Development of a Global Evaporative Stress Index Based on TIR and MW LST

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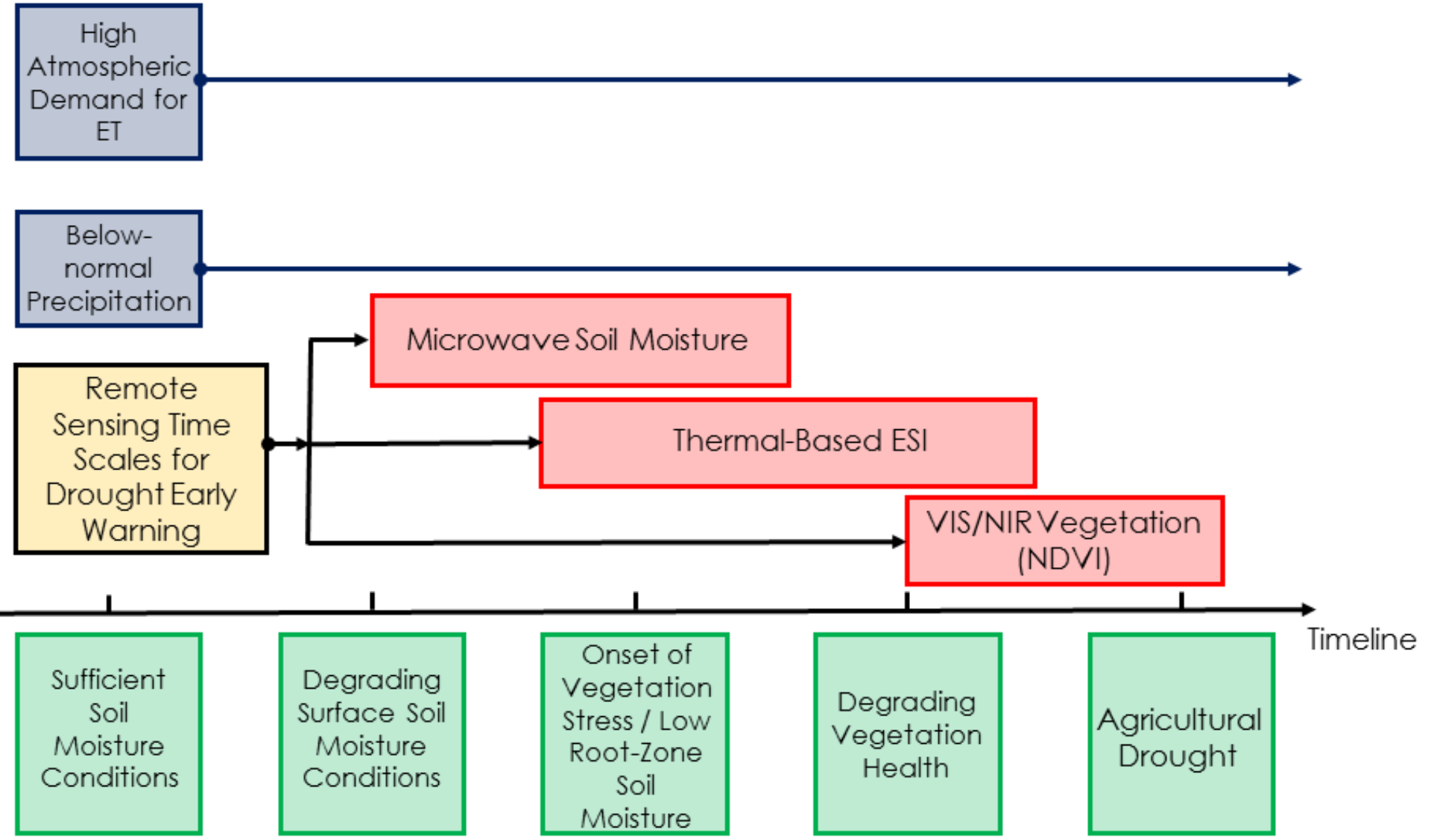
