Operational Evapotranspiration for the State of New Mexico

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Operational Evapotranspiration for the State of New Mexico

Vision

- Help New Mexico access more comprehensive, timely information on water use and drought conditions; support their use of this info in determining state-level water priorities and dissemination to other NM agencies for decision-making

Objectives

- Operationalize production of NASA EOS-based drought monitoring data for NM
- Develop access and dissemination mechanism of the drought product suite
- Apply and demonstrate utility of products in decision-making and WR planning
- Transition system to operational use by NM

Project Partner

Office of the State Engineer
nm
Interstate Stream Commission

- New Mexico is among the most arid states and consistently suffers drought conditions
- New Mexico disseminates information about landscape / drought / water conditions to multiple agencies, to help them manage agriculture, ranching, grazing, fire response, and other water related activities
- New Mexico develops a State Water Plan to inform water management priorities and strategies within the state

Potential Stakeholders & Decisions

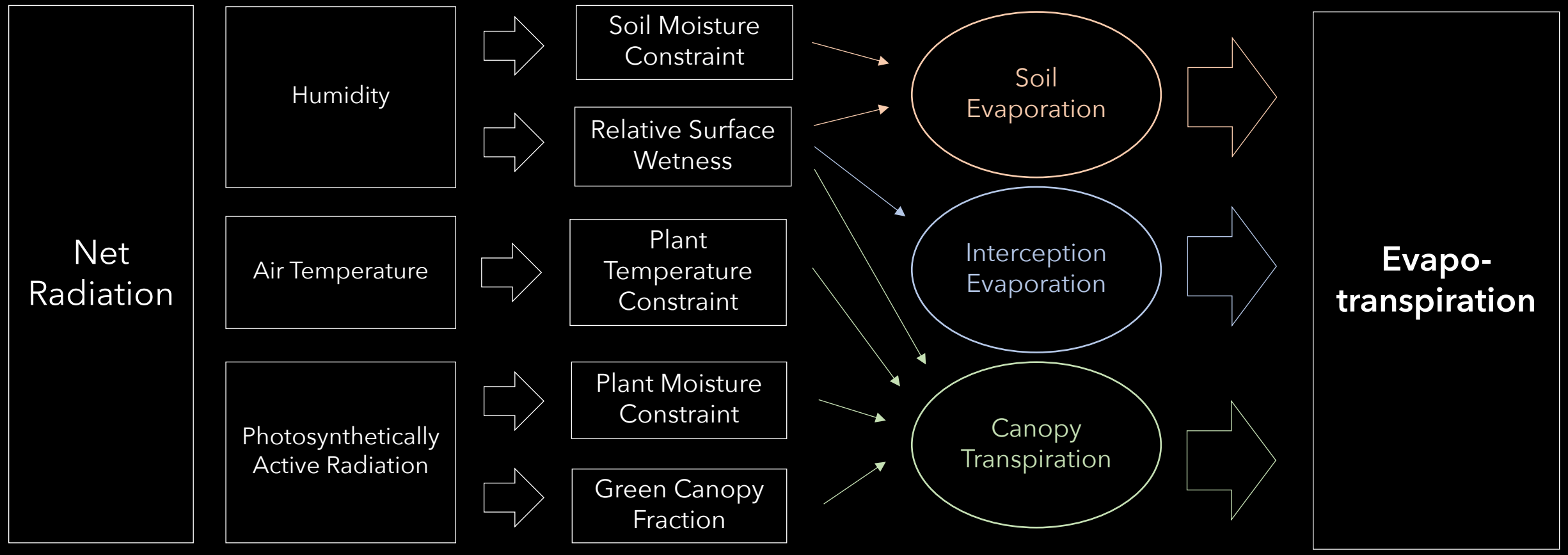
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

- monitoring drought in major river basins, such as the Rio Grande and Pecos
- improving water budget modeling
- comparing ET data with other models

NEW MEXICO
STATE FORESTRY

- evaluate water consumption changes associated with vegetation restoration efforts
- invasive species removal
- forest thinning

Satellite ET Algorithm: **PT-JPL**



Fisher et al. 2008

FLUXNET
A Global Network

PT-JPL has been independently validated at *hundreds of sites*, shown repeatedly to be the top-performing algorithm

Geosci. Model Dev. Discuss., 8, 6809–6866, 2015
www.geosci-model-dev-discuss.net/8/6809/2015/
doi:10.5194/gmdd-8-6809-2015
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Geoscientific Model Development Discussions
Open Access

This discussion paper is/has been under review for the journal Geoscientific Model Development (GMD). Please refer to the corresponding final paper in GMD if available.

The GEWEX LandFlux project: evaluation of model evaporation using tower-based and globally-gridded forcing data

M. F. McCabe[1], A. Ershadi[1], C. Jimenez[2], D. G. Miralles[3], D. Michel[4], and E. F. Wood[5]

Agricultural and Forest Meteorology 187 (2014) 46–61
Contents lists available at ScienceDirect
Agricultural and Forest Meteorology
journal homepage: www.elsevie

stations as independent metrics of performance, the tower-based analysis indicated that PT-JPL provided the highest overally statistical performance (0.72; 61 W m^{-2}; 0.65), followed closely by GLEAM (0.68; 64 W m^{-2}; 0.62), with values in parenthe-

Multi-site evaluation of terrestrial evaporation models using FLUXNET data

A. Ershadi[a,*], M.F. McCabe[b], J.P. Evans[c,d], N.W. Chaney[e], E.F. Wood[e]

Remote Sensing of Environment 115 (2011) 801–823
Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

Global estimates of evapotranspiration for climate studies using multi-sensor remote sensing data: Evaluation of three process-based approaches

Raghuveer K. Vinukollu[a,*], Eric F. Wood[a], Craig R. Ferguso

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Remote Sensing of Environment 14
Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

Comparison of satellite-based evapotranspiration models over terrestrial ecosystems in China

Yang Chen[a,b], Jiangzhou Xia[a,b], Shunlin Liang[b,c], Jinming Fe
Shuguang Liu[g], Zhuguo Ma[d], Akira Miyata[h], Qiaozhen Mu[i]
Jun Wen[f], Yueju Xue[l], Guirui Yu[m], Tonggang Zha[n], Li Zhan
Liang Zhao[p], Wenping Yuan[a,q,*]

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Manuscript prepared for Hydrol. Earth Syst. Sci.
with version 2015/04/24 7.83 Copernicus papers of the LaTeX class copernicus.cls.
Date: 4 September 2015

The WACMOS-ET project - Part 1: Tower-scale evaluation of four observation-based evapotranspiration algorithms

D. Michel[1], C. Jiménez[2,3], D.M. Miralles[4,5]
B. Martens[5], M.F. McCabe[7], J.B. Fisher[8], C
E.F. Wood[11], and D. Fernández-Prieto[12]

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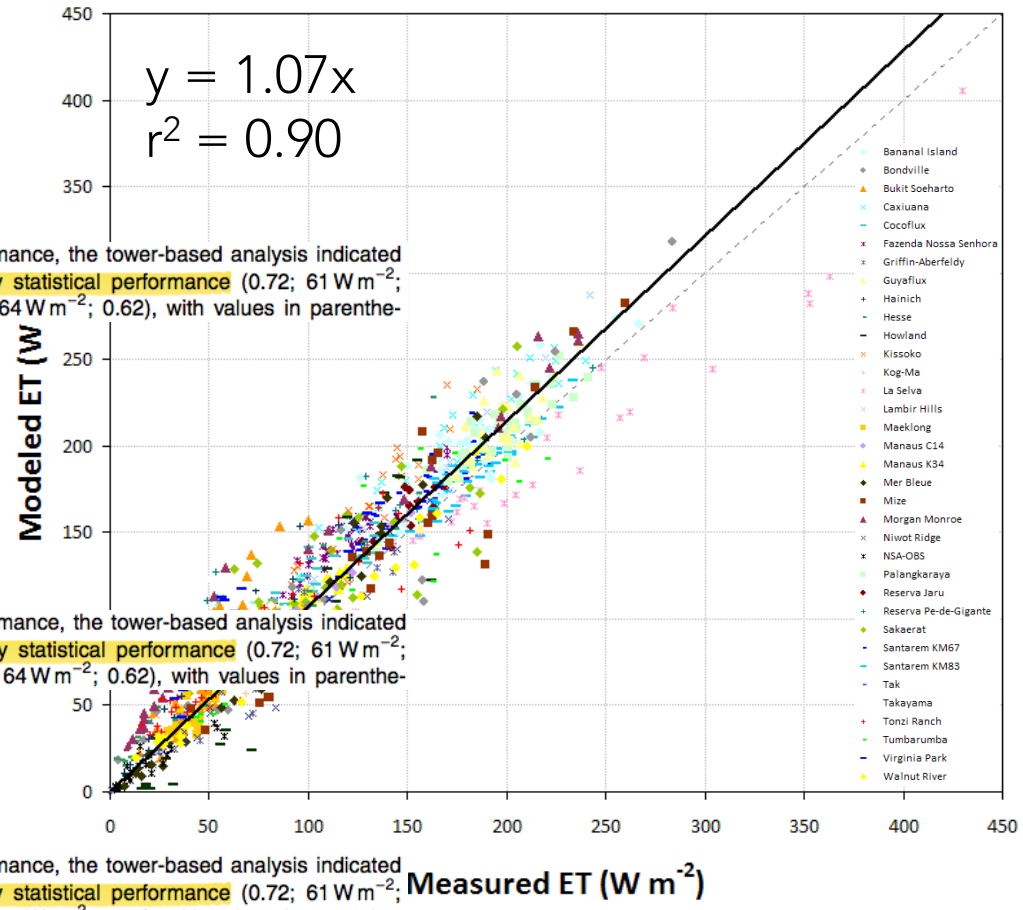


