





CENTERS FOR DISEASE CONTROL AND PREVENTION

Improving Malaria Decision Support with Earth Observations

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HAQ17-0017



Our Project



NASA Earth Observations for Health Information Systems (NEOH)



Researchers at the University of Alabama in Huntsville (UAH) in collaboration with the Centers for Disease Control and Prevention (CDC) and NASA are developing and deploying a technology for incorporating the latest NASA Earth observations for surface temperatures, precipitation, and vegetation health into the District Health Information Software 2 (DHIS2) to enhance malaria control decision making in sub-Saharan Africa.







PI:	John Beck, UAH
Co-ls:	Todd Berendes, UAH
	Udaysankar Nair, UAH
	Jeffrey Luvall, MSFC/NASA
	John Painter, CDC
Team:	Navaneeth Selvaraj, UAH
	Nelli Westercamp, CDC



Motivation



Demonstrate that integration of Earth **Observations** (Precipitation, Surface Temperatures, and Vegetation Health) with disease and health information will provide disease control decision makers with the integrated, accurate, and up-to-date situational view needed to optimize interventions.





Precipitation



NASA's Global Precipitation Measurement mission:

An international network of satellites that provide the next-generation global observations of rain and snow to advance our understanding of Earth's water and energy cycle, improve forecasting of extreme events, and provide accurate and timely information to directly benefit society.





An example of NASA's GPM IMERG daily data for Sierra Leone and the data aggregated into health districts for Sierra Leone.



Surface Temperatures



NASA's MODIS Instrument Surface Temperatures:

The Moderate Resolution Imaging Spectroradiometer (MODIS) provides Land Surface Temperatures (LST) and Emissivity daily data that are retrieved at 1km pixels by the generalized split-window algorithm and at 6km grids by the day/night algorithm.



An example of NASA's MODIS 1km derived Land Surface Temperature (LST), 2017 average for Sierra Leone.



Vegetation Health



NASA's MODIS Instrument Vegetation Index:

The Moderate Resolution Imaging Spectroradiometer (MODIS) provides vegetation indices, produced on 16-day intervals and at multiple spatial resolutions, provide consistent spatial and temporal comparisons of vegetation canopy greenness, a composite property of leaf area, chlorophyll and canopy structure.



An example of NASA's MODIS 500 m 16-day Normalized Difference Vegetation Index product, nadir view. Combines both Terra and Aqua overpass for Sierra Leone.

Performance ARL





• Start-of-Project ARL = <u>3</u> (11/16/2018)

- We estimated that the starting ARL for this project was a 3. Components of DHIS2 had been tested and validated by independent users, we conducted a simple feasibility study that assessed the potential viability of modifying the DHIS2 software and we established a proof a concept for the application, and we have a convincing case for the viability of our concept.
- Goal ARL = <mark>9</mark>
- Current ARL = 7 (08/03/2021)
 - We have completed version 1.0 of the software and Co-I Painter has successfully installed the application into a DHIS2 application instance at the CDC. The software is working as expected and Co-I Painter is evaluating against Malaria data.



Project Schedule



Project Steps by Project Year Quarter		Ye	ear 1			Ye	ear 2			Ye	ar 3	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 1 - NASA Earth Observation (EO) Data Identific	ation/Ac	quisition	and Inte	gration v	vith Distr	rict Healt	h Inform	ation Sof	tware (D	HIS2)		
Install and test DHIS2 with demonstration data	X	X	X									
Identify EO datasets, select common format, and develop												
scripts to automate the aggregation of data into DHIS2		X	X									
Health District Boundaries		~										
Create appropriate DHIS2 fields, categories, data			V		Y							
elements, etc. for EO data integration			^									
Use DHIS2 Web API and develop scripts for populating			V									
the DHIS2 database with EO data			^									
Build charts, tables, and maps for use by the CDC and			X				X					
NASA partners for testing and validation												
Phase 2 – Develop DHIS2 Plugin, Conduct NASA Data	Analysis	, and Per	form Ini	tial Deplo	oyment a	nd Testin	ıg					
Expand DHIS2 metadata object models		X	X	X	X	X	X					
Develop and deploy EO data plugin for DHIS2				X	X	X	X	X	X			
Conduct data analysis with historical data				X	X	X	X	X	X	X		
Initial deployment, evaluation, and feedback							X	X	X	X	X	
Phase 3 - Adaptation into Decision Making Activity												
Establish data sharing agreements with countries				X	X	X						
Define EO data subscriptions to support future NASA									V			
data access for users									X		X	
Assist decision makers with environmental trends for					Y							
precipitation, temperature, and vegetation						^						
Provide training, documentation, seek additional users								X				
ARL Level	3			4		5		6		7	8	9

X = Completed



Challenges and Risks



Rank	Туре*	Risk	Mitigation Action
1	PM/B/ES	Overseas travel restrictions for the foreseeable future due to COVID-19	UAH team members and the CDC are implementing alternative outreach methods to demonstrate and deploy the technology to partner countries in Africa. We plan to present the functionality of our application through the development of a demonstration video. We will need to reallocate budget dollars from materials and supplies to other categories of need such as labor.
2	РМ	Sustainability (Cloud EO Data Processing)	Opportunities such as using Open Data Cube is a possible solution for long-term sustainment for the cloud EO data processing. Other options may include integration with NASA data centers.