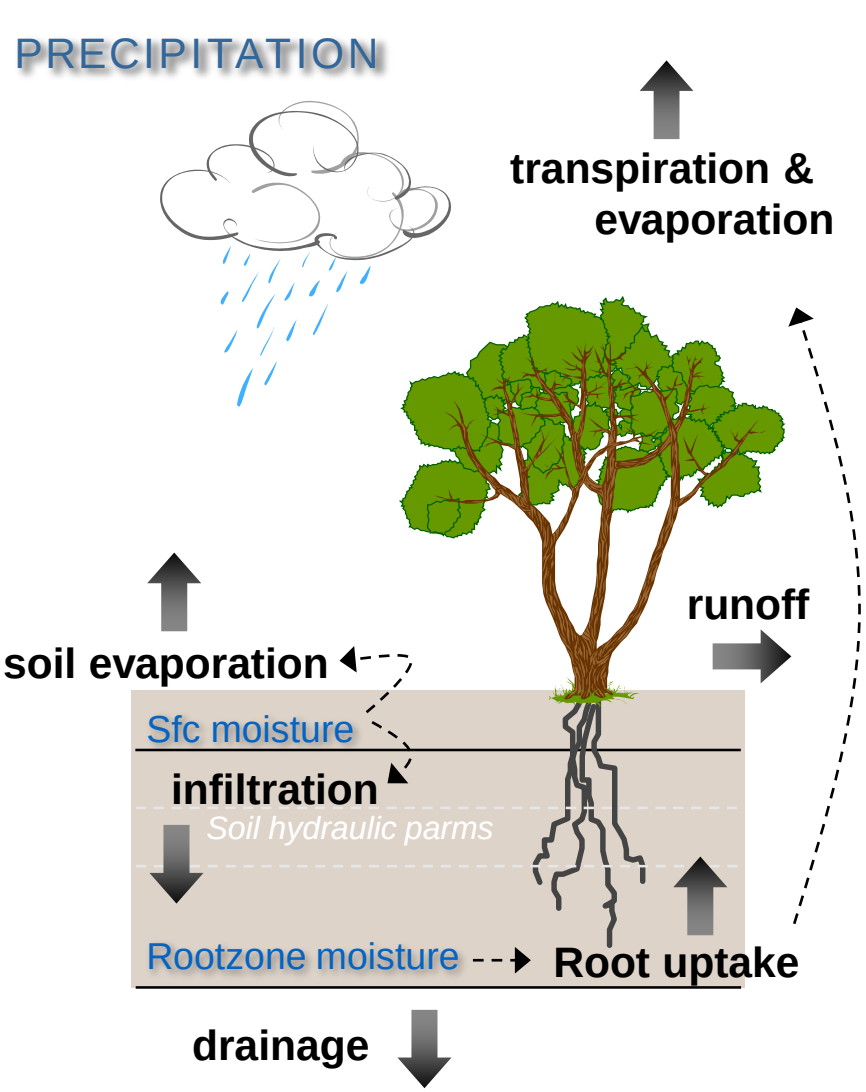
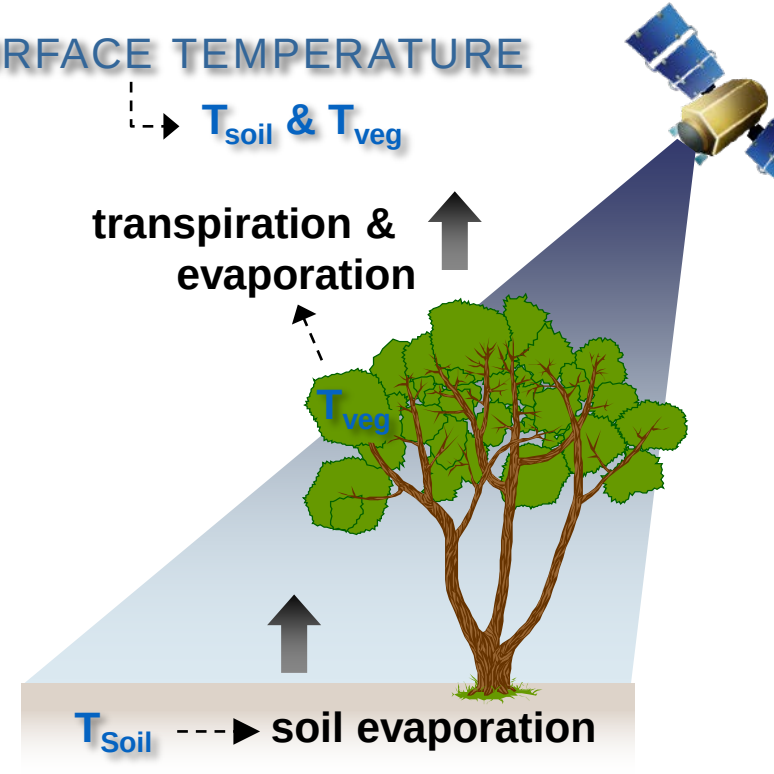
Example of the Evolution of Agricultural Drought