-JPL ET VALIDATION

Dissemination System

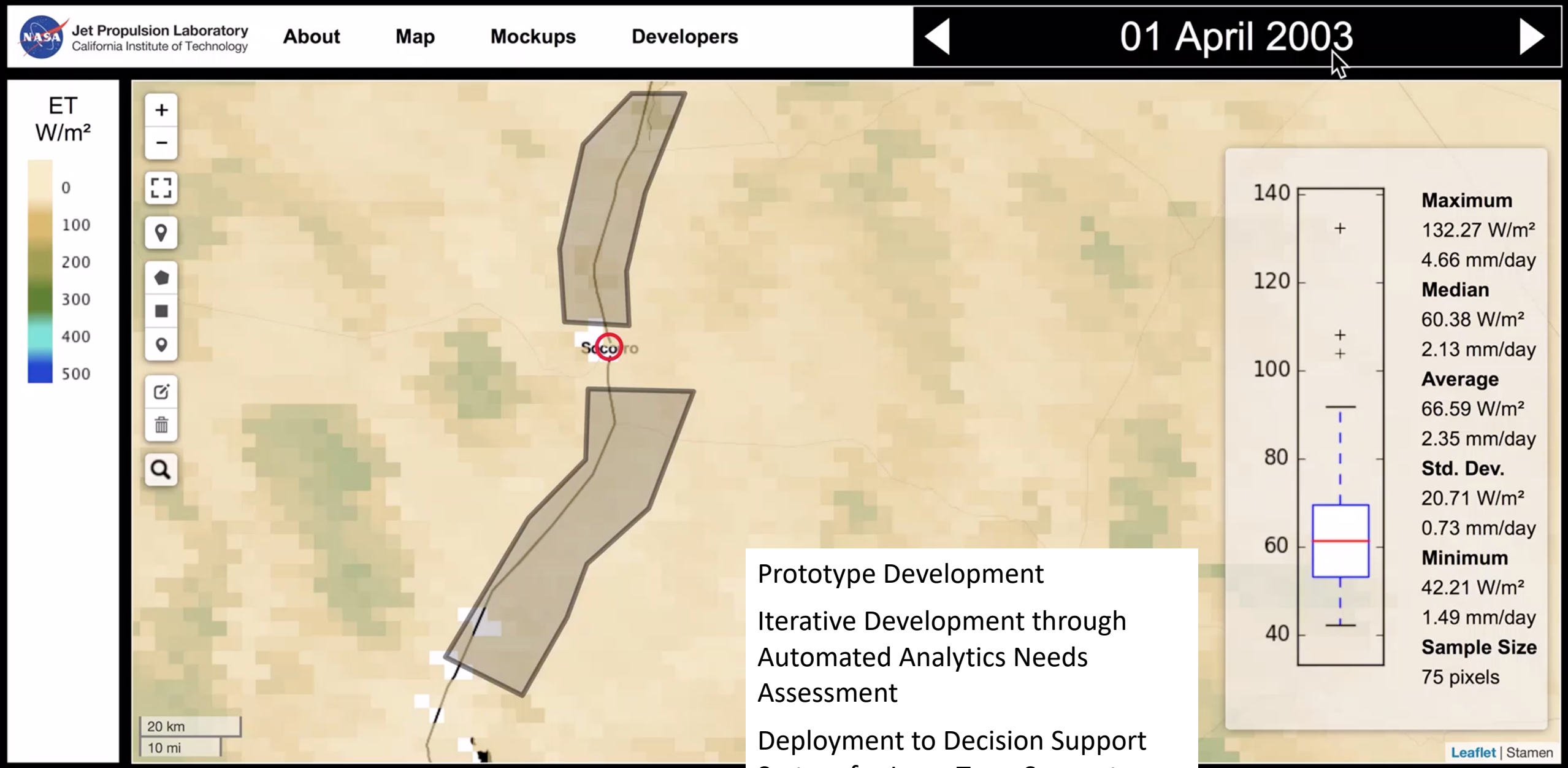
GeoServer

django

Leaflet

The data dissemination system uses a combination of GeoServer, Django, and Leaflet to provide a WebGIS platform for Decision Support System development.

This WebGIS and automated data analytics system will be developed to the applications needs of stakeholders through collaboration



Prototype Development

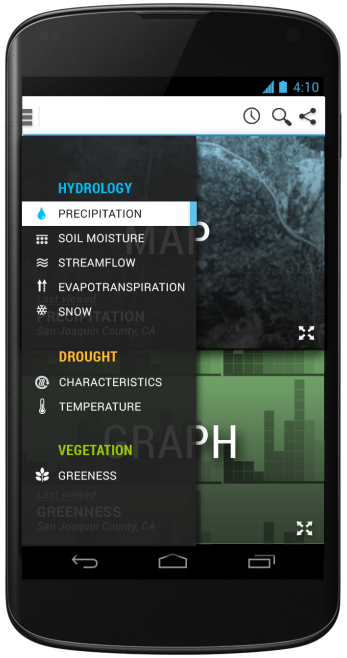
Iterative Development through Automated Analytics Needs Assessment

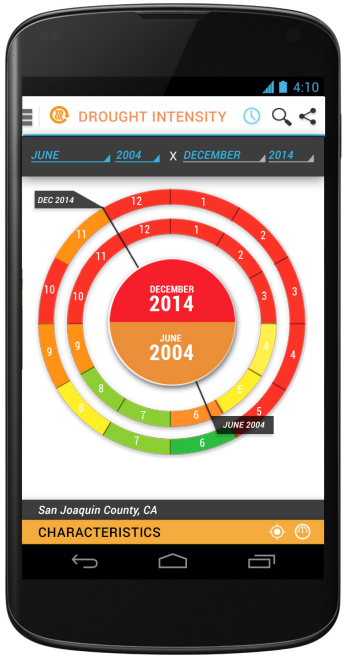
Deployment to Decision Support System for Long-Term Support

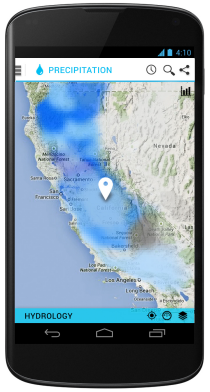
RHEAS DROUGHT MOBILE APPLICATION

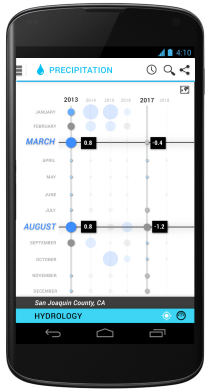
App Features:

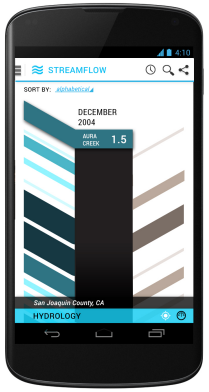
- Drought, hydrology, and vegetation products
- New and innovative visualization methods
- Current location enabled maps
- Form your own area of interest
- Location search
- Time and duration search
- Download and sharing of screenshots



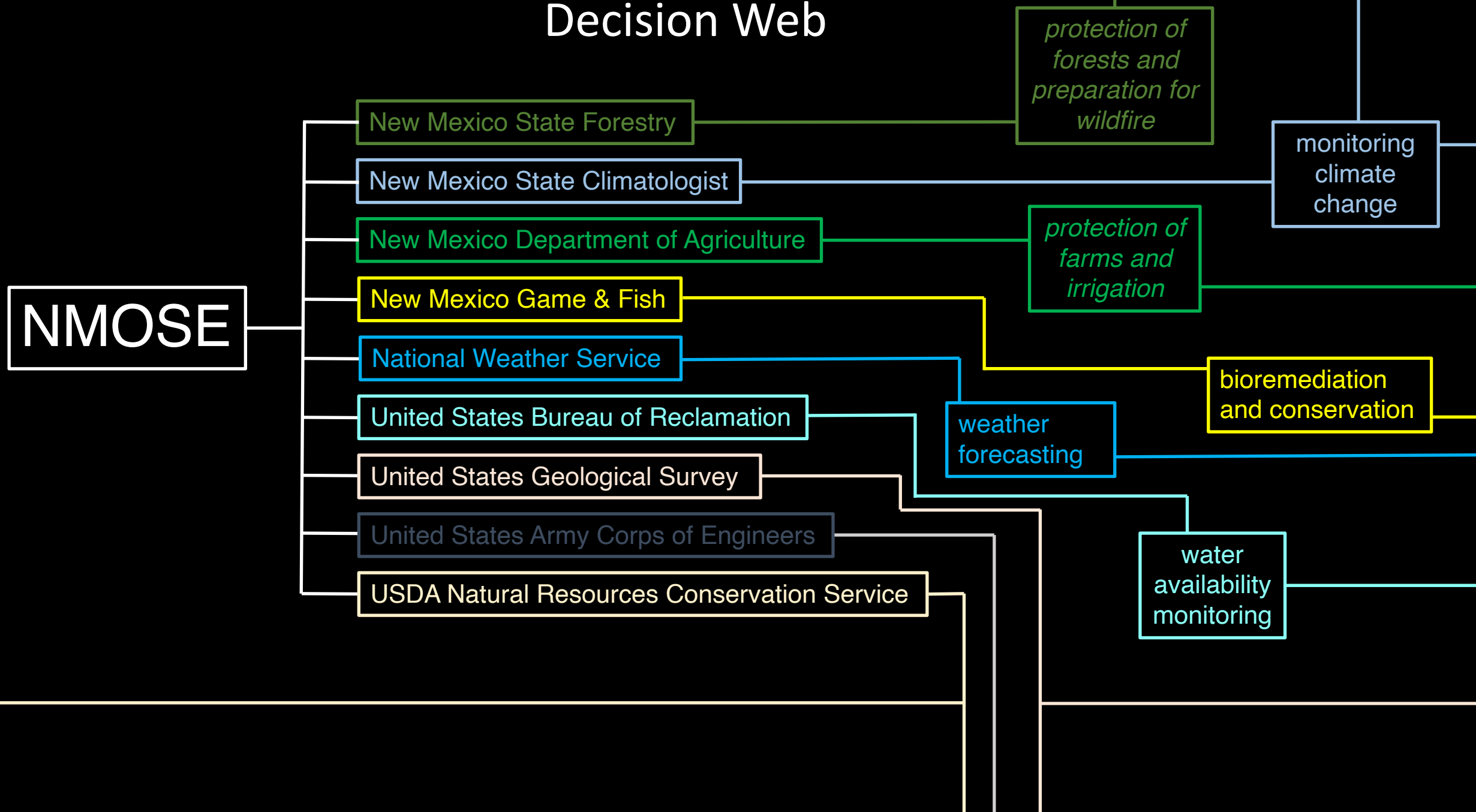








Decision Web



NEW MEXICO ET CASE STUDIES

1

MANAGEMENT & ADMINISTRATION

2

State Water Plan

Lucia Sanchez, Water Planning Program Manager, Interstate Stream Commission, Lucia.Sanchez@state.nm.us
Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us

NM reviews the State Water Plan every 5 years. This plan describes the top-level water use and needs throughout the state. The plan quantifies consumptive use (ET) for planning and infrastructure investments. The NM Water Resources Research Institute (WRRI) is currently developing the Statewide Water Assessment, which may be used as part of the State Water Plan. NM has not had state-wide ET maps to use for the Plan.

Decision
- Statewide planning for water through infrastructure investments
- Determination of what is needed to support and manage consumptive use (ET)

Impact
- Improve formulation of State Water Plan ($)
- Infrastructure investments ($$$)

Data Requirements
- Spatial: State-wide (1 km)
- Temporal: Annual, Monthly?
- Historical: 5 year?
- NRT: No

Data Delivery
- Map images and summary statistics (need to collaborate with WRRI)

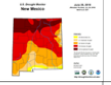
3

Drought Monitoring Working Group (DMWG)

Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us
Royce Fontenot, Senior Service Hydrologist, National Weather Service, royce.fontenot@noaa.gov

The NMOSE participates in the DMWG with other state and federal agencies, and regularly assesses drought conditions for the State. Drought classification can impact federal assistance given to agricultural lands. Improved ET data provided to the National Weather Service (NWS) would feed into the US Drought Monitor (USDM) and improve drought assessments for the State.

Decision
- Statewide declaration of Drought



Impact
- Federal financial assistance ($$$$)

Data Requirements
- Spatial: State-wide (1 km)
- Temporal: Daily
- Historical: Anomalies
- NRT: Yes

Data Delivery
- Map images and summary statistics
- Data format input to NWS?

