Expanding rice farming in the Delta: Significance for GHG, water supply reliability and water quality.

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Stillwater Sciences
ESA
Delta Science Center
USGS science for a changing world

Three Scenarios for Rice in Delta

Business as Usual

- Private land use based on economic viability
- Duel conveyance through Delta
- Infrastructure stays in place

Conveyance Delta

Place & manage rice to:

- Protect through – conveyance
- Protect water quality

Optimize Commons

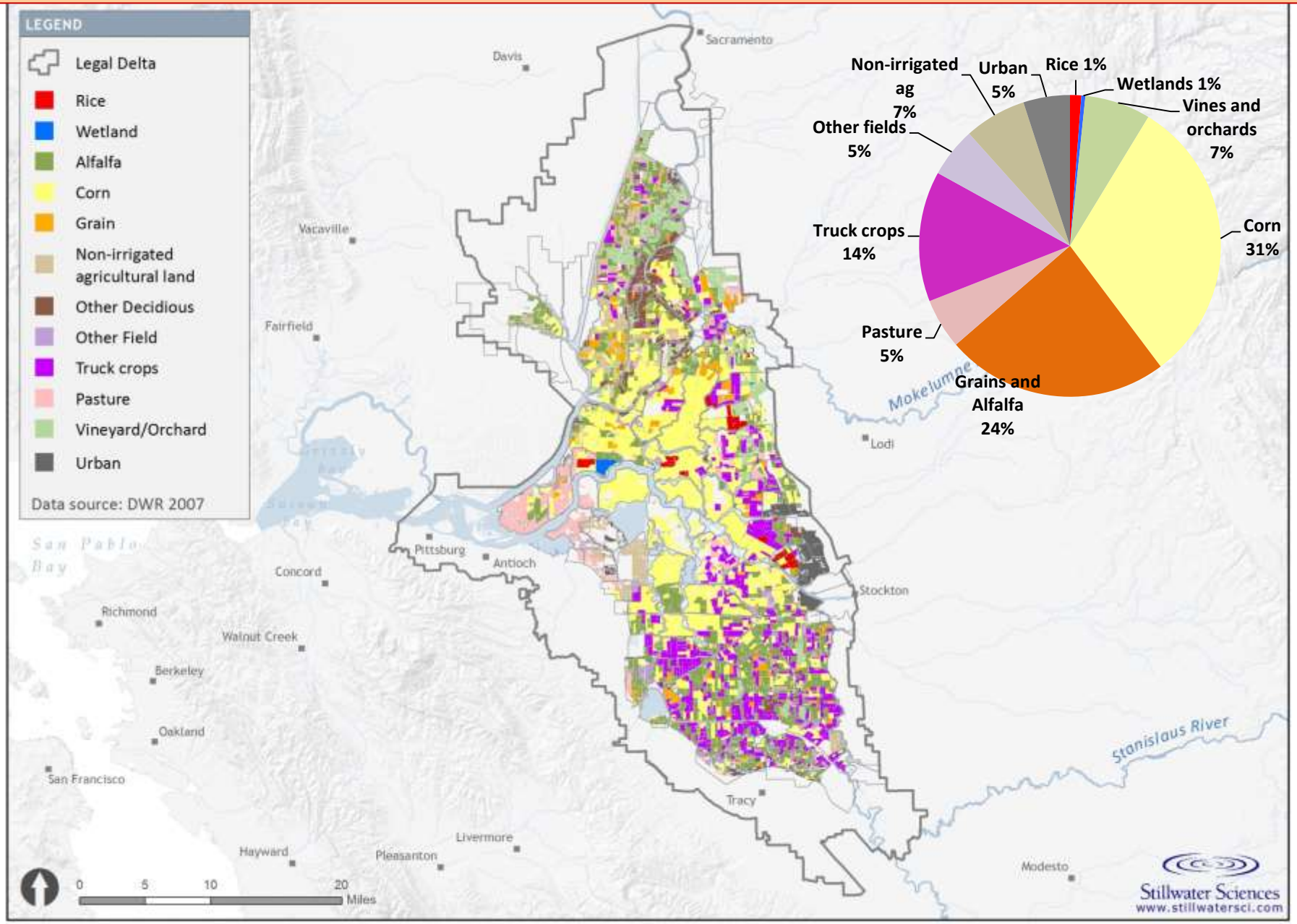
Place & manage rice to:

- Maximize net GHG uptake
- Minimize/reverse subsidence
- Protect water quality

Effects of Rice Culture in the Delta

- Subsidence
- Levee stability
- GHG emissions/ C sequestration
- Water quality (DOC, MeHg)
- Infrastructure
- Local and state economy

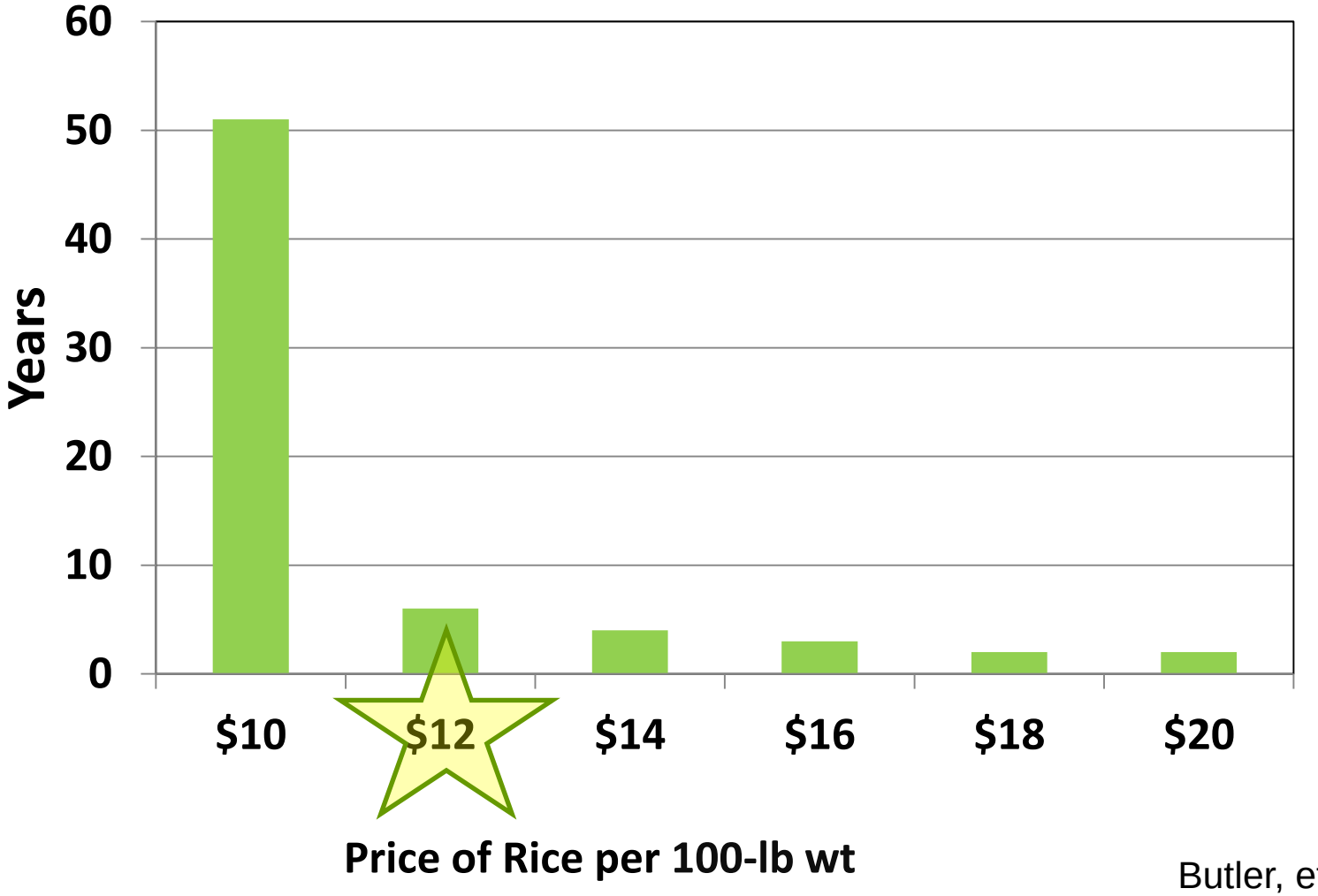
Business as Usual (BAU)