WATER BALANCE APPROACH
(prognostic modeling)



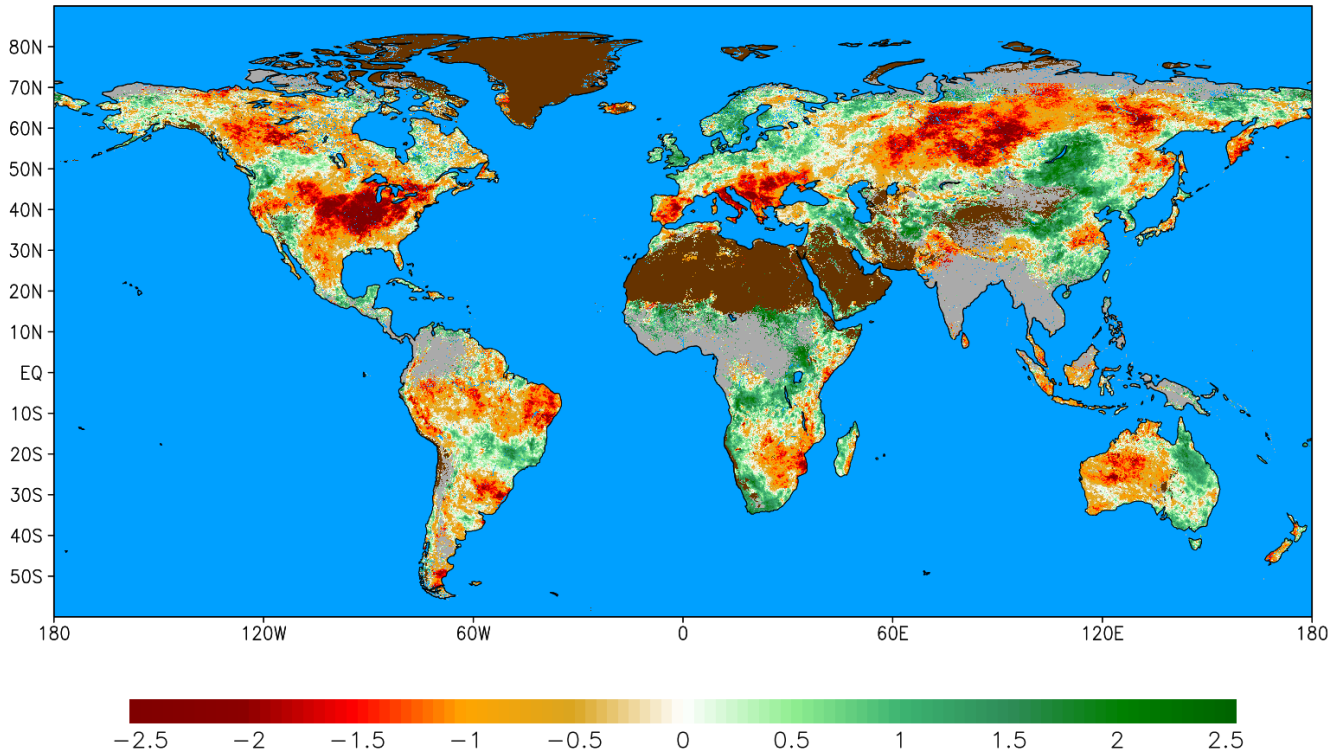
Given known radiative energy inputs, how much water loss is required to keep the soil and vegetation at the observed temperatures?

ENERGY BALANCE APPROACH
(diagnostic modeling)

Global Evaporative Stress Index Methodology

ALEXI ESI represents temporal anomalies in the ratio of actual ET to potential ET.

- The current surface moisture state is deduced directly from the remotely sensed LST
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs
- Inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows)



1 August 2012

Project Stakeholders

WORLD RESOURCES INSTITUTE

Agriculture and Agri-Food Canada

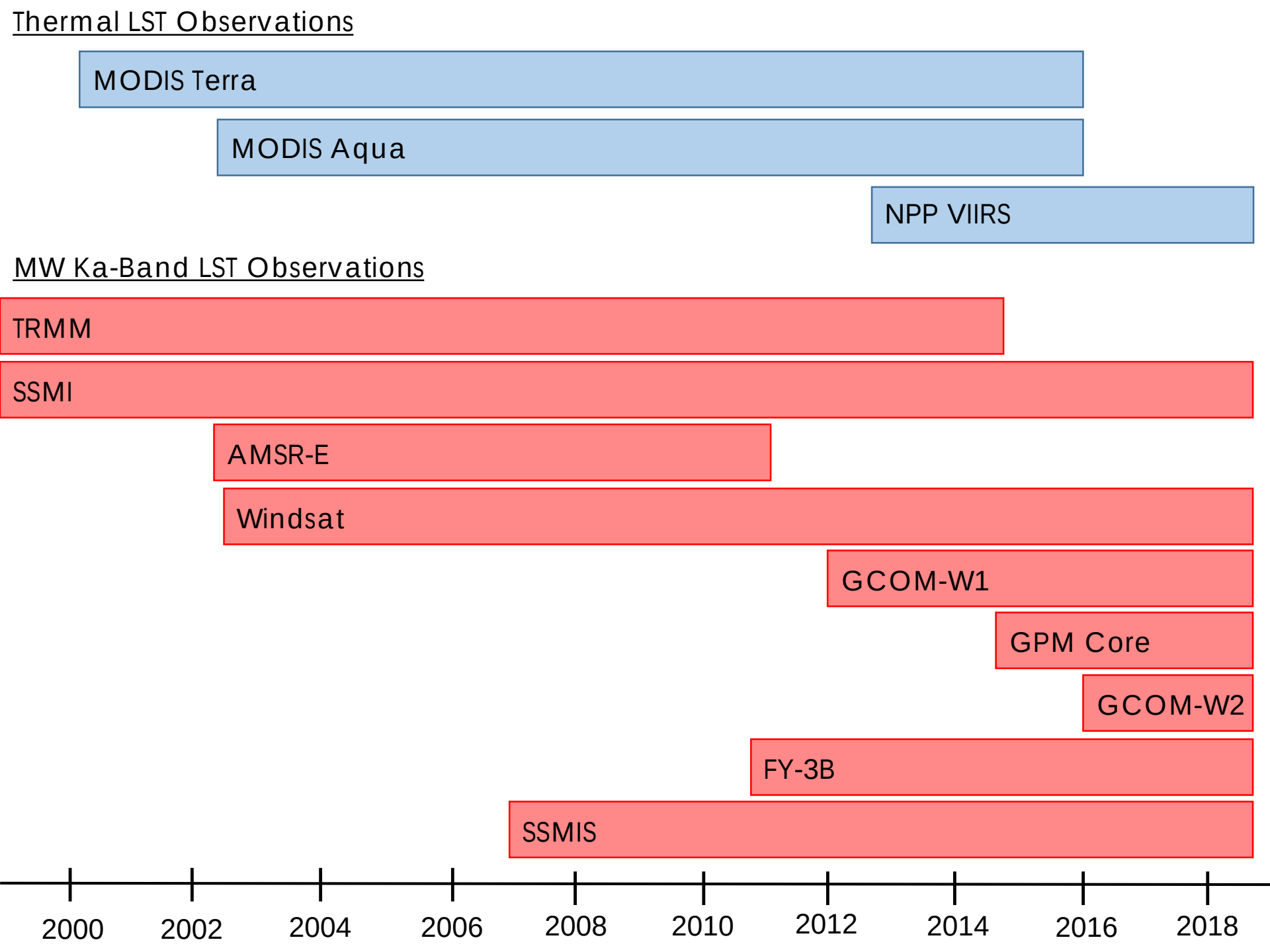
NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION

SERVIR

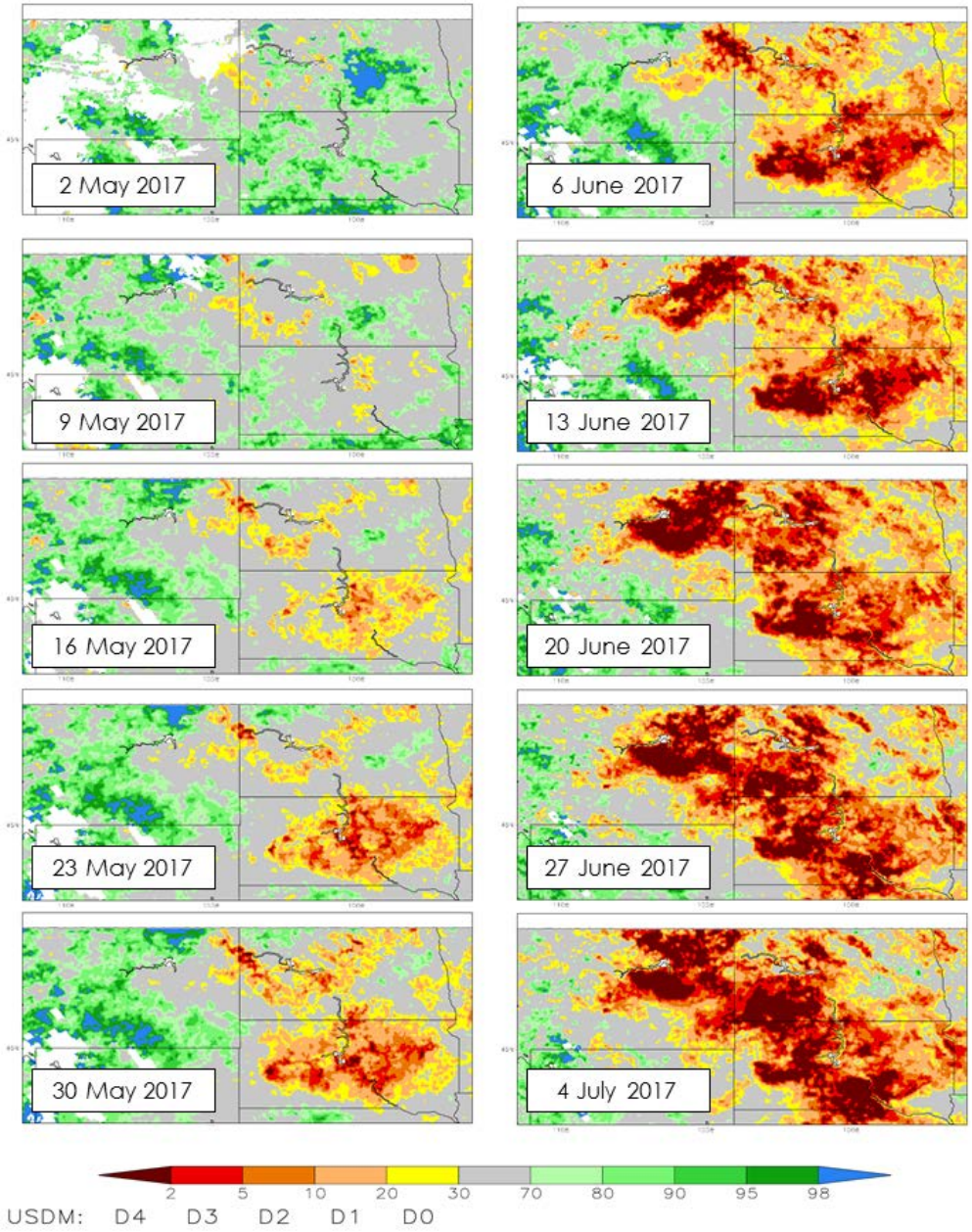
EARTH DATA FOR INFORMED AGRICULTURAL DECISIONS

INTERSUCHO

Climate Engine


Thermal LST Observations
MODIS Terra
MODIS Aqua
NPP VIIRS
MW Ka-Band LST Observations
TRMM
SSMI
AMSR-E
Windsat
GCOM-W1
GPM Core
GCOM-W2
FY-3B
SSMIS
