ND WATER QUALITY MONITORING CONFERENCE

Hydrologic and Water-Quality Impacts of Agricultural Land Use Changes Incurred from Bioenergy Policies

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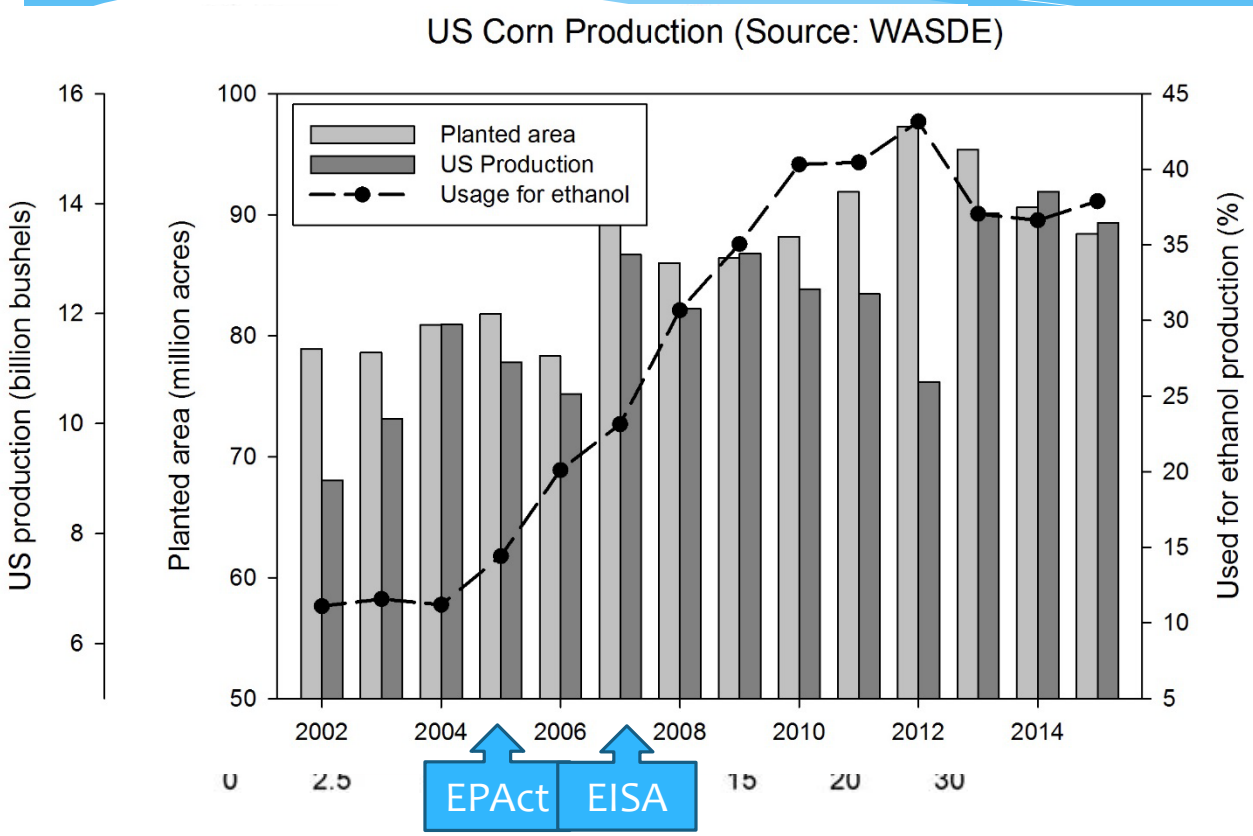
This work is funded by USDA National Institute of Food and Agriculture (Projects: 2013-67020-21366 & 2013-03902) and NSF (Award: IIA-1355466)

EISA (2007) and land use changes

Red River Basin (RRB)



Independence and
y Act (EISA) signed in
ber 2007

dates use of 15 BGY corn-
d ethanol in transportation
s by 2015 and 36 BGY of
wable fuels by 2022

3G gasoline consumed in US
014 (EIA)

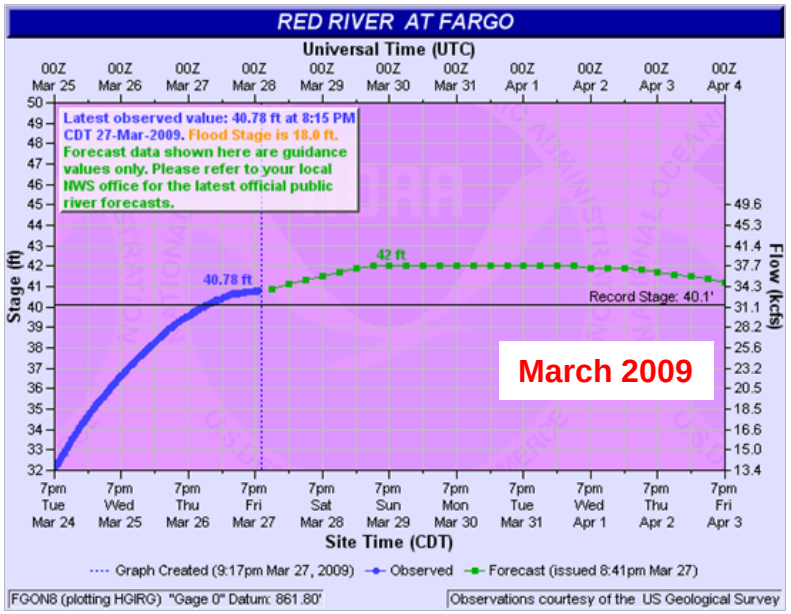
& Wimberly (2013)

