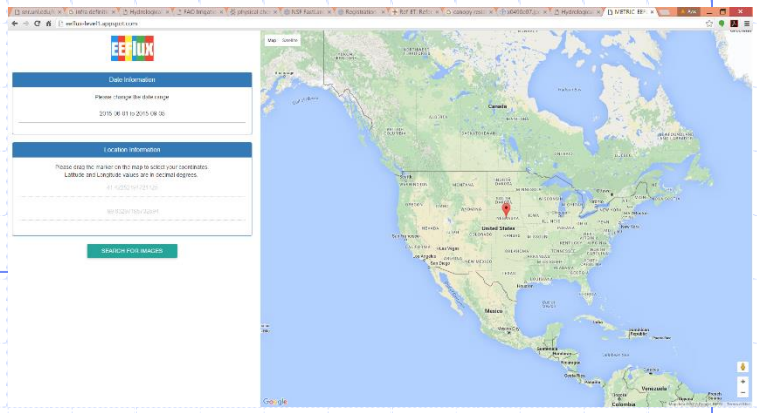
Google Earth Engine Evapotranspiration Flux --- EEFlux

&

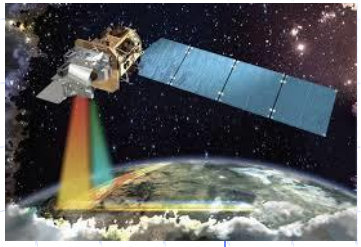
Residential Water Use --- --- GEARUP

Ayse Kilic, University of Nebraska-Lincoln

University of Nebraska Lincoln



Google Earth Engine Evapotranspiration Flux --- EEFlux



Ayse Kilic, University of Nebraska-Lincoln

Rick Allen, University of Idaho

Justin Huntington, Desert Research Institute

Members of the Landsat Science Team

Doruk Ozturk, University of Nebraska-Lincoln

WHAT IS EEFlux?

- Earth Engine Evapotranspiration Flux
- Began in 2012
- Uses the METRIC ET process (thermally-driven energy balance) as foundation
- Operates on the Google Earth Engine and Computational Cloud
- Automated operation and calibration

Current Stakeholders/Testers

- **Metropolitan Water District of Southern California**
  - Conversion of Residential Turf to Artificial Turf
  - Transfer of Agricultural Water to Cities
  - Linking EEFlux to GEARUP for NAIP 1m Scale ET
- **California Water Resources Control Board**
  - Monitoring of Ground-water Depletion
  - Regulation for Sustained Use
- **World Bank - Tamil Nadu**
  - Pre- and Post- Investment assessments
  - Demonstration of Rapid Response with EEFlux to Support Water Consumption Assessments
- **Flatwater Group, Lincoln, NE**
  - Platte River Irrigation Management and Modeling

METRIC/EEFLUX TRAINING at UC DAVIS, CA

Sponsor: CALIFORNIA DEPARTMENT OF WATER RESOURCES

(27 PARTICIPANTS – 4 days)

Sept 8-14, 2015 and August 22-25, 2016

Nebraska UNIVERSITY OF Lincoln

Google

METRIC/EEFLUX TRAINING at Los Angeles, CA

Sponsor: Metropolitan Water District of Southern California

(10 PARTICIPANTS – 4 days)

- Monitoring Impacts of Conversion of Residential Turf to Artificial Turf on Water Conservation
- Transfer of Agricultural Water to Cities
- Linking EEFlux to GEARUP for NAIP 1m Scale ET

