Landsat Thermal Data:

Bringing Peace to Western Water Rights

Whiskey's for drinking.
Water's for fighting over.

Tony Morse Idaho Department of Water Resources July 16, 2008

Agenda

State applications using thermal data

- Idaho in detail
- Other states briefly

Sharpening thermal data: NN versus CC

Landsat TIR Significance

1. Unbiased data
2. Single data source
3. Only source of field-level data
4. Availability of a large data archive.

Idaho Example

Water call 12/07 by A&B Irrigation District

Water Call

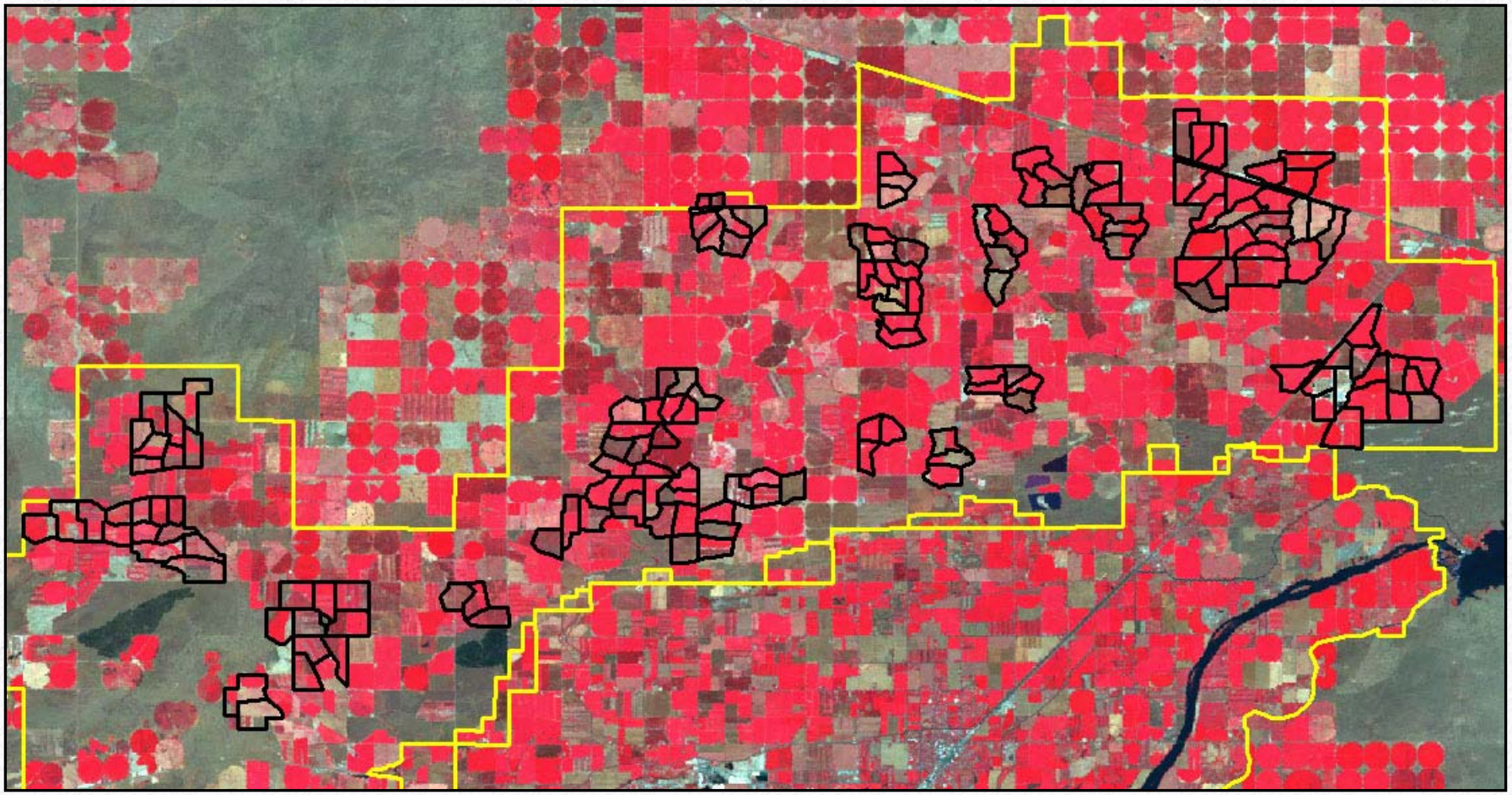
- Claim of injury due to water shortage in 2006
- Demand for curtailment order to junior irrigators

A Curtailment Order

- Issued by IDWR
- Has the force of law
- Built on Findings of Fact

At stake: >1,000 farmers' livelihoods.

Findings of Fact



Polygons of fields claimed to be water-short in 2006.

The Crux of the Issue

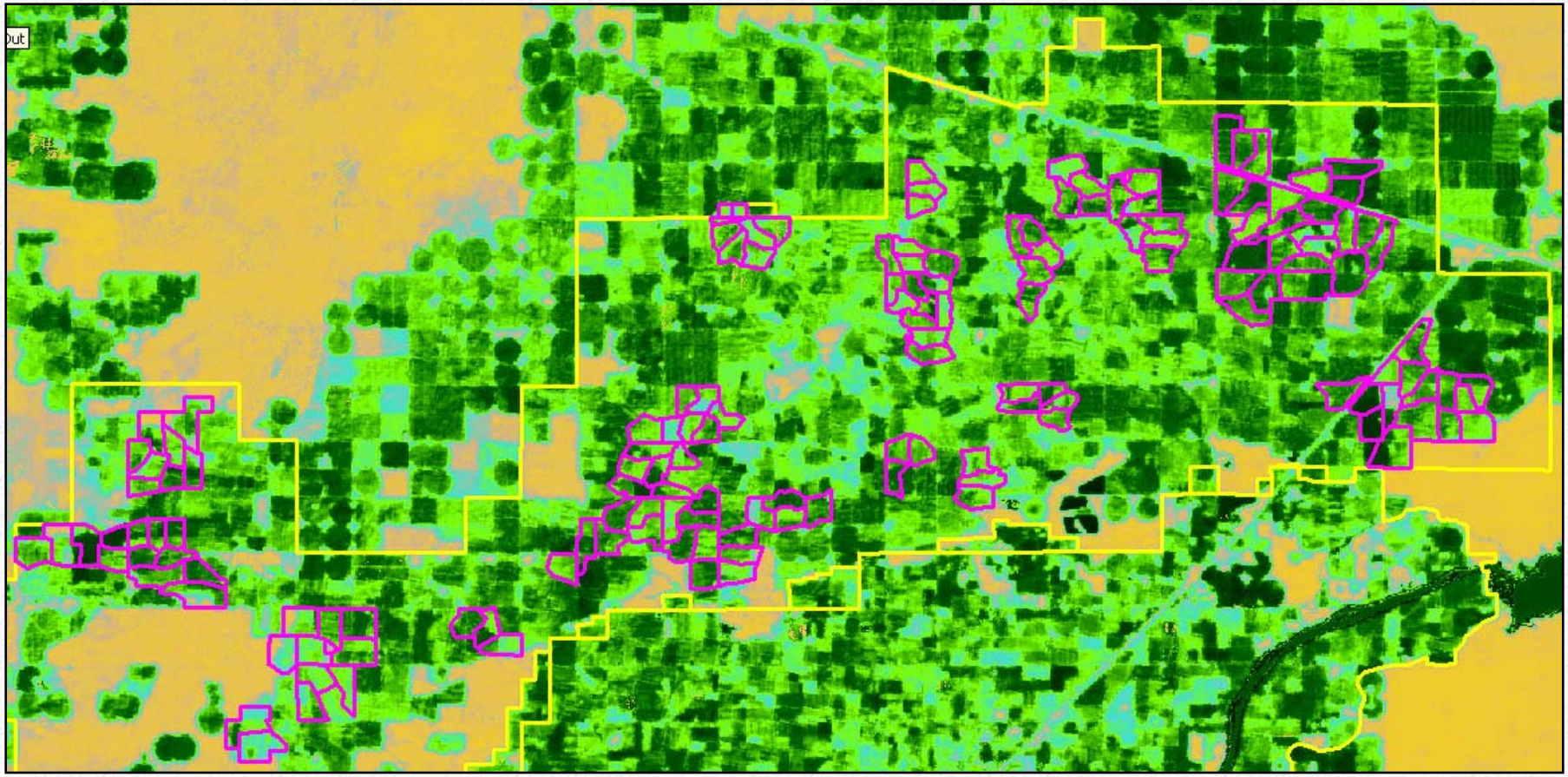
Was there enough water in 2006?

How do you assess that 2 years later?

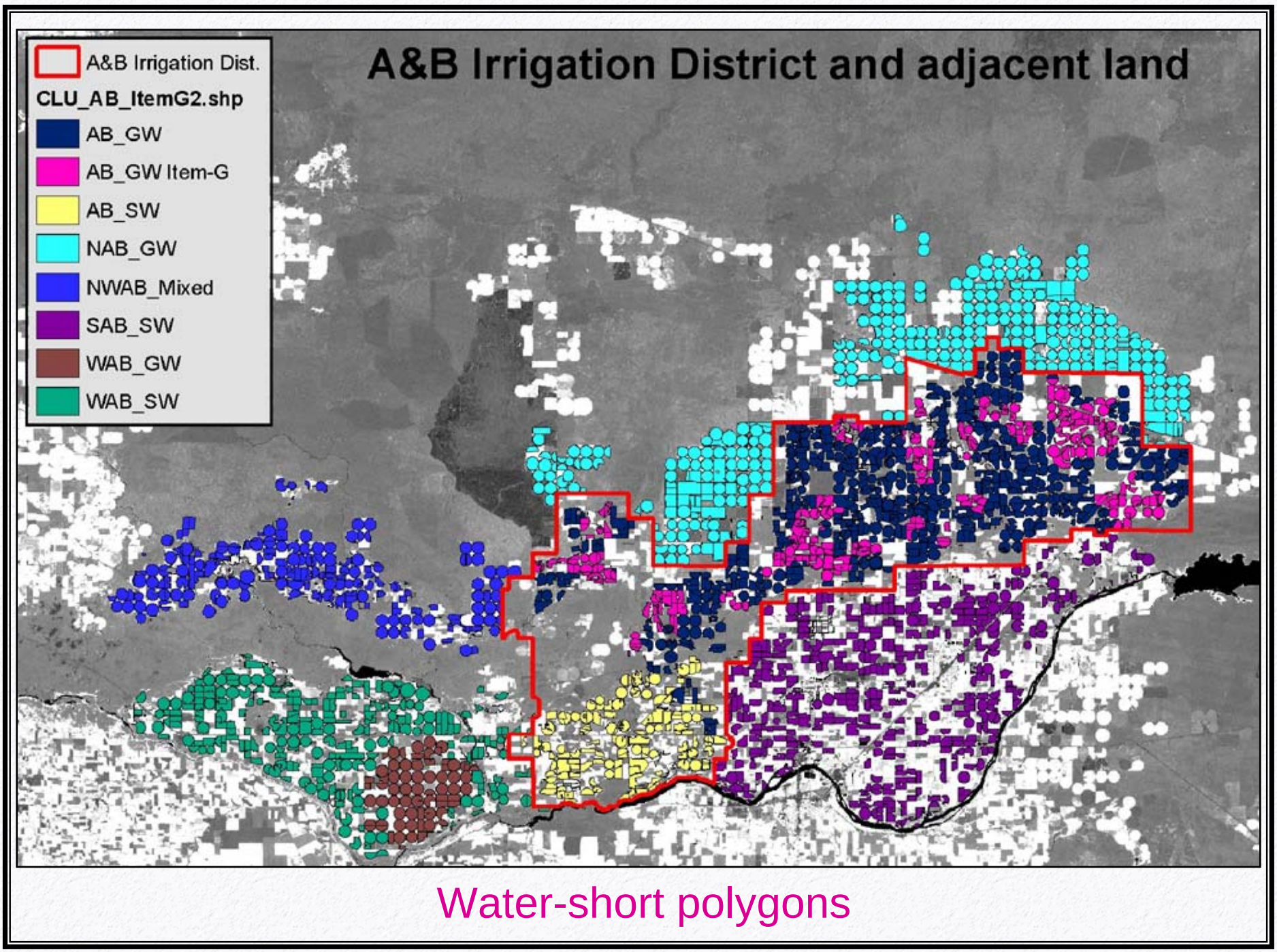
How do you evaluate individual fields?

The Answer

Use Landsat to map 2006 evapotranspiration



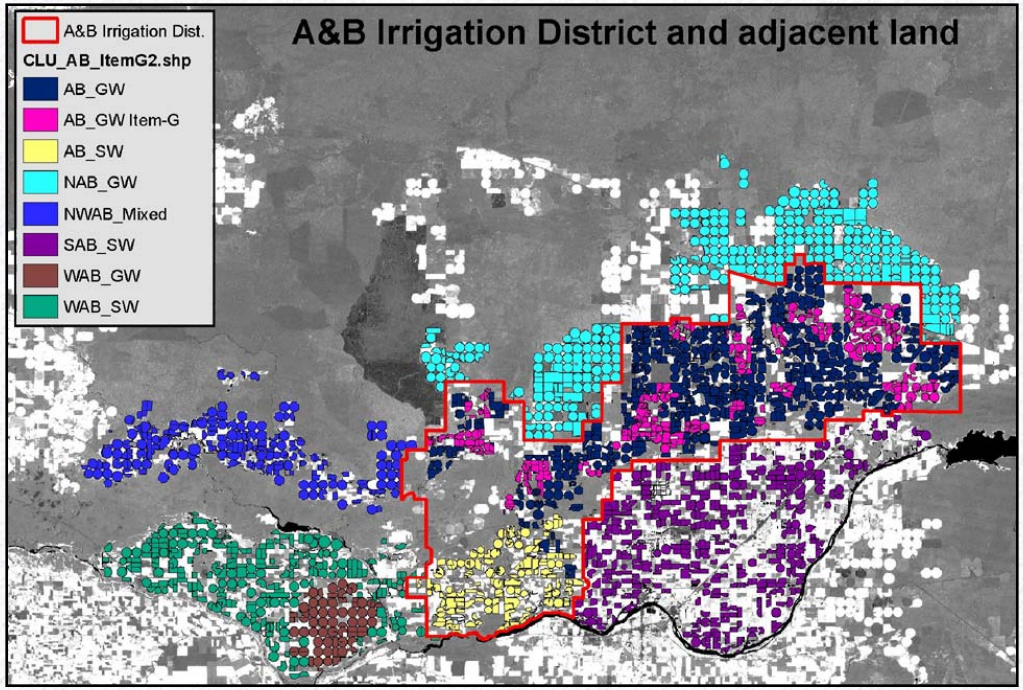
Purple polygons are fields claimed to be water-short in 2006



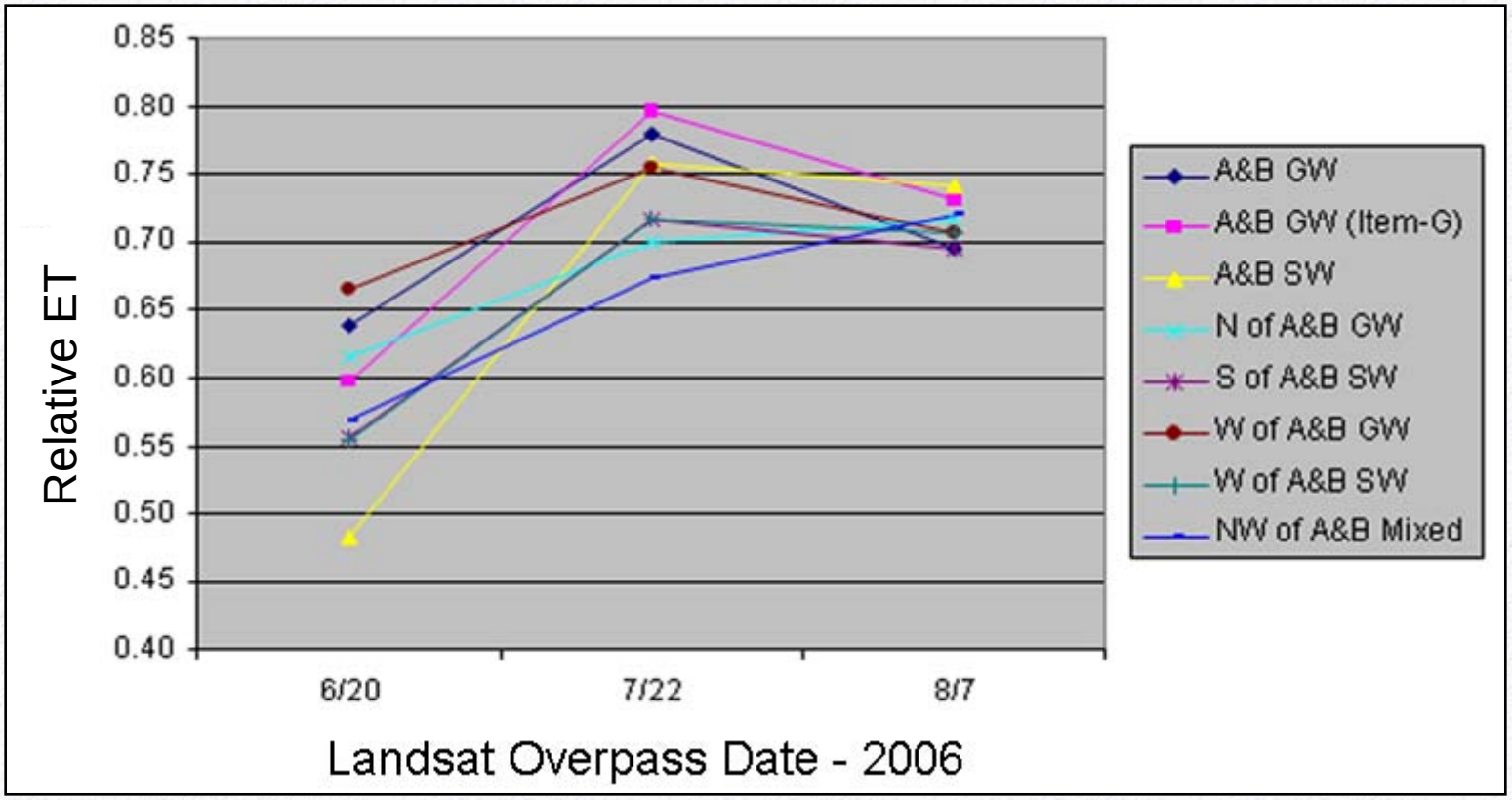
Water-short polygons

The Analysis

2006 Images: 6/20, 7/22, 8/7
Compared mean 24-hour ET
Compared mean NDVI values
Compared mean ratio ET / NDVI

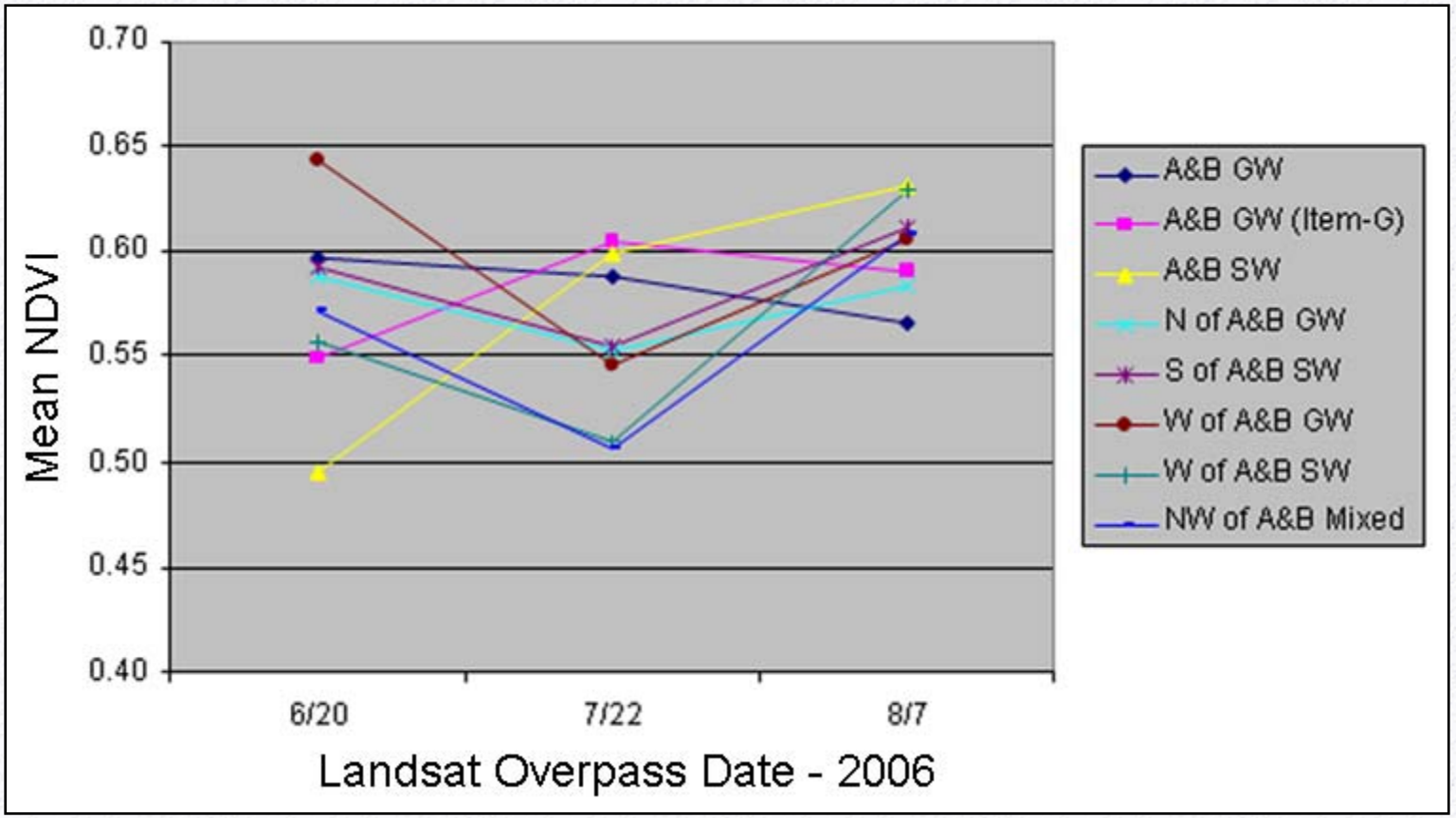


Relative ET



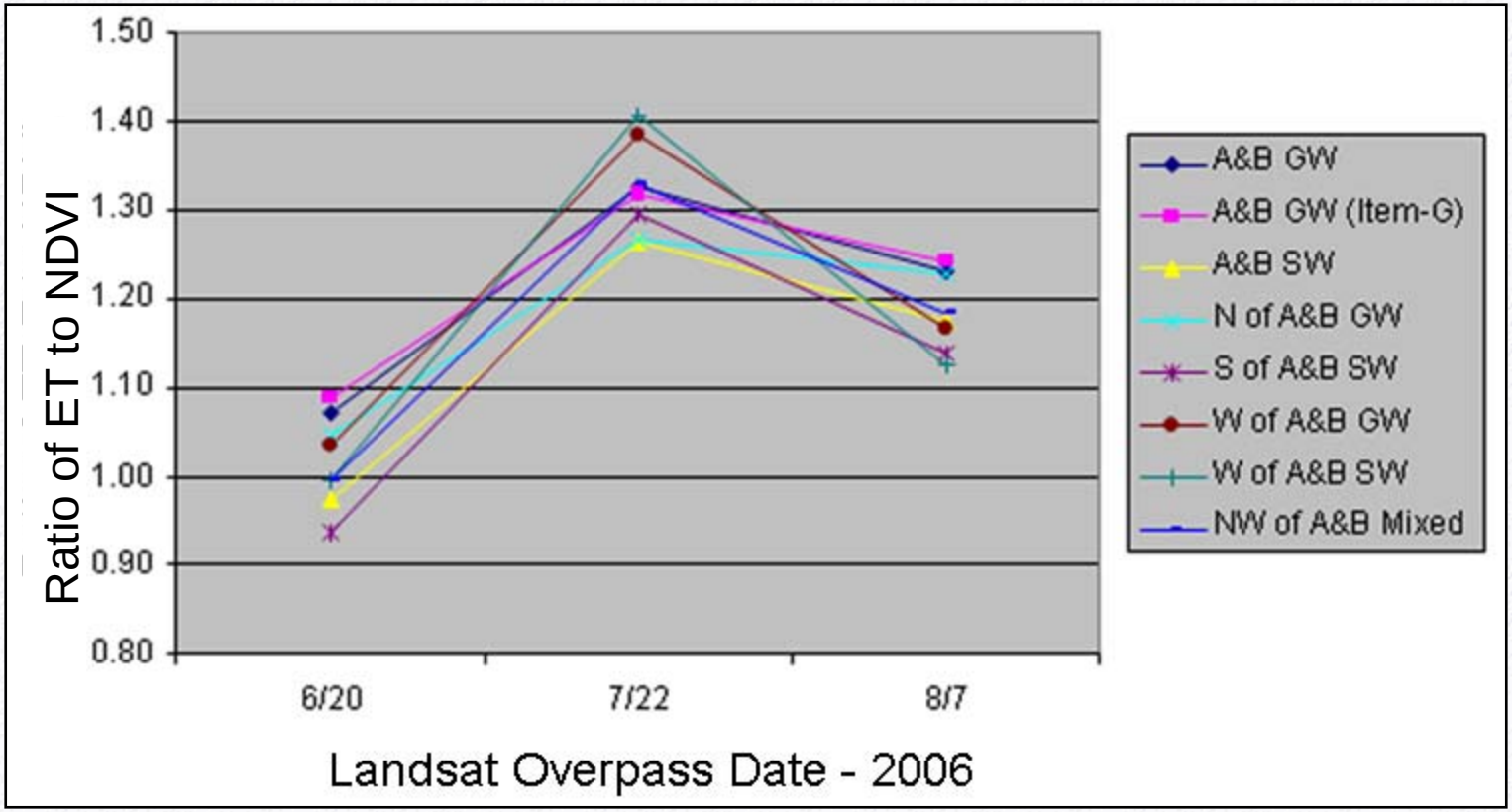
How much evapotranspiration?

Mean NDVI



How much vegetation?

ET / NDVI



How much evapotranspiration per amount of vegetation?

Result

IDWR denied the call

A&B is appealing

Analysis based on

- unbiased data sets
- single data source
- field-level data.

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF THE PETITION FOR DELIVERY CALL OF A&B IRRIGATION DISTRICT FOR THE DELIVERY OF GROUND WATER AND FOR THE CREATION OF A GROUND WATER MANAGEMENT AREA	)	**ORDER**

This matter originally came before the Director of the Department of Water Resources ("Director" or "Department") on July 26, 1994 when the A&B Irrigation District ("A&B" or "District") filed a petition for delivery call, which sought administration of junior priority ground water rights diverting from the Eastern Snake Plain Aquifer ("ESPA"), as well as the designation of the ESPA as a ground water management area.

On May 1, 1995, A&B, the Department, and other participants entered into an agreement that stayed the petition for delivery call until such time as a motion to proceed was filed with the Director. On March 16, 2007, A&B filed a motion to proceed seeking the administration of junior priority ground water rights, as well as the designation of the ESPA as a ground water management area.

Based upon the Director's consideration of the available information and documents filed herein, the Director enters the following Findings of Fact, Conclusions of Law, and Order.

FINDINGS OF FACT

Procedural History

1. On July 26, 1994, A&B filed a Petition for Delivery Call ("Petition") with the Department. The boundary of the A&B Irrigation District is depicted in Attachment A. According to the Petition, A&B "is the beneficial owner of Water License No. 20736, now known as A-36-02080, which entitles the Irrigation District to divert eleven hundred (1100) cfs from one hundred seventy-seven (177) wells for the irrigation of sixty-two thousand six hundred four and three tenths (62,604.3) acres within the irrigation district, with a priority of September 9, 1948." *Petition* at 1, ¶ 2. "That said water right is held in trust by the United States, for the benefit of the owners of said 62,604.3 acres, all of whom are landowners within and are included within A&B Irrigation District." *Id.* at 1, ¶ 3. Additionally, the Petition stated that due to diversions from the ESPA by junior priority ground water users, A&B "is suffering material injury as a result of the lowering of the ground water pumping level within the E[SPA] by an

Other States

Water resource applications of evapotranspiration based on Landsat thermal data

Nevada

Montana

Colorado

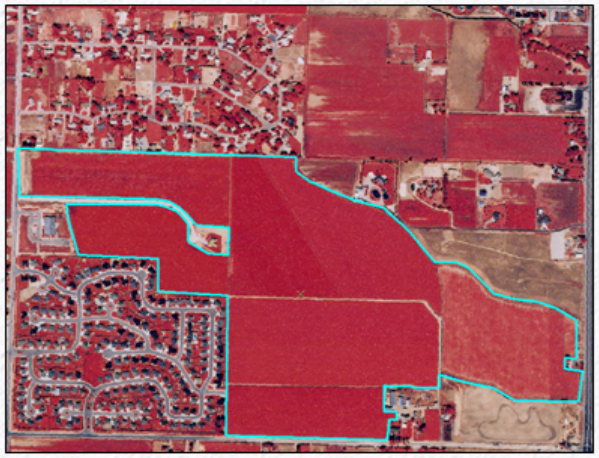
New Mexico

Nevada

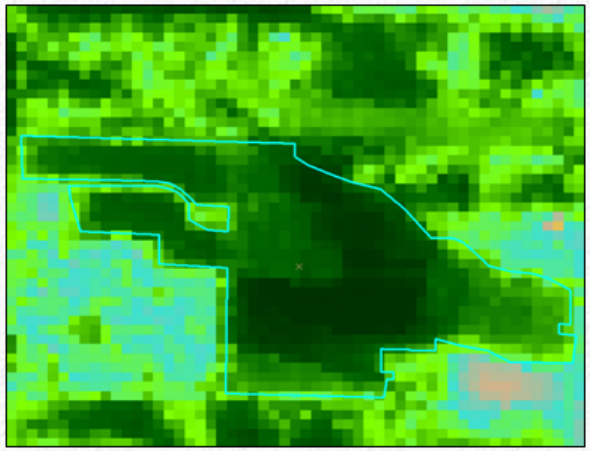
Issue: Water transfers from agriculture to cities

How much water used by an alfalfa field before conversion to residential?

Need Landsat TIR for the answer



2000



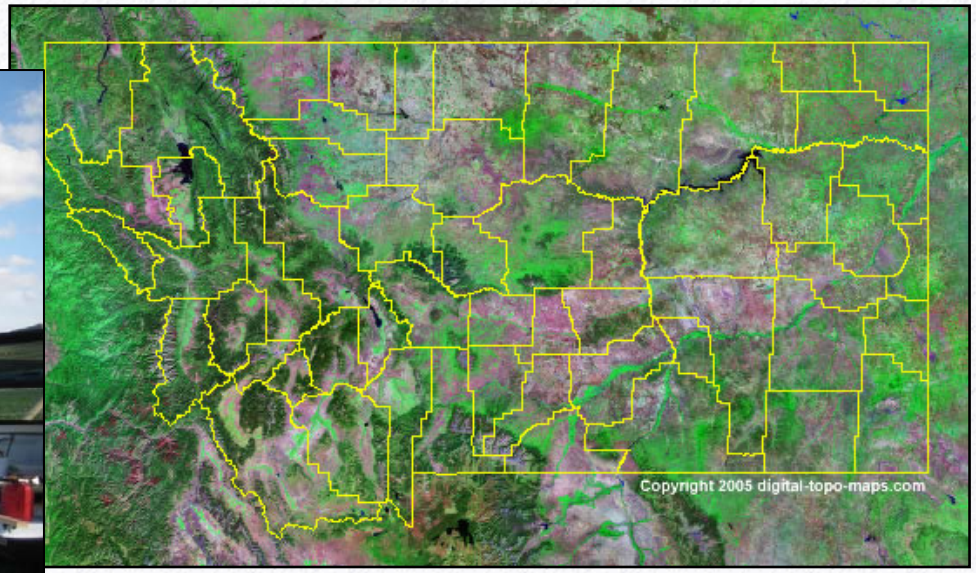
2000 Seasonal ET

2006

Montana

Issue: Indian Water Rights

ET from Landsat thermal data confirm historical field-by-field water consumption.



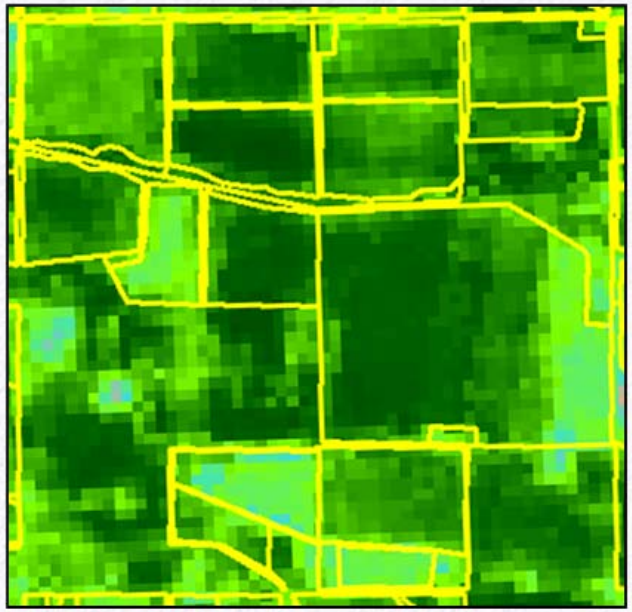
Colorado

Issue: Ground-water irrigation impacts river flows

State Engineer curtailing individual fields

You can’t manage what you can’t quantify

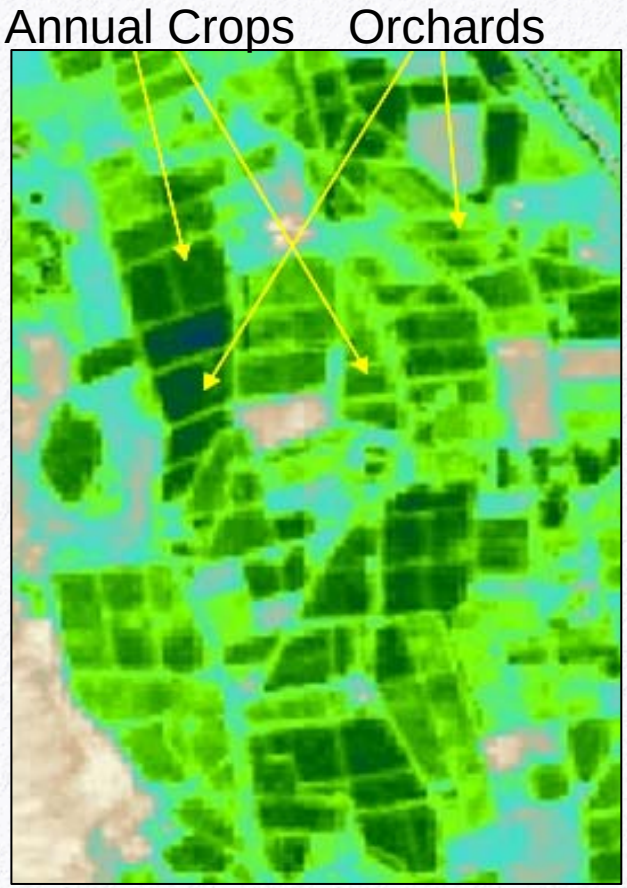
Only Landsat can quantify ET field-by-field.



New Mexico

Issue: Water-use by orchards

Intermingled orchards and crops require field-level data.



Final Thought

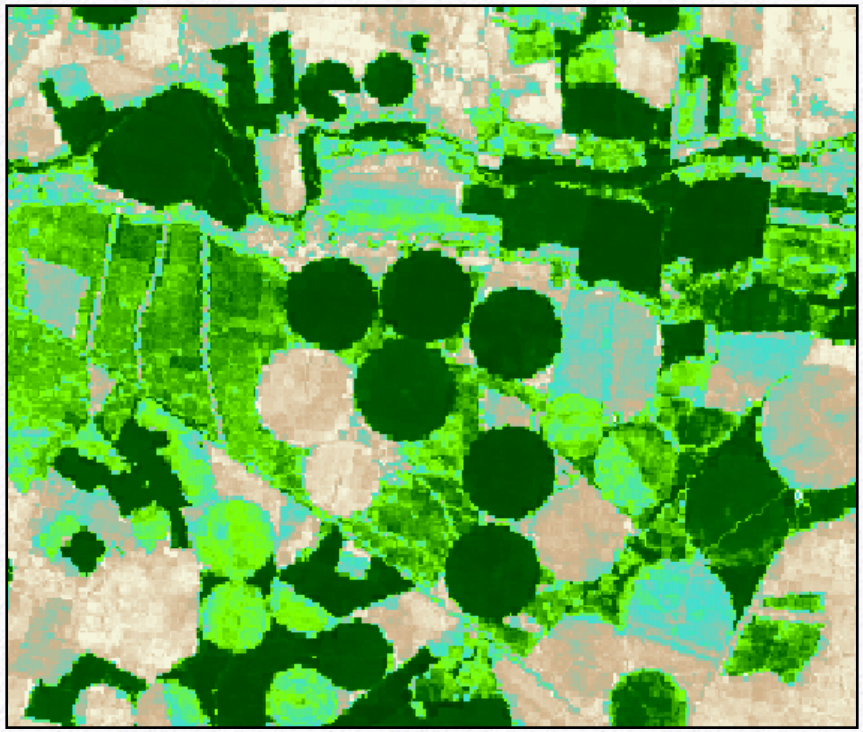
The state of Nebraska sued Wyoming in 1986 over provisions of the 1945 North Platte Decree. Wyoming agreed to many reporting requirements as a part of the settlement decree, one of which is estimating consumptive use.

We believe that using Landsat thermal band data would be an efficient way for making consumptive use calculations that would be agreeable to all the parties, including the federal government, which is party to the settlement, represented by the Bureau of Reclamation.

Patrick Tyrrell, Wyoming State Engineer
to
Dr. Gene Whitney, OSTP
August 11, 2006

Sharpening Thermal Data

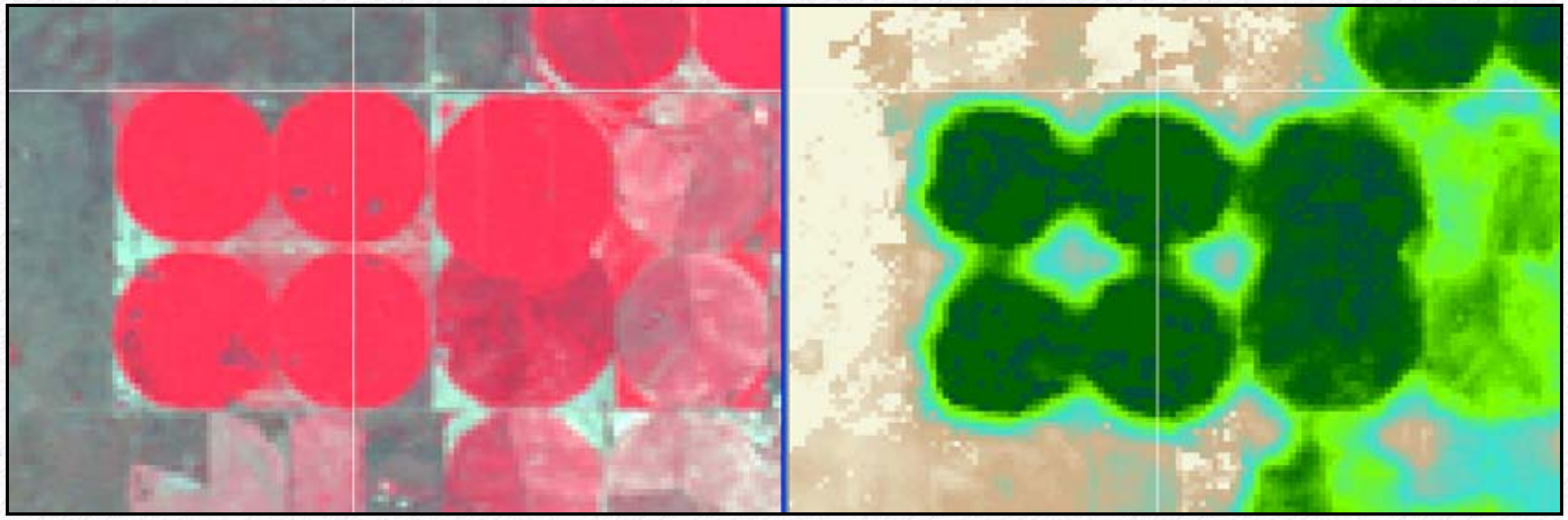
120-meter good; 60-meter better
Nearest neighbor is better than cubic convolution