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

North Central US Flash Drought of 2017



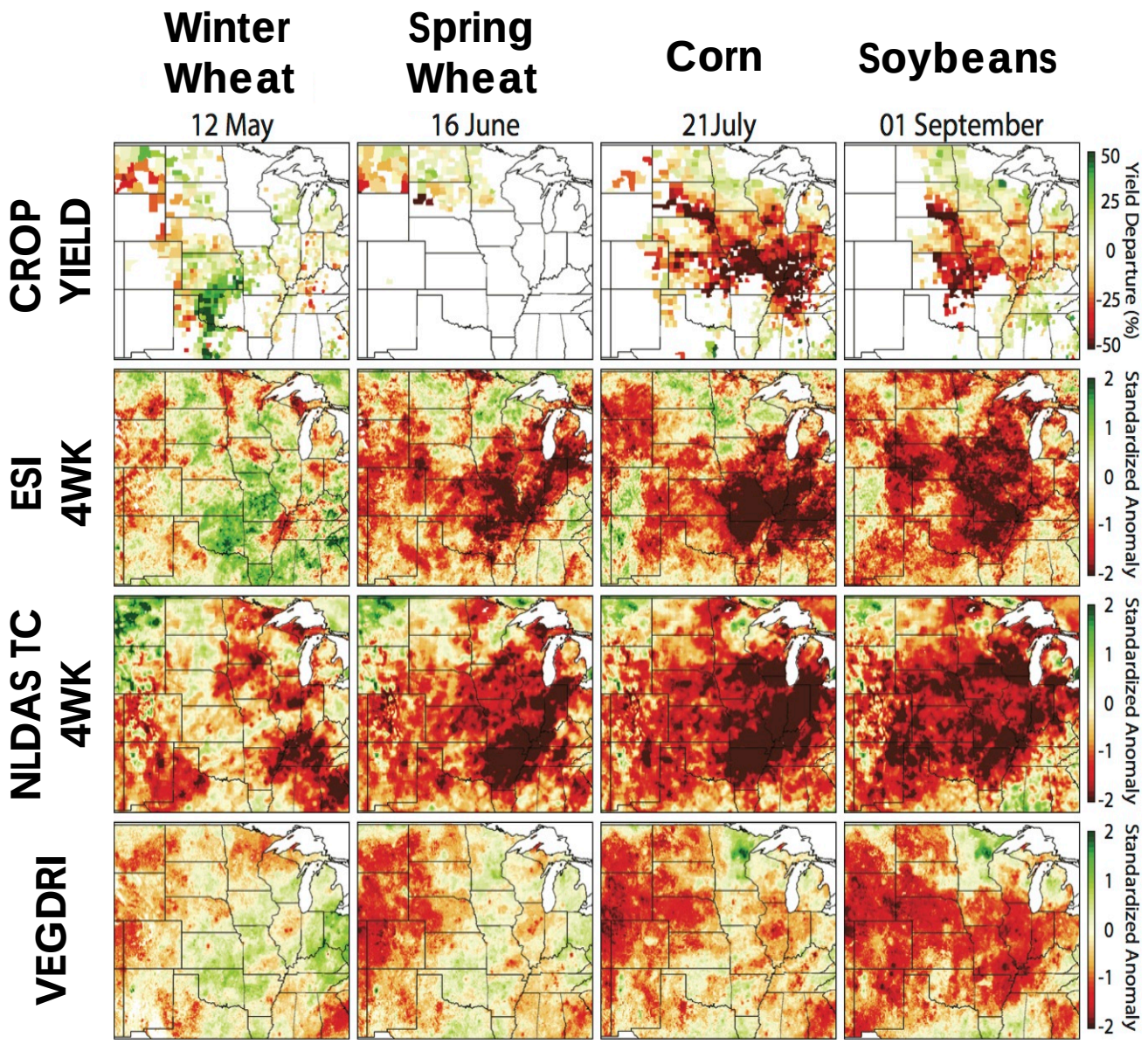
Flash drought are rapid onset events typically driven by:

1) precipitation deficits,
2) high temperature anomalies;
3) strong winds;
4) Anomalous incoming solar radiation.

