**NASA DEVELOP National Program**

North Central Climate Center, Fort Collins, CO

**Fall 2013**

**Colorado Water Resources**

*Utilizing Landsat 8 to Assess Impacts of the Historic 2013 Flooding in Colorado’s Northern Front Range*

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**Applied Sciences National Applications Addressed:**

Water Resources, Disasters

**Study Area:** Northern Front Range, Colorado

**Study Period:** Aug 2013 - Sep 2013

**Community Concerns**

* What is the total extent and area of the flood that destroyed 1,800 homes and damaged more than 16,000 others, resulting in an estimated $2 billion in property damage? (Disaster response, damage estimation, and recovery planning)
* Do FEMA’s and local government’s existing flood hazard data accurately depict floodplain boundaries observed in this historic event?
* How have river channels changed as a result of the floods? How will this affect future risk assessment, zoning, and hazard mapping?
* What downstream effects might there be on both the environment and the state’s $40 billion agriculture industry?

**80-100 Word Blurb**

In the aftermath of recent and devastating flooding along the Colorado Front Range, the Colorado Water Resources team worked to observe and assess the damage caused by these historic flood waters. Employing a combination of remote sensing techniques and GIS data, the team used Landsat 8 imagery taken before and during the floods to calculate the total inundated area and delineate flood extent. This extent was then used to assess the region’s existing FEMA flood maps. The resultant products will be utilized in recovery and mitigation planning across the Front Range.

**Abstract**

On September 12, 2013, tropical moisture drawn north from Mexico by a low-pressure system blew up into the Rocky Mountains and began to release its contents over the Colorado Front Range. Over the next five days, over 17 inches of rain fell in some areas, flooding 17 counties and over 2,000 square miles of land. Eight lives were lost, and thousands of others were displaced or stranded as damage to 200 miles of roadways and 50 bridges cut off access to numerous residential areas. The flood waters destroyed 1,800 homes and damaged more than 16,000 others, resulting in an estimated $2 billion in property damage both to residential and commercial properties. In addition to the effects of Colorado’s infrastructure, the state’s $40 billion agriculture industry has seen many of its fields inundated, and there are now increasing concerns over environmental and public health in the face of groundwater contamination. Utilizing a combination of remote sensing techniques and GIS data, the Fort Collins Water Resources team employed Landsat 8 imagery taken before and during the floods to calculate total inundated area and delineate flood extent. This data was then used to assess pre-existing flood hazard maps of the area. The resulting maps from this project will be delivered to local governments, land managers, and researchers as they work to better understand this historic event and plan for recovery throughout the region.

**Partners/Collaborators**

Partner 1: Department of Ecosystem Science and Sustainability and the Geospatial Centroid, CSU: Melinda Laituri

Partner 2: Department of Ecosystem Science and Sustainability, CSU: Stephanie Kampf

Partner 3: City of Fort Collins GIS: Doug Cain

**Current Management Practices & Policies**

Numerous efforts are taking place to respond to the recent Colorado flooding, including aerial and ground surveys and assessment of river gauge data. However, at this time, there is not a map available detailing the extent of the flooding during or near peak flow. Government organizations, private industries, and affected citizens have great interest in a product detailing flood extent to better assess damage to buildings, roads, and lands, as well as to better understand the magnitude of the flooding event.

**Benefit to End-User:**

* Final products allow for improved risk assessment of flood damage, including roads, buildings, and agricultural or open lands
* This project contributes information about the current flooding which allows for better mitigation against future flooding
* Flood extent and damage assessment allow more effective and timely post-flood recovery efforts

**Decision Support Tools**

* Maps detailing flooding extent and area.
* New datasets depicting locations of future risk for flooding
* Flood extent in relation to previous floodplain assessments
* Maps identifying changes to the river’s course and floodplain

**Earth Observations & Parameters**

Landsat 8, OLI - Modified Normalized Difference Water Index (MNDWI)

**Future Applicable NASA Missions**

Aqua/Terra: MODIS – Near Infrared Bands

Soil Moisture Active Passive (SMAP) - Terrestrial soil moisture

Surface Water and Ocean Topography Spacecraft (SWOT) - Surface water

**Ancillary Datasets Utilized**

* FEMA DFIRM flood plain data:
  + *Counties:* Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Elbert, Fremont, Jefferson, Larimer, Weld
* National Hydrography Dataset (NHD) – Colorado Decision Support Systems
* Esri Satellite Imagery (ArcGIS 10.1 Basemap)

**Software Utilized**

Esri ArcGIS 10.1 – geoprocessing, change detection, overlay analysis, map creation

Exelis VIS ENVI 5.0 software – Landsat 8 calibration

**Imagery & Captions**

Figure 1: Modified Normalized Water Index (MNDWI) from pre-flood (left) and during-flood (right) over section of the Colorado Front Range. White pixels indicate water. MNDWI derived from Landsat 8 OLI. Path/Row: 34/32. Image dates: 08/16/13 (pre), 09/17/13 (during).