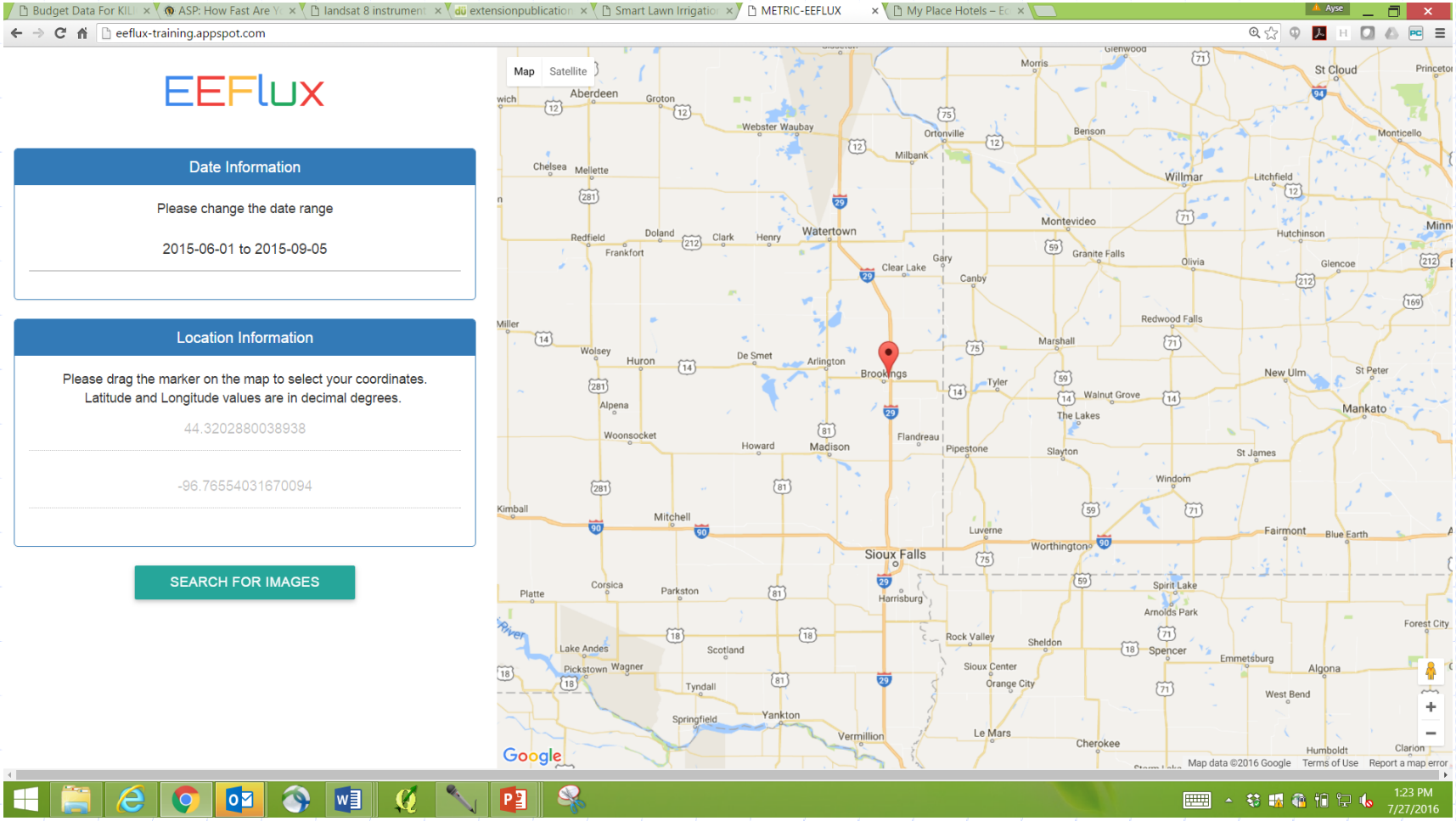
May 10-13, 2016

University of Nebraska Lincoln

Google

Google Earth Engine Evapotranspiration Flux --- EEFlux

http://eeflux-level1.appspot.com/

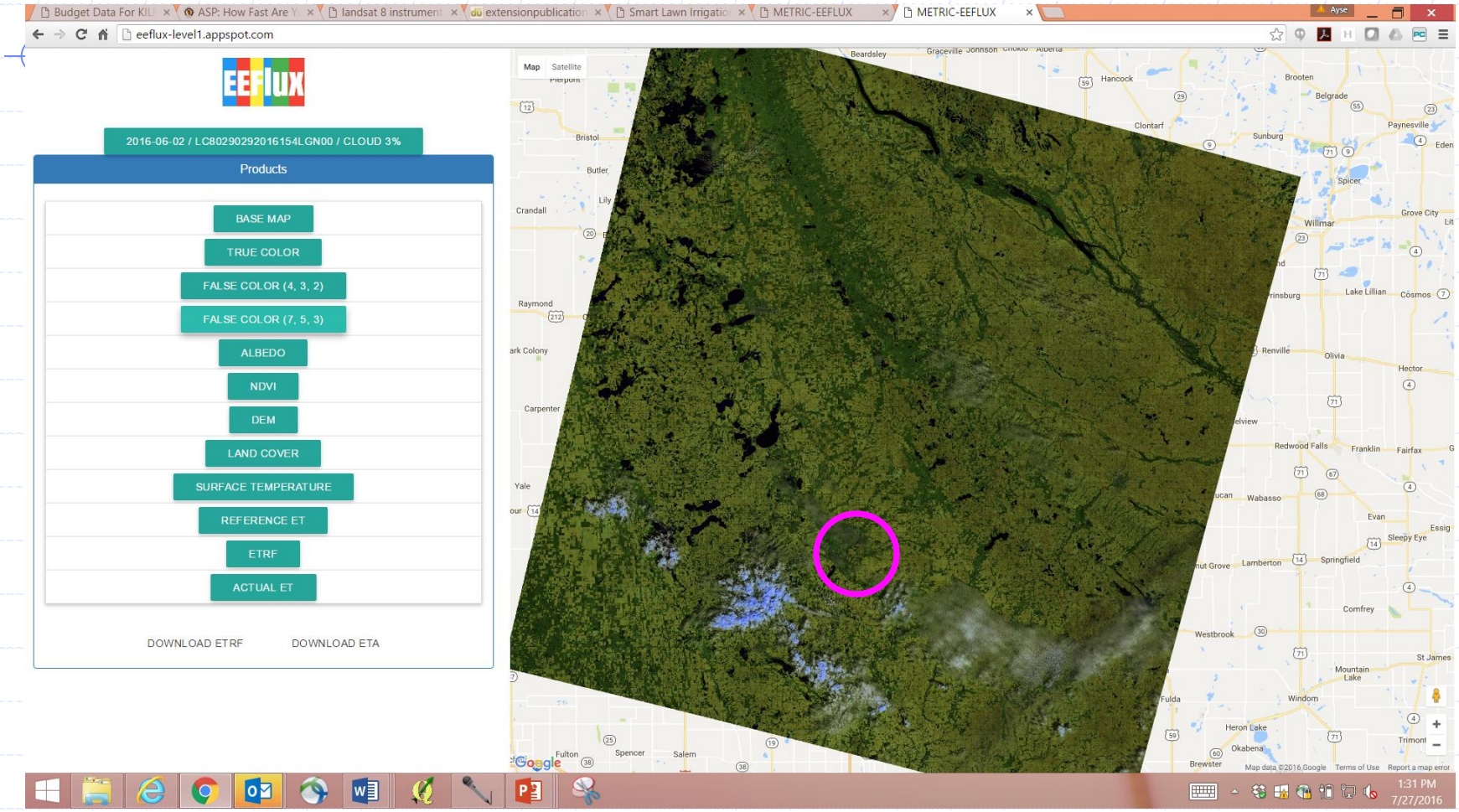


Path 29/Row 20- June 2/2016

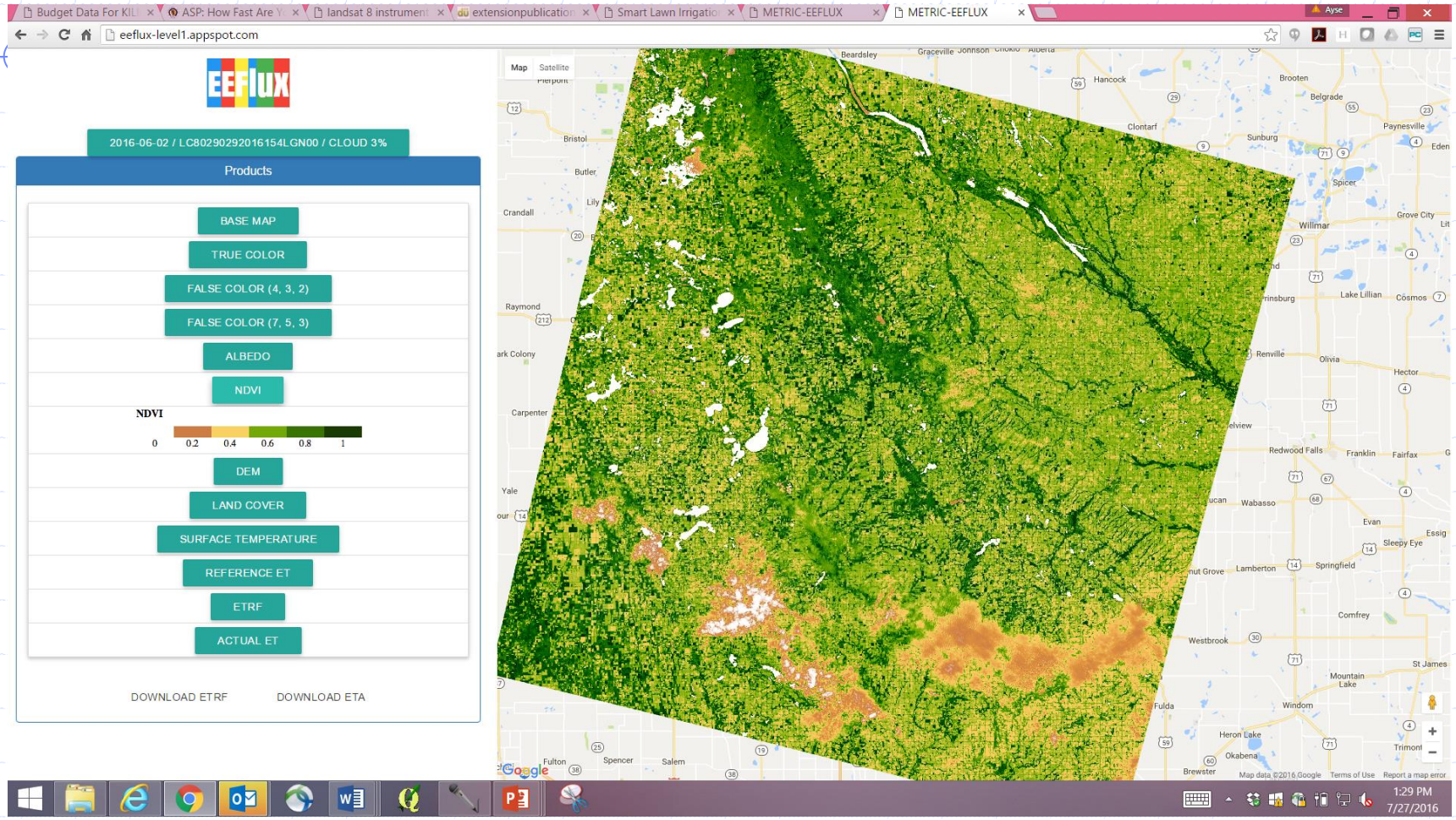
University of Nebraska Lincoln

Google

Path 29/Row 20- June 2/2016
7,5,3 False Color



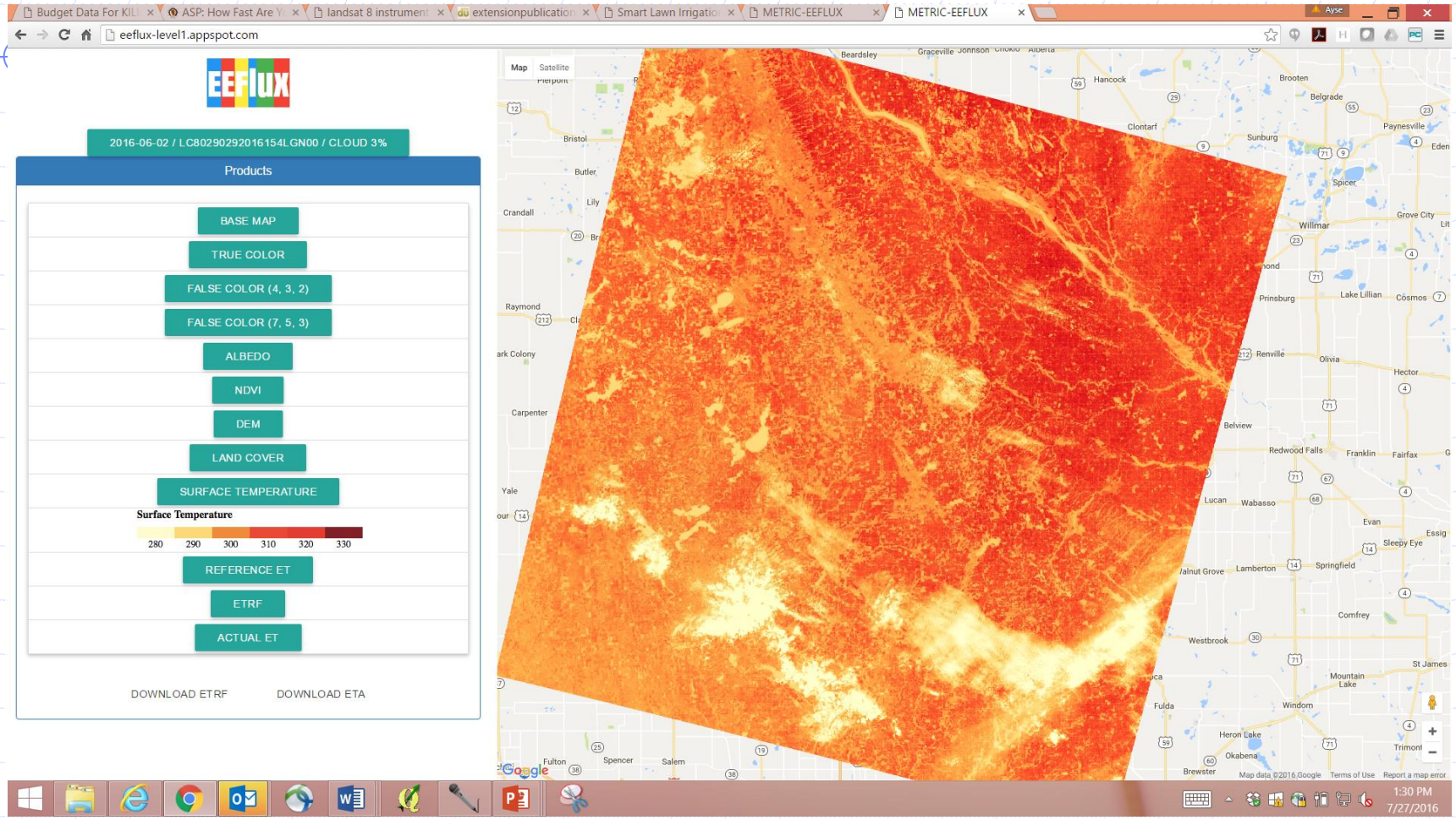
Path 29/Row 20- June 2/2016
NDVI Map



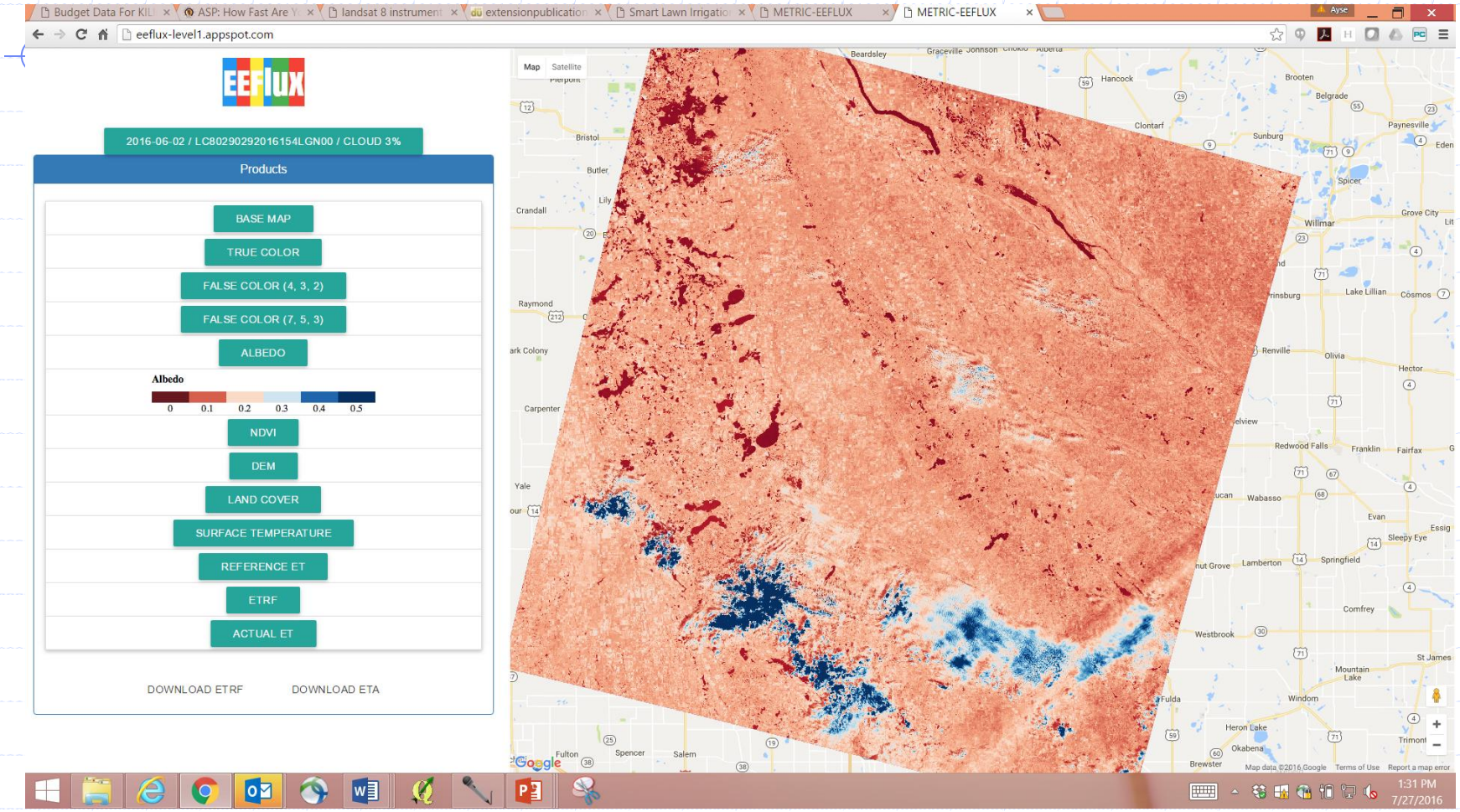
University of Nebraska Lincoln

Google

Path 29/Row 20- June 2/2016
Surface Temperature (ºK)