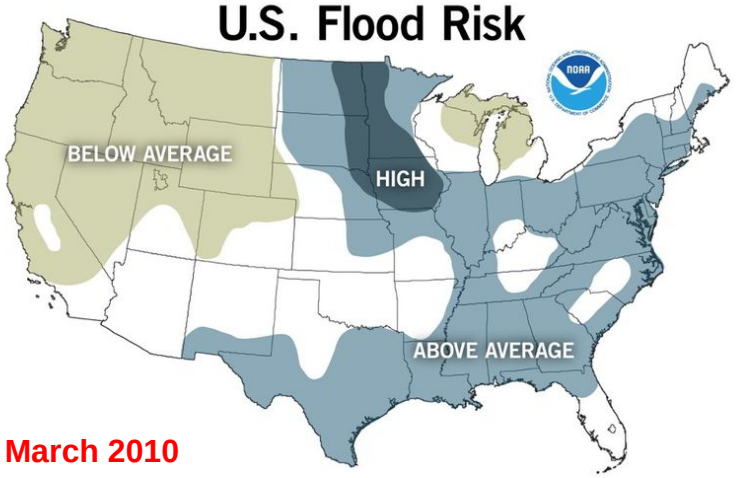
S – Grassland to Corn or
eans from 2006 to 2011

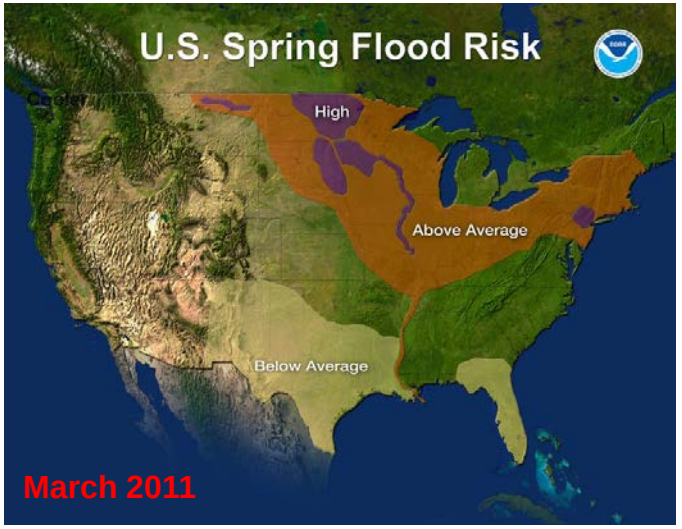
tive GRCS – absolute GRCS
led by 2006 grassland

Other issues in RRB: (1) Spring flood

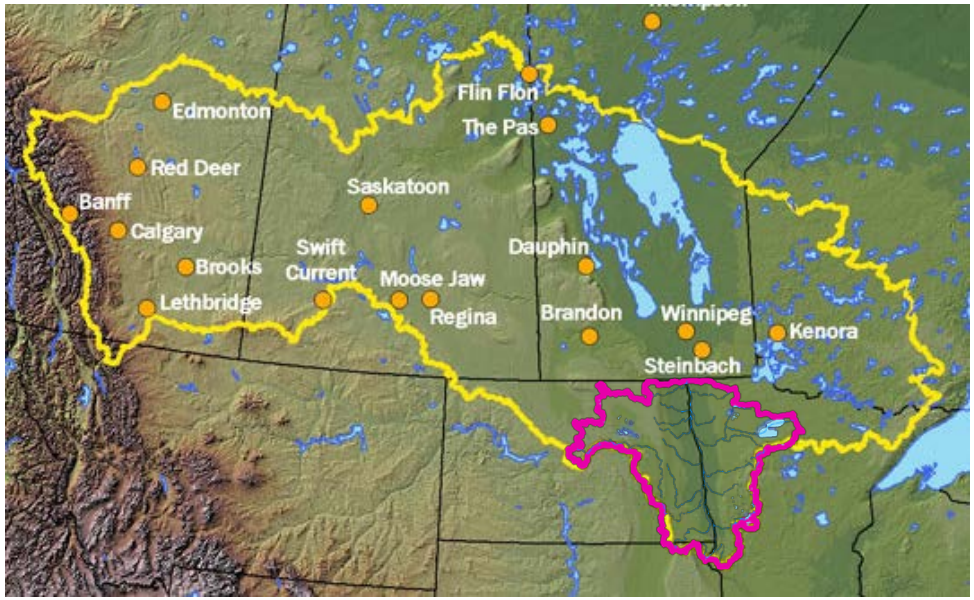
* Wet weather cycle since 1993
  * 7 out of 15 major floods occurred in the last 20 years (Fargo)
  * 2009 (1st), 2010 (7th), 2011 (4th)







Other issues in RRB: (2) Nutrients to Lake Winnipeg



* RRB's portions among all Lake Winnipeg tributaries
  * Monthly average flow: 16%
  * TP load: 55% (US 32%)
  * TN load: 34% (US 22%)