ESI provides early warning of the onset of vegetation stress.

Provides information physically related to "actual" stress.

Early Warning Metrics for Onset of Vegetation Stress



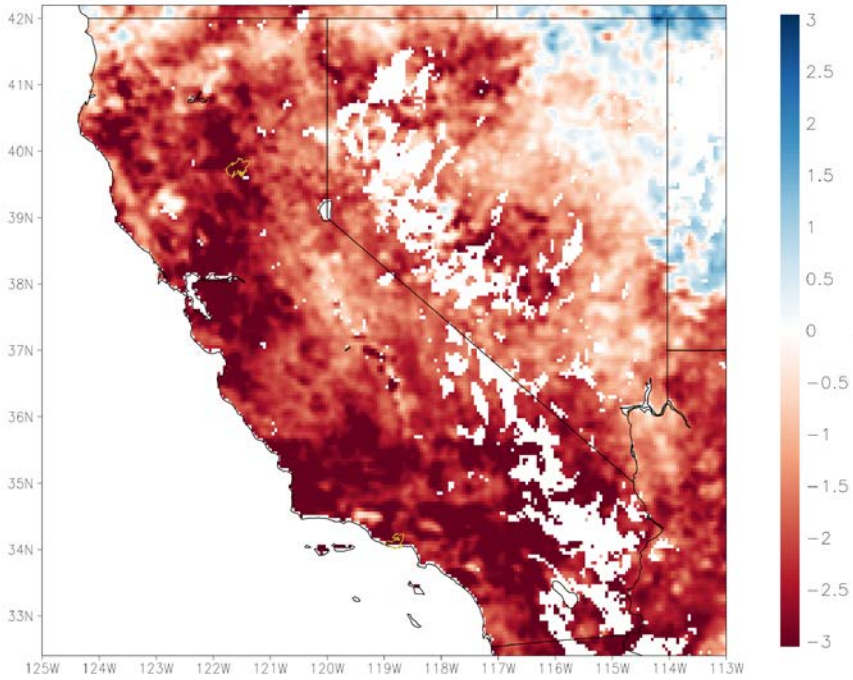
- Strong relationship between wheat yield and the ESI and VegDRI during critical crop stages
- NLDAS has strong (weak) relationship to corn/soybeans (wheat) yield
- ESI had strongest correlation to the wheat, corn, and soybean yield departures

Wildfire Applications

- ESI is strongly correlated with soil moisture, thus providing an independent assessment of current moisture conditions that can be compared to models that are driven by observations precipitation.

- ESI may better represent "dry fuel load" than remote sensing techniques such as NDVI which is focused on how "green" or "brown" vegetation is.
  - Stressed vegetation may susceptible to rapid fire growth before "brownness" is observed in a vegetation index such as NDVI.

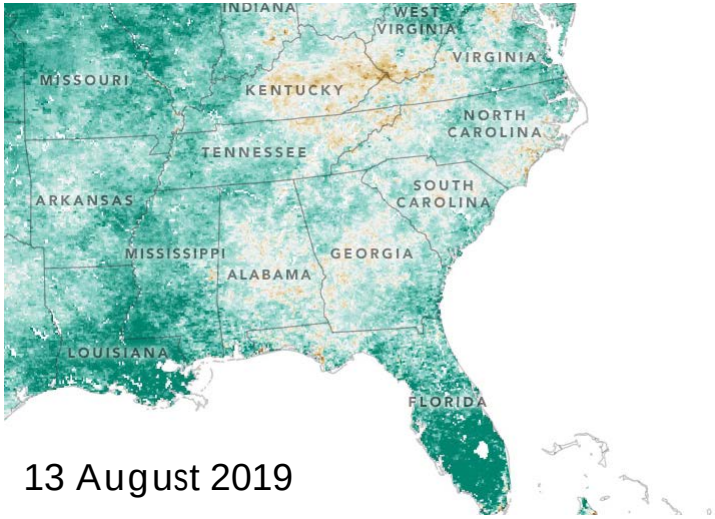
28-day change in ESI (October 16 – November 12)