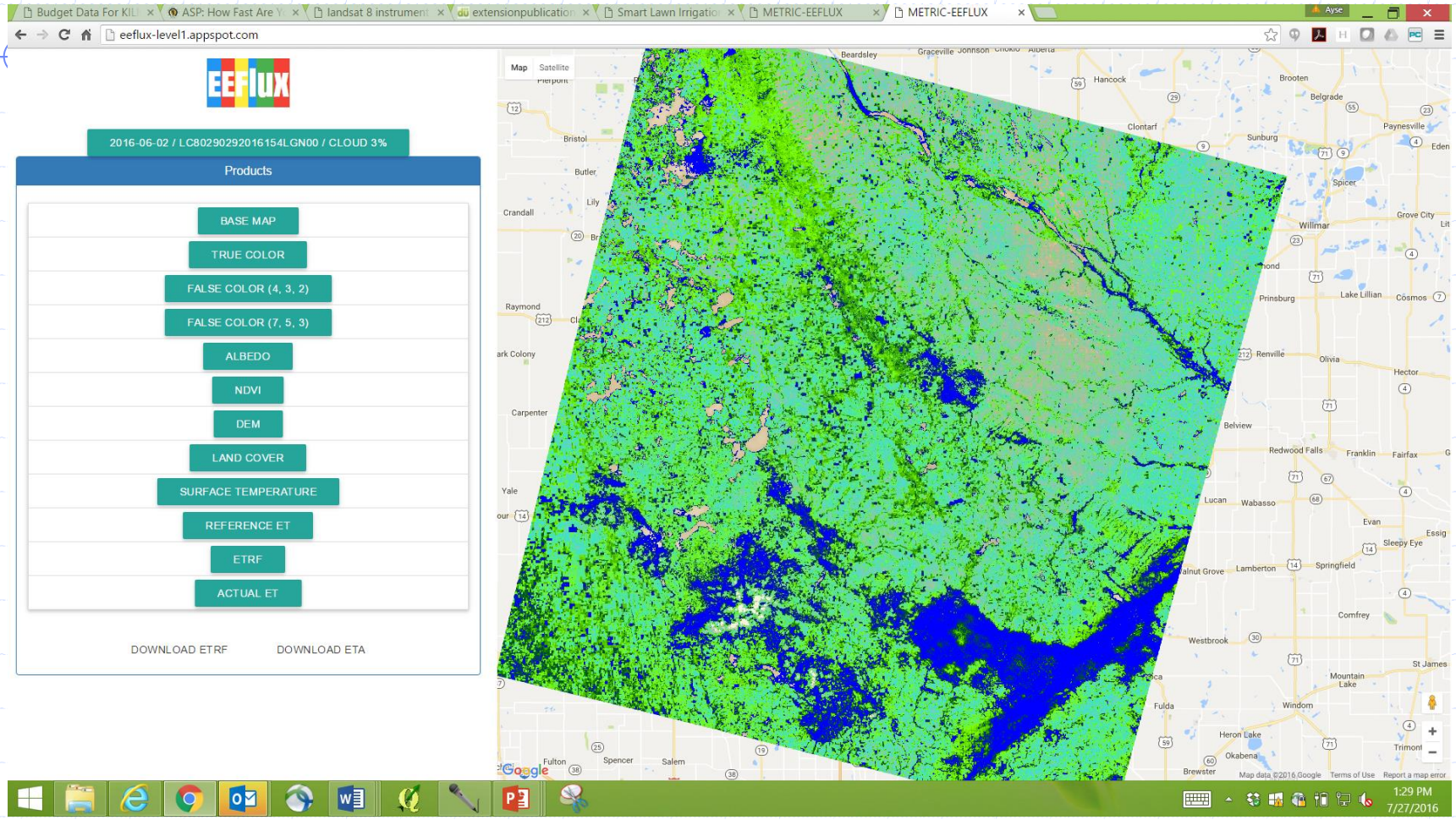
Path 29/Row 20- June 2/2016
Albedo



University of Nebraska Lincoln

Google

Path 29/Row 20- June 2/2016
Evapotranspiration

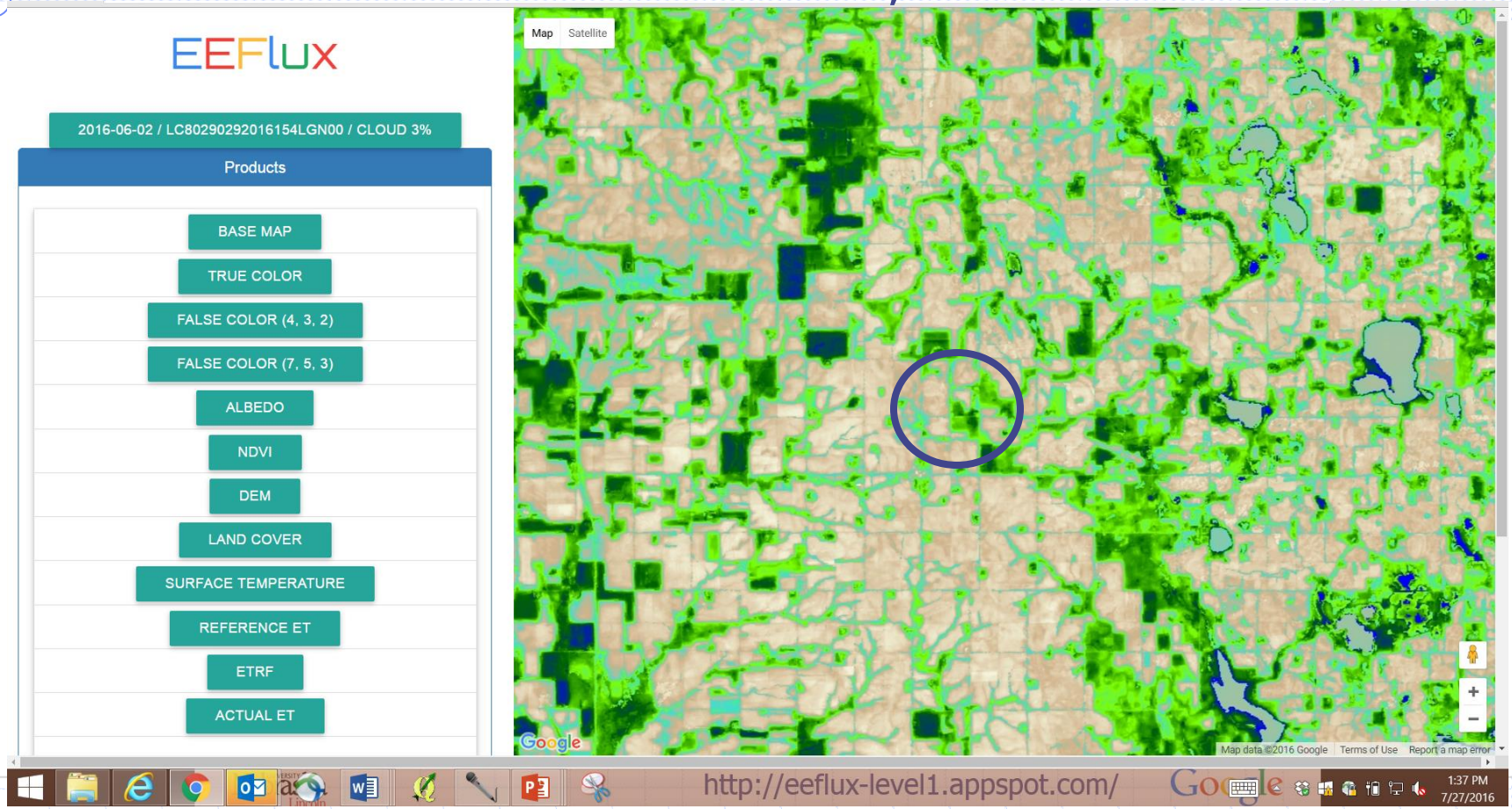


Google Earth Engine

Landsat 8 – June 2, 2016

Evapotranspiration Flux --- EEFlux

Toronto, South Dakota



http://eeflux-level1.appspot.com/

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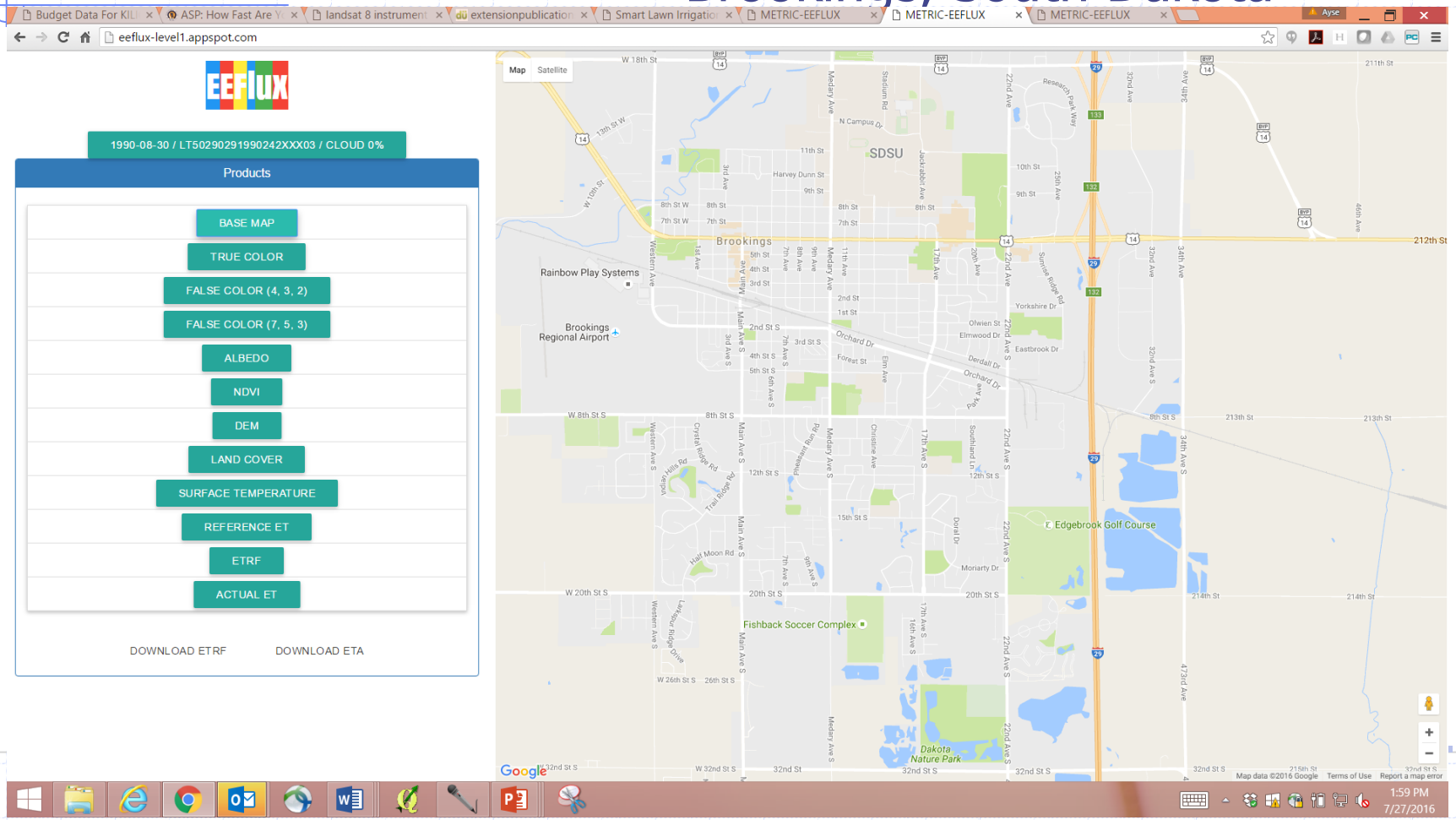
Google