Business as Usual (BAU)

Assume decisions are based primarily on the bottom line.

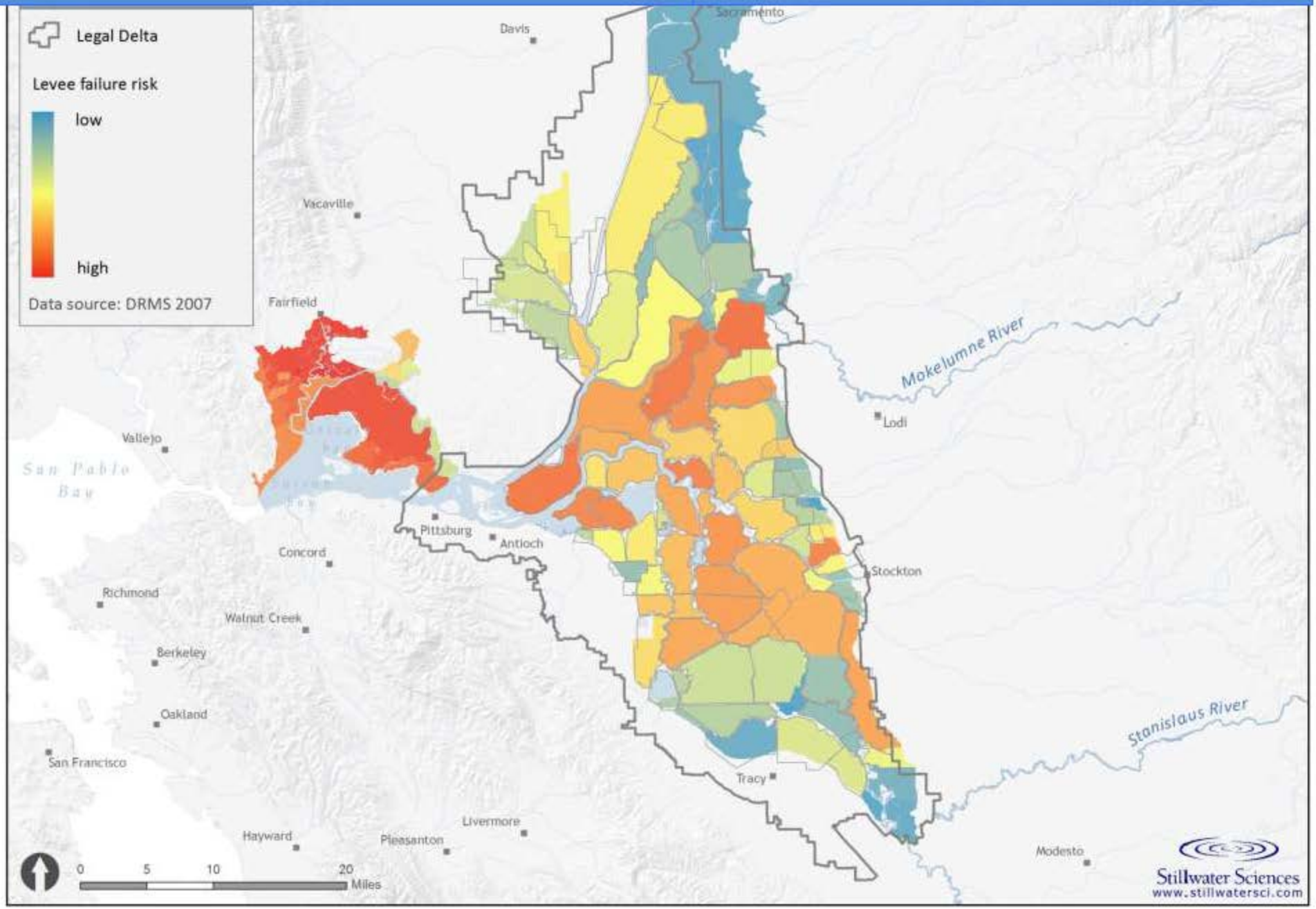
Net Present Value: **Years to breakeven** at various prices for rice