End User / Stakeholder Engagement



- Held several meetings with the developers of DHIS2 at the University of Oslo, Norway. They want to partner with us to establish a means to incorporate our project and web application into the core functions of DHIS2. In addition, they will help establish relationships with us and the African countries that use DHIS2.
- Submitted an abstract to the upcoming 2021 AGU Annual Conference.
- Submitted an abstract to the upcoming 2022 AMS Annual Conference.
- Accepted an invitation to give a presentation at the upcoming American Mosquito Control Association 2022 Annual Meeting.
- This program was highlighted in NASA's Applied Sciences Program during the National Mosquito Control Awareness Week 2021.
- Participated in a Video Tele-Conference (VTC) with members from the Bill and Melinda Gates Foundation with regards to Malaria elimination.



Project Details



NASA Earth Observations for Health Information Systems (NEOH)



- Cloud-based Analytical Processing Application

 Retrieve, Process, and Disseminate Earth
 Observations from NASA
- DHIS2 Web Application
 - "Earth Observations Import Tool"



NEOH Components







DHIS2 EO Import App





Datasets Precipitation	•		
Org Unit	_	Agg Period	_
	•	Daily	*
Start date		End date	
1/1/2015 01:00:01	Ē	6/30/2015 23:59:59	Ē
	Sut	omit	



DHIS2 EO Import App



NASA Earthdata Imp	rter
▲ Get Data ■ Status	NASA Earthdata Importer
	Precipitation Temperature Vegetation Start date 1/1/2015 01:00:01 End date 6/30/2015 23:59:59

Web Application Interface for the NASA Earthdata Importer for DHIS2.



DHIS2 EO Import App





l	Dataset	Status	Function	Message	Date created	View/Publish
	precipitation	working	download	GES DISC downloaded file 15 of 181	08-10-2020T17:10:16Z	
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Data Status Page NASA Earthdata Importer for DHIS2.

We implemented multiple processing



Precipitation



NASA's GPM IMERG Product

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Precipitation









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OTHER DIMENSIONS		
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OUR DIMENSIONS	22	
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Commodities	20 19.9	
Diagnosis	18.7	
@ Donor	17.9 18.1 18.2 18.1 17.4	
DS TEST CATEGORY 123	16.8	16.2
DS TEST CATEGORY 45	16	10.0
EPI/nutrition age	14.4 14.4	
Facility Ownership	14 13.9 13.6	
Facility Type		12.9 12.6
Funding Agency	12 11.2 11.5 11.3 11.1 11.5 11.3	11.9
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 Location Fixed/Outreach Location Pixed/Outreach 	4 3.6 3.9 4.2 3.6 3.0 3.0	
Location Rural/Urban	3 3 3 2 3 4 2 9 2 8 3 1 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4	
 Main data element groups 		2.1
Morbidity Age	0.5 0.54 0.7 0.85 0.61 0.37 0.78 0.62 0.78 0.58	1.2 1.1 0.54
Morbidity/Mortality		.09 0.13
PMTCT	Bo Bombali Bonthe Kailahun Kambia Kenema Koinadugu Kono Moyamba Port Loko Pujehun	Tonkolili Western Area
Pregnant/Non-pregnant	😑 January 2018 🔹 February 2018 🔹 March 2018 🛸 April 2018 🔹 May 2018 🔹 June 2018 🖕 July 2018 🔹 August 2018 🛸 September 2018 🔹 October 2018 🛸 November 2	018 🔴 December 2018
@ Project		





- Co-I Berendes developing scripts to ingest ECOSTRESS data to provide auxiliary temperature data from space.
- Co-I Luvall is providing updated ECOSTRESS data (night and day pairs) for processing into the system
- Co-I Painter currently evaluating version 1.0 and comparing demonstration Malaria data from Sierra Leone with actual data stored at the CDC.
- Co-I Nair is working on a presentation and paper. He submitted an abstract to the Health and Air Quality Team's session at the upcoming AGU Annual Conference.
 PI Beck is working on the narrative for producing a demonstration video.



Contact Information



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