Google Earth Engine Landsat Sequence, 1990-2015

Evapotranspiration Flux --- EEFlux

Brookings, South Dakota



http://eeflux-level1.appspot.com/

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Google

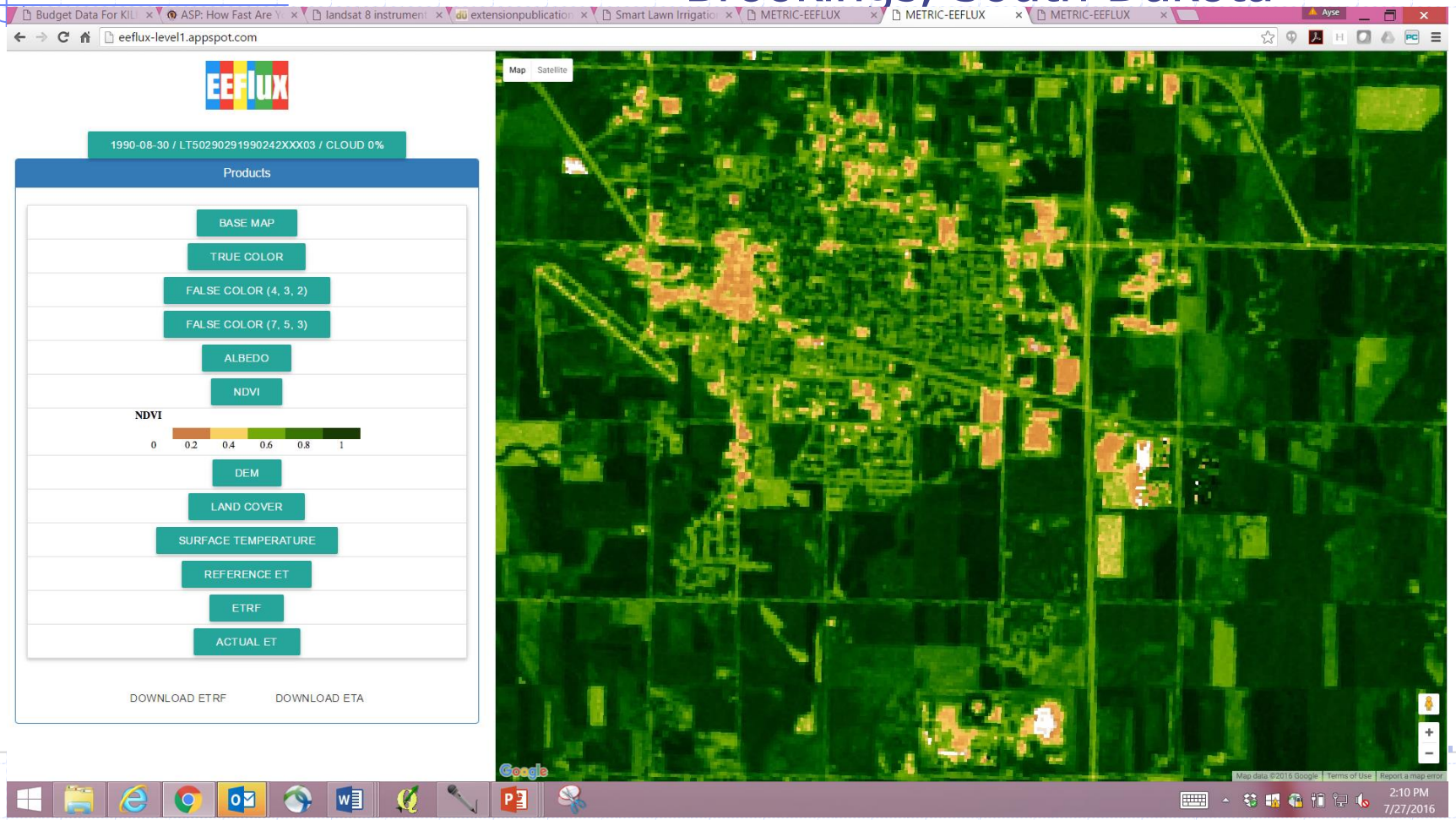
Google Earth Engine

Landsat 5 – August 30, 1990

Evapotranspiration Flux --- EEFlux

NDVI

Brookings, South Dakota



http://eeflux-level1.appspot.com/

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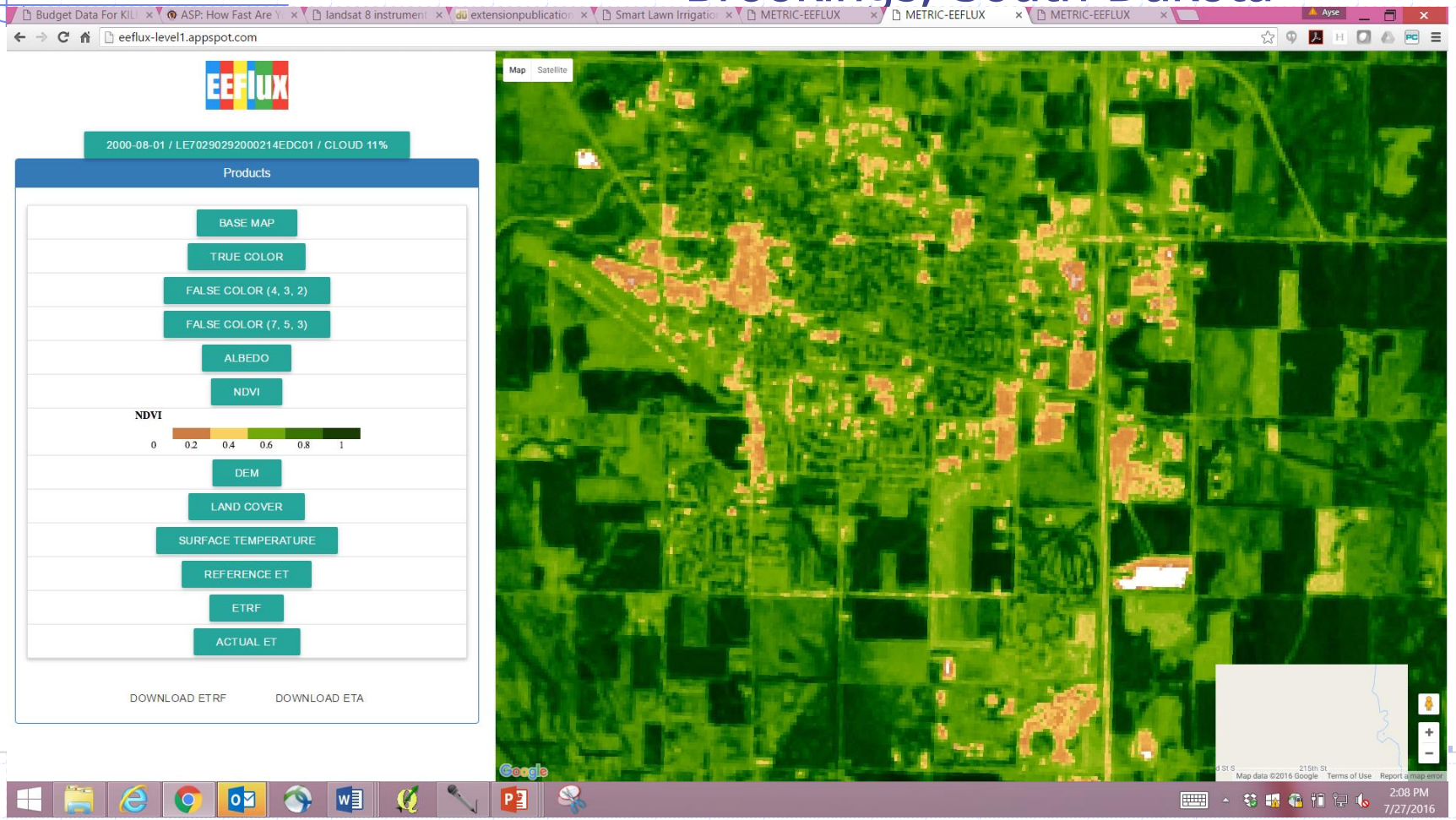
Google Earth Engine

Landsat 7 – August 01, 2000

Evapotranspiration Flux --- EEFlux

NDVI

Brookings, South Dakota



http://eeflux-level1.appspot.com/

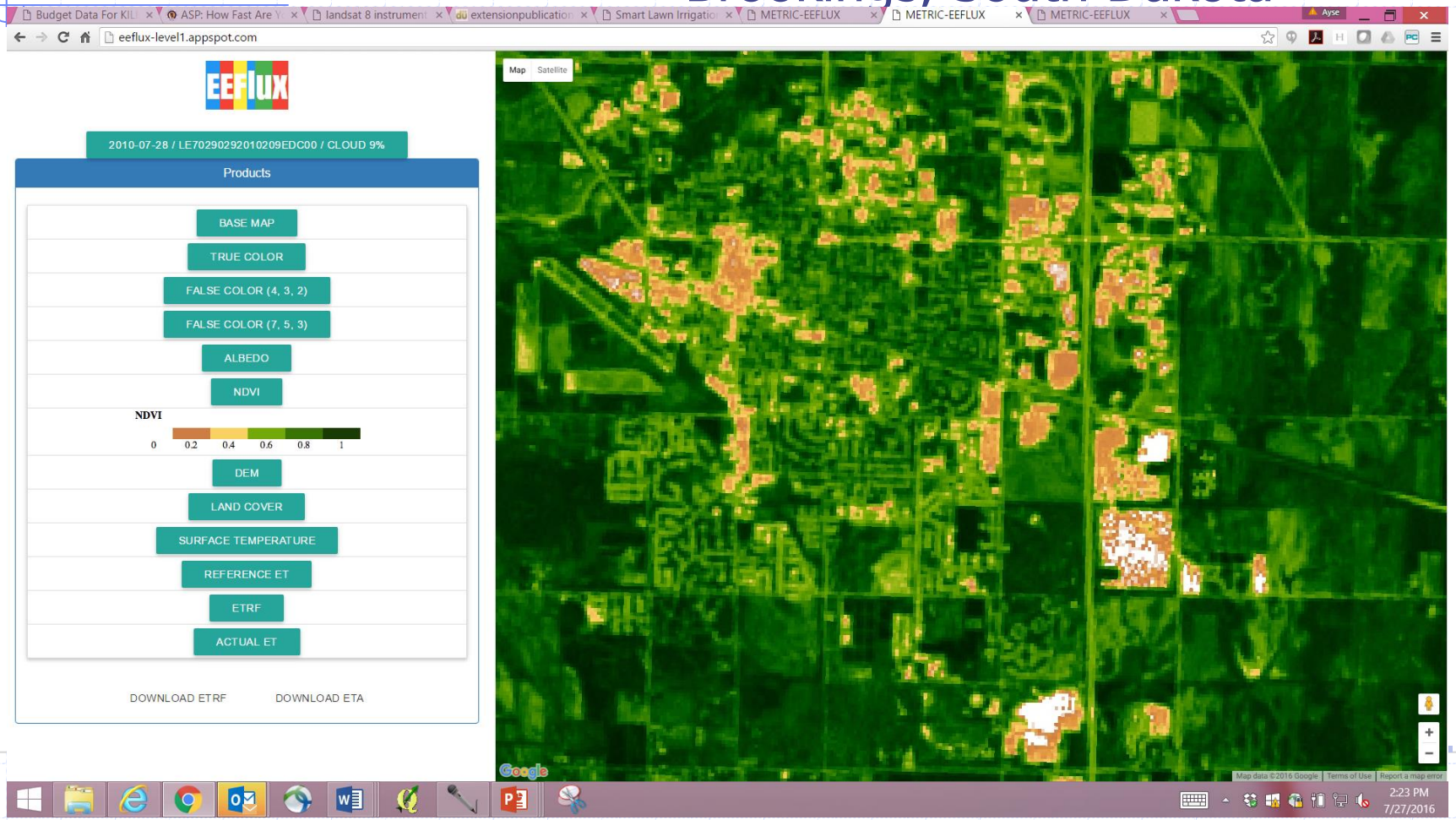
Google Earth Engine

Landsat 7 – July 28, 2010

Evapotranspiration Flux --- EEFlux

NDVI

Brookings, South Dakota



http://eeflux-level1.appspot.com/

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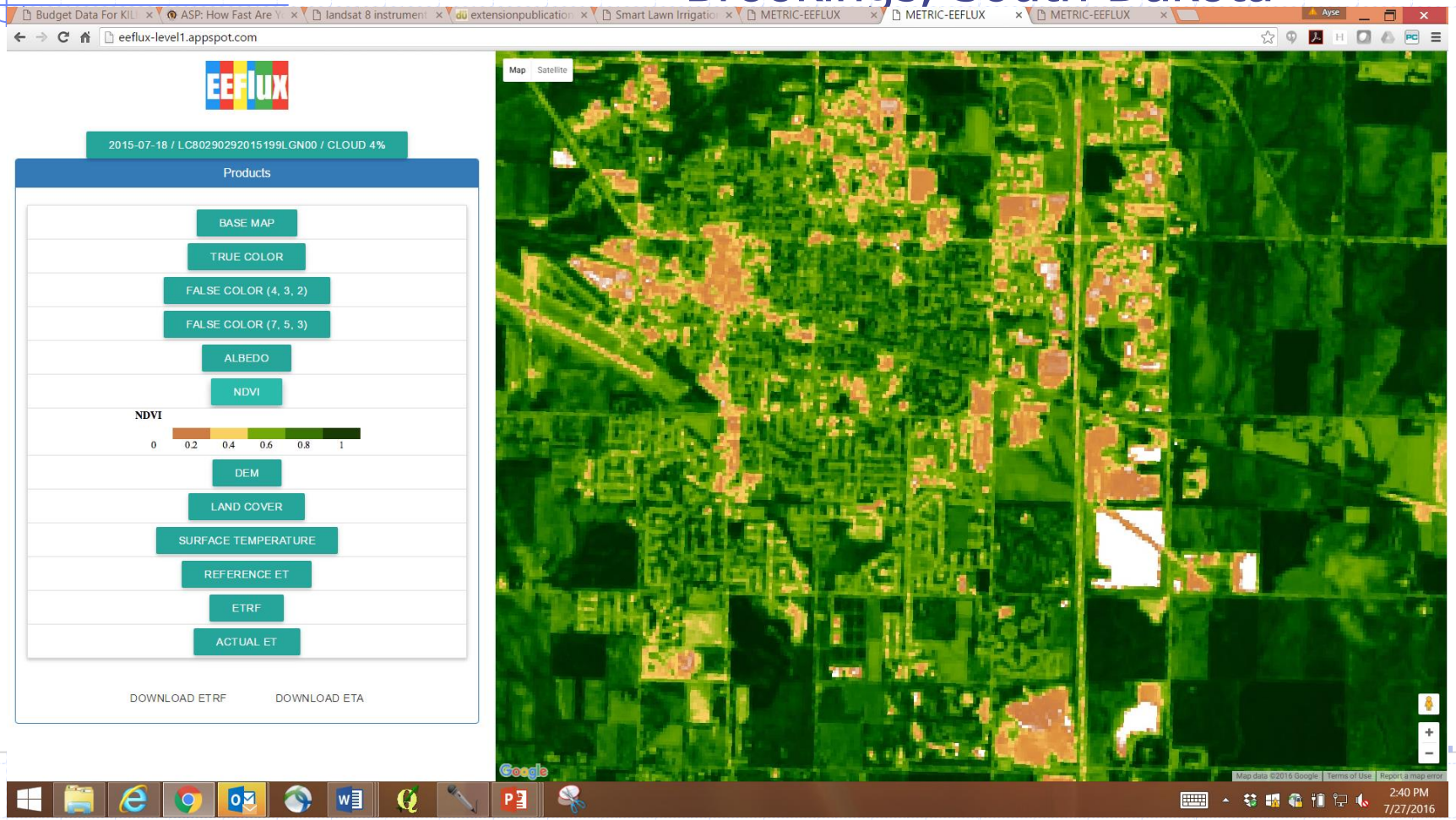
Google Earth Engine

Landsat 8 – July 18, 2015

Evapotranspiration Flux --- EEFlux

NDVI

Brookings, South Dakota



http://eeflux-level1.appspot.com/

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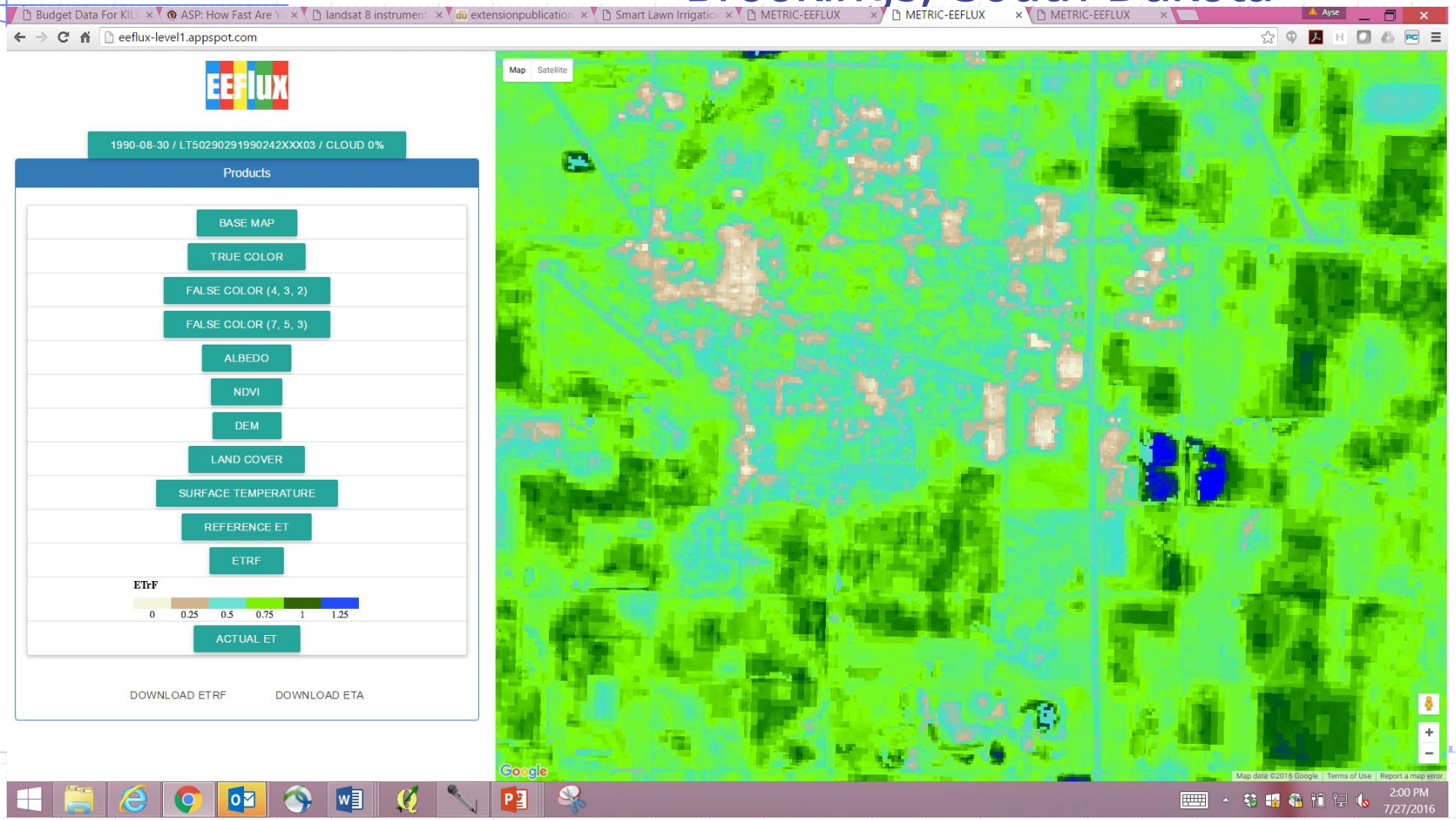
Google Earth Engine