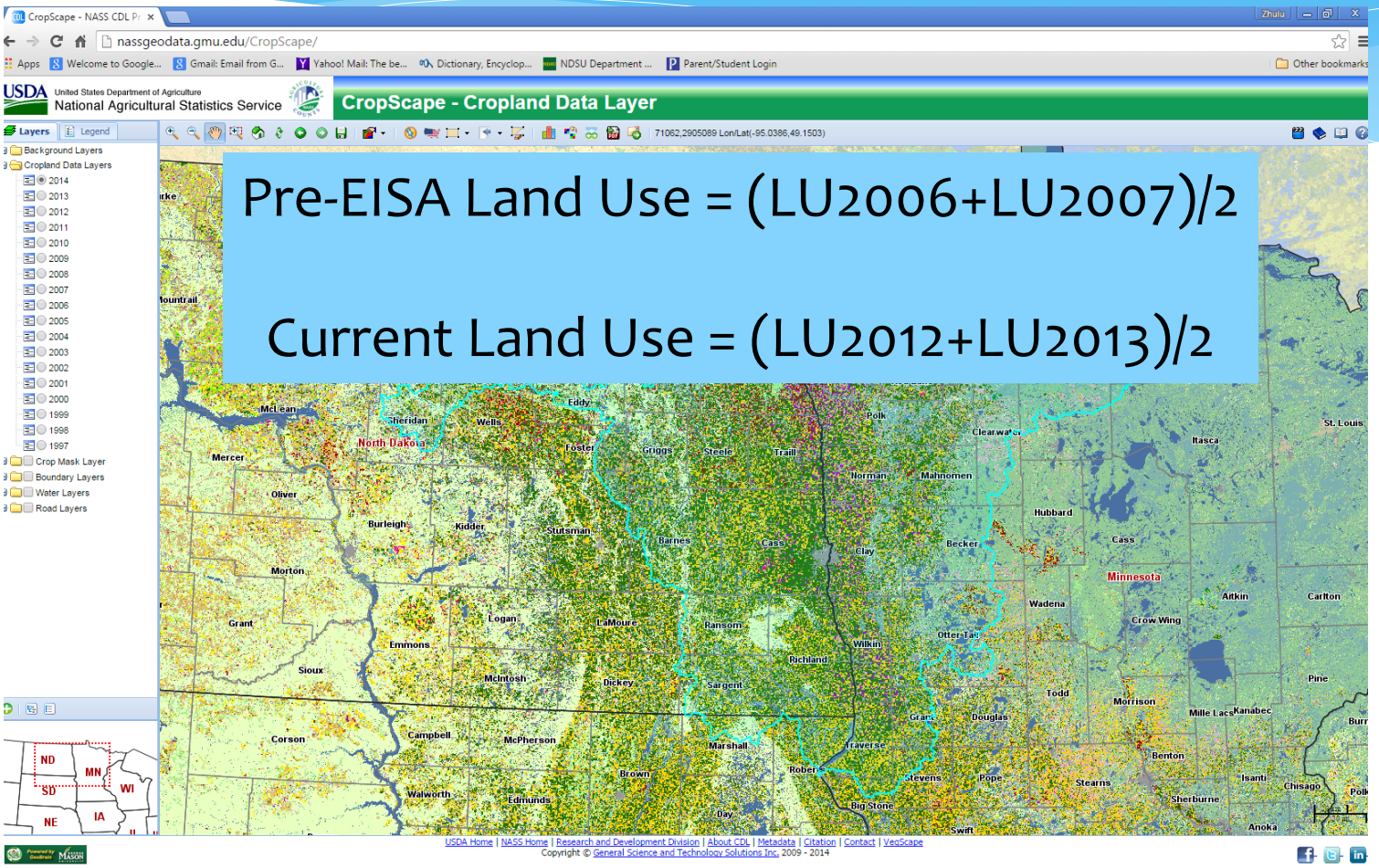
— Source: Manitoba Water Stewardship (2011)

Objectives

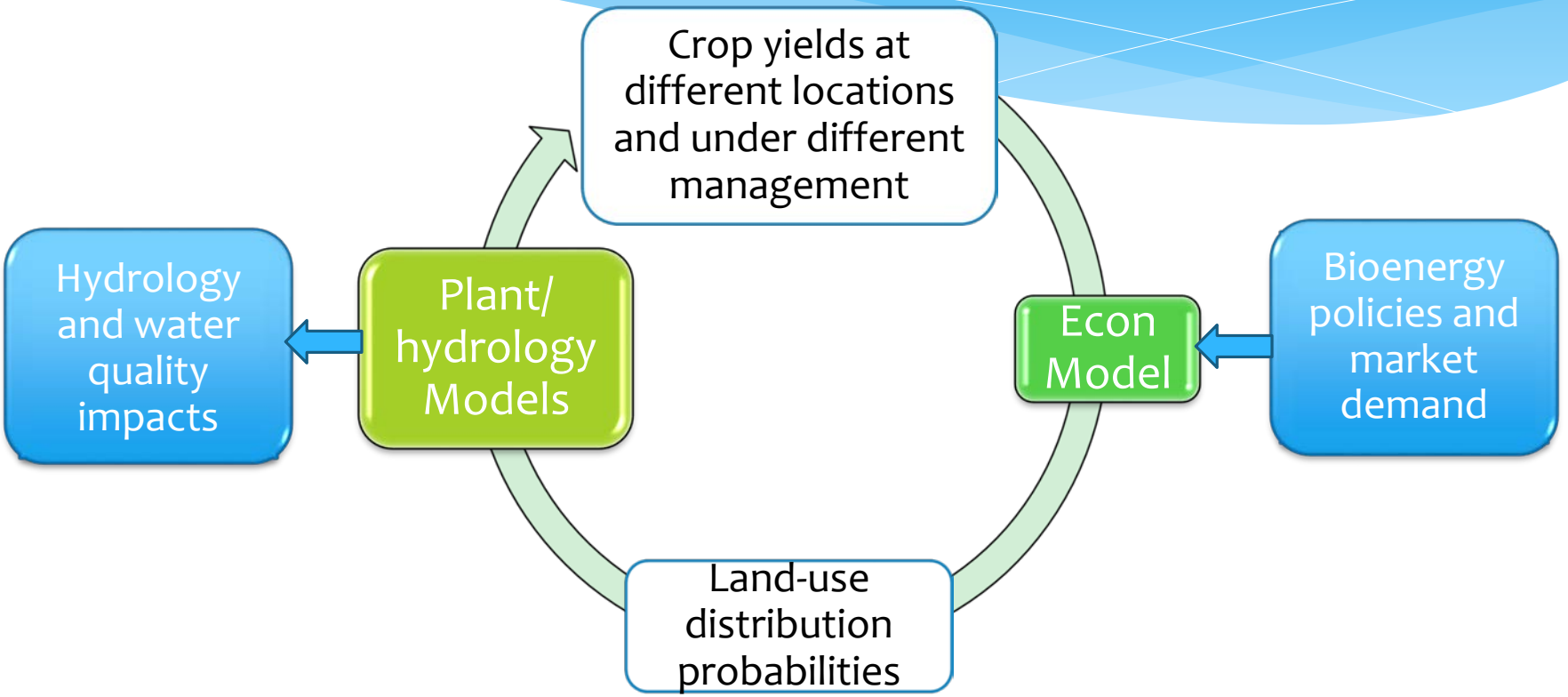
* To estimate agricultural land use changes that occurred in the Red River Basin after the enactment of EISA of 2007

