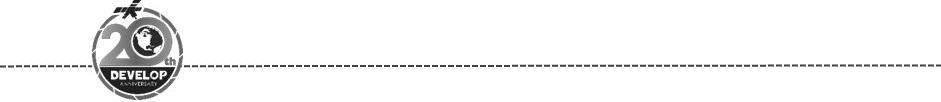
**NASA DEVELOP National Program**

**Alabama – Mobile**

*Project Summary – Summer 2018*

**New Orleans Urban Development**

*Utilizing Earth Observations to Assist Groundwork New Orleans in Reducing Flood Vulnerability in New Orleans, Louisiana, Metropolitan Area*

**VPS Title:** Going Green in the Big Easy

**Project Team**

***Project Team*:**

Rupsa Bhowmick (Project Lead), rbhowm1@lsu.edu

Lulin Zheng

Madison Murphy

Chelsea Randall

***Advisors & Mentors*:**

Joseph Spruce, Science Advisor (Science Systems & Applications, Inc.)

Dr. Kenton Ross, Science Advisor (NASA Langley Research Center)

Bernard H. Eichold II, M.D., Dr. P.H., Mentor (Mobile County Health Department)

**Project Overview**

***Project Synopsis*:** New Orleans, Louisiana is highly vulnerable to flooding due to its low elevation, substantial impervious cover, and frequent rainfall. Groundwork New Orleans (GWNO) a local nonprofit organization, is dedicated to mitigating storm water threats by planting trees, particularly in the underserved communities. This project utilized satellite imagery and remote sensing application to assess urban tree canopy cover, grey infrastructure, flood extent based on recent flood events, and the urban heat island effect. The project end results will supplement the end user’s current techniques for monitoring land cover variations and evaluating the municipal zones that have a higher exposure to surface runoff.

***Abstract*:**

Flooding in New Orleans, Louisiana has increased in intensity and frequency due to sea level rise and land subsidence. Considered one of the rainiest cities in the country, New Orleans often experiences localized street flooding, causing damages to homes and businesses. Groundwork New Orleans (GWNO) has been dedicated to increase urban resilience to flooding by implementing green infrastructure. However, the current practices for site selection and assessment implemented by GWNO are costly and time consuming. NASA and ESA Earth Observation data were acquired and used to create end products that can supplement GWNO current methods. The project utilized Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS), Sentinel-2 Multispectral Instrument (MSI), Sentinel-1 C-Band Synthetic Aperture Radar (C-SAR), and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) imagery from 2013 to 2018. Data was acquired for summer months with consideration to the Atlantic hurricane season to quantify the impact of GWNO’s tree planting campaigns and provide additional data to supplement GWNO’s current practices towards mitigating flood risk in the area. The team used remote sensing and geospatial analysis to map areas with high surface runoff and flood vulnerability. Land cover classification product and Normalized Difference Vegetation Index (NDVI) assessment were produced to monitor changes in urban tree canopy and impervious surface cover. Normalized Difference Flood Index (NDFI), Normalized Difference Flood Vegetation Index (NDFVI), along with land surface temperature was computed to create a discrete-time series analysis of flood extent along with outlining shallow water in short vegetation and monitor urban heat islands effect in flood vulnerable communities. Project end products will provide the partner with geospatial evidence of the effectiveness of the GWNO current tree-planting project for increasing the urban tree cover and improving community resilience to flooding over time.

**Keywords:**

Remote sensing, Landsat 8, Sentinel-1 C SAR, MODIS, NDVI, NDFI, green infrastructure, Land Surface Temperature (LST)

***National Application Area Addressed:*** Urban Development

***Study Location:*** New Orleans, LA

***Study Period:*** May 2013 – June 2018

***Community Concern:***

* New Orleans is vulnerable to flooding threats posed by extreme meteorological events due to the city’s low elevation and its location at the junction of the Mississippi River, Lake Pontchartrain, and the Gulf of Mexico.
* The risk of flooding is exacerbated in many heavily-populated areas in New Orleans due to low elevations that are often below sea level and dependent on water pumping stations and levees to stay dry.
* GWNO current practices are insufficient for identifying tree-planting sites with the greatest potential for flood risk mitigation.