Landsat 5 – August 30, 1990

Evapotranspiration Flux --- EEFlux

ET

Brookings, South Dakota



http://eeflux-level1.appspot.com/

University of Nebraska Lincoln

Google

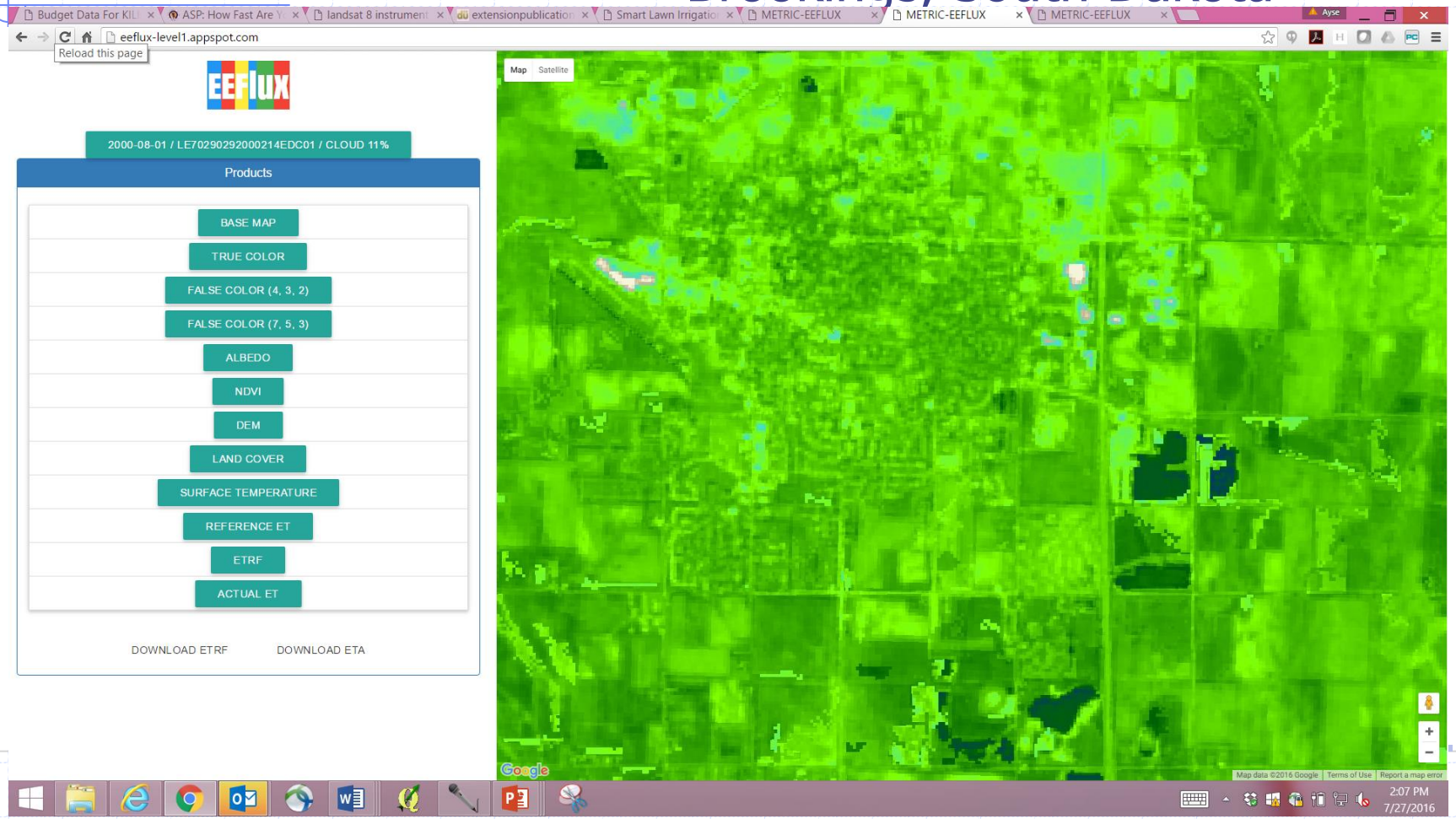
Google Earth Engine

Landsat 7 – August 01, 2000

Evapotranspiration Flux --- EEFlux

ET

Brookings, South Dakota



http://eeflux-level1.appspot.com/

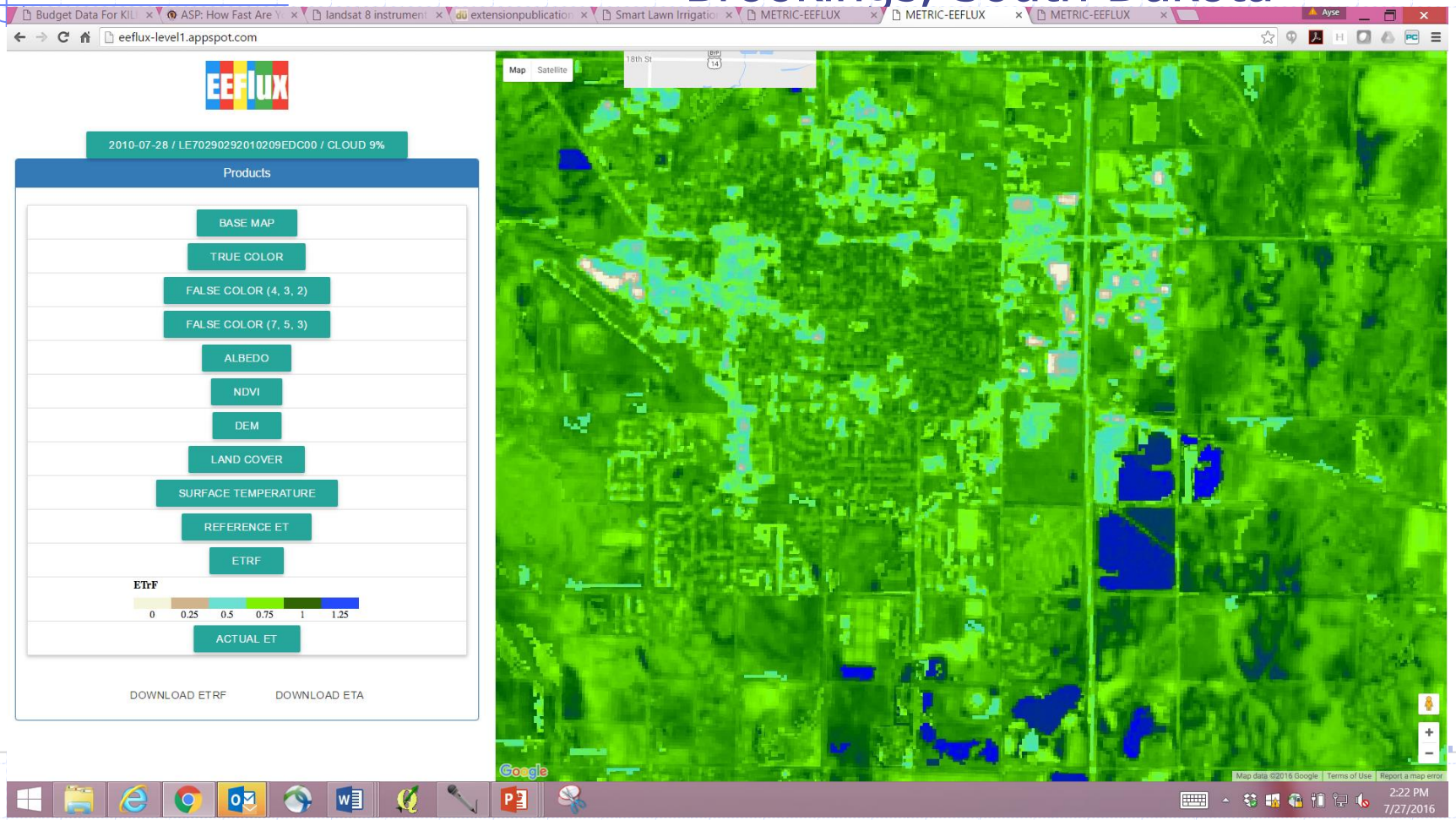
Google Earth Engine

Landsat 7 – July 28, 2010

Evapotranspiration Flux --- EEFlux

ET

Brookings, South Dakota



http://eeflux-level1.appspot.com/

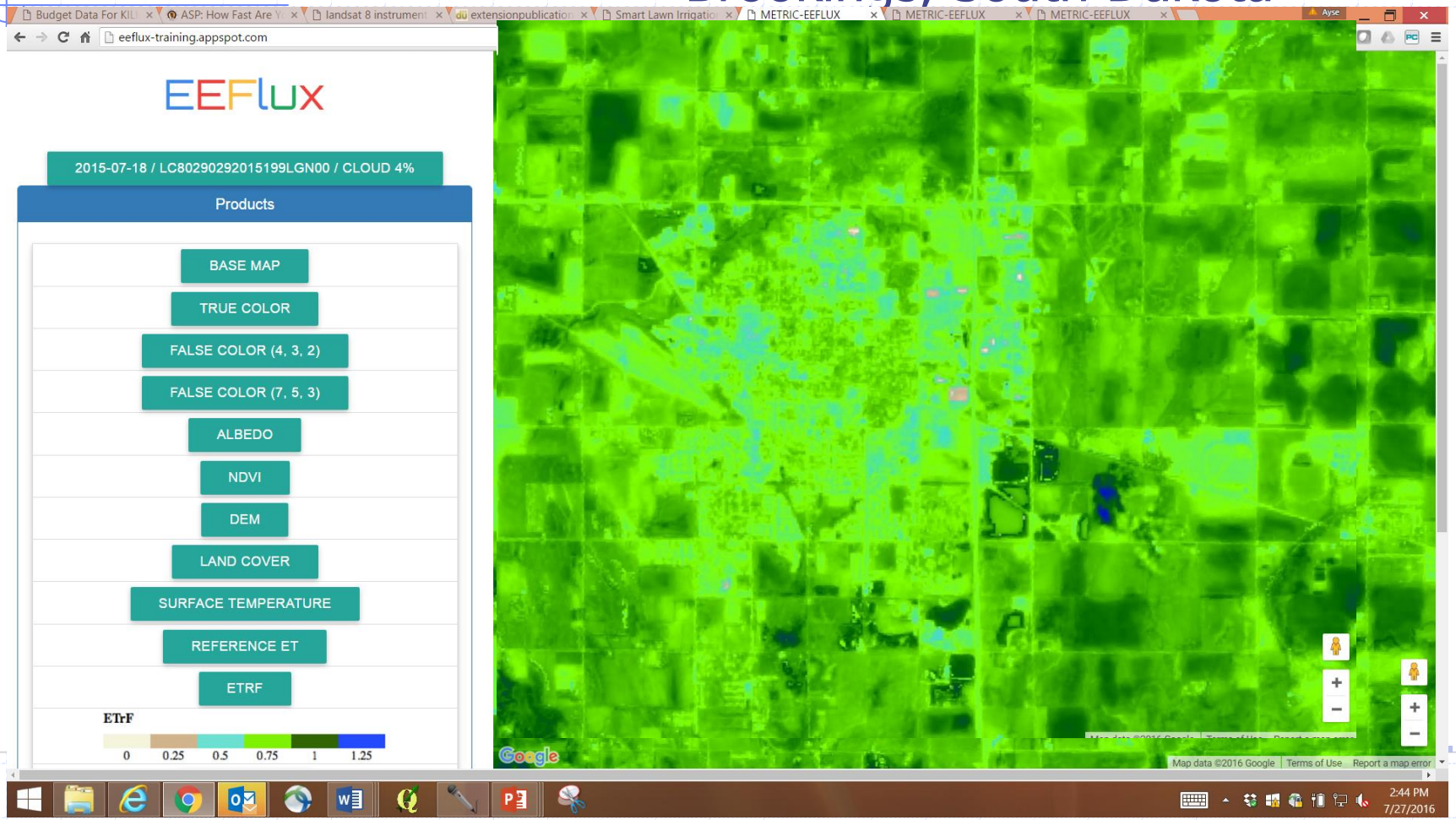
Google Earth Engine

Landsat 8 – July 18, 2015

Evapotranspiration Flux --- EEFlux

ET

Brookings, South Dakota



http://eeflux-level1.appspot.com/

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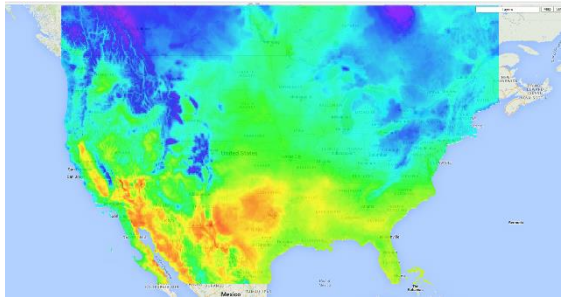
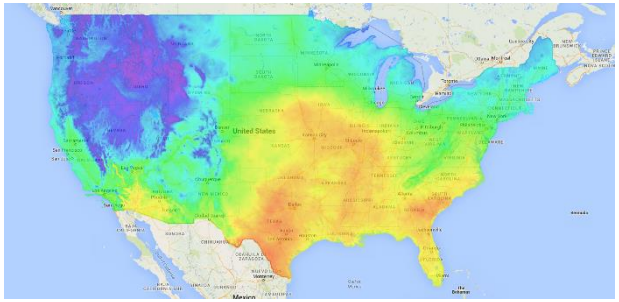
Data Resources Used by EEFlux