* To assess the impacts of the bioenergy-related land use changes on ***spring flood*** and ***water quality*** in the Red River Basin through economic-hydrological modeling

Overall land use changes – CropScape

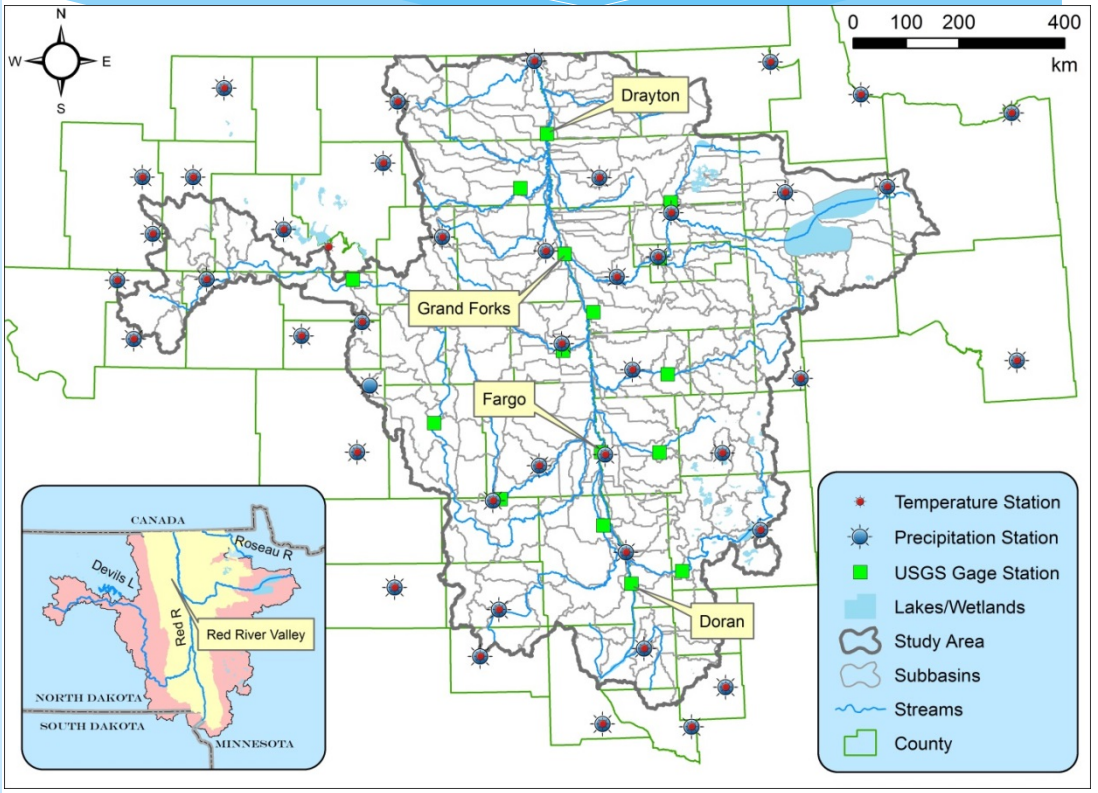


Economic-physical modeling



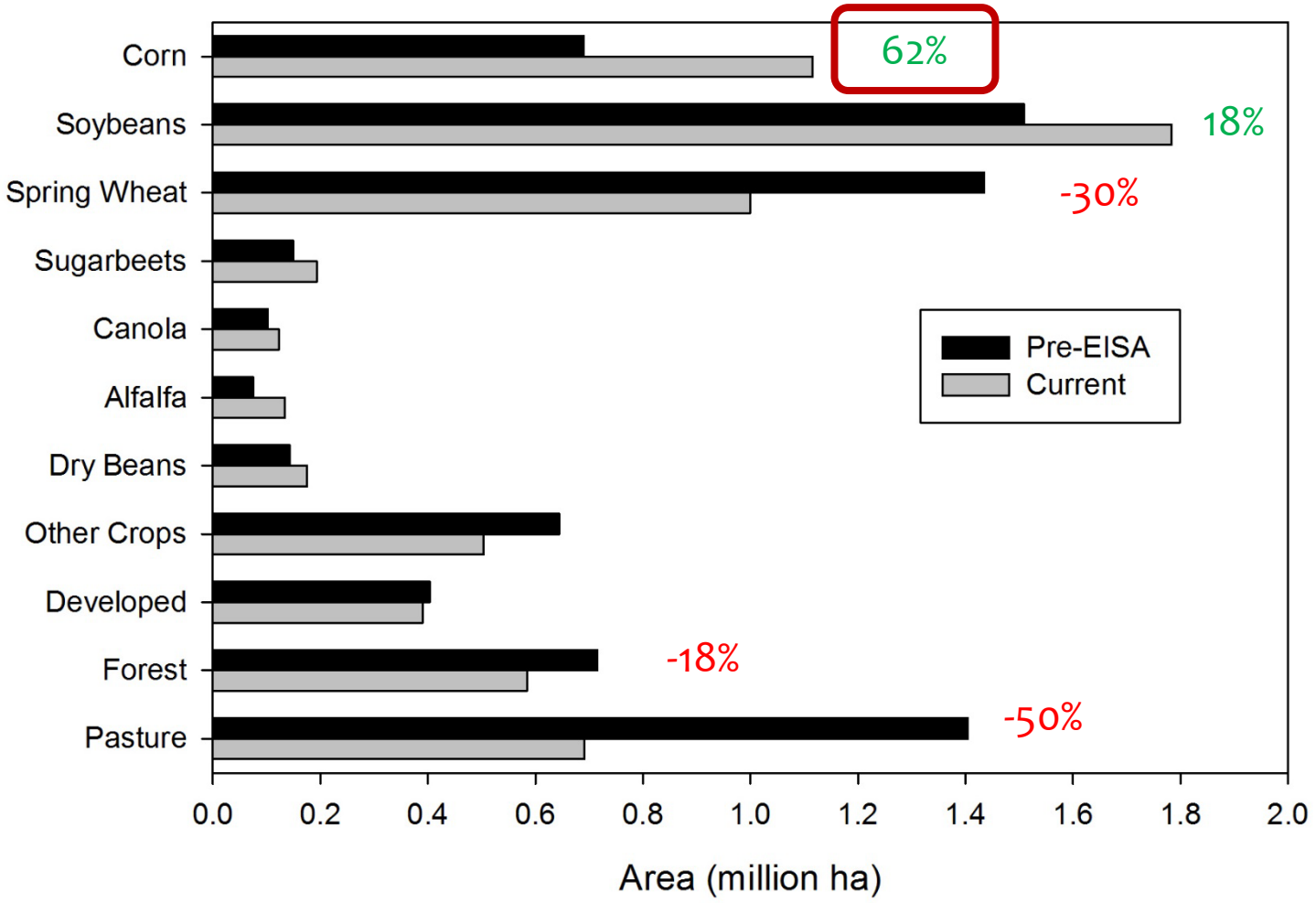
Plant growth and hydrology model – SWAT

- Development and calibration
  - 178 subbasins/2136 HRUs
  - 45 counties (SSURGO)
  - 30 weather stations
  - 12 land-use classes
  - 5-m DEM (LiDAR)
  - 5 large lakes and reservoirs
  - Calibration
    - County-level crop yields
    - 16 streamflow stations
    - 2 water quality stations
- Simulation (2000-2012)
  - 4 dry years + 4 wet years
- Lin et al. (2015)