Butler, et al., 2013

Current Situation

Conveyance Delta



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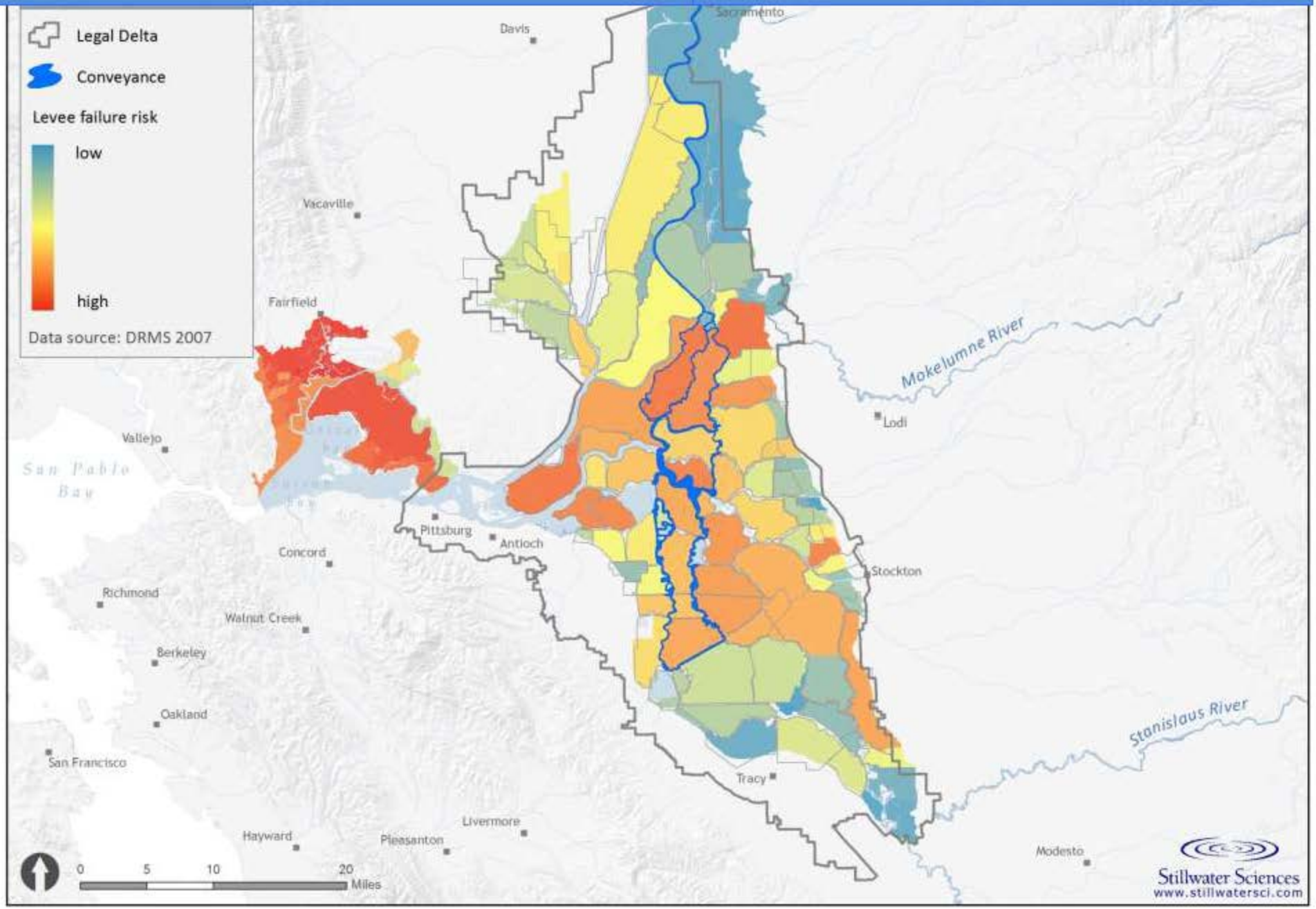
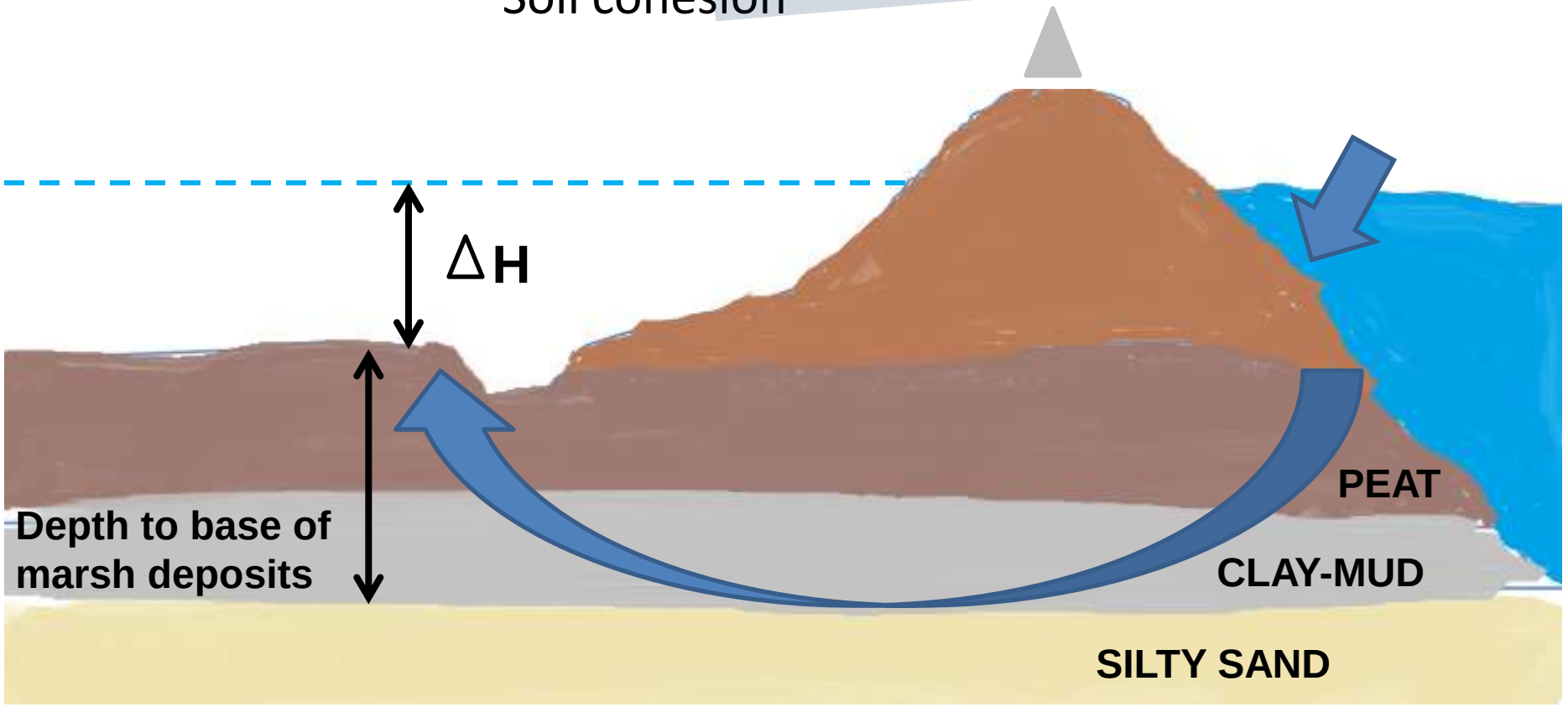