***Project Objectives:***

* Utilize satellite imagery to:
* Identify and monitor canopy cover and gray infrastructure changes to quantify the impacts of GWNO green initiatives by assessing changes in the neighborhoods in which the organization operates.
* Produce discrete-time analysis of flood extent based on specific flood event dates (March 22, 2015; August 19, 2016; April 4, 2017; August 14, 2017; June 10, 2018), utilizing Normalized Difference Flood Index (NDFI) and report shallow water in short vegetation utilizing Normalized Difference Flood Vegetation Index (NDFVI) index to generate flood risk assessment mapping products.
* Monitor land surface temperature to determine urban heat island effects on municipal zones with high exposure to surface runoff.
* Provide GWNO with:
* Webinars incorporating the methodology to create the end products to educate GWNO in GIS and remote sensing applications.
* Geospatial data for use as promotional and educational materials

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Groundwork USA, Groundwork New Orleans** | Alicia Neal, Executive Director | End User | Yes |

***Decision Making Practices & Policies***:

Currently, GWNO collects *in situ* data to assist in site selection for tree planting campaigns, which can be costly and time-consuming. GWNO also conducts risk-mitigation projects including construction of rain gardens and bioswales, tree plantings, and other community beautification and restoration techniques. GWNO also provides storm water survey information to residents to determine what green infrastructure is most efficient in their communities.

***Project Benefit to End User***:

The project methodologies and end products will contribute to GWNO’s current techniques for mapping tree coverage and provide additional methods for generating flood maps and determining the areas with higher exposure to storm surface runoff in the underserved communities of the New Orleans metropolitan area. The partner will be able to use the end results to better understand how their current tree-planting project has mitigated the storm water threats and to disseminate the information to the public to enhance the communities’ awareness of these issues. Additionally, the GWNO Green Team will receive webinar trainings and will contribute to project deliverables to build their capacity in remote sensing and GIS applications.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI/TIRS** | Land Cover Classifications, NDVI, Land Surface Temperature | Landsat 8 OLI data were used to derive land cover products to identify low urban tree coverage, compute canopy variations over time, and map municipal zones with higher exposure to surface runoff. Landsat 8 TIRS data were utilized to monitor urban heat islands and their effect on neighborhoods with history of flooding. |
| **Sentinel-2 MSI** | Land Cover Classification, NDVI | Sentinel-2 MSI data from the European Space Agency (ESA) were used to derive land cover products to identify low urban tree coverage, compute canopy variations over time, and mapping municipal zones with higher exposure to surface runoff at a higher resolution. |
| **Sentinel-1 C-SAR** | NDFI, NDFVI | Sentinel-1 C-SAR data from the ESA were used to compute NDFI and NDFVI index to create flood maps for conducting a time series analysis of storm water trends and for aiding flood risk assessment. |
| **Terra MODIS** | Land Surface Temperature | Terra MODIS MOD11A1 and MOD11A2 data from the LP DAAC were used to validate the land surface temperature product derived from Landsat 8 TIRS |

***Ancillary Datasets:***

National Agricultural Imagery Program (NAIP) County Mosaic – the high resolution (1m) aerial imagery from 2013 and 2017 will be used to create the reference training points for accuracy analysis of the land cover classification product.

***Software & Scripting:***

QGIS 2.18.20 – raster manipulation, land cover maps compilation, flood maps creation, and geo spatial data visualization

Esri ArcGIS Pro 2.0.1– raster manipulation, map product generation, and image classification development

ESA SNAP toolbox 6 – radar data pre-processing.