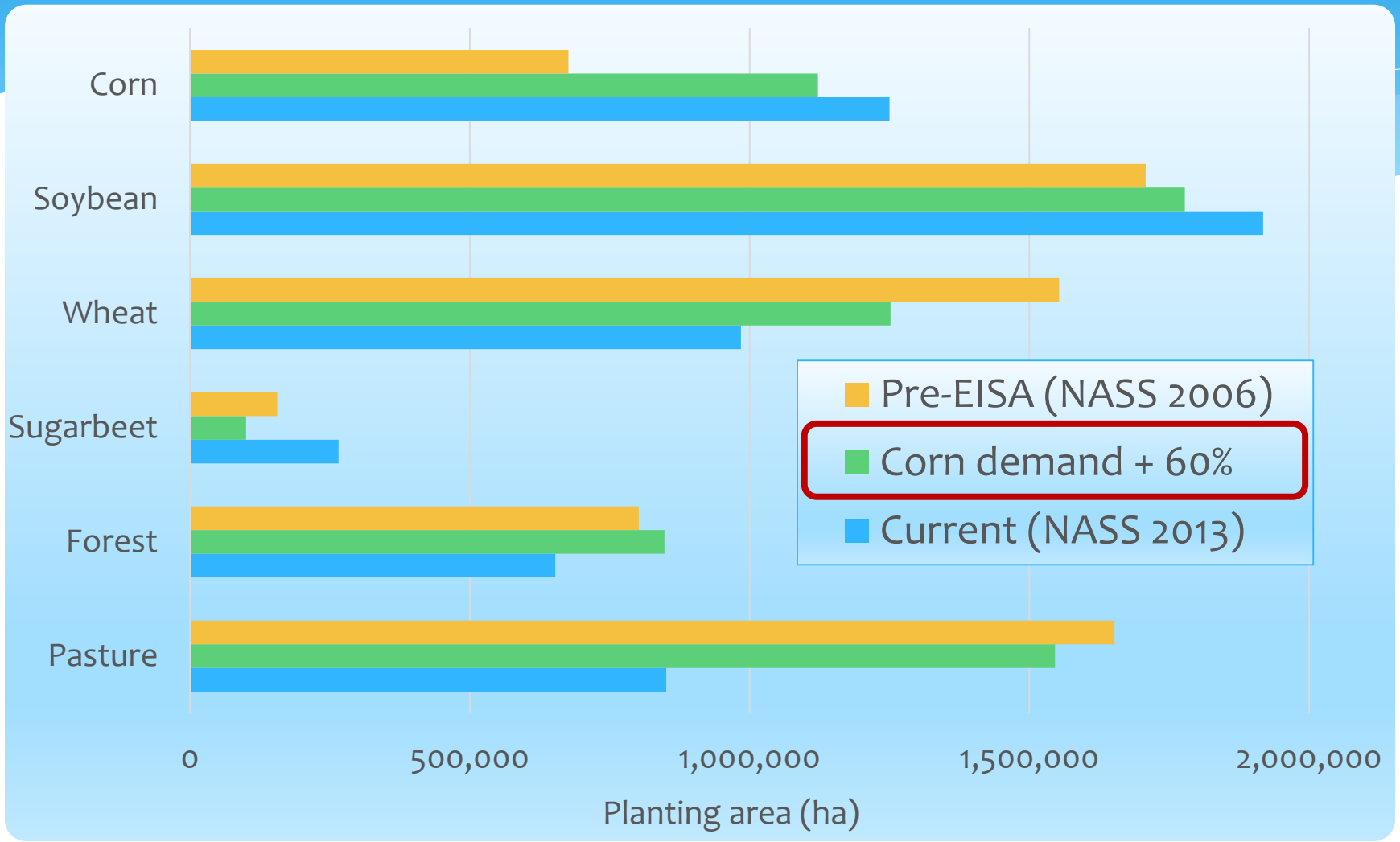


Results and Discussion

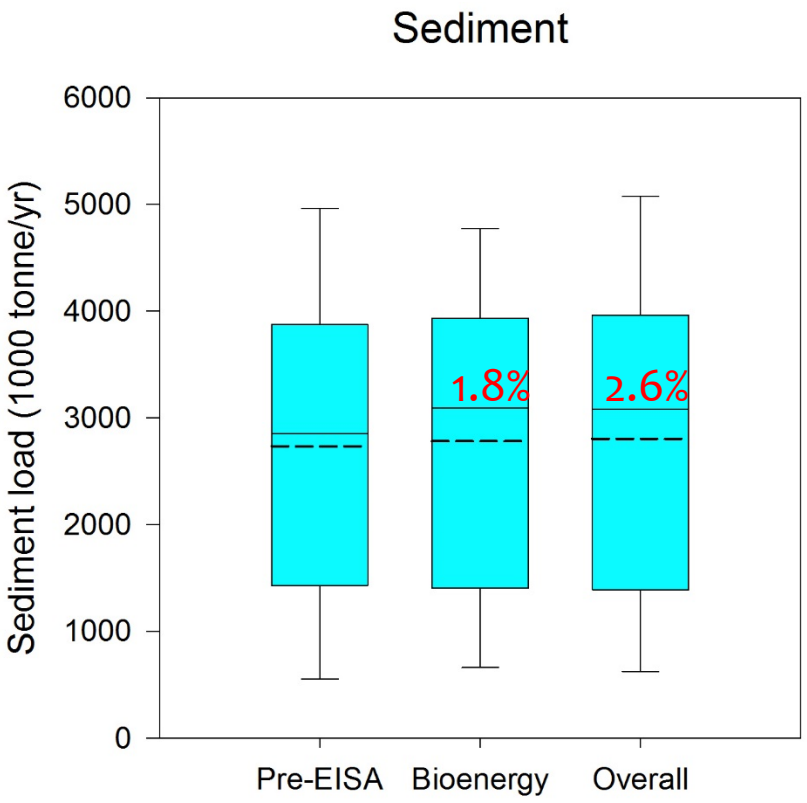
Overall land use changes

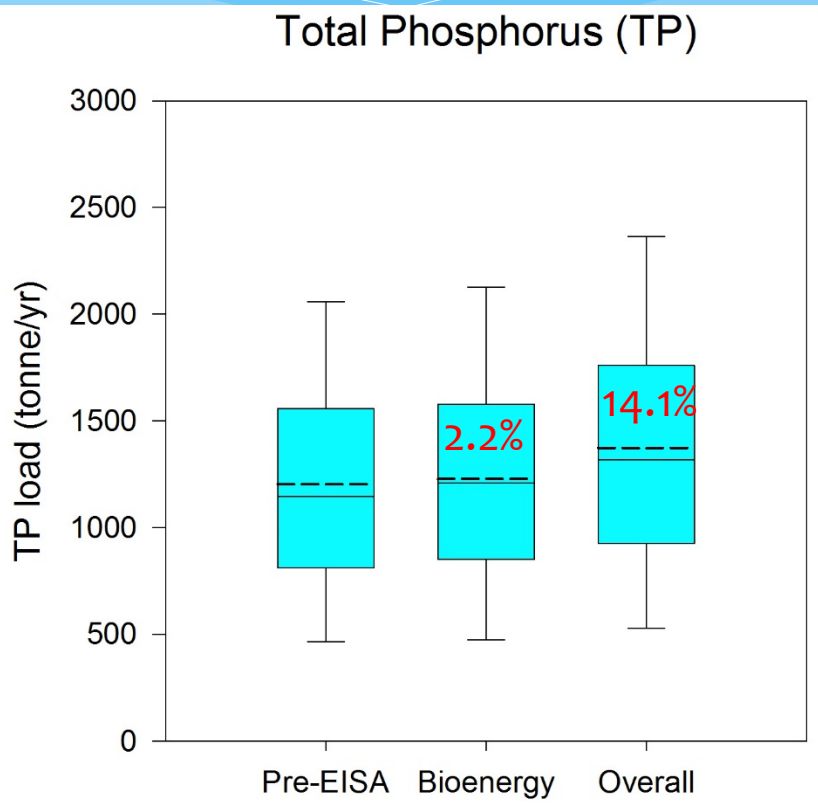


