Service Registry (CSR)[15], which is one of the four corner stones of GEOSS. Additionally, he used to be a member of GEOSS Infrastructure Implementation Board (IIB). Currently, he is the co-chair of the GEO 2017-2019 Work programme item “Access to climate data in GEOSS” (Activity ID: 75) [2], and a member of the GEOSS-Evolve group.

Therefore, his great experience with the architecture of GEOSS will ensure a seamless integration of the resulting data services into GEOSS.

3 TIMELINE

To make sure the progress of the programme, timeline is divided to 6-moth chunks,

[2] https://www.earthobservations.org/activity.php?id=75

similar to some other programs plans . Additionally, the tasks in the consecutive chunks are continuous, like algorithm will be developed both in first chunk and second chunk, which leaves room for adjusting timeline.

Time	Task	Deliverables
2019.6.1-2019.11.31	1. Integrating current data source for all fire products 2. Data Processing Algorithm Development for burnt Area products	Burnt Area products processing components
2019.12.1-2020.05.31	1. Data Processing Algorithm Development for active fire products 2. Data distribution archive Development	Active Fire products processing components
2020.6.1-2020.11.31	1 Burnt Area data service Development 2 Burnt Area data service Test	Data distribution archive for both active fire products and Burnt Area products
2020.12.1-2021.05.31	1 Burnt Area data service Test 2 Active data service Development	Burnt Area data service
2021.6.1-2021.11.31	1 Active data service Test 2 Data visualized Dashboard Development	Active data service
2021.12.1-2022.05.31	1. Data visualized Dashboard Test 2. Projects Summary	Data visualized Dashboard, Publications

REFERENCE:

[1] Lentile, L. B. , Holden, Z. A. , Smith, A. M. S. , Falkowski, M. J. , Hudak, A. T. , & Morgan, P. , et al. (2006). Remote sensing techniques to assess active fire

characteristics and post-fire effects. International Journal of Wildland Fire, 15(3), 319.

[2] Robinson JM (1991) Fire from space: Global fire evaluation using infrared remote sensing. International Journal of Remote Sensing 12, 3–24.

[3] Dozier, J. (1981). A method for satellite identification of surface temperature fields of subpixel resolution. Remote Sensing of Environment, 11(3), 221-229.

[4] Louis, G., Jacques, D., Justice, C. O., & Kaufinan, Y. J. (2003). An enhanced contextual fire detection algorithm for modis. Remote Sensing of Environment, 87(2), 273-282.

[5] Prins, E. M., Feltz, J. M., Menzel, W. P., & Ward, D. E. (1998). An overview of goes8 diurnal fire and smoke results for scar-b and 1995 fire season in south america. Journal of Geophysical Research Atmospheres, 103(103), 31821-31835.

[6] Koltunov, A., Ustin, S. L., & Prins, E. M. (2012). On timeliness and accuracy of wildfire detection by the goes wf-abba algorithm over california during the 2006 fire season. Remote Sensing of Environment, 127(127), 194-209.

[7] Fournier, & Richard, A. . (2001). Globaland regional vegetation fire monitoring from space: planning a coordinated international effort. Canadian Journal of Remote Sensing, 27(6), 698-698.

[8] Chathura, W. , Simon, J. , Karin, R. , & Luke, W. . (2016). Development of a multi-spatial resolution approach to the surveillance of active fire lines using himawari-8. Remote Sensing, 8(11), 932-.

[9] Veraverbeke, S. , Harris, S. , & Hook, S. . (2011). Evaluating spectral indices for burned area discrimination using modis/aster (master) airborne simulator data. Remote Sensing of Environment, 115(10), 2702-2709.

[10] Shachak, A. (2011). Burnt area delineation from a uni-temporal perspective based on landsat tm imagery classification using support vector machines. International Journal of Applied Earth Observations & Geoinformation, 13(1), 70-80.

[11] Li, Z., Nadon, S., & Cihlar, J. (2000). Satellite-based detection of canadian boreal forest fires: development and application of the algorithm. International Journal of

Remote Sensing, 21(16), 3057-3069.

[12] Gong, P., Pu, R., Li, Z., & Scarborough, J. (2006). An integrated approach for wildland fire mapping in california, usa using noaa/avhrr data. Photogrammetric Engineering & Remote Sensing, 72(2), 139-150.

[13] Kempeneers, P., Sedano, F., Strobl, P., Mcinerney, D. O., & San-Miguel-Ayanz, J. (2012). Increasing robustness of postclassification change detection using time series of land cover maps. IEEE Transactions on Geoscience & Remote Sensing, 50(9), 3327-3339.

[14] Roy, D. P., Jin, Y., Lewis, P. E., & Justice, C. O. (2005). Prototyping a global algorithm for systematic fire-affected area mapping using modis time series data. Remote Sensing of Environment, 97(2), 137-162.

[15] Bai, Y., Di, L., Nebert, D. D., Chen, A., Wei, Y., Cheng, X., ... & Wang, H. (2012). GEOSS component and service registry: Design, implementation and lessons learned. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 5(6), 1678-1686.