Current Situation

Balance of forces

Weight of levee, land
Shear resistance
Soil cohesion

Hydrostatic pressure
Hydraulic conductivity



Current Situation

Conveyance Delta

Failure types:
Static slope failure
Under-seepage
Through-seepage
Seismic
Over-topping

Balance of forces

Weight of levee, land
Shear resistance
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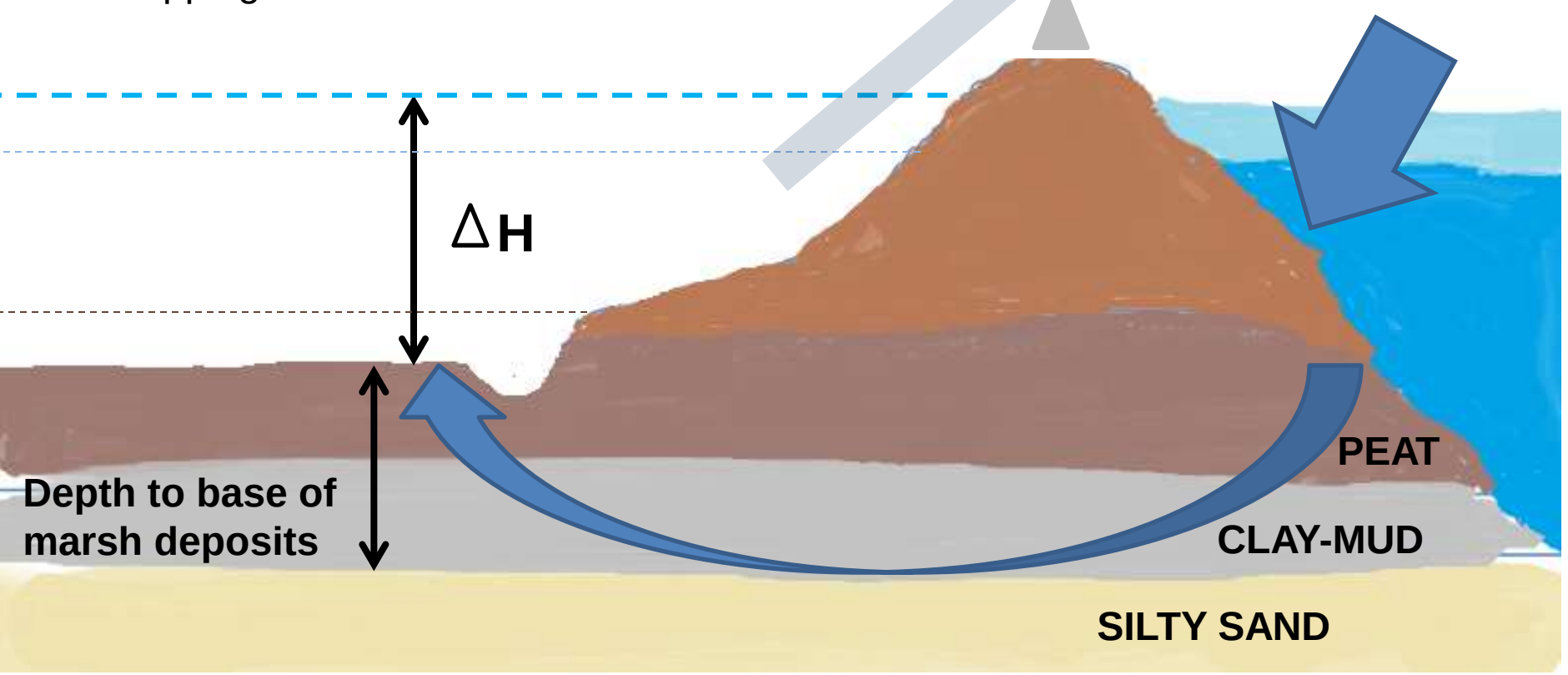
Hydraulic conductivity