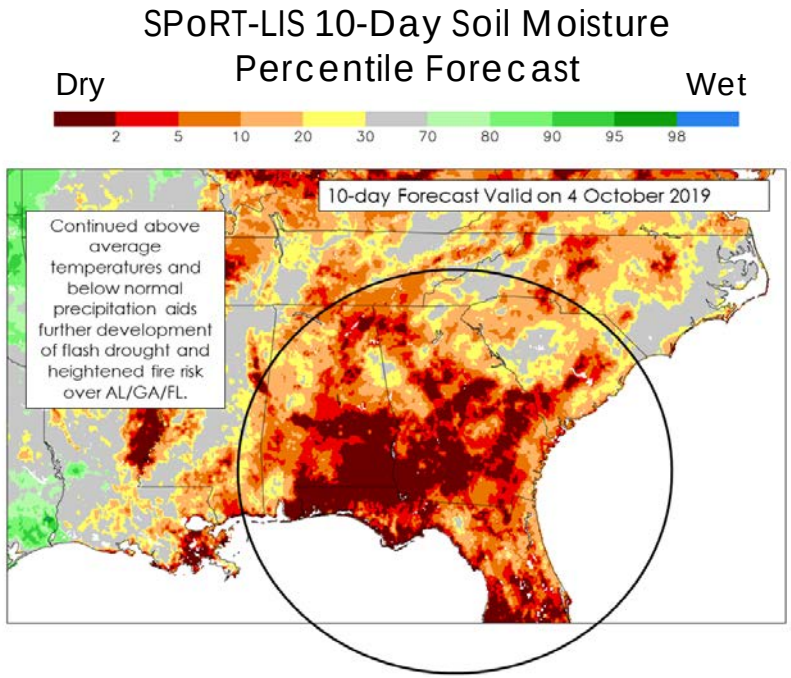
Rapid changes in ESI over California show significant increases in vegetation and moisture stress with the vegetation

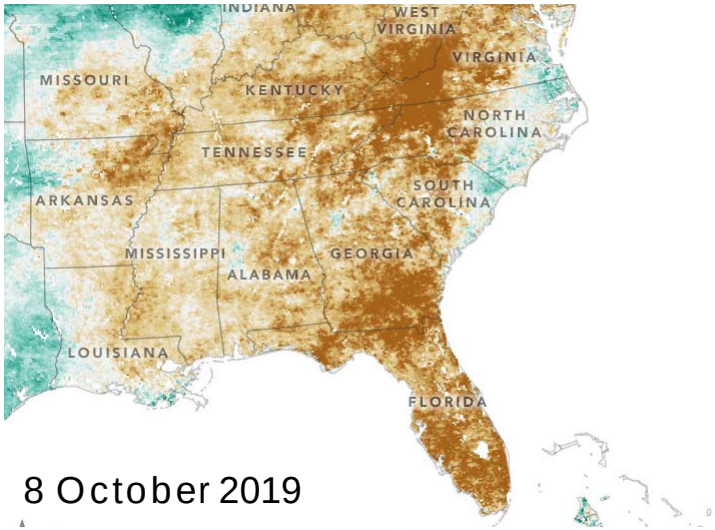
ESI in Operational Situational Awareness

- Near-real-time ESI products are important for tracking rapidly changing drought conditions.
- For example, the evolution of the flash drought in the SE US (August – October) was accurately captured by ESI.



13 August 2019



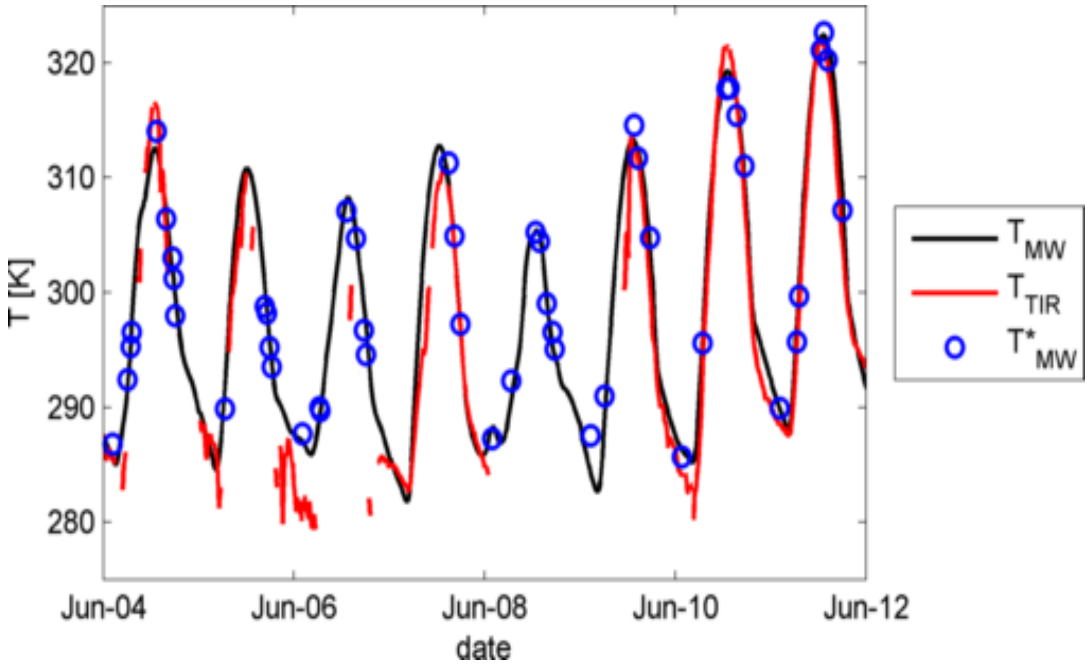


8 October 2019

The synergy between TIR and MW observations is further being exploited by the development of LST observations from MW observations(Ka-band).