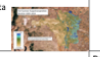
4

Pecos River Basin Study Report

Dagmar Llewellyn, Hydrologist, US Bureau of Reclamation, dllewellyn@usbr.gov
Hannah Riseley-White, Pecos River Bureau Chief, Interstate Stream Commission, hannah.riseley-white@state.nm.us

Report describing USBR capabilities for water assessment. High demand for ET data. Report to point to WWAO project. The Pecos River Basin Study seeks to develop strategies for anticipated future reductions in water supplies by improving water budget estimates in the Fort Sumner Basin and achieving consensus on climate change scenarios, including water supply, demand, and reliability issues.
https://www.usbr.gov/watersmart/bsp/docs/fy2012/FactSheet-PecosRiverBasinStudy.pdf

Decision
- Develop strategies to adapt to reduced water supply
- Investments and mobilization of resources to respond to analysis and decision needs based on available resources
- Investments to equip for use of ET data



Impact
- Improve climate resilience to uncertain water supply ($$)
- Resource investments to improve water management capabilities ($$$)

Data Requirements
- Spatial: Fort Sumner Basin (1 km)
- Temporal: Annual
- Historical: 2008-2016
- NRT: No

Data Delivery
- Map images
- GeoTIFFs

5

Active Water Resource Management

John Romero, Water Rights Division Director, Office of the State Engineer, john.romero2@state.nm.us

Active Water Resource Management (AWRM) manages water shortages without solely following priority administration and cutting people off. AWRM allows for compromises, such as shortage sharing agreements, rotational and deficit irrigation. The OSE needs to ensure compliance (ET) when these agreements are in place. This program currently relies on gauge data, which is sparse, and in some parts of the state completely unavailable. Remotely sensed ET can fill this need.

Decision
- Arbitrate water needs (ET) claims from users and managers
- Shortage sharing agreements during scarcity
- Ensure compliance (ET)
- Select farms for deficit irrigation (ET)

Impact
- Maximize production and sustainability under water shortage ($$)
- Ensure compliance (💧)
- Improve relations between water masters and farmers (👪)
- Reduce litigation ($$$)

Data Requirements
- Spatial: Field scale (30 m)
- Temporal: Weekly?
- Historical: 1 year?
- NRT: Yes

Data Delivery
- Potential phone app for quick access
- Map images showing irrigation "light up"
- Review ET on a timeline

6

Interstate Compact Compliance

Paul Harms, Staff Engineer, Interstate Stream Commission, paul.harms@state.nm.us
Rolf Schmidt-Peterson, Colorado River Bureau Chief, Interstate Stream Commission

Prioritization and subsidization of fallowing (ET stop) and deficit irrigation (ET decrease) to increase downstream water deliveries. Current methods include field surveys, examining NAIP imagery, and point-estimates of ET using Blaney-Criddle.

Decision
- Select farms for fallowing (ET stop)
- Select farms for deficit irrigation (ET decrease)
- Determination of water savings (ET decrease with river increase)

Impact
- Maintain compact water compliance between states, avoid litigation ($$$)

Data Requirements
- Spatial: Field scale (30 m)
- Temporal: Monthly?
- Historical: Near-term history to see if farms actually stopped irrigating or not
- NRT: Yes

Data Delivery
- Map viewer?
- GeoTIFF, UTM 13 N?
- Map images for a parcel showing ET light up over time

7

Priority Administration

POC Name, Position, Institution, email

Application description

Decision
- ...

Impact
- ...

Data Requirements
- Spatial:
- Temporal:
- Historical:
- NRT:

Data Delivery
- ...

8

Water Rights Transfer

John Romero, Water Rights Division Director, Office of the State Engineer, john.romero2@state.nm.us

The OSE reviews applications (currently backlogged, especially in southeastern NM) to transfer the place and purpose of use for water rights. The OSE must assess the historic continuous beneficial use of water (ET) for each water right application in question. Long-term historical records of field scale ET will be highly beneficial.

Decision
- Accept, deny, or reappraise water rights transfer applications based on historical beneficial use (ET)

Impact
- Re-appraisal of over-valued water rights, reducing waste ($)
- Hundred of thousands of dollars in applications ($$$)
- Expedite application processing ($)
- Improve economic activity ($$)

Data Requirements
- Spatial: Field scale (30 m)
- Temporal: Monthly?
- Historical: As long as possible (decades)
- NRT: None

Data Delivery
- Time-series browser quantifying beneficial use over a long historical record
- Map images for a parcel showing ET light up over time, or NOT light up

9

Reservoir Depletion

Dagmar Llewellyn, Hydrologist, US Bureau of Reclamation, dllewellyn@usbr.gov
Kenneth Richard, Project Manager/Hydrologist, US Bureau of Reclamation, kenneth.richard@state.nm.us
Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us
Page Pegram, Acting Basin Manager of the Rio Grande, Interstate Stream Commission, page.pegram@state.nm.us

Reservoirs lose water through evaporation (ET) (and infiltration), but at different rates depending on reservoir and within reservoirs. Water can be transferred between reservoirs to avoid loss. The State is required to pay for water losses. The USBR lacks consistent, large-scale, and high quality data on reservoir evaporative loss.

Decision
- Determine evaporative loss among reservoirs
- Determine management strategies for r
- Calculate how much the State owes for

Impact
- Save water used to make up for evaporative loss (💧)
- Save money to State in paying for loss ($$$)
- More accurate compact delivery numbers ($$$)

Data Requirements
- Spatial: Bathymetry-scale (30 m)
- Temporal: Monthly
- Historical: 3 years
- NRT: No

Data Delivery
- Summary statistics

10

RIVER/BASIN MONITORING

11

River Health Support, Pecos Diversions, Fort Sumner Basin

Carolyn Donnelly, Civil Engineer, USBR, cdonnelly@uc.usbr.gov
Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us
Hannah Riseley-White, Pecos River Bureau Chief, Interstate Stream Commission, hannah.riseley-white@state.nm.us

Reinterpreted water rights in Fort Sumner basin have been taking more water than they should. The river must have enough water to support fish. How much water is being used (ET) in Fort Sumner that can be saved for the river?

Decision
- Maintain water for biology
- Determine how much water is being used (ET) in Fort Sumner that can be saved for the river
- When and where to transfer populations of minnows along the river

Impact
- Protect endangered species (🐟)
- Avoid litigation from Endangered Species Act ($$$)

Data Requirements
- Spatial: Field scale (30 m)?
- Temporal: Monthly?
- Historical: Decadal
- NRT: Need timely information for bioremediation actions?

Data Delivery
- GeoTIFF, UTM 13 N?
- Summary statistics?

12

River Realignment Monitoring, San Acacia Reach of the Rio Grande

Page Pegram, Acting Basin Manager of the Rio Grande, Interstate Stream Commission, page.pegram@state.nm.us

Engineered river realignments (e.g., on the Rio Grande, San Acacia reach) affect riparian habitats. We need to know how this affects total streamflow. Is there more or less ET within a basin/sub-basin when a river is moved? When the ISC finds a depletion in the river, the USBR has to cover it and figure out who pays for the water.

Decision
- Determine where there is a depletion based on change in basin/sub-basin ET

Impact
- Save water (💧)
- Protect endangered species (🐟)
- Avoid litigation from Endangered Species Act ($$$)
- Save labor with less people needed to do fieldwork and review data

Data Requirements
- Spatial: Riparian scale (30 m); or basin scale (1 km)?
- Temporal: Monthly?
- Historical: No (except for research demonstration)
- NRT: Yes

Data Delivery
- GeoTIFF, UTM 13 N?

13

FORESTS

14

Fire Risk Mitigation

Susan Rich, Forest & Watershed Health Coordinator, NM Energy, Minerals & Natural Resources Dept., SusanE.Rich@state.nm.us

Identify forest areas drying (anomalously low ET) for fire prevention, management, mobilization. May be due to disease (bark beetle).

Decision
- Identify dry areas (anomalously low ET)
- Select areas of forest for treatment (thinning, prescribed burn)

Impact
- Prevent catastrophic fire, preserve ecosystem health, reduce fire-fighting costs, save lives, improve air quality ($$$, 👪, 🌬)

Data Requirements
- Spatial: 1 km
- Temporal: Daily
- Historical: Decade for anomalies
- NRT: Yes

Data Delivery
- GeoTIFF linked to monitoring system?

15

Forest ET Reduction

Susan Rich, Forest & Watershed Health Coordinator, NM Energy, Minerals & Natural Resources Dept., SusanE.Rich@state.nm.us
Page Pegram, Acting Basin Manager of the Rio Grande, Interstate Stream Commission, page.pegram@state.nm.us

Reduce water use (ET) by forests so more water is available to the river for other uses.

Decision
- Identify forest areas with high ET
- Selectively treat those areas, including thinning and prescribed burns

Impact
- Reduce water consumption of forest (💧)
- More water available for other uses ($)

Data Requirements
- Spatial: Forest heterogeneity (30 m)
- Temporal: Monthly
- Historical: 5 years before and after historical treatments
- NRT: Yes

Data Delivery
- GeoTIFF
- Maps or tables TBD

16

Snowpack Improvement, Rio Grande Water Fund

Susan Rich, Forest & Watershed Health Coordinator, NM Energy, Minerals & Natural Resources Dept., SusanE.Rich@state.nm.us

Snowpack is better preserved below forest canopies than on top of canopies (less direct radiation and sublimation). Thinning dense parts of the forest improves below-canopy snow storage. Is there less evaporative (ET) and sublimation loss given different management approaches?

Decision
- Different management approaches to preserve below-canopy snowpack
- Is there less evaporative (ET) and sublimation loss given different management approaches?
- Select areas of forest for treatment

Impact
- Maximize below-canopy snowpack, transfer to river, minimize evaporative and sublimation loss (💧 , $$$)

Data Requirements
- Spatial: Management scale (30 m)
- Temporal: Monthly
- Historical: Yes?
- NRT: No

Data Delivery
- GeoTIFF

17

MODELING

18

URGWOM (Upper Rio Grande Water Operations Model), Rio Grande New Mexico Basin Study, Middle Rio Grande Cochiti to Caballo, Upper Rio Grande Basin Focus Area Study, Pecos River Basin Study Report

Page Pegram, Acting Basin Manager of the Rio Grande, Interstate Stream Commission, page.pegram@state.nm.us
Kyle R. Douglas-Mankin, Supervisory Research Hydrologist, US Geological Survey, kdouglas-mankin@usgs.gov
Dagmar Llewellyn, Hydrologist, US Bureau of Reclamation, dllewellyn@usbr.gov

Characterize changes to water supply in a changing climate. Constrain existing ET in model and test different climate scenarios.
https://www.usgs.gov/centers/nm-water/science/upper-rio-grande-basin-focus-area-study?qt-science_center_objects=0#qt-science_center_objects

Decision
- Project future water supply
- Develop strategies to adapt to reduced water supply
- Predict consequences of cutting irrigated agriculture
- Pick which crops best fit with climate scenarios
- Decide size of grazing allotments
- Decide stocking rates

Impact
- Adapt to trend of increasing temperatures and changes in water supply and demand (🌡 , $$$)
- Improve efficiency of irrigation (💧)
- Increase agricultural productivity ($$$)
- Better utilize land, reduce degradation (🚜)
- Income from efficient grazing ($$$)

Data Requirements
- Spatial: Basin-scale (1 km)?
- Temporal: Daily?
- Historical: TBD?
- NRT: No?
- Limitations: Requires capability to parameterize model and run scenarios

Data Delivery
- CSV averages?
- Table of values for hydrologic response units for each day (need shapefile for HRUs)

19

Evapotranspiration Toolbox, Irrigation Network

Carolyn Donnelly, Civil Engineer, US Bureau of Reclamation, cdonnelly@uc.usbr.gov
Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us

An ET calculator has been available for diverse users for multiple uses. But, the calculator is outdated and unlikely to be supported into the future. A replacement will be needed.