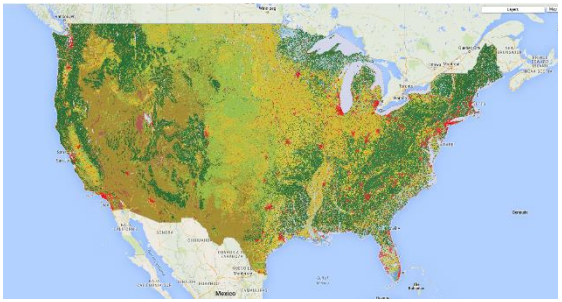
NLDAS-Jan 1, 1979 - Current



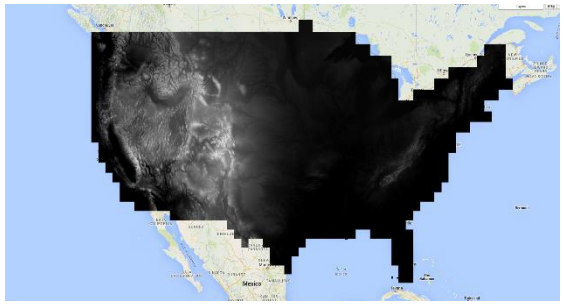
GRIDMET-Jan 1, 1979 - Current



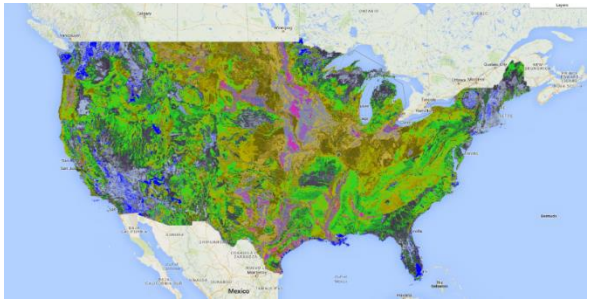
NLCD Landuse



DEM



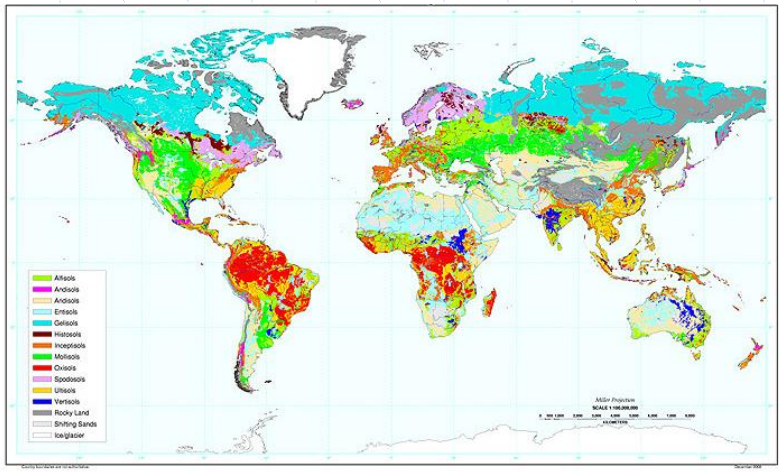
Soil Data Layers



- Landsat 5/7/8 and MODIS
- Weather Data
  - Hourly Weather Data (NLDAS)--CONUS
  - Daily Weather Data (GRIDMET)--CONUS
  - Climate Forecast System Version 2, 6-hourly Products (CFSV2)--nonCONUS
- Landuse and Digital Elevation Maps
- Soil Data Layers (STATSGO--CONUS and FAO)

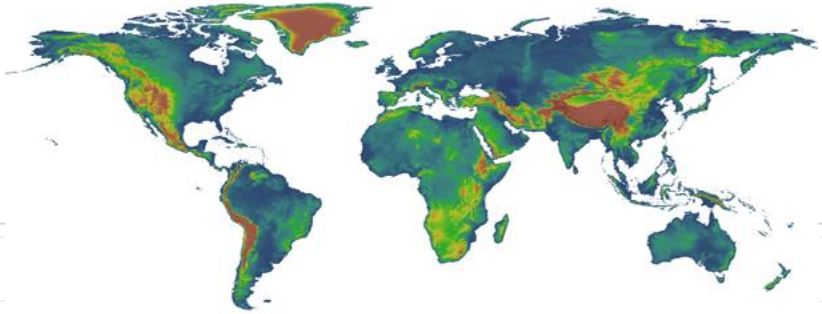
EEFlux -- IT IS RUNNING GLOBALLY

GLOBAL SOIL



LANDUSE-ESA

DIGITAL ELEVATION DATABASE-SRTM



LANDSAT 5/7/8

These data products are loaded and are functional on Earth Engine

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Current Work

Automation of:

- Cloud detection (Google Fmask etc.) and mitigation
- METRIC Mountain Radiation and Aerodynamic Algorithms for Complex Terrain
- Time integration to produce monthly and annual ET volumes
- Mosaicing paths seamlessly –Allow user to download for a water resources region (basin/river)

Porting EEFlux to an Open API (Application programming interface)

- callable by any Earth Engine user
- can be used to ingest ET into other processes
  - use the ET in other applications such as land use change
- primary Google partner: Dr. Tyler Erickson
- Free access

Nebraska University of Lincoln

Google

A Tool For Smarter Lawn Irrigation

- Help homeowners manage water applications for their lawn
- Designed for the whole CONUS
- Link to Beta version of App is at: **http://appgearup.appspot.com/**
- Link to You tube video that shows calibration of NAIP with LANDSAT: https://www.youtube.com/watch?v=9aV8vduSTu0

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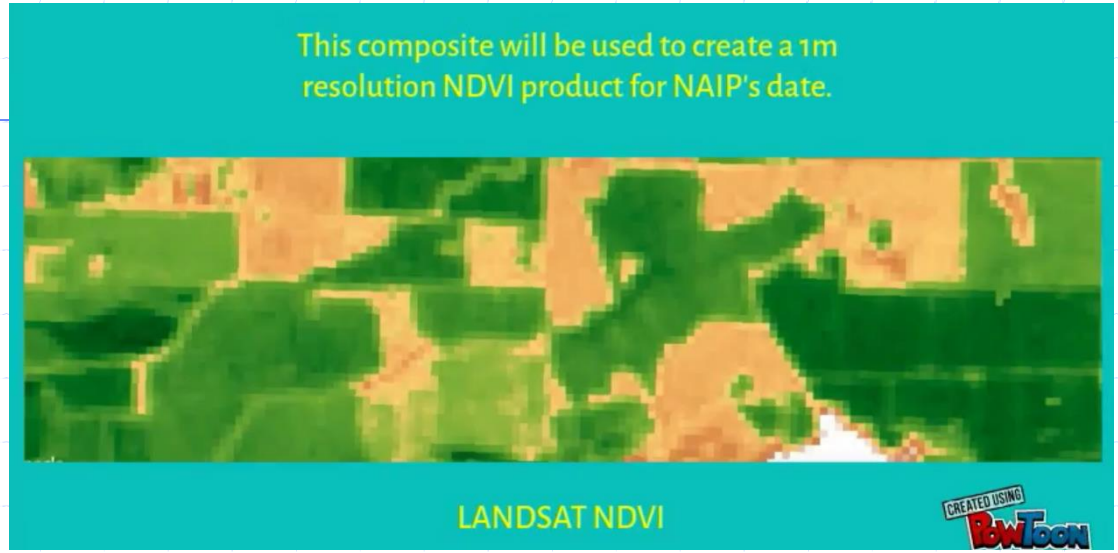
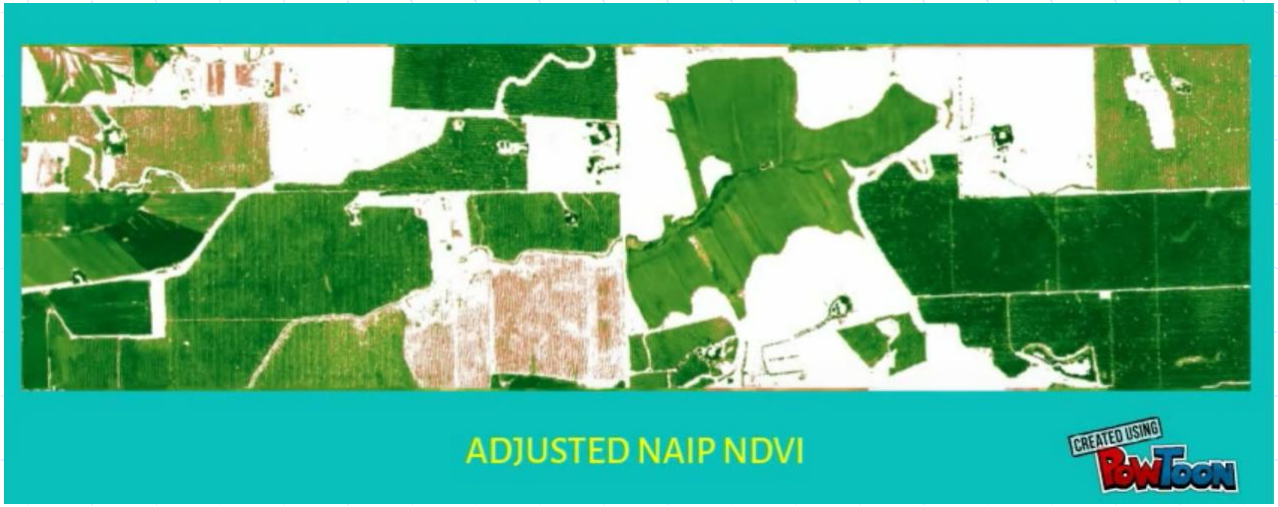


Landsat NDVI vs. NAIP NDVI following calibration



http://appgearup.appspot.com/#

How we calculate ET for a lawn

ET = KL x Reference ET

INPUT

OUTPUT

NAIP = National Agriculture Imagery Program (1 m near-infrared)
NAIP imagery is available as Digital Number (DN), only.
We convert NAIP to reflectance using Landsat.

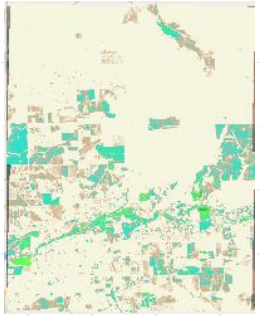
Vegetation

NAIP

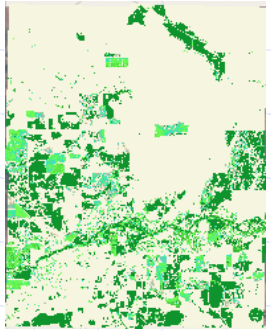
Landsat

→ KL

Reference ET represent "near maximum ET expected given the weather conditions"