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Urban Tree Canopy Assessment** | Landsat 8 OLI and Sentinel-2 MSI | The Urban Tree Canopy Assessment products will allow end user to identify areas with low tree coverage, provide an estimate of the area of tree canopy variations over the study period, and to provide further information on to what degree their current tree planting project has reduced flood vulnerability within the city. | N/A |
| **Gray Infrastructure and Impervious Surface Cover Analysis** | Landsat 8 OLI and Sentinel-2 MSI | The partner will be able to utilize this product to determine civic zones with higher risk to surface runoff and flooding based on impervious land cover. Additionally, the product will provide an annual analysis of urban expansion in the region to understand the land cover modification to grey infrastructure. | N/A |
| **Flood Extent Analysis** | Sentinel-1 C SAR | This product will provide a series of storm water surface coverage suitability maps and flood classification maps to allow partner to expand their current techniques in detecting the flooded lands, shallow water in short vegetation lands and to mitigate the flood risk for future practices. | N/A |
| **Surface Heat Assessment** | Landsat 8 TIRS | The surface heat assessment will deliver annual and seasonal analysis of surface temperature of urban areas. This will help to aid the partner’s current techniques in understanding the impacts of land surface temperature on communities and storm water threats. The result will demonstrate the correlation between urban cover areas and surface temperature over time. | N/A |

**Project Handoff Package**

**Transition Plan:**

The team met with representatives from GWNO throughout the term to provide 3 webinar-based tutorials to explain each end-product and the methodologies involved on June 28, July 5, and July 12, 2018. The DEVELOP team met with GWNO for a project hand-off where additional methodology explanations and map products were presented. All deliverables created by the team were shared with the partner through a shared Google Drive folder.

**Team POC:** Rupsa Bhowmick, rbhowm1@lsu.edu

**Partner POC**: Alicia Neal, Alicia@groundworknola.org

**Handoff Package:**

* Technical Paper
* Poster
* Presentation
* Project Video
* Tutorial
* Urban Tree Canopy Cover Assessment
* Surface Heat Assessment
* Gray Infrastructure and Impervious Surface Cover Analysis
* Flood Extent Analysis

**References:**

Cian, F., Marconcini, M., & Ceccato, P. (2018). Normalized Difference Flood Index for rapid flood mapping: Taking advantage of EO big data. *Remote Sensing of Environment, 209*, 712-730. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0034425718300993>

Jiménez-Muñoz, J. C., Sobrino, J. A., Skoković, D., Mattar, C., & Cristóbal, J. (2014). Land surface temperature retrieval methods from Landsat-8 thermal infrared sensor data. *IEEE Geoscience and Remote Sensing Letters, 11*(10), 1840-1843. Retrieved from <https://ieeexplore.ieee.org/abstract/document/6784508/?reload=true>

Rufat, S., Tate, E., Burton, C.G., & Maroof, A.S. (2015). Social vulnerability to floods: Review of case studies and implications for measurements. *International Journal of Disaster Risk Reduction, 14(4),* 470-486. Retrieved from<https://www.sciencedirect.com/science/article/pii/S2212420915300935>

Sobrino, J. A., El Kharraz, J., & Li, Z. L. (2003). Surface temperature and water vapour retrieval from MODIS data. *International Journal of Remote Sensing, 24*(24), 5161-5182. Retrieved from <https://pdfs.semanticscholar.org/bd22/e52e587c582cda7ec2cf76a21092964580ac.pdf>

Sobrino, J. A., Jiménez-Muñoz, J. C., & Paolini, L. (2004). Land surface temperature retrieval from LANDSAT TM 5. *Remote Sensing of Environment, 90*(4), 434-440. Retrieved from ftp://[atmosfera.cl/pub/elias/Paula/2004\_Sobrino\_RSE.pdf](http://atmosfera.cl/pub/elias/Paula/2004_Sobrino_RSE.pdf)

U.S. Census Bureau (2016). Population data, city of New Orleans. Retrieved from: <https://www.census.gov/quickfacts/fact/table/neworleanscitylouisiana/PST045216>

Vatseva R., Kopecka, M., Otahel, J., Rosina, K., Kitev, & A., Genchev, S. (2016). In Bandrova, T. & Konecny, M. *Mapping Urban Green Spaces Based on Remote Sensing Data: Case Studies in Bulgaria and Slovakia*. Paper presented at The 6th International Conference on Cartography and GIS, Albena, Bulgaria (569-578). Retrieved from <https://cartography-gis.com/docsbca/iccgis2016/ICCGIS2016-58.pdf>