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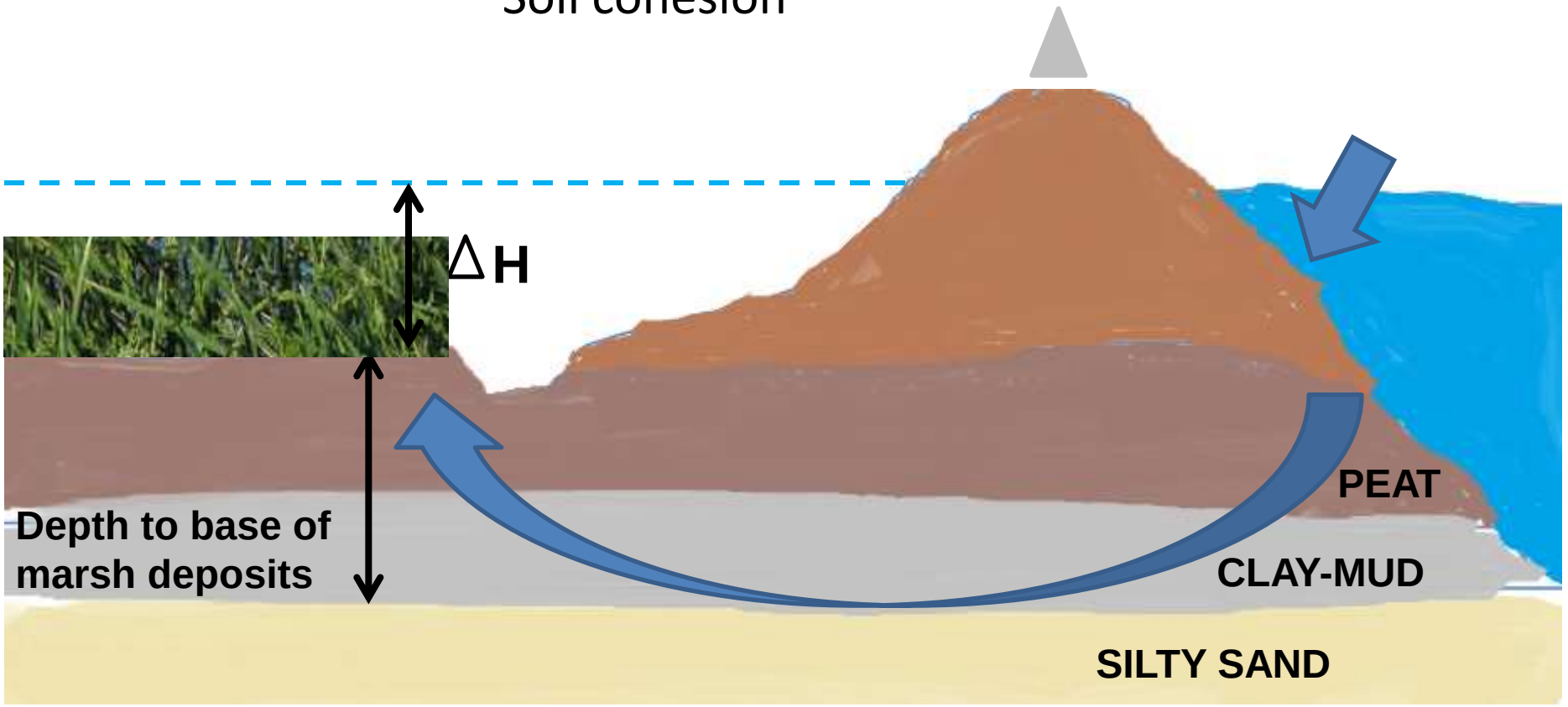