Landscape Coefficient (Kl) Before Calibration with Landsat



Landscape Coefficient (Kl) After Calibration with Landsat

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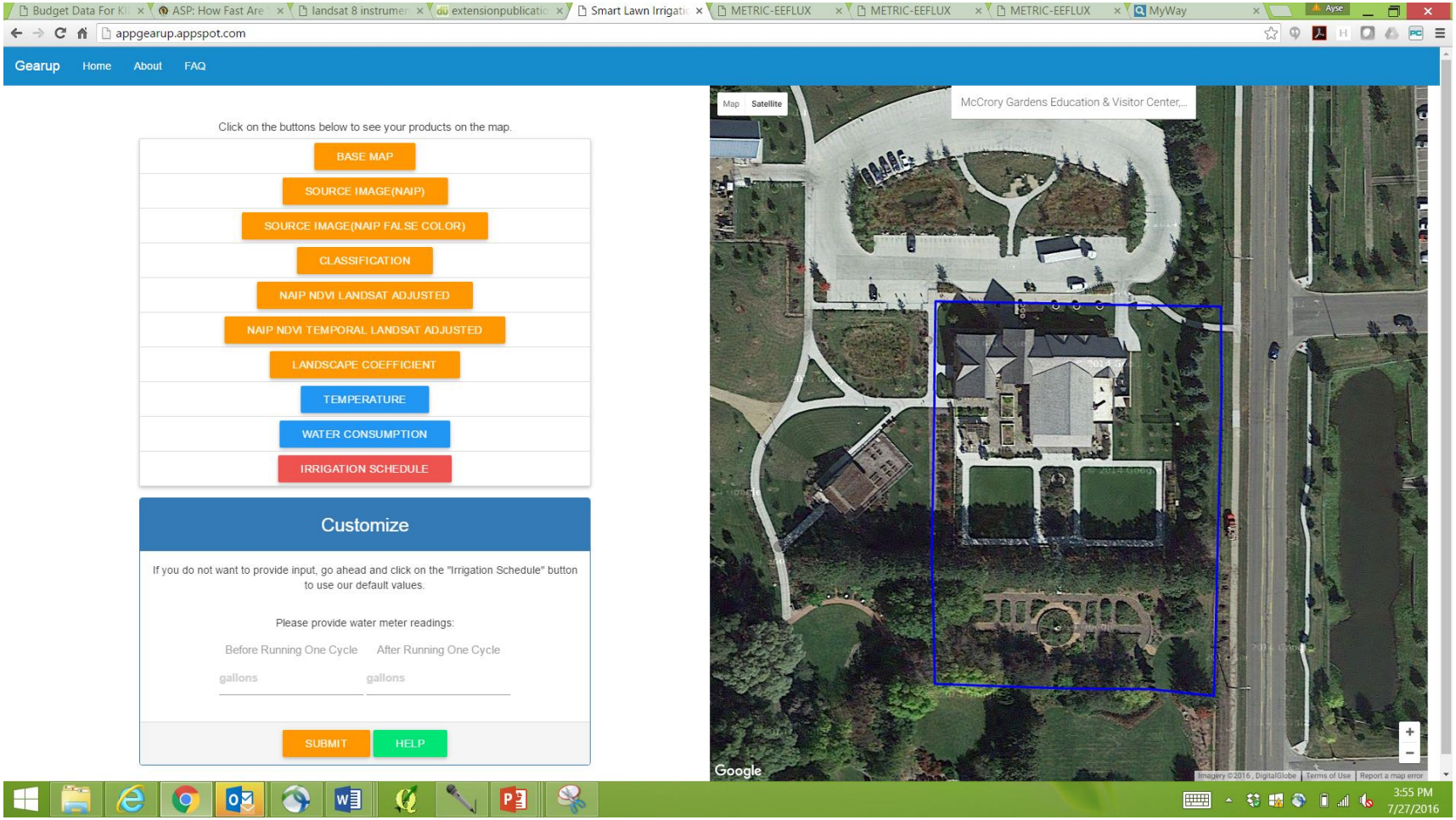
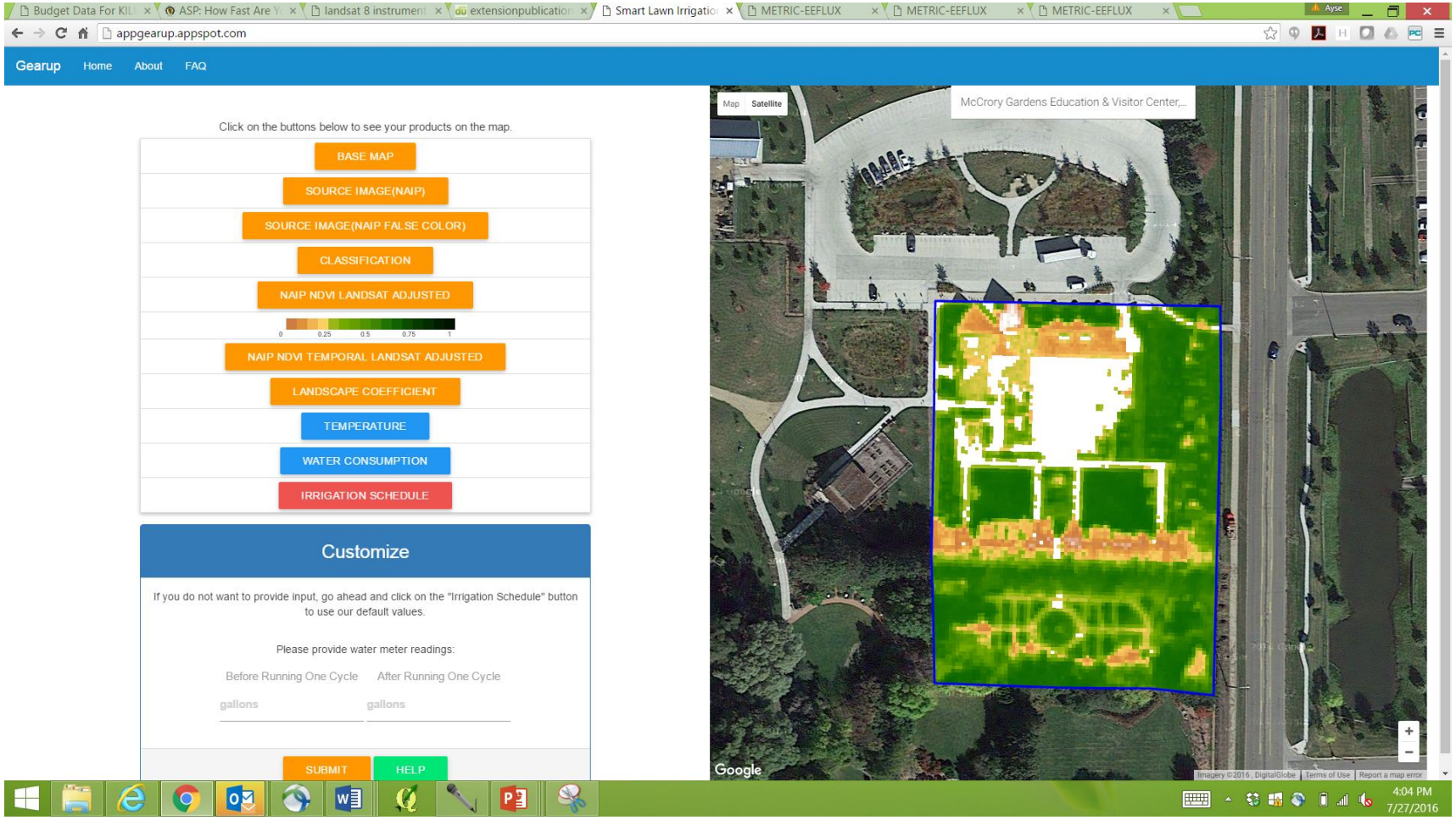
McCrory Gardens, Visitor Center, Brookings, SD

Google Map overlaid as a base map

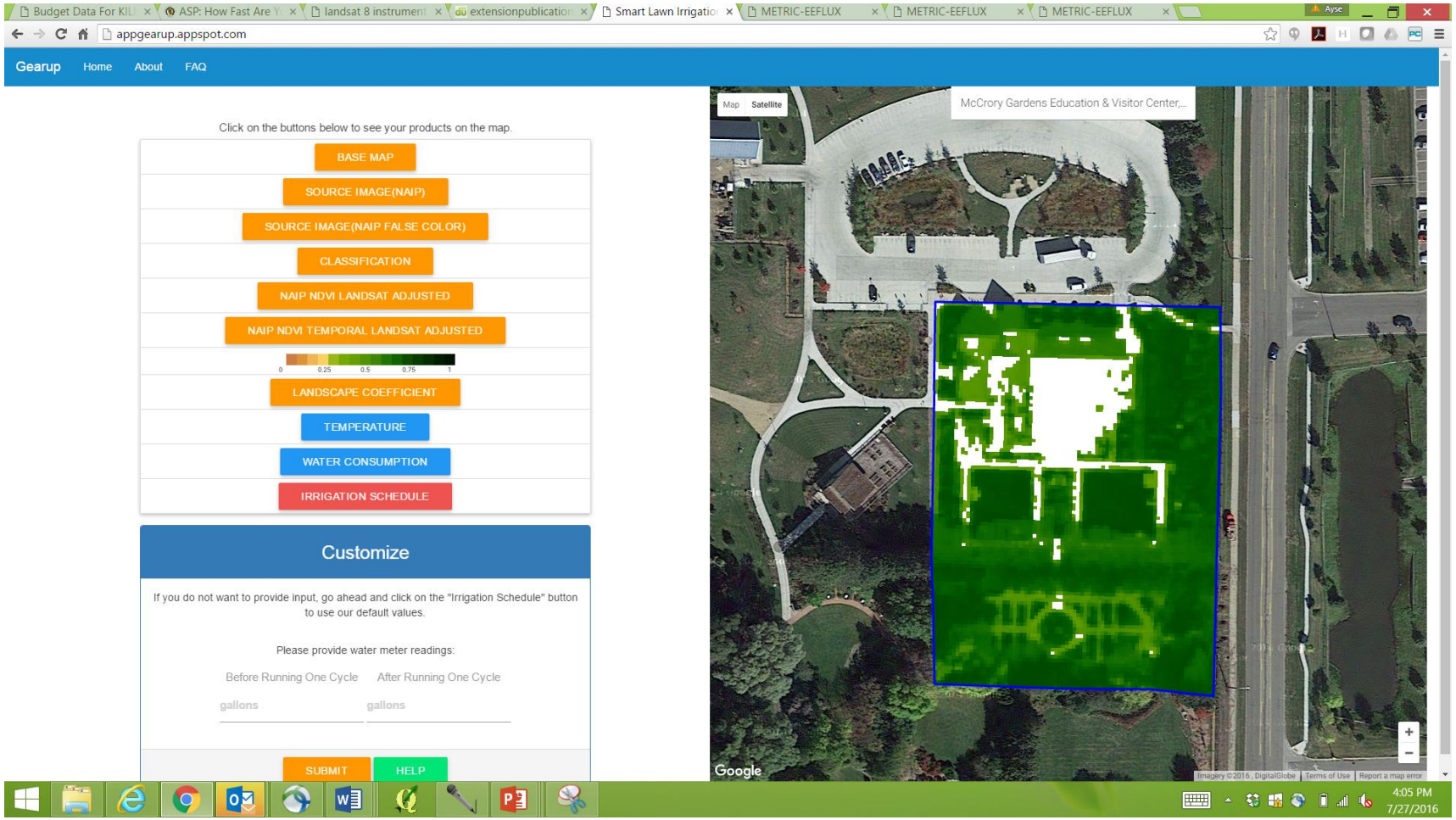


NAIP NDVI- on the day of NAIP image
Calibrated using Landsat reflectance



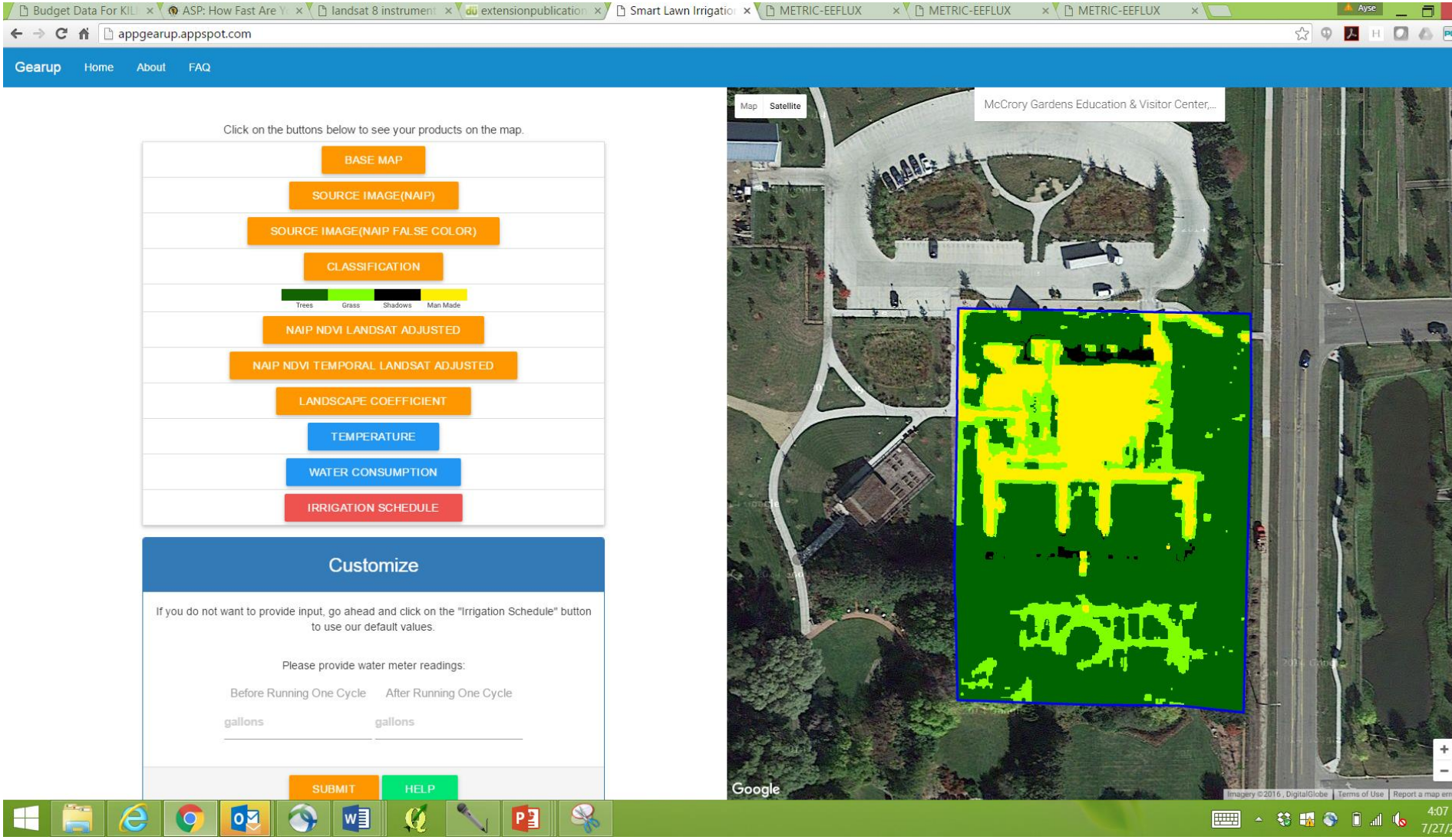
McCrory Gardens, Visitor Center, Brookings, SD