Bioenergy-induced land use changes

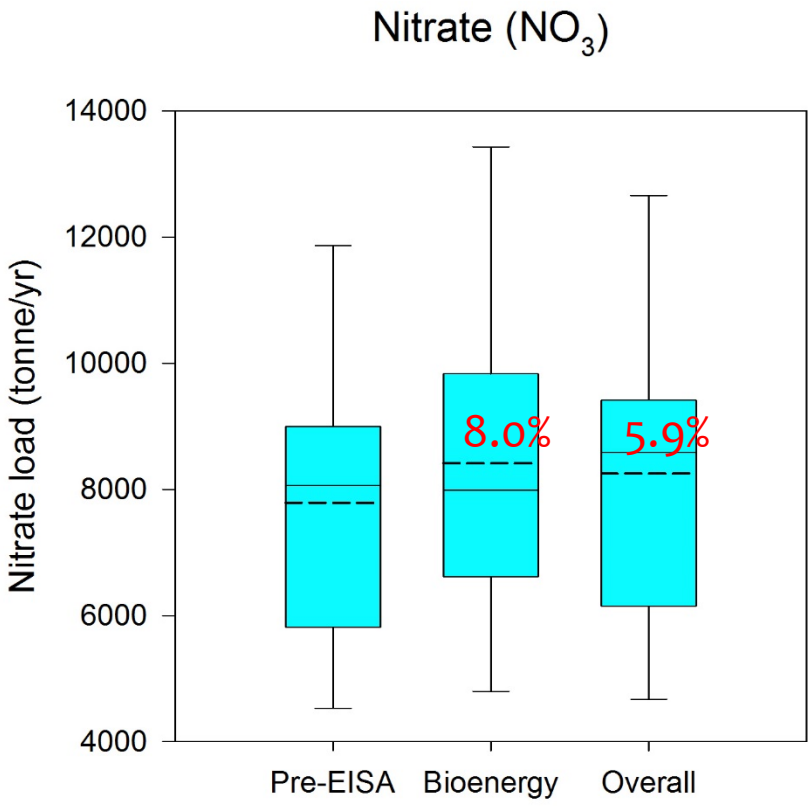


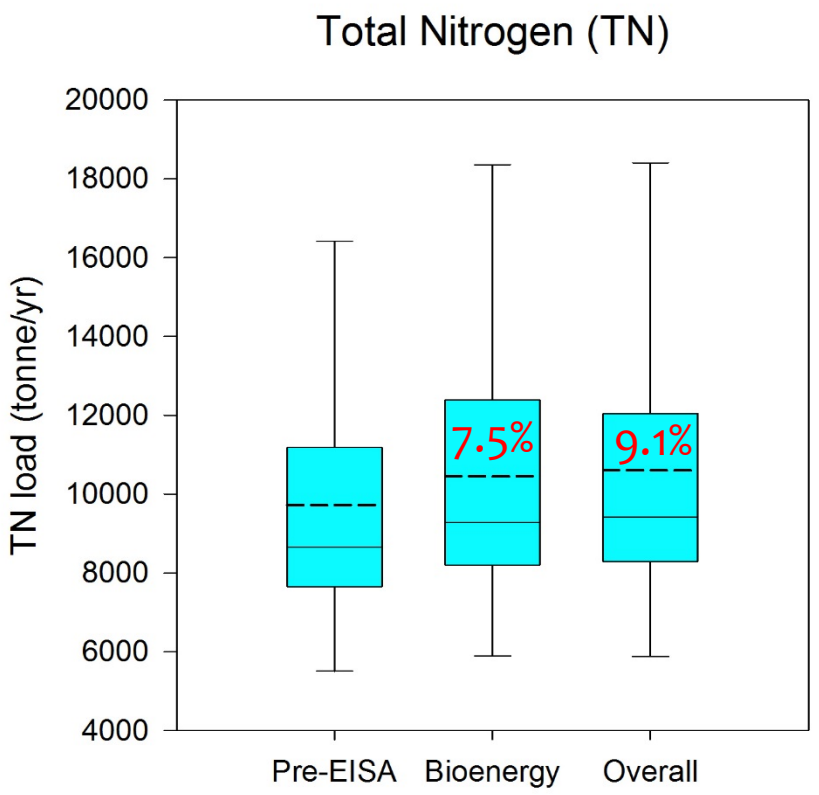
Land use change impact on WQ (1)





Land use change Impact on WQ (2)