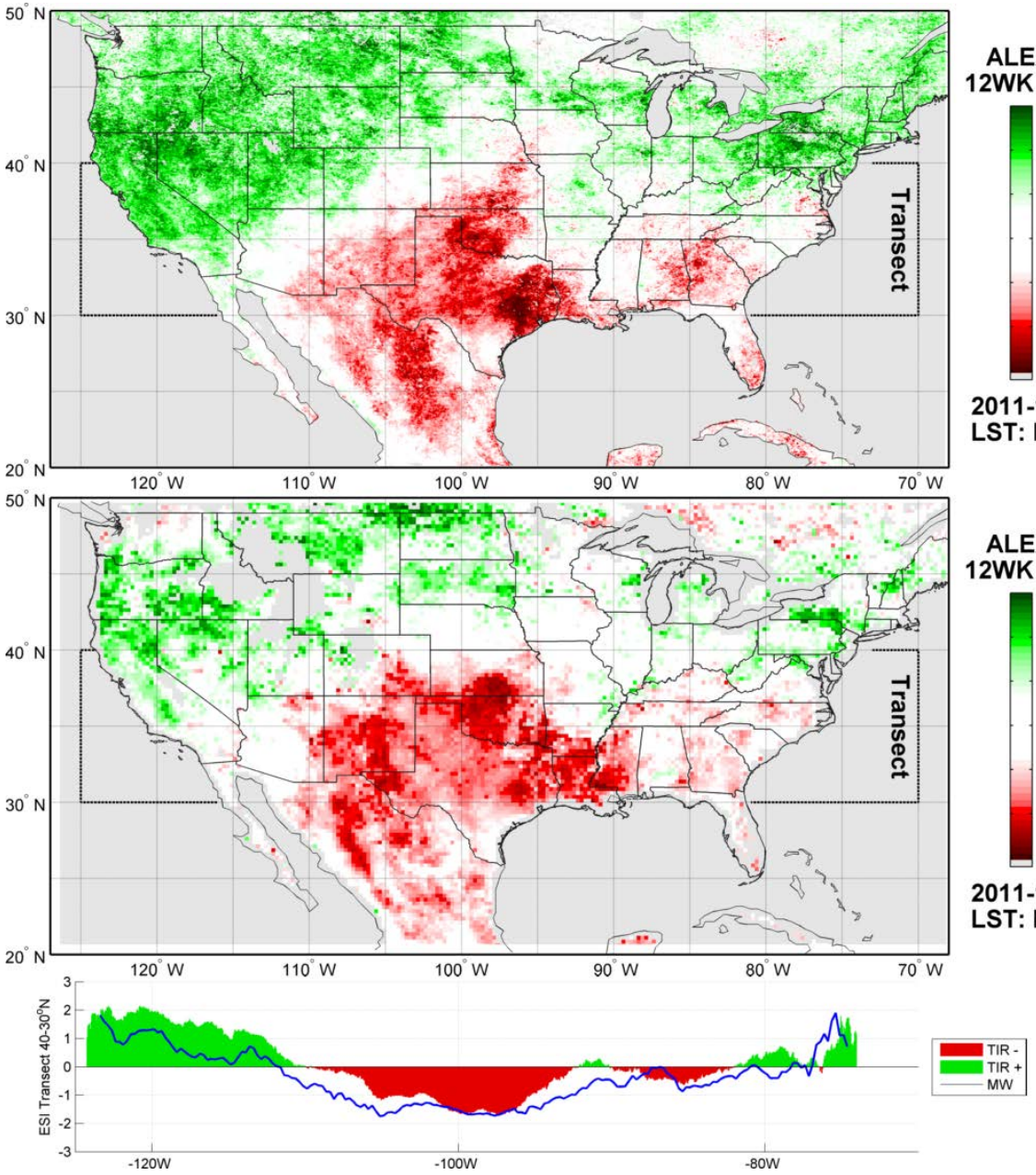
The integration of MW LST will allow for retrieval of surface fluxes under cloud cover.

This capability fills in a significant gap in a TIR-only system over tropical equatorial regions.



Anomaly analysis with MW-ALEXI

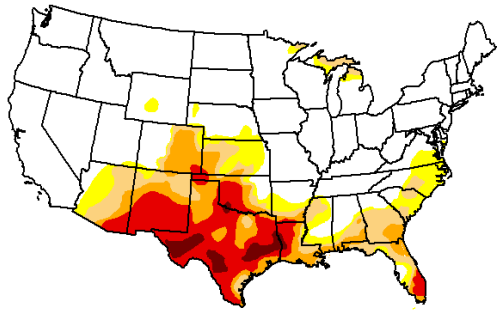
ESI 12week moving window



U.S. Drought Monitor

CONUS

June 7th, 2011



Conclusions

LST-Based Drought Indicators

- Diagnostically captures non-precipitation related moisture sources/sinks (irrigation, shallow groundwater, drainage)
- Provides early warning of on-set of actual vegetation stress
- Provides information about current soil moisture state without the need for knowledge of antecedent precipitation

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NRT data feed: https://gis1.servirglobal.net/data/esi/