NAIP NDVI- as of today using Landsat reflectance

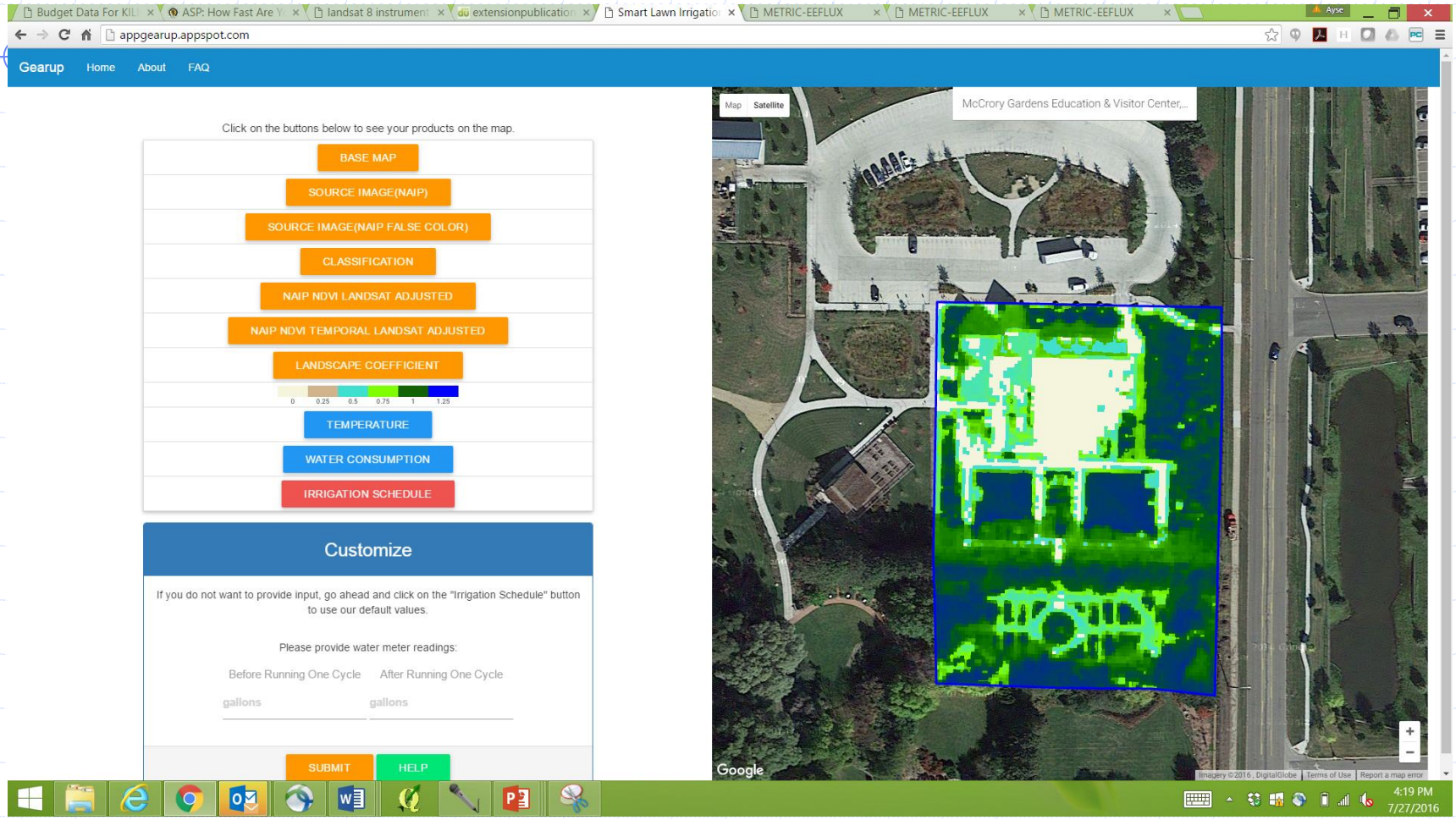


McCrory Gardens, Visitor Center, Brookings, SD

Landuse classification
McCrory Gardens, Visitor Senter, Brookings, SD



Landscape coefficient, K_l
McCrory Gardens, Visitor Senter, Brookings, SD



University of Nebraska Lincoln

Google

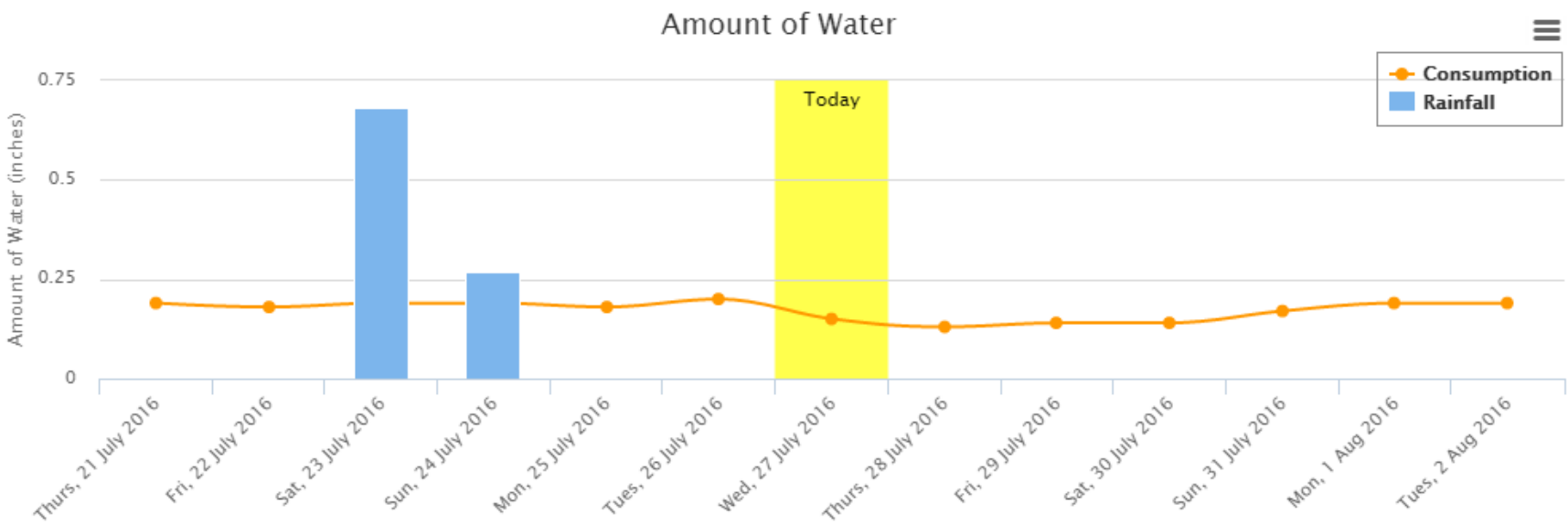
Irrigation Information

Irrigation Schedule

Date	Wed, 27 July 2016	Thurs, 28 July 2016	Fri, 29 July 2016	Sat, 30 July 2016	Sun, 31 July 2016	Mon, 1 Aug 2016	Tues, 2 Aug 2016
Irrigation	Off	Off	Off	On	Off	On	On

If the schedule indicates "On" get minutes using the table below based on your sprinkler heads application rate

Inches Per Hour	0.5	1	1.5	2
Minutes	35	17	11	8



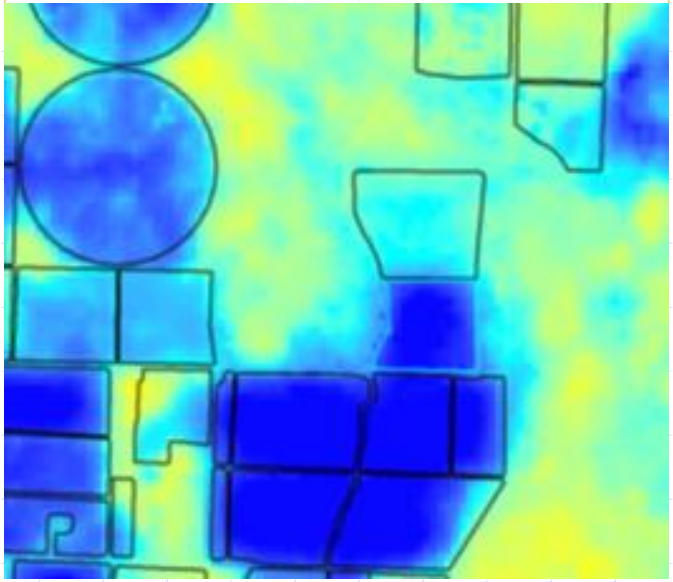
Rapid Production of 30 Years of Landsat-based ET via energy balance in the Central Valley of California

Justin Huntington
Associate Research Professor
Desert Research Institute (DRI)

Charles Morton, Andrew Vitale (DRI)
Forrest Melton, Alberto Guzman, Kirk Post (NASA ARC-CREST CSUMB)
Richard Allen (U of Idaho

Purpose

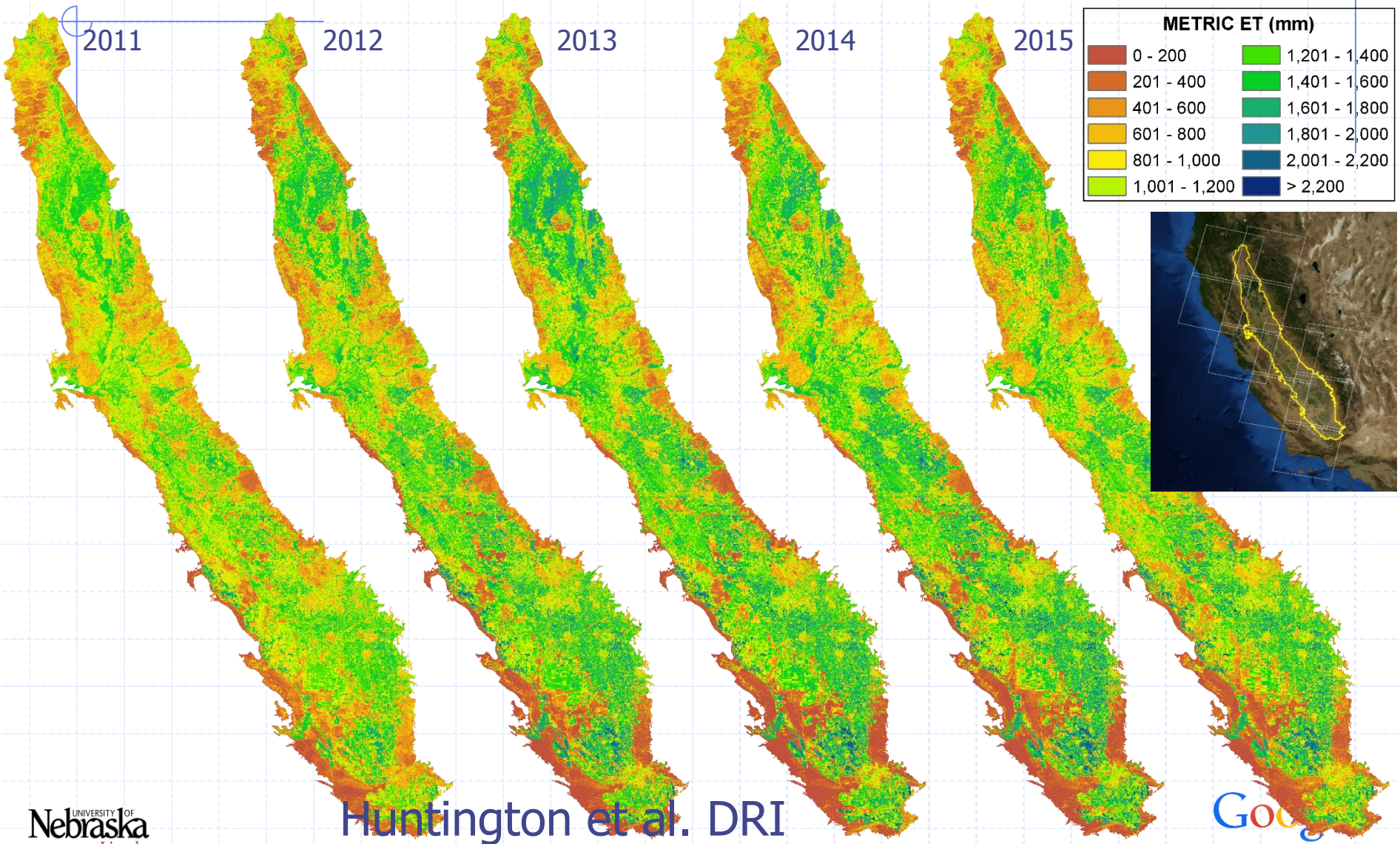
- Field scale ET is important for understanding agricultural consumptive use
- Groundwater consumption in California has been out of control. New laws are requiring both monitoring of depletions and management for sustainable use.
- Historical ET maps support predictive studies of surface and groundwater demand
- Remote sensing is the most effective and accurate way to estimate actual consumptive use over large areas and long time histories



Huntington et al. DRI

Example Results – ET for the last 5 years

- Lower ET during drought in areas that were water limited
- Higher ET in areas that were well-watered, especially in 2012 and 2013



Huntington et al. DRI