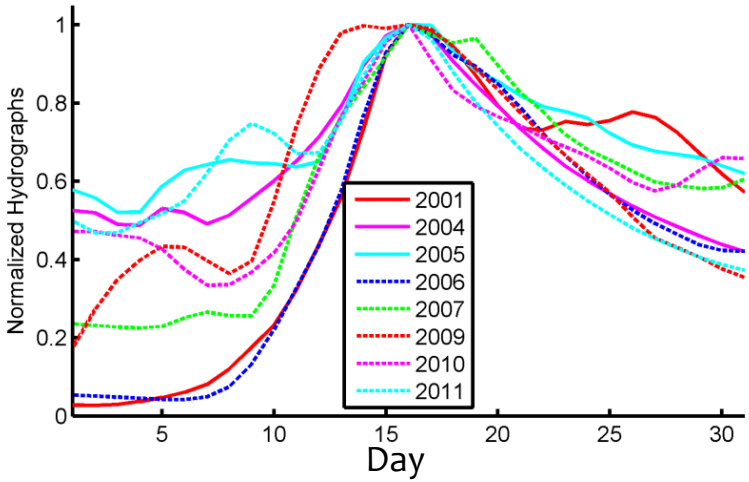


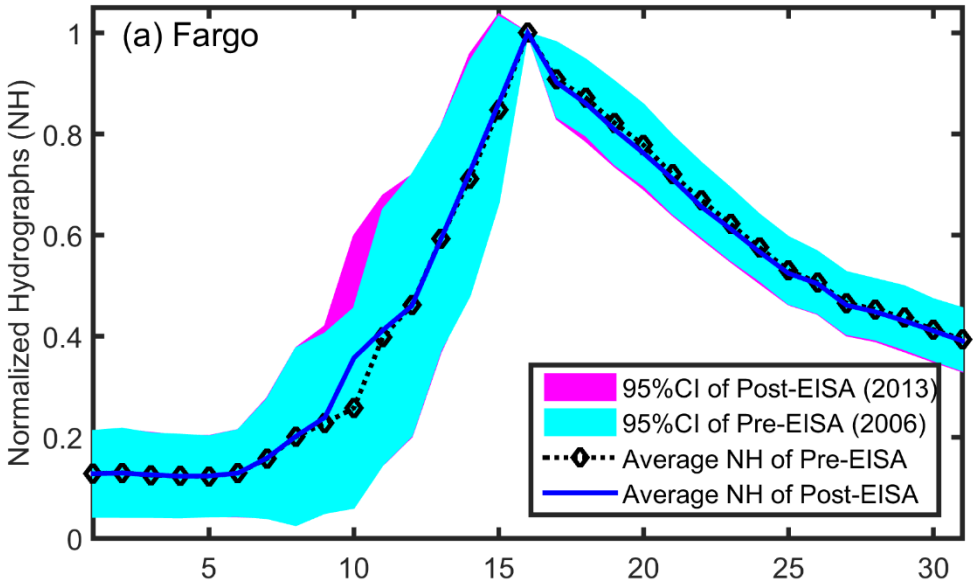


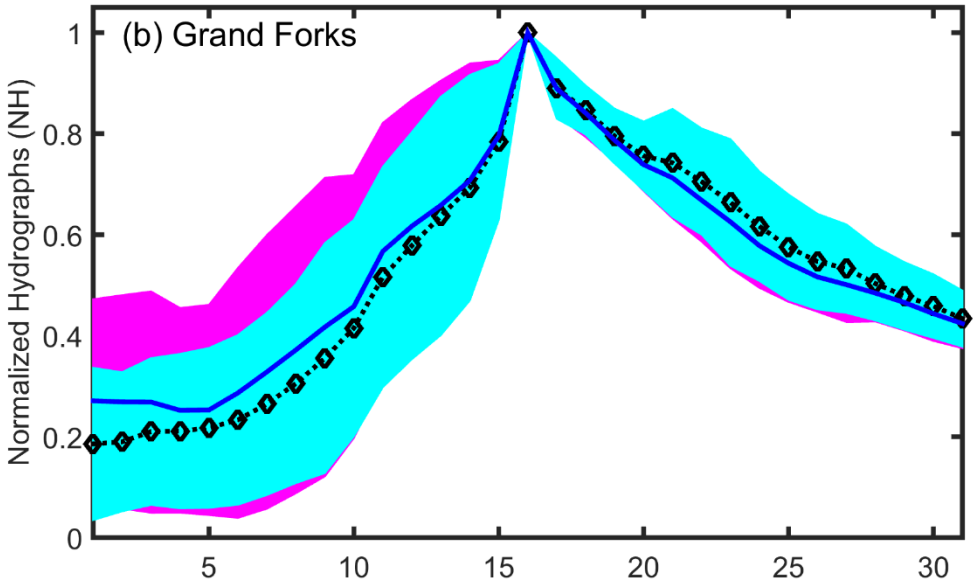
Impacts on spring flood

Normalized Hydrographs

(2000-2012 Single Peak Snowmelt Events)







Conclusions

* Land-use changes in the RRB from 2006 to 2013:
  * Increased: Corn (62%), Soybean (18%), sugarbeet, canola, dry beans, alfalfa;
  * Decreased: Spring wheat (30%), forest (18%), pasture (50%), barley, oats;
  * Factors: bioenergy policies, soil salinity, etc.

* Impacts on water quality
  * Overall land use change – sediment by 2.6%, TP by 14.1%, nitrate by 5.9%, TN by 9.1%.
  * Bioenergy policy contributions – sediment by 1.8%, TP by 2.2%, nitrate by 8.0%, TN by 7.5%

* Impacts on spring flood
  * No change on flood magnitude
  * Greater prediction uncertainty under post-EISA condition

Acknowledgements

* Mohammad Anar (NDSU) , Brent Silvis (UND), and Dave Zimmermann (NRCS) for their assistance