Decision
- Multiple uses (undefined, but see report)
- Irrigation and reservoir management

Impact
- Multiple? (💧 , $$$)
- Improve irrigation (💧)

Data Requirements
- Spatial: ?
- Temporal: 7-day forecast
- Historical: NA
- NRT: Yes

Data Delivery
- TBD

20

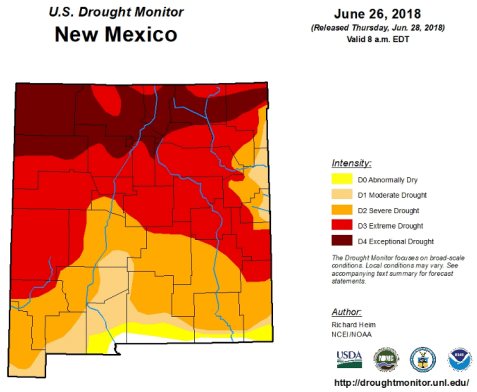
Drought Monitoring Working Group (DMWG)

Molly Magnuson, Water Use and Conservation Bureau Chief, Office of the State Engineer, molly.magnuson@state.nm.us
Royce Fontenot, Senior Service Hydrologist, National Weather Service, royce.fontenot@noaa.gov

The NMOSE participates in the DMWG with other state and federal agencies, and regularly assesses drought conditions for the State. Drought classification can impact federal assistance given to agricultural lands. Improved **ET** data provided to the National Weather Service (NWS) would feed into the US Drought Monitor (USDM) and improve drought assessments for the State.

Decision

- Statewide declaration of Drought



Impact

- Federal financial assistance ($$$)

Data Requirements

- Spatial: State-wide (1 km)
- Temporal: Daily
- Historical: Anomalies
- NRT: Yes

Data Delivery

- Map images and summary statistics
- Data format input to NWS?

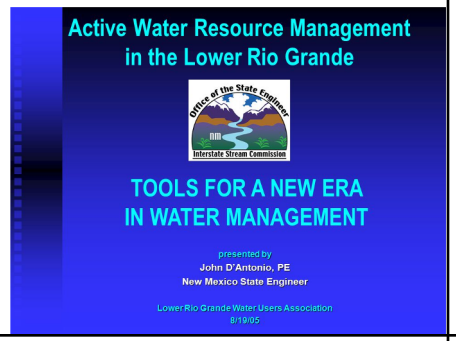
Active Water Resource Management

John Romero, Water Rights Division Director, Office of the State Engineer, john.romero2@state.nm.us

Active Water Resource Management (AWRM) manages water shortages without solely following priority administration and cutting people off. AWRM allows for compromises, such as shortage sharing agreements, rotational and deficit irrigation. The OSE needs to ensure compliance (ET) when these agreements are in place. This program currently relies on gauge data, which is sparse, and in some parts of the state completely unavailable. Remotely sensed **ET** can fill this need.

Decision

- Arbitrate water needs (**ET**) claims from users and managers
- Shortage sharing agreements during scarcity
- Ensure compliance (**ET**)
- Select farms for deficit irrigation (**ET**)



Impact

- Maximize production and sustainability under water shortage ($$)
- Ensure compliance (💧)
- Improve relations between water masters and farmers (👬)
- Reduce litigation ($$$)

Data Requirements

- Spatial: Field scale (30 m)
- Temporal: Weekly?
- Historical: 1 year?
- NRT: Yes

Data Delivery

- Potential phone app for quick access
- Map images showing irrigation “light up”
- Review ET on a timeline

Water Rights Transfer

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Decision

- Accept, deny, or reappraise water rights transfer applications based on historical beneficial use (**ET**)

Impact

- Re-appraisal of over-valued water rights, reducing waste ($)
- Hundred of thousands of dollars in applications ($$$)
- Expedite application processing ($)
- Improve economic activity ($$)

Data Requirements

- Spatial: Field scale (30 m)
- Temporal: Monthly?
- Historical: As long as possible (decades)
- NRT: None

Data Delivery

- Time-series browser quantifying beneficial use over a long historical record
- Map images for a parcel showing ET light up over time, or NOT light up

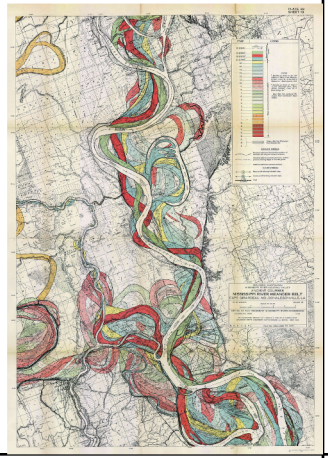
River Realignment Monitoring, San Acacia Reach of the Rio Grande

Page Pegram, Acting Basin Manager of the Rio Grande, Interstate Stream Commission, page.pegram@state.nm.us

Engineered river realignments (e.g., on the Rio Grande, San Acacia reach) affect riparian habitats. We need to know how this affects total streamflow. Is there more or less **ET** within a basin/sub-basin when a river is moved? When the ISC finds a depletion in the river, the USBR has to cover it and figure out who pays for the water.

Decision

- Determine where there is a depletion based on change in basin/sub-basin **ET**



Impact

- Save water (💧)
- Protect endangered species (🐟)
- Avoid litigation from Endangered Species Act ($$$)
- Save labor with less people needed to do fieldwork and review data

Data Requirements

- Spatial: Riparian scale (30 m); or basin scale (1 km)?
- Temporal: Monthly?
- Historical: No (except for research demonstration)
- NRT: Yes

Data Delivery

- GeoTIFF, UTM 13 N?

Fire Risk Mitigation

Susan Rich, Forest & Watershed Health Coordinator, NM Energy, Minerals & Natural Resources Dept., SusanE.Rich@state.nm.us

Identify forest areas drying (anomalously low **ET**) for fire prevention, management, mobilization. May be due to disease (bark beetle).

Decision

- Identify dry areas (anomalously low **ET**)
- Select areas of forest for treatment (thinning, prescribed burn)

Impact

- Prevent catastrophic fire, preserve ecosystem health, reduce fire-fighting costs, save lives, improve air quality ($$$, 👬, 🌿)

Data Requirements

- Spatial: 1 km
- Temporal: Daily
- Historical: Decade for anomalies
- NRT: Yes

Data Delivery

- GeoTIFF linked to monitoring system?

Case Study

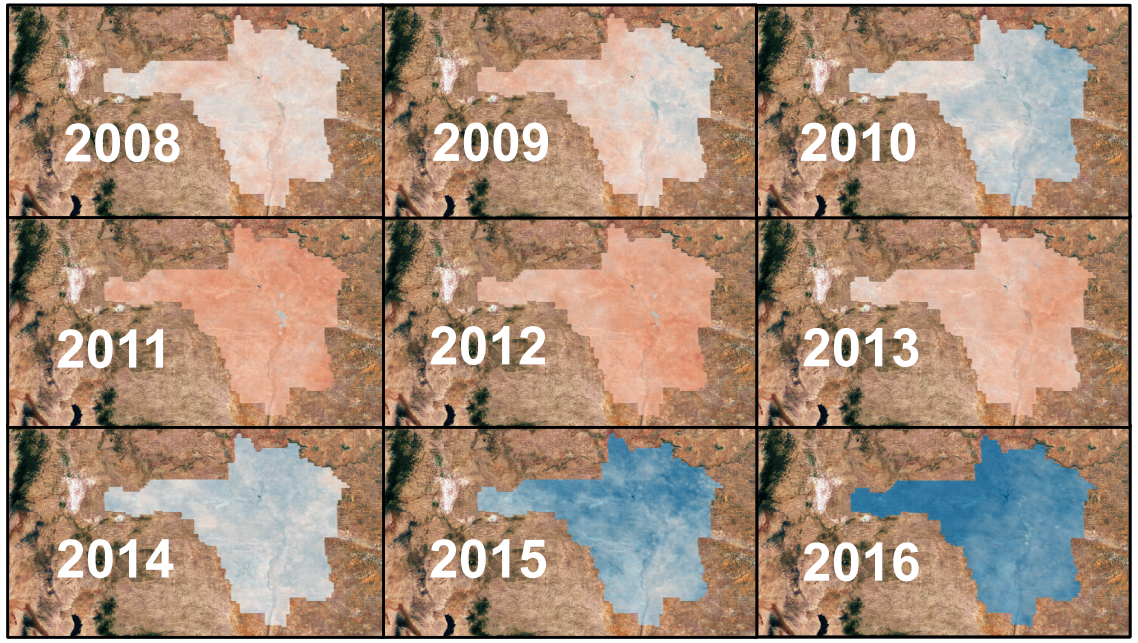
Monitoring drought in the Fort Sumner Water Basin

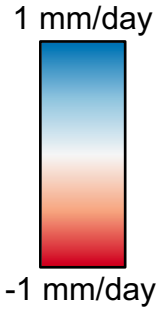
Bureau of Reclamation via NMOSE

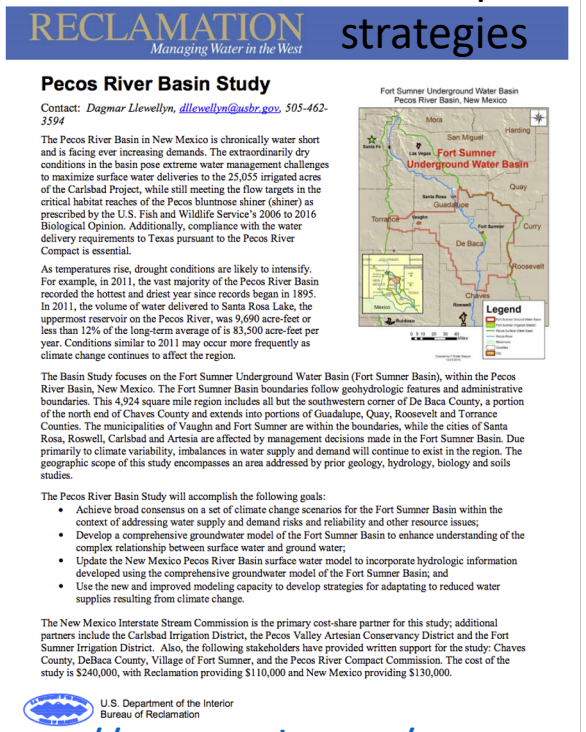
Case Study: Drought Monitoring and Water Budget Refinement

1. Develop climate scenarios
2. Update groundwater model
3. Update surface water model
4. Strategize adaptations to reduced water supply
5. Develop drought contingency strategies

The Pecos River Basin Study has recommended increased water use data collection. The Pecos River is a low volume system where pumping can impact flows. Evapotranspiration improves water management decisions through knowledge of surface water loss and availability. Having a long-term record of refined surface water availability aids in monitoring climate change and planning resilience to geographic changes in water distribution.







RECLAMATION
Managing Water in the West

Pecos River Basin Study

Contact: *Dagmar Llewellyn, dllewellyn@usbr.gov, 505-462-3594*

The Pecos River Basin in New Mexico is chronically water short and is facing ever increasing demands. The extraordinarily dry conditions in the basin pose extreme water management challenges to maximize surface water deliveries to the 25,055 irrigated acres of the Carlsbad Project, while still meeting the flow targets in the critical habitat reaches of the Pecos bluntnose shiner (shiner) as prescribed by the U.S. Fish and Wildlife Service's 2006 to 2016 Biological Opinion. Additionally, compliance with the water delivery requirements to Texas pursuant to the Pecos River Compact is essential.

As temperatures rise, drought conditions are likely to intensify. For example, in 2011, the vast majority of the Pecos River Basin recorded the hottest and driest year since records began in 1895. In 2011, the volume of water delivered to Santa Rosa Lake, the uppermost reservoir on the Pecos River, was 9,690 acre-feet or less than 12% of the long-term average of is 83,500 acre-feet per year. Conditions similar to 2011 may occur more frequently as climate change continues to affect the region.

Fort Sumner Underground Water Basin
Pecos River Basin, New Mexico

The Basin Study focuses on the Fort Sumner Underground Water Basin (Fort Sumner Basin), within the Pecos River Basin, New Mexico. The Fort Sumner Basin boundaries follow geohydrologic features and administrative boundaries. This 4,924 square mile region includes all but the southwestern corner of De Baca County, a portion of the north end of Chaves County and extends into portions of Guadalupe, Quay, Roosevelt and Torrance Counties. The municipalities of Vaughn and Fort Sumner are within the boundaries, while the cities of Santa Rosa, Roswell, Carlsbad and Artesia are affected by management decisions made in the Fort Sumner Basin. Due primarily to climate variability, imbalances in water supply and demand will continue to exist in the region. The geographic scope of this study encompasses an area addressed by prior geology, hydrology, biology and soils studies.

The Pecos River Basin Study will accomplish the following goals:

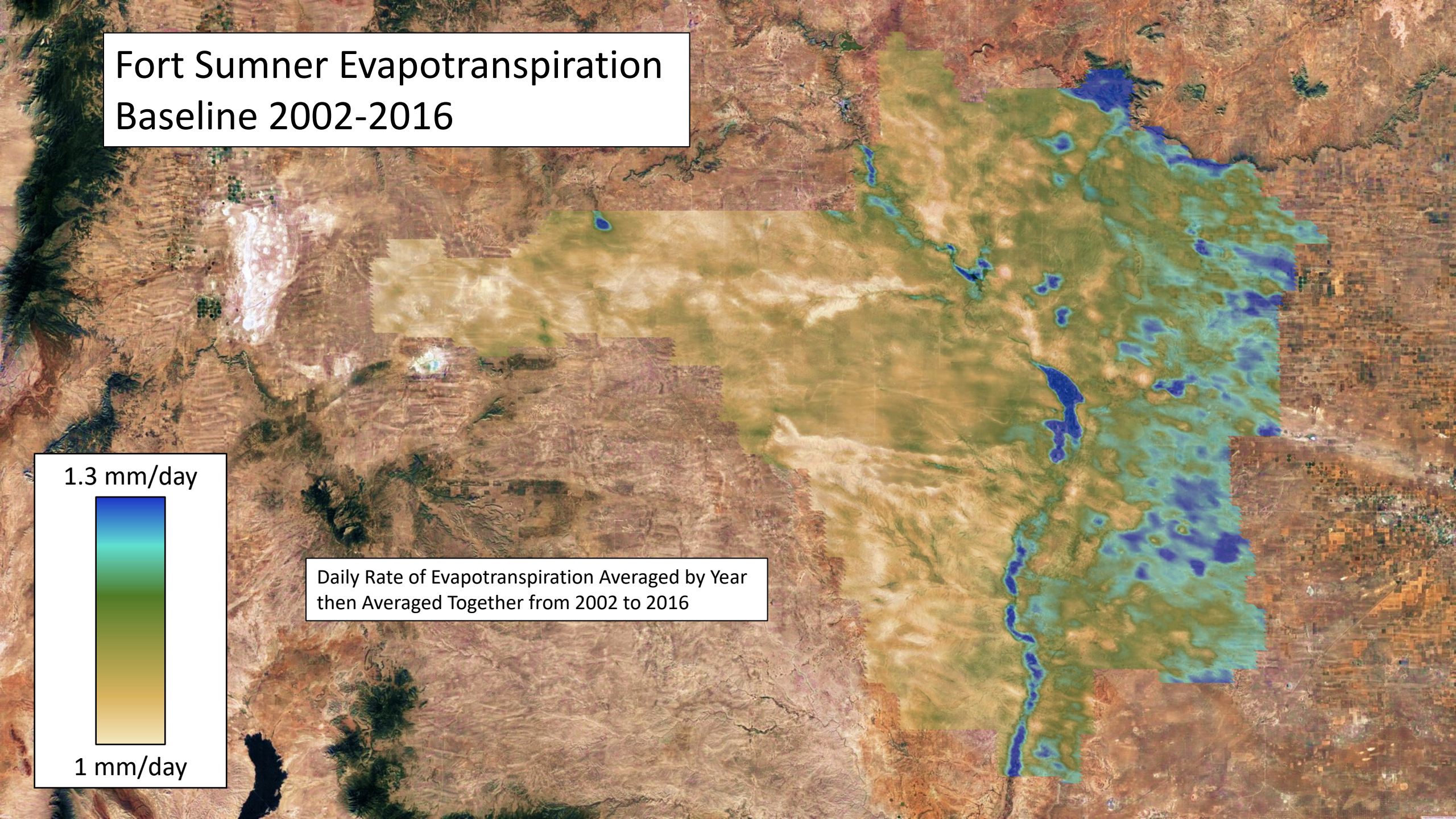
- Achieve broad consensus on a set of climate change scenarios for the Fort Sumner Basin within the context of addressing water supply and demand risks and reliability and other resource issues;
- Develop a comprehensive groundwater model of the Fort Sumner Basin to enhance understanding of the complex relationship between surface water and ground water;
- Update the New Mexico Pecos River Basin surface water model to incorporate hydrologic information developed using the comprehensive groundwater model of the Fort Sumner Basin; and
- Use the new and improved modeling capacity to develop strategies for adaptating to reduced water supplies resulting from climate change.

The New Mexico Interstate Stream Commission is the primary cost-share partner for this study; additional partners include the Carlsbad Irrigation District, the Pecos Valley Artesian Conservancy District and the Fort Sumner Irrigation District. Also, the following stakeholders have provided written support for the study: Chaves County, DeBaca County, Village of Fort Sumner, and the Pecos River Compact Commission. The cost of the study is $240,000, with Reclamation providing $110,000 and New Mexico providing $130,000.

U.S. Department of the Interior
Bureau of Reclamation

https://www.usbr.gov/watersmart/bsp/docs/fy2012/FactSheet-PecosRiverBasinStudy.pdf

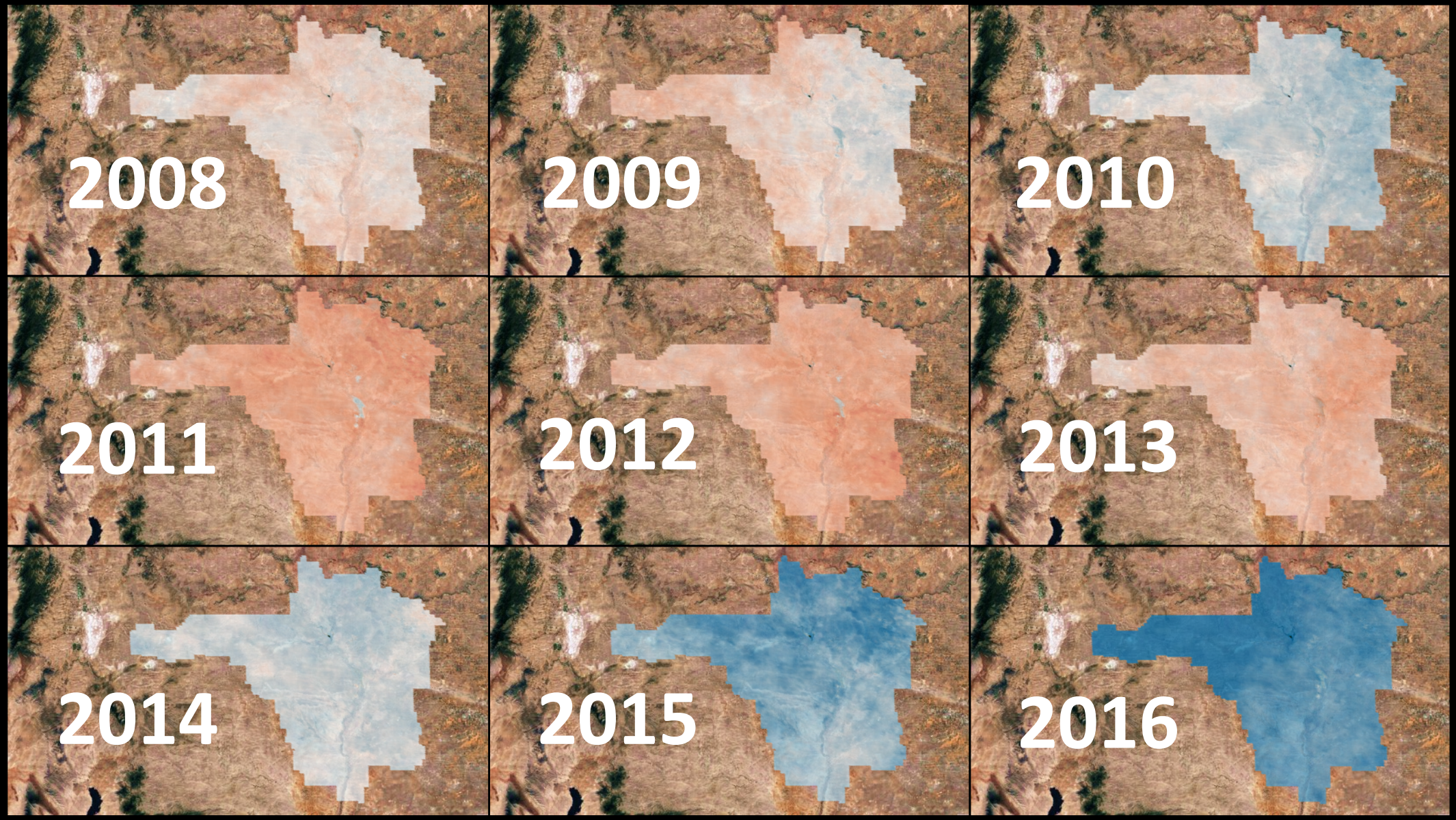
Fort Sumner Evapotranspiration Baseline 2002-2016

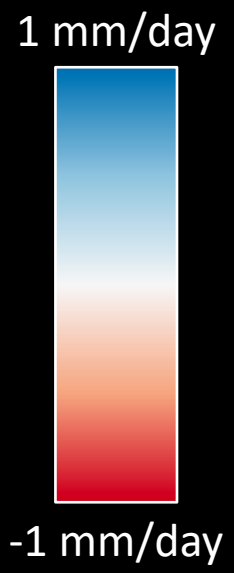


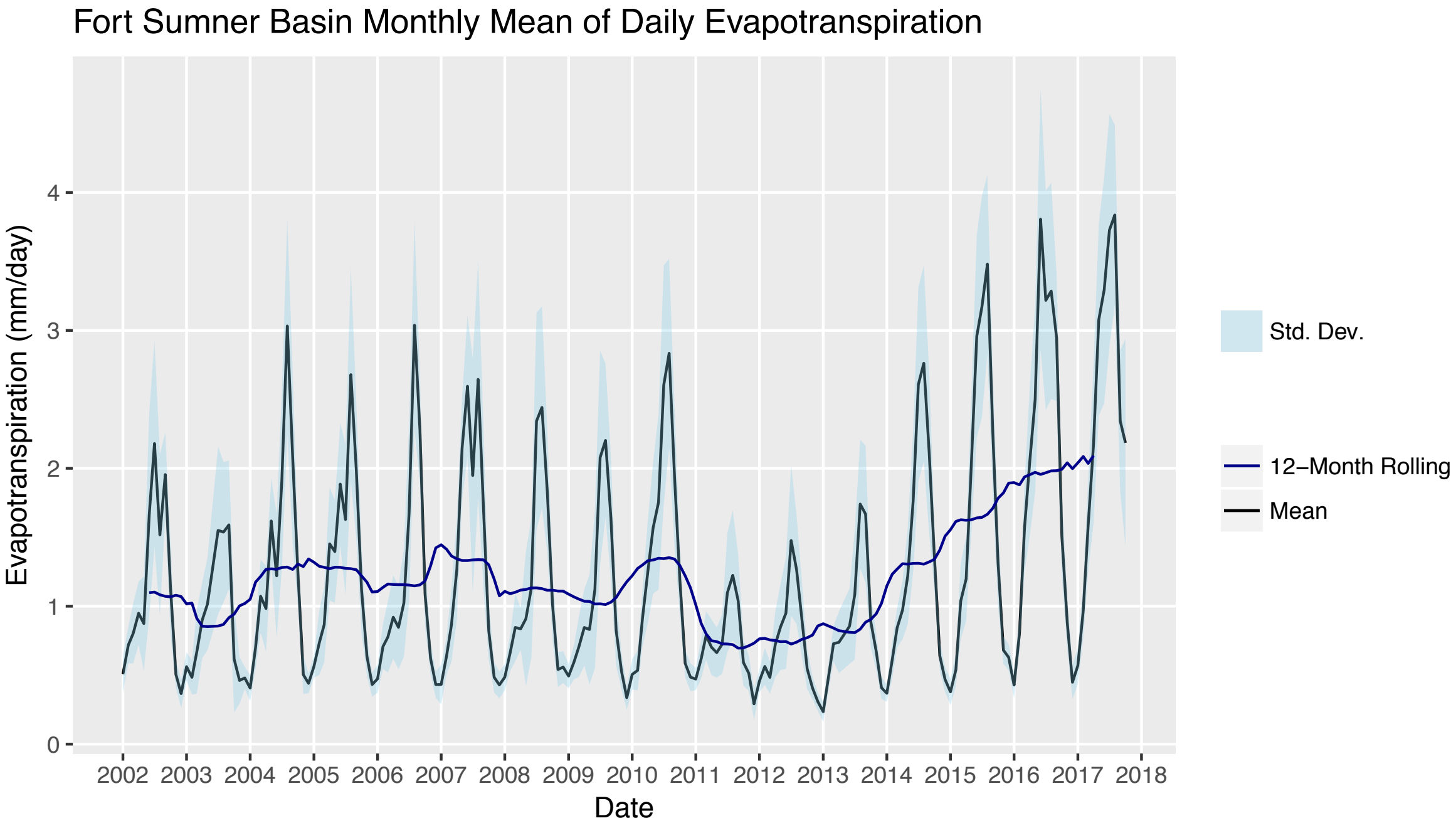
Daily Rate of Evapotranspiration Averaged by Year then Averaged Together from 2002 to 2016

Fort Sumner Evapotranspiration Anomaly

Daily Rate of Evapotranspiration Averaged by Year then Subtracted by Baseline






Fort Sumner Basin Monthly Mean of Daily Evapotranspiration
Evapotranspiration (mm/day)
0
1
2
3
4
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Date
Std. Dev.
12–Month Rolling
Mean

Case Study

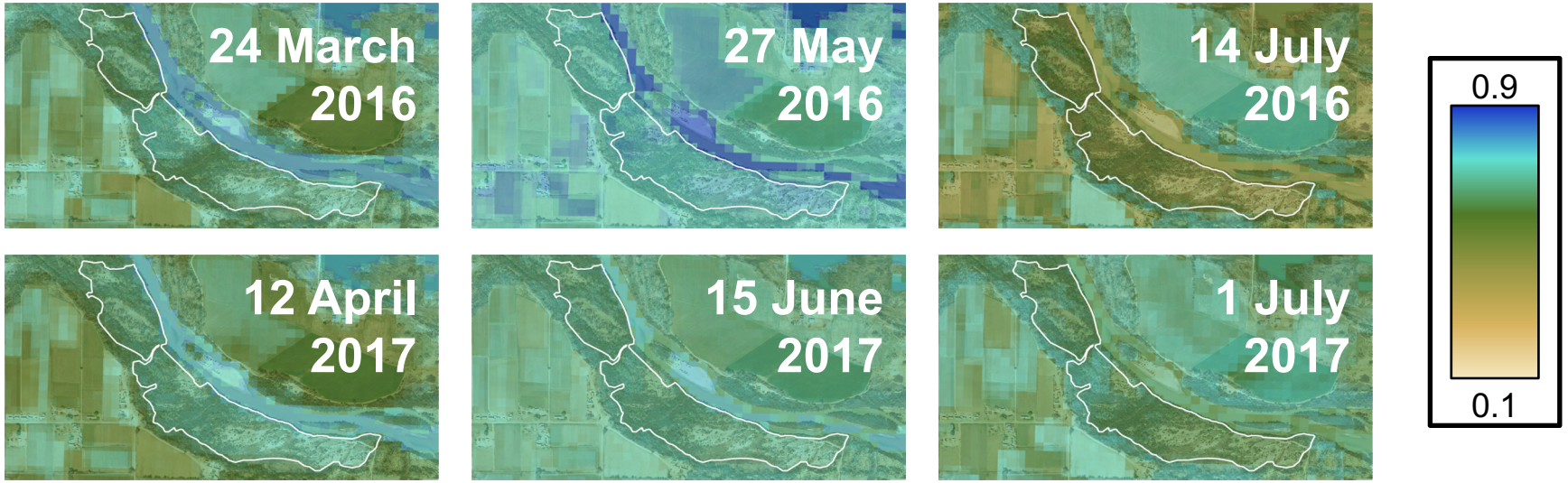
Reducing water consumption from the invasive Russian Olive along the San Juan River

New Mexico State Forestry via NMOSE

Case Study: Drought Monitoring and Water Budget Refinement

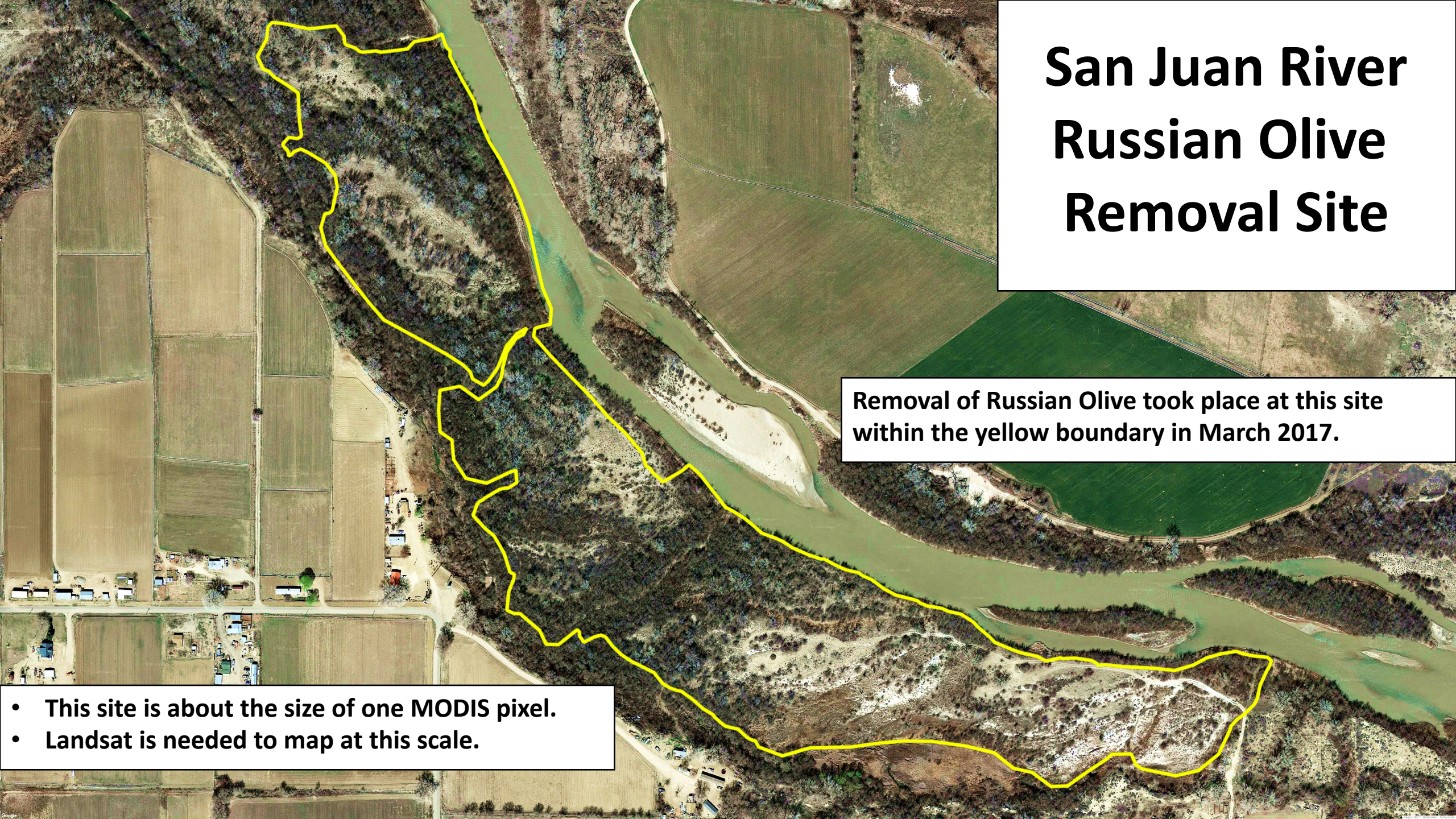
1. Identify areas of invasive water consumption
2. Assess reduction in consumption due to removal

Invasive species in riparian areas consume water and deplete the river as a source of potable water for human use. This example uses remotely sensed evapotranspiration to measure the effectiveness of invasive species removal.



"This riparian corridor was laden with invasive Russian Olive (Elaeagnus angustifolia). Treatment included mechanical cutting to include mastication and herbicide stump spray. Treatment was completed in March of 2017. Follow-up treatments will include foliar treatments for two growing seasons to eliminate re-sprout or germination of target species. Pending future funding, native cottonwood poles will be planted."

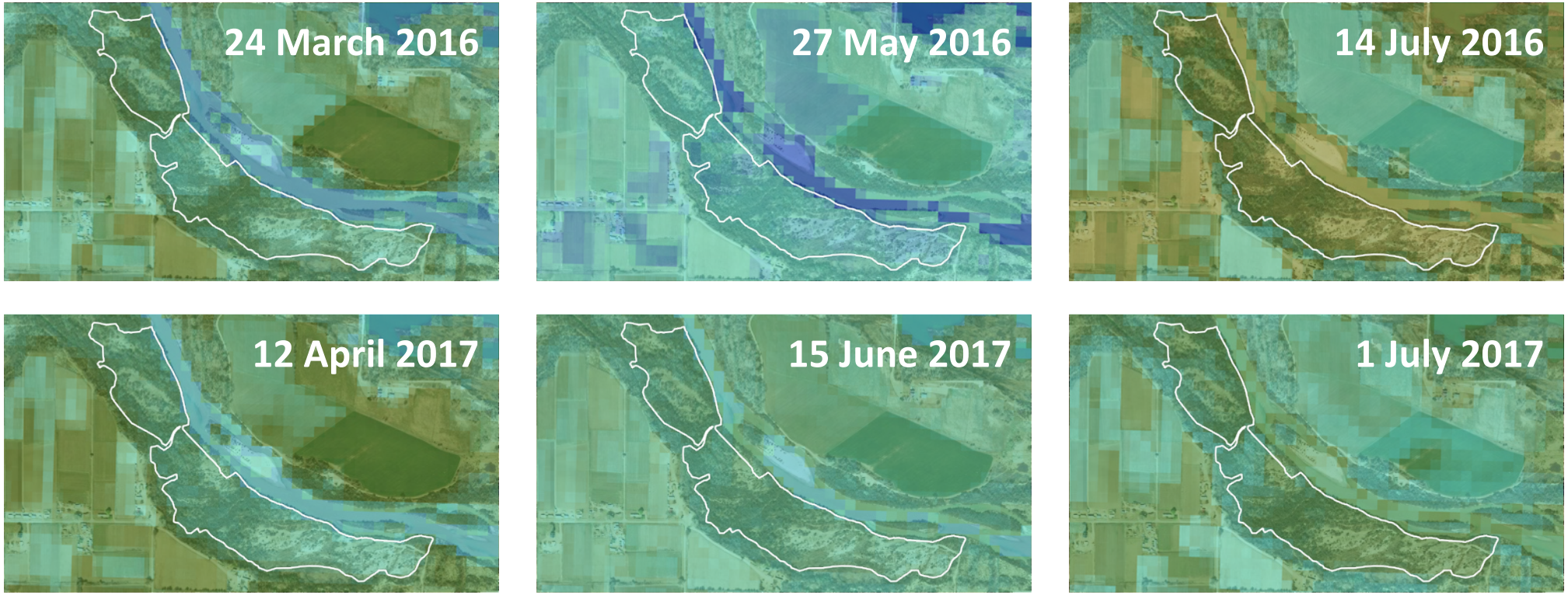
Jose Carrillo
Timber Management Officer

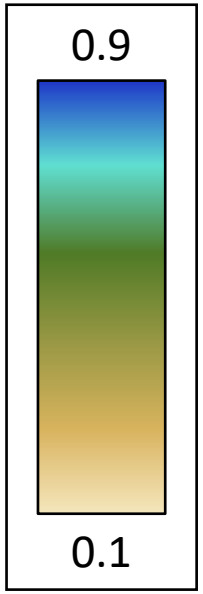

San Juan River
Russian Olive
Removal Site
Removal of Russian Olive took place at this site within the yellow boundary in March 2017.
• This site is about the size of one MODIS pixel.
• Landsat is needed to map at this scale.

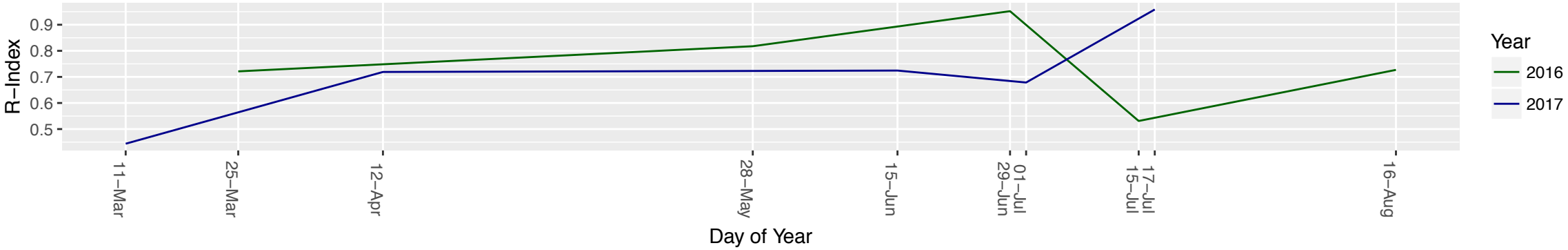
Russian Olive *Elaeagnus angustifolia*

- Thrives on poor soil
- Low seedling mortality rate
- Matures in a few years
- Outcompetes native vegetation
- Invades riparian areas and consumes water

Landsat Evapotranspiration R-Index
Monitoring of Invasive Species Water Use







Stakeholder Engagement Plan

- Collaborative development of automated, ready-made visualization and reports of data for Decision Support System
- Adaptive schedule for collaboration, including weekly to bi-weekly meetings between JPL and NMOSE as needed
- Monthly meetings between NMOSE and State and Federal agencies
- Providing stakeholders opportunity to influence project planning and decision making
- Providing data and obtaining feedback from state and federal agencies as needed
- Providing feedback to software developers on user needs and user experience

Project Milestones

Task/Milestone	Year 1												Year 2												Year 3											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Operations																																				
Proof of application concept matching with user interests																																				
Automated daily data ingest and run																																				
Completion of version 1.0 software system at JPL									★																											
Database interface with web front end																																				
Prototype of WebGIS with accessibility to partner												★																								
Development of web front end																																				
Initial operational system ready for integration and verification																				★																
Integration																																				
Outreach to interested parties/downstream users																																				
Present draft prototype of system to interested parties for feedback												★																								
Applications development through review of suite of case studies																																				
Stakeholders involved in development of decision support system																																				
Document case studies involving scenarios																								★												
System exploration, validation, matching to decision environment																																				
Iteration for refinement of system																																				
Integration and demonstration in decision-making process																																				
~~*Full integration of application prototype into decision-making*~~																														★						
Transition																																				
Routine communication keeping partner informed of technical developments																																				
Document partner technical capabilities and potential for system transition																																				
Partner has knowledge of technical functioning of decision support system																								★												
Code migration																																				
~~Peer reviewed papers describing system~~																																				
~~Testing, validation, verification~~																																				
~~Code development for future scenarios~~																																				
~~*Final approved transition to operational deployment complete*~~																																				★

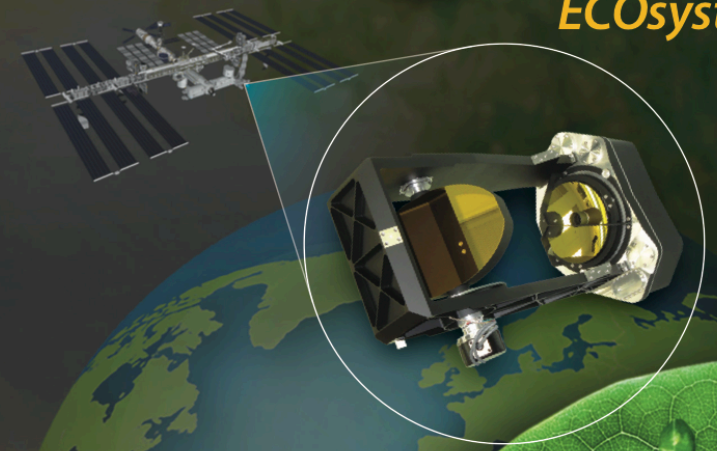
Objective 1 [Year 1-2]: *Develop a seamless, operational ET system that meets the requirements of the data user and is ready for integration into the decision making process.*

Objective 2 [Year 1-2]: *Test and improve the system prototype in the water management environment and fully integrate into the decision making process.*

~~**Objective 3 [Year 3]:** *Deploy the system to a low maintenance, operational environment for sustained use in water management decision making.*~~

ECOSTRESS

ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station



An Earth Venture Instrument-2 Proposal

Submitted in response to

AO NNH12ZDA006O EVI2

Prepared for

National Aeronautics and Space Administration
Science Mission Directorate

PI — Simon Hook (JPL)

Science Lead — **Joshua B. Fisher** (JPL)

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Chris Hain (UMD)
Glynn Hulley (JPL)
Eric Wood (Princeton U.)

November 25, 2013

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29 JUN 2018: 5.30am

CRS-15 Mission
T- 00:00:10
UPCOMING
LIFTOFF
STARTUP
THE FALCON 9 FLIGHT COMPUTERS HAVE TAKEN CONTROL OF THE COUNTDOWN
LAUNCH: CRS-15
STARTUP
MAX-Q
SECOND ENGINE STARTUP
DRAGON DEPLOY
SPACEX

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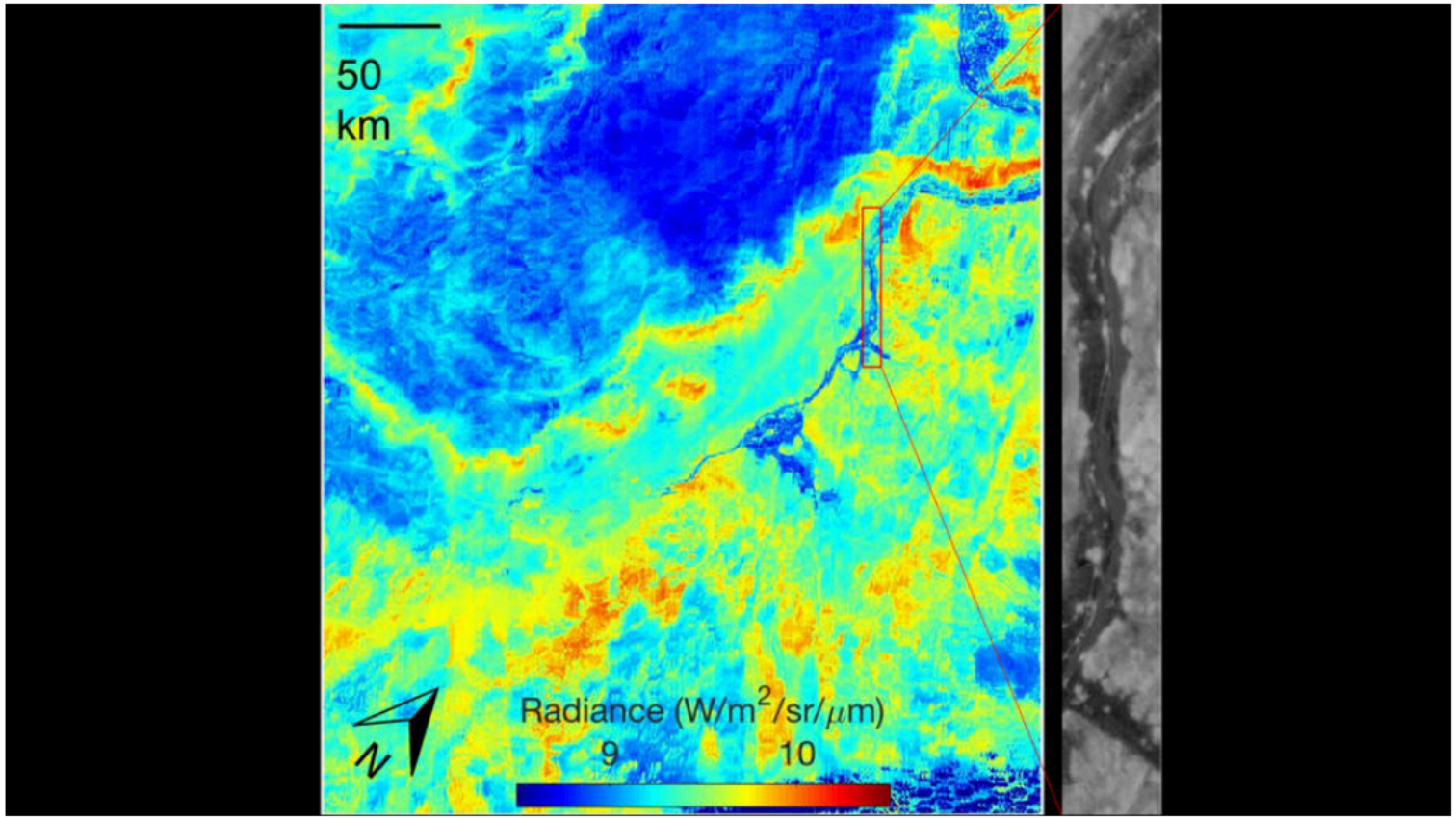
ECOSTRESS

July 23, 2018

NASA's 'Space Botanist' Gathers First Data



ECOSTRESS acquired this image the night of July 9 over Egypt. Yellow and red indicate generally higher temperatures. The River Nile is visible as a thin blue line on the main image. The black-and-white inset shows the level of detail available from ECOSTRESS, with the relatively cool Nile River and surrounding vegetation appearing darker.
Credits: NASA/JPL-Caltech
Full image and caption

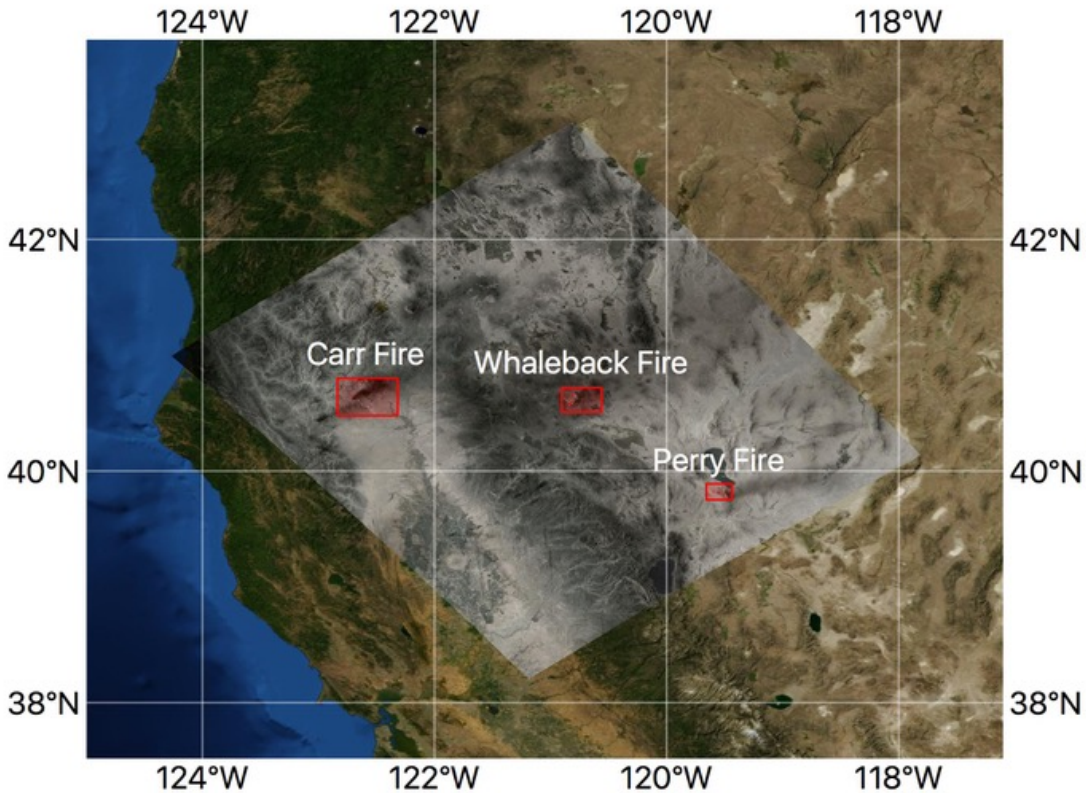
Just days after its successful installation on the International Space Station, NASA's newest Earth-observing mission, the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), has collected its first science data on Earth's surface temperature.

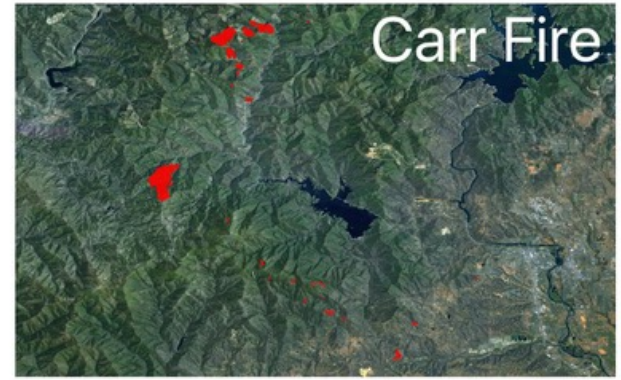
Carr, Whaleback, and Perry Fires as seen by ECOSTRESS 28 July 2018 18:45 PST

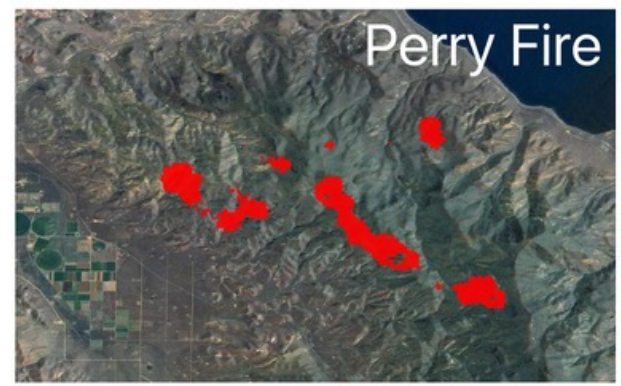
Band 4 Radiance Centered at 10.5 µm

8 W m^{-2} sr^{-1} μm^{-1} 12

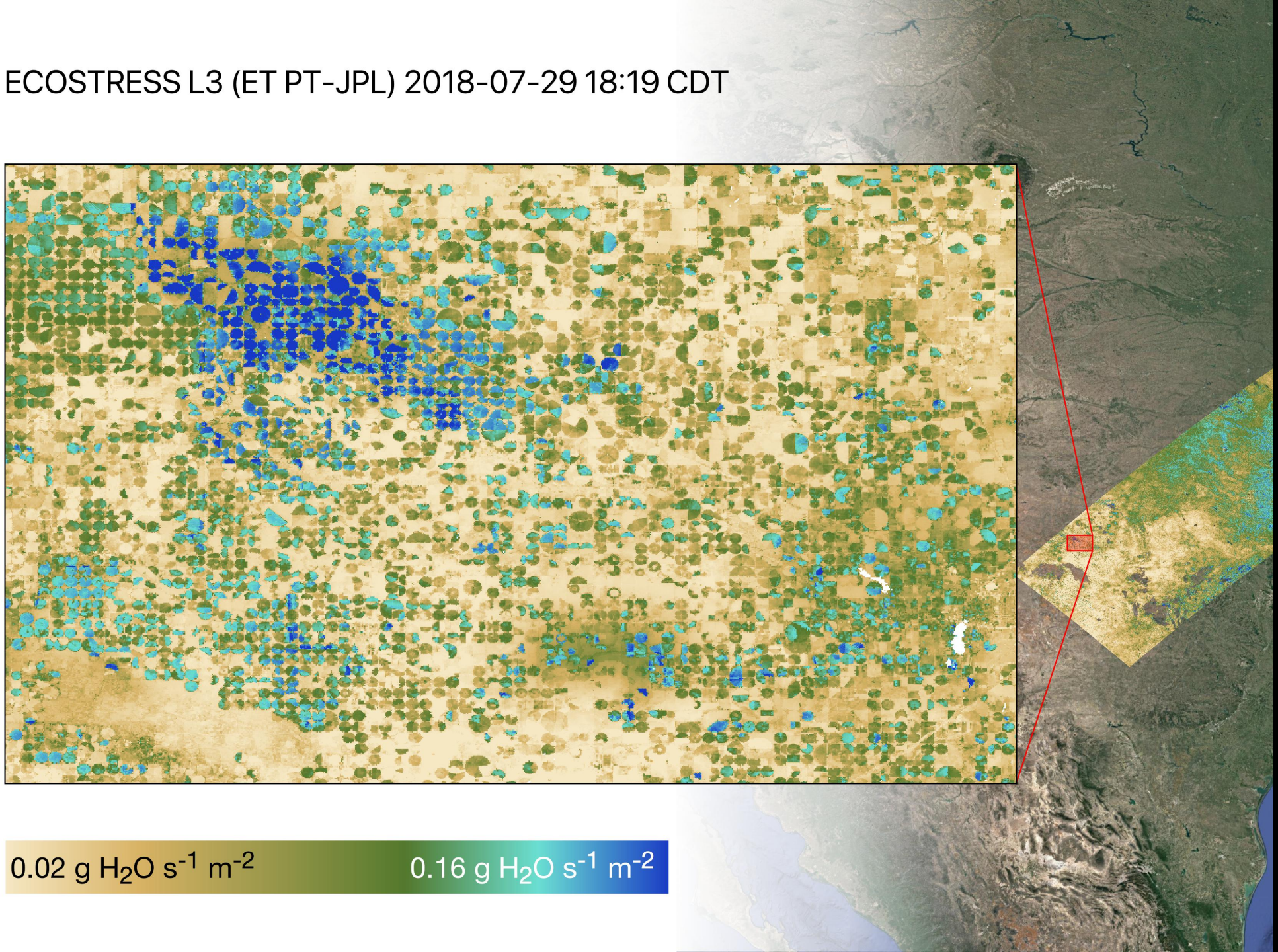
Fire > 12







ECOSTRESS L3 (ET PT-JPL) 2018-07-29 18:19 CDT



THE FUTURE OF
EVAPOTRANSPIRATION
Global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources.