

Presentation on the Background of the ET Mapping Procedure

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Ag Engineer

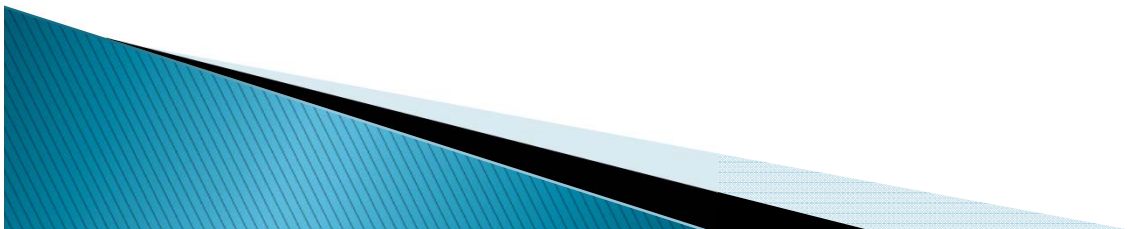
Montana Reserved Water Rights Compact Commission

September 4, 2012



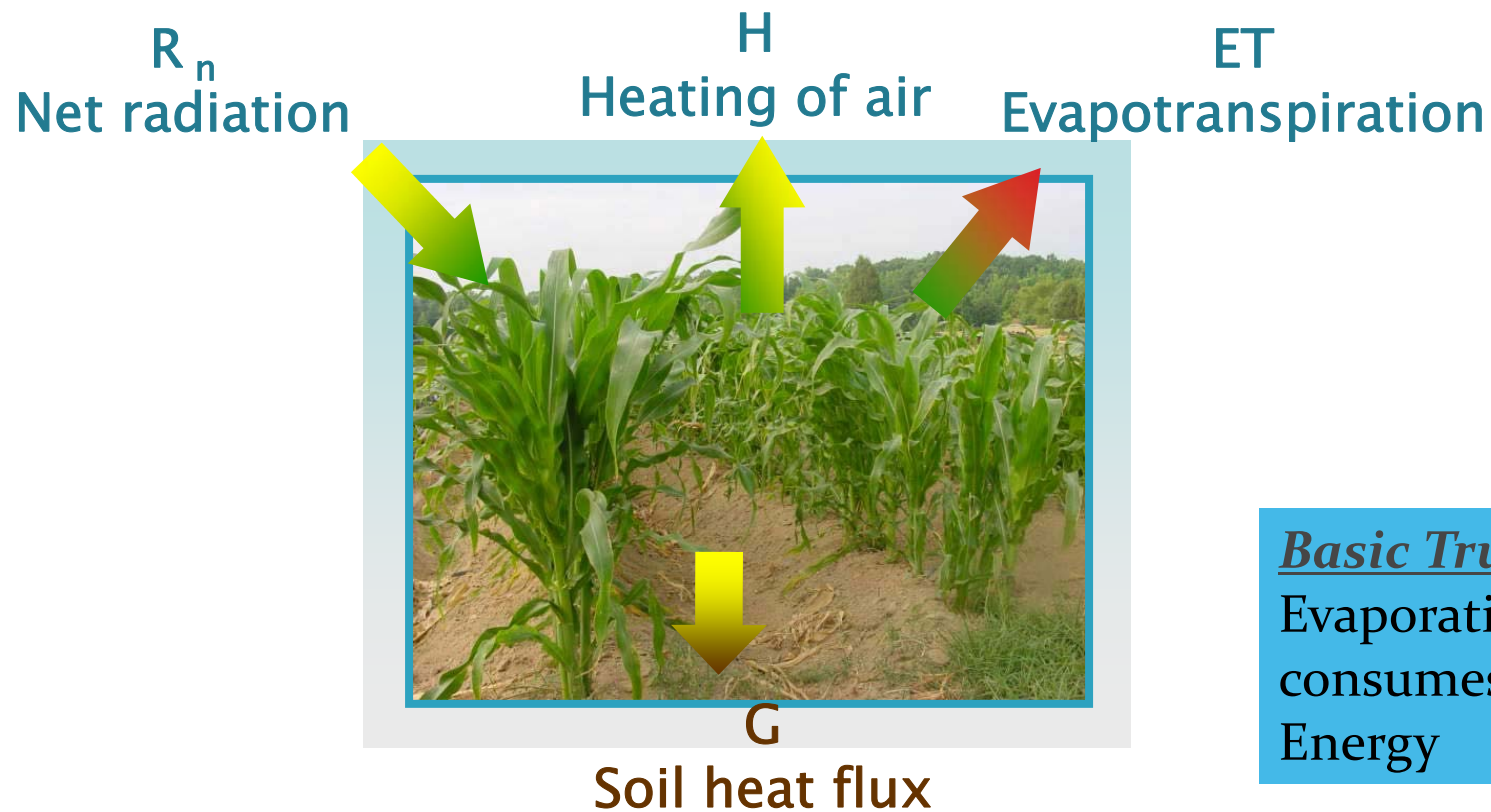
METRIC (Mapping Evapotranspiration at high Resolution using Internalized Calculations)

- ▶ RWRCC contracted with University of Idaho to apply a method (METRIC) they had developed for estimating crop water consumption to lands on the Flathead Reservation
 - ▶ Primary Idaho scientists:
Dr. Richard Allen
Dr. Jeppe Kjaersgaard



METRIC Energy Balance

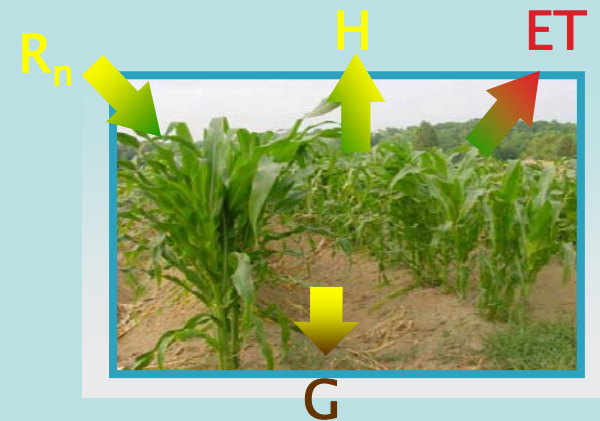
ET is calculated as a “residual” of the energy balance: $ET = R_n - G - H$



Basic Truth:
Evaporation
consumes
Energy

METRIC Energy Balance

- **Net Radiation (R_n)**
 - Sun-earth geometry
 - Spectral reflectance
 - Thermal radiance
 - Humidity (minor effect)
- **Ground Heat Flux (G)**
 - Vegetation Index
 - Net radiation
 - Thermal radiance
- **Sensible Heat Flux (H)**
 - Thermal radiance
 - Wind speed
 - Surface cover type and roughness
 - Surface to air temperature difference, dT



underlined terms are obtained from the satellite

We can “see” reduction in ET due to factors such as:

- soil water shortage (stress)
- plant density
- soil salinity
- fertility deficiencies
- disease
- insect pressures
- weeds
- senescence
- tillage/traffic
- hail/frost



Standardized Reference ET

Penman-Monteith equation applied to alfalfa for hourly application

$$ET_{ref} = \frac{\Delta(R_n - G) + \rho c_p (e_s - e_a) / r_a}{\Delta + \gamma \left(1 + \frac{r_s}{k_a} \right)}$$

30 s m^{-1}
(daylight)

$= f(0.5 \text{ m ht})$

The output from METRIC is commonly stated as $ET_r F$

$$K_c = ET_r F = \frac{ET_{calc}}{ET_{ref}}$$

(ASCE-EWRI, 2005)

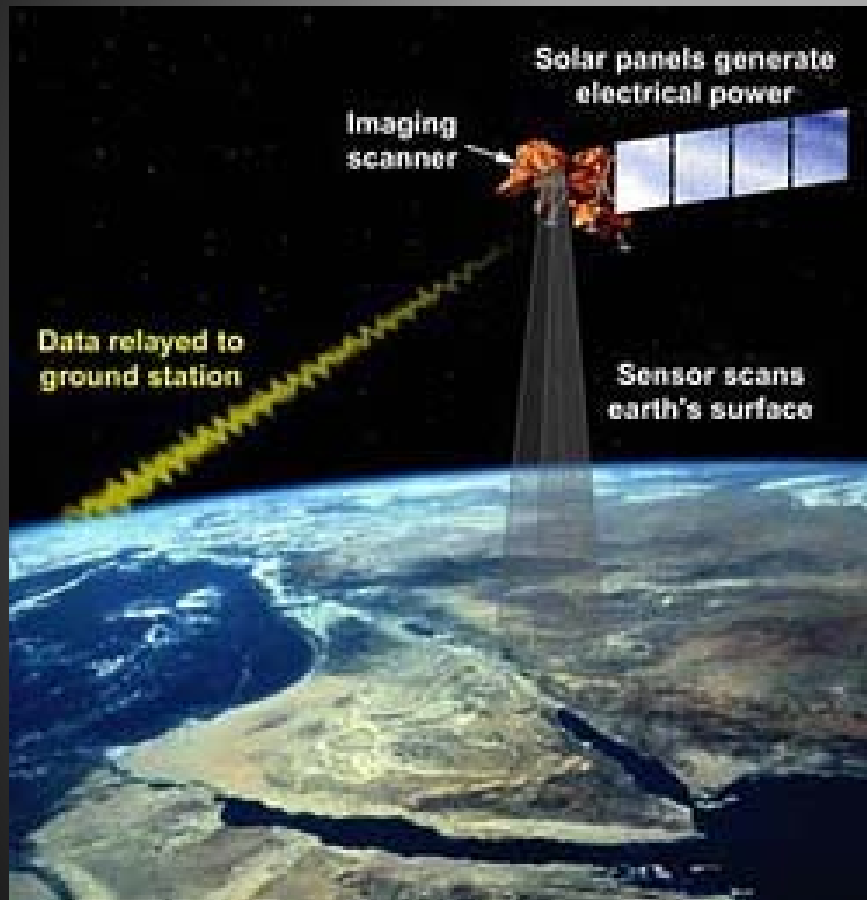
LandStat evaluation by RWRCC

- ▶ Using the METRIC method, Compact Commission technical staff worked to assess ETrf for lands in the JBC Districts of the FIIP
- ▶ ETrf – Evapotranspiration calculated for a reference crop (such as grass).
- ▶ MF – project Management Factor is equal to ETrf which is the percent of maximum potential water use.

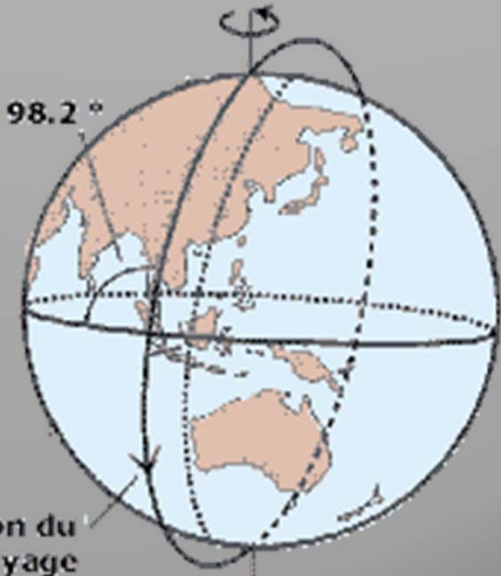


Landsat – Polar Orbiting

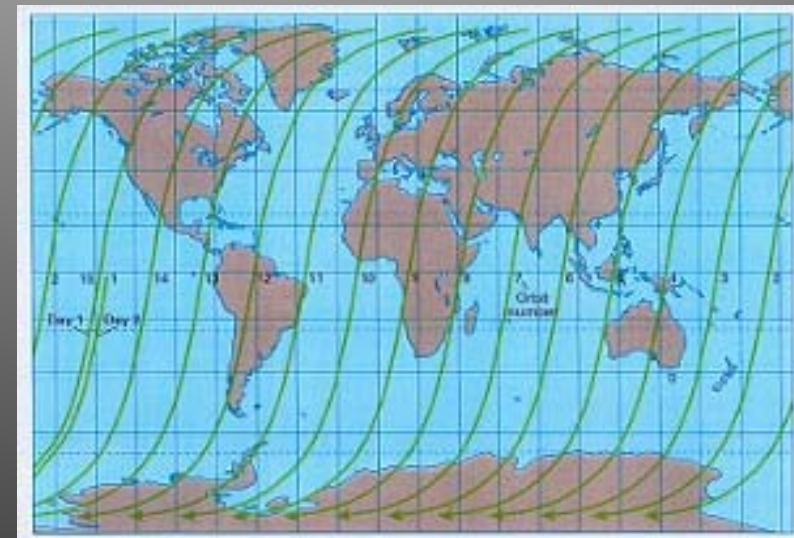
Altitude : 705 km



Inclinaison : 98.2°



Durée de l'orbite : 98.8 minutes



*A new image each 16 days
for a specific location*

Landsat Image

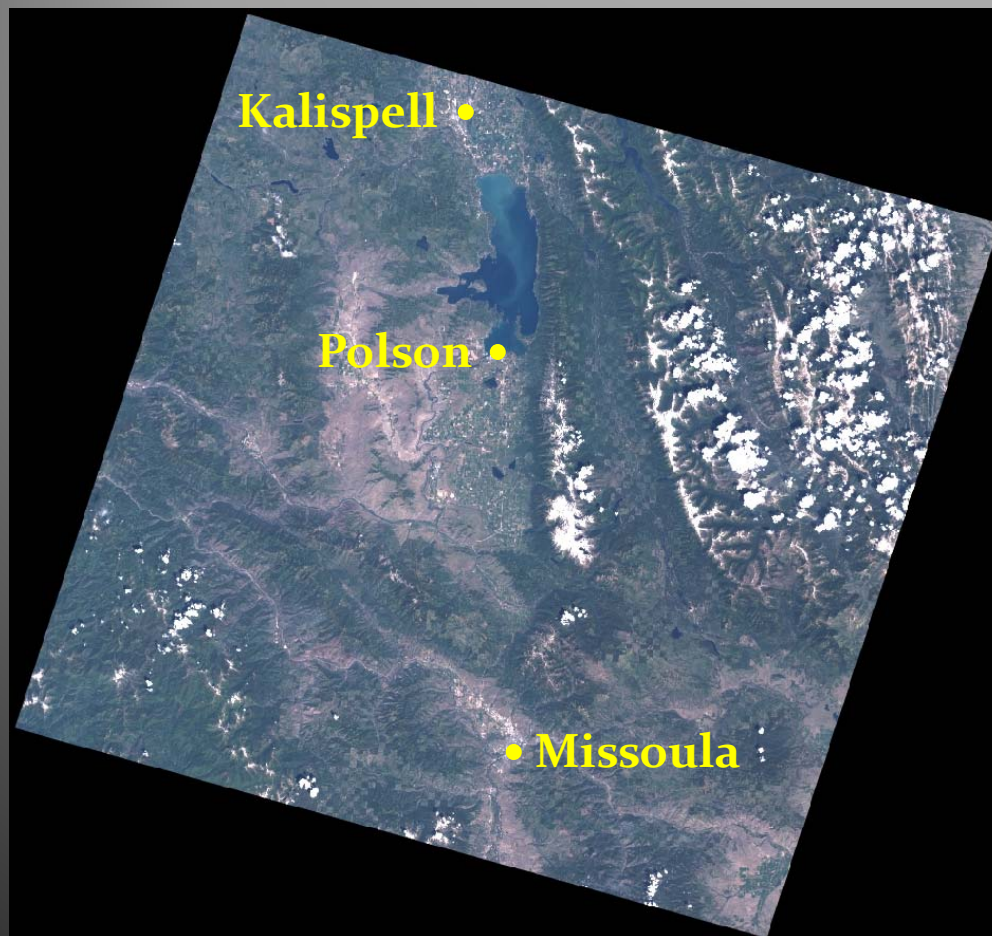
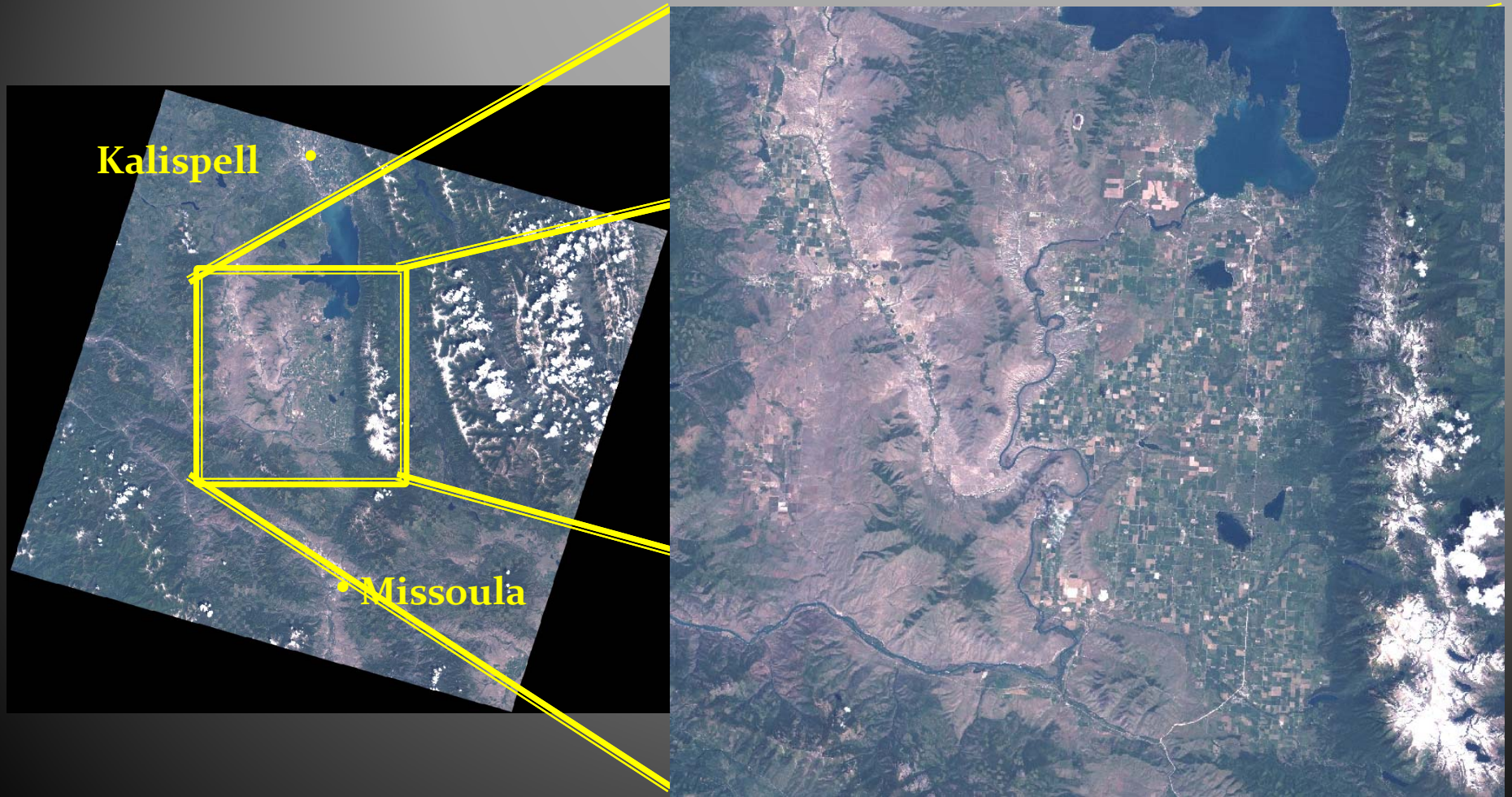


Image from July 27 2006

Close-up of the Mission Valley



Close-up of Polson



LandSat image - July 16 2007



□ Fiip.shp
July16_2007.img
:Band_3
:Band_2
:Band_1

ETrf map of LandSat image - July 16 2007



LandSat image - June27 2006



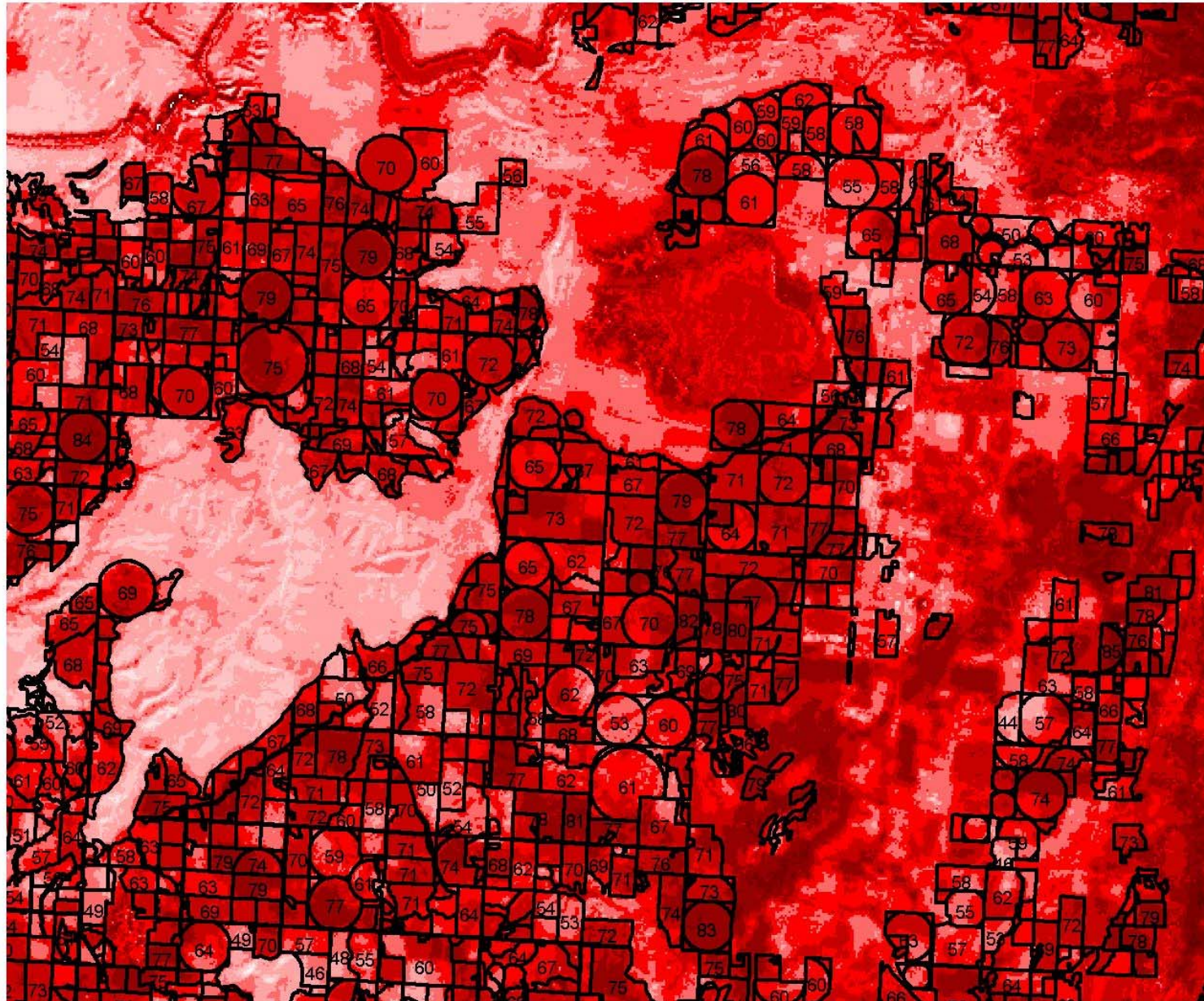
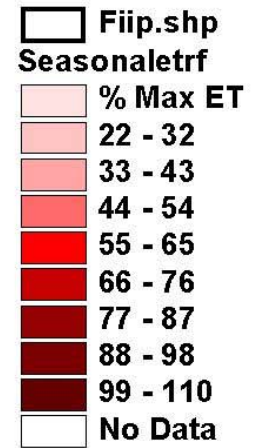
□ Flip.shp
June27_2006.img
:Band_3
:Band_2
:Band_1

Landsat Images used by Metric

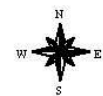
Date	Satellite	Path Row
05/10/2006	Landsat 5	41 27
06/27/2006	Landsat 5	41 27
10/01/2006	Landsat 5	41 27
07/16/2007	Landsat 5	41 27
08/01/2007	Landsat 5	41 27
09/02/2007	Landsat 5	41 27
04/13/2008	Landsat 5	41 27
05/31/2008	Landsat 5	41 27



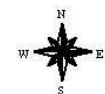
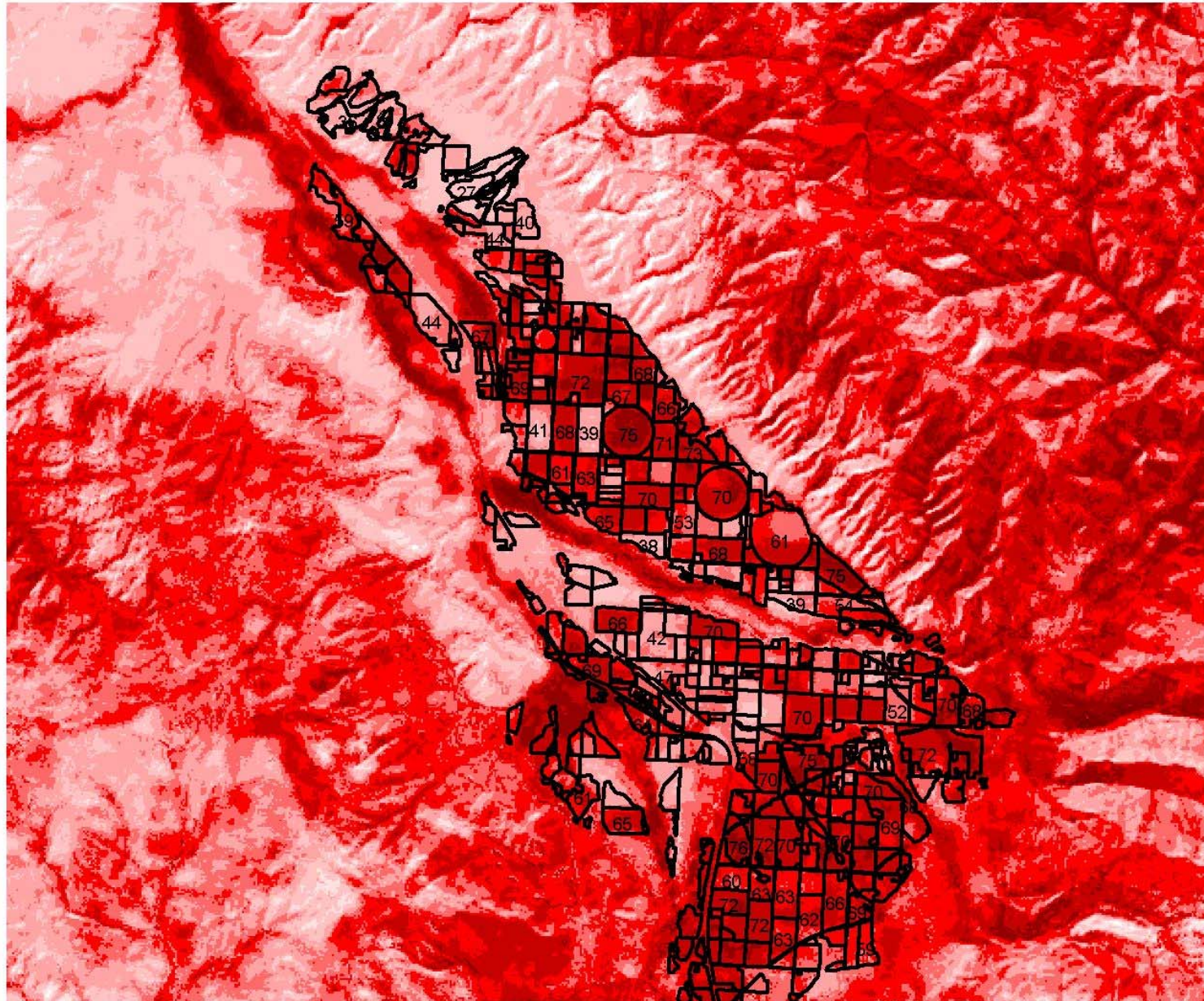
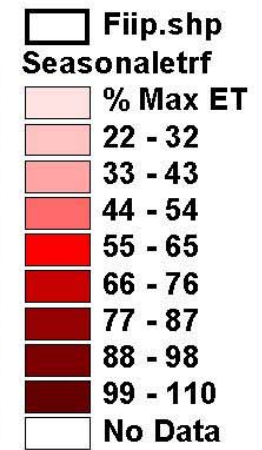
Metric ETrf - Mission 66% avg



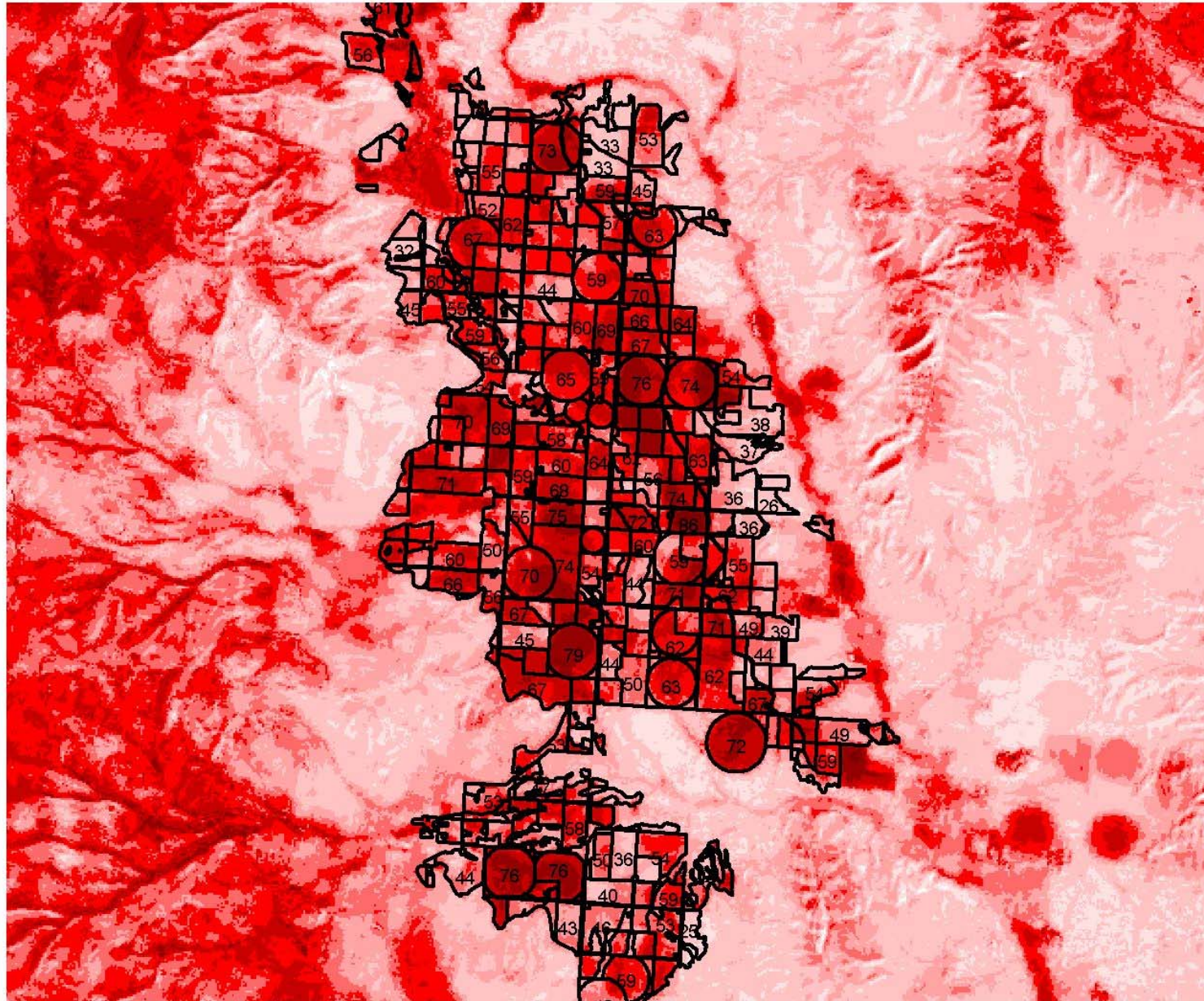
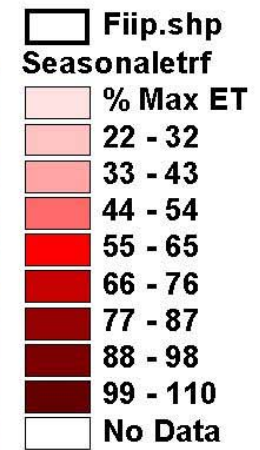
3 0 3 6 Miles



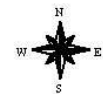
Metric ETrf - Jocko 60% avg



Metric ETrf - Camas 56% avg



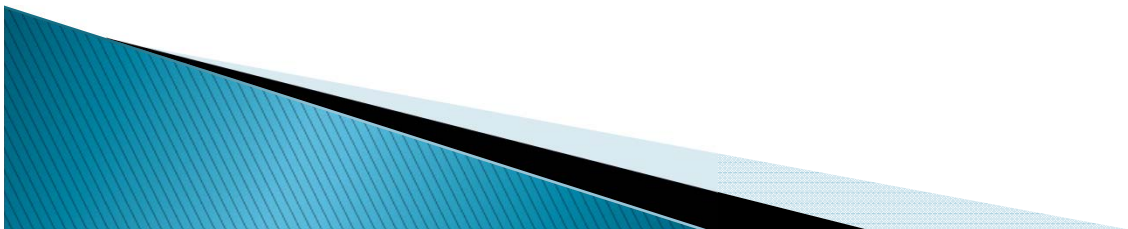
3 0 3 6 Miles



What the Math Tells US

- ▶ The average ETrf
- ▶ or Project management factor (MF percent of maximum reference crop ET)

- ▶ Mission district = 0.66 – 66%
- ▶ Jocko district = 0.60 – 60%
- ▶ Camas district = 0.56 – 56%



Conclusion

-METRIC is a strong method for evaluating crop water use.

-it is only secondarily able to assess how much water must be diverted from a source to deliver enough water to a field to satisfy historic crop depletions.

-Based on METRIC, the Farm Turnout Allowance (FTA) discussed in the stipulation talks between the Tribes and JBC, seems roughly adequate for the FIIP project needs.