ET using sharpened Landsat 5 TIR

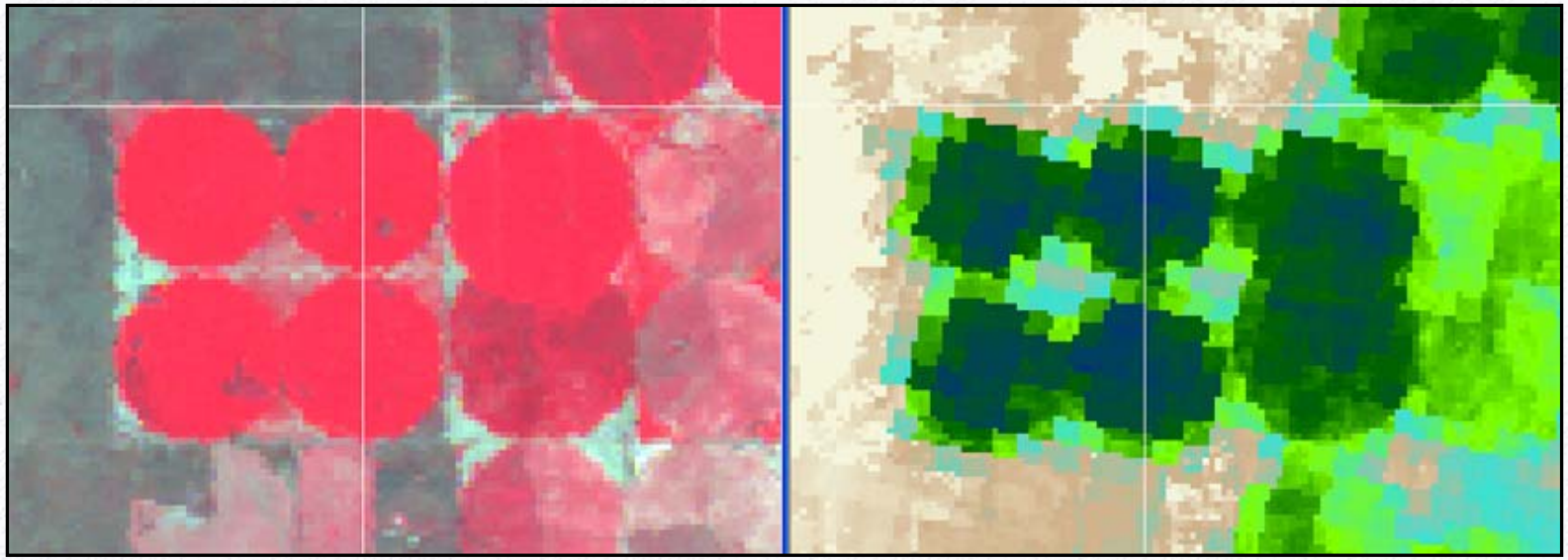
Landsat 5 06/20/06 – Cubic Convolution

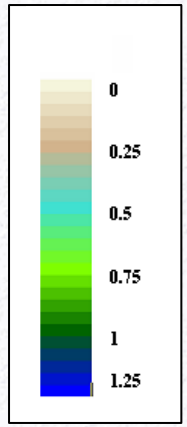
Relative ET



Landsat 5 06/20/06 – Nearest Neighbor

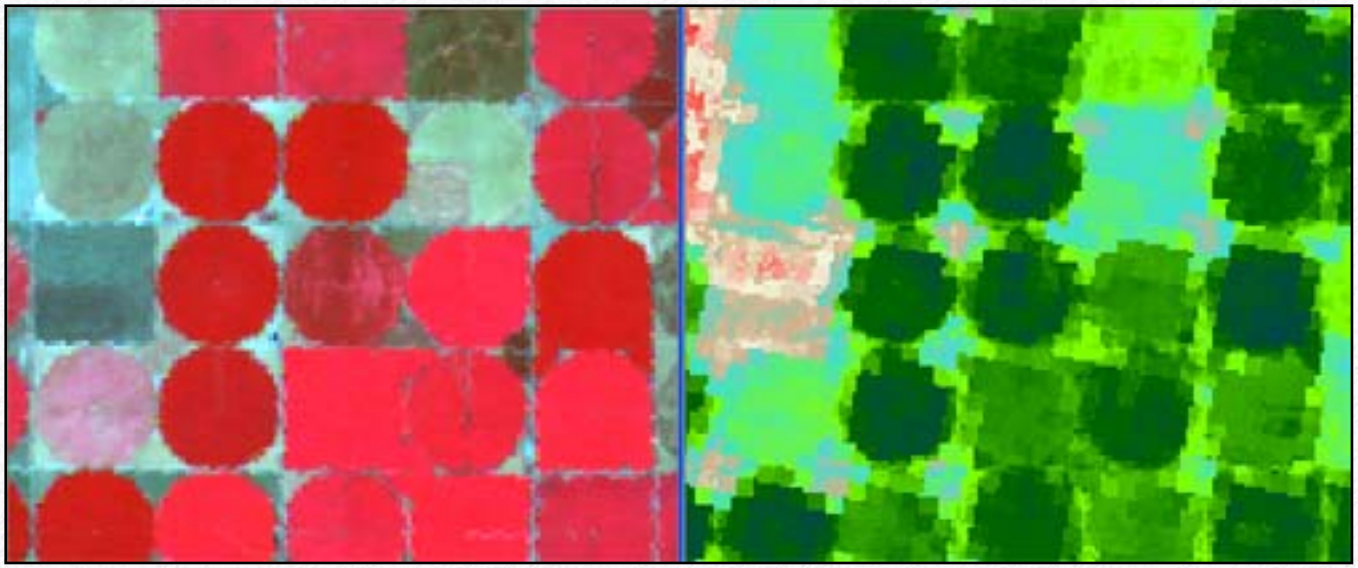
Relative ET





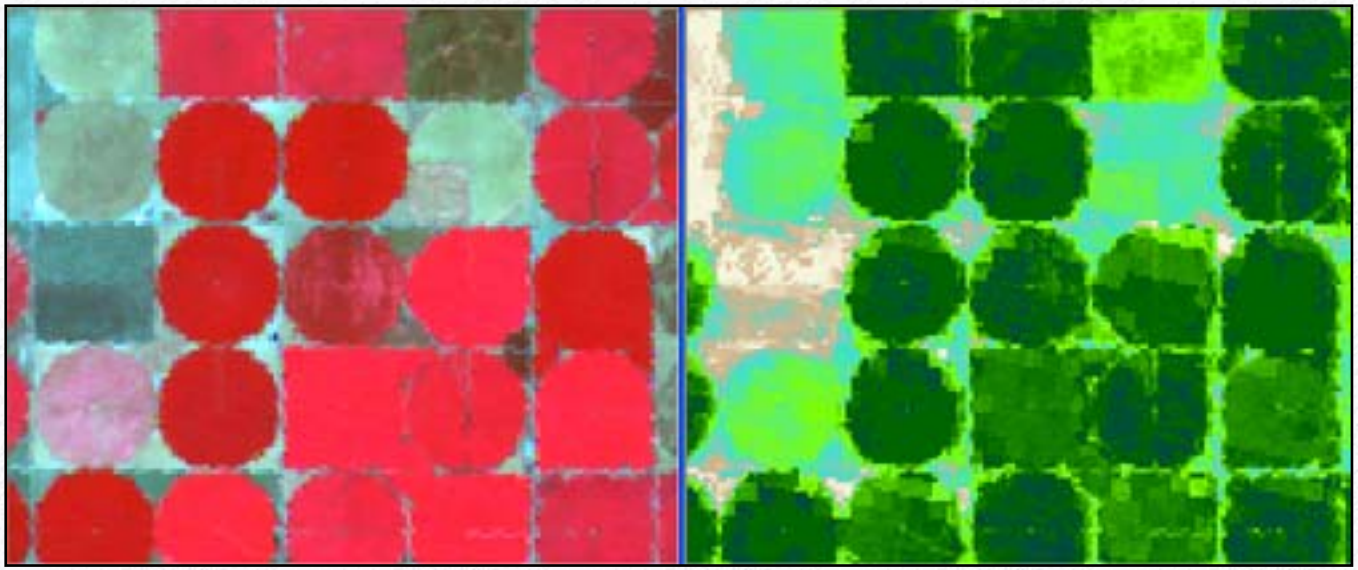
Landsat 5 07/22/06

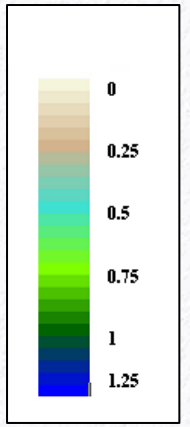
Relative ET NN temperature



Landsat 5 07/22/06

Relative ET sharpened temperature



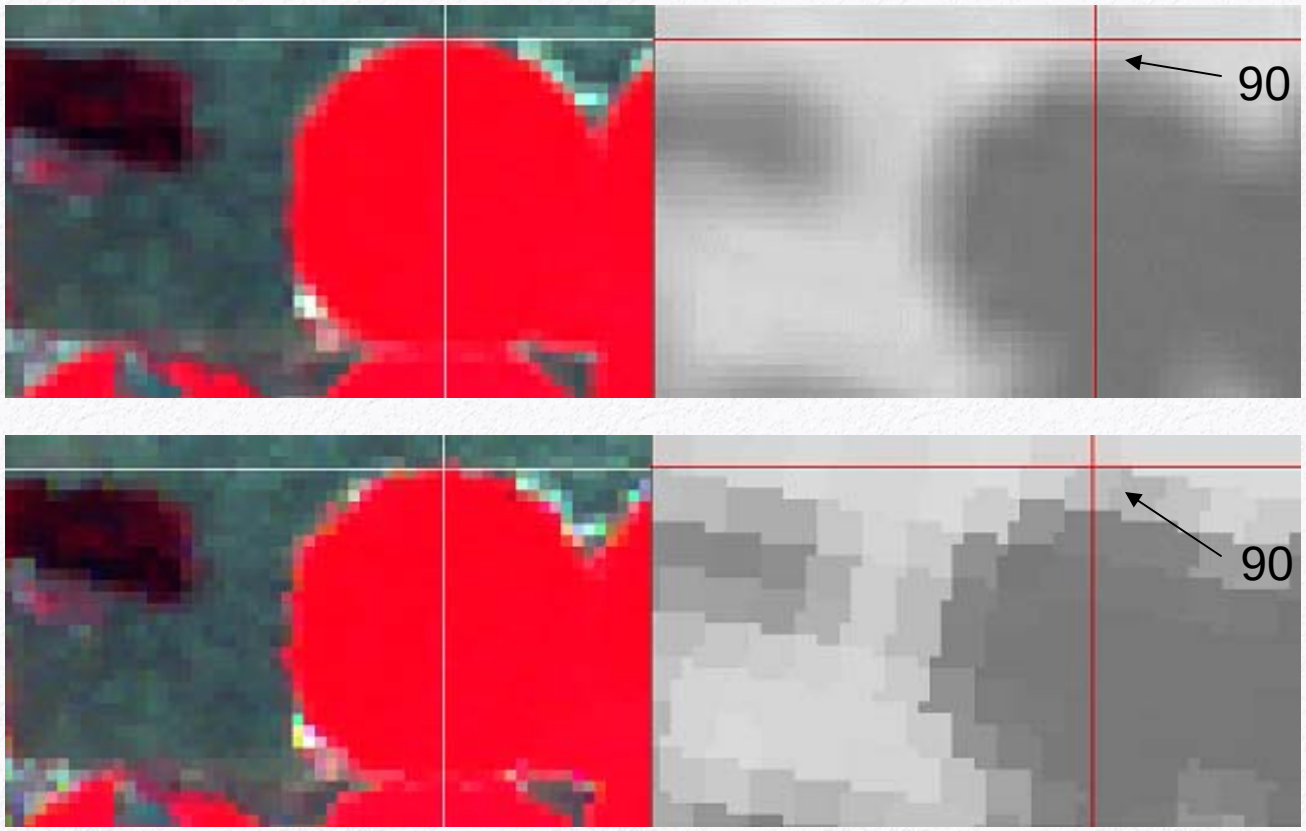


2008 Issue – Landsat 5

EROS L1T thermal band shift when re-sampled to 30 m

Reported to EROS (*unresolved)*

False color Thermal



The Future

(if TIR is on LDCM)

Under the provisions of the Colorado River Compact, if the upper basin states are not able to satisfy their obligation of water, curtailment will be based on the water-use in the previous year.

Wyoming does not now have that information available. We believe that Wyoming could determine consumptive water use from irrigated lands much more cheaply and efficiently using Landsat technology rather than the standard methods we currently use.

Excerpt of a letter from
Patrick Tyrrell, Wyoming State Engineer
to
Dr. Gene Whitney, OSTP
Aug.11, 2006


Questions?

Method	Number of wells	Total Cost	Cost per Well
Power Consumption Coefficients	3,830	$456,995	$119.32
Landsat Thermal Data ESPA	3,830	$121,700	$ 32.15
Landsat Thermal South Idaho	5,948	$199,450	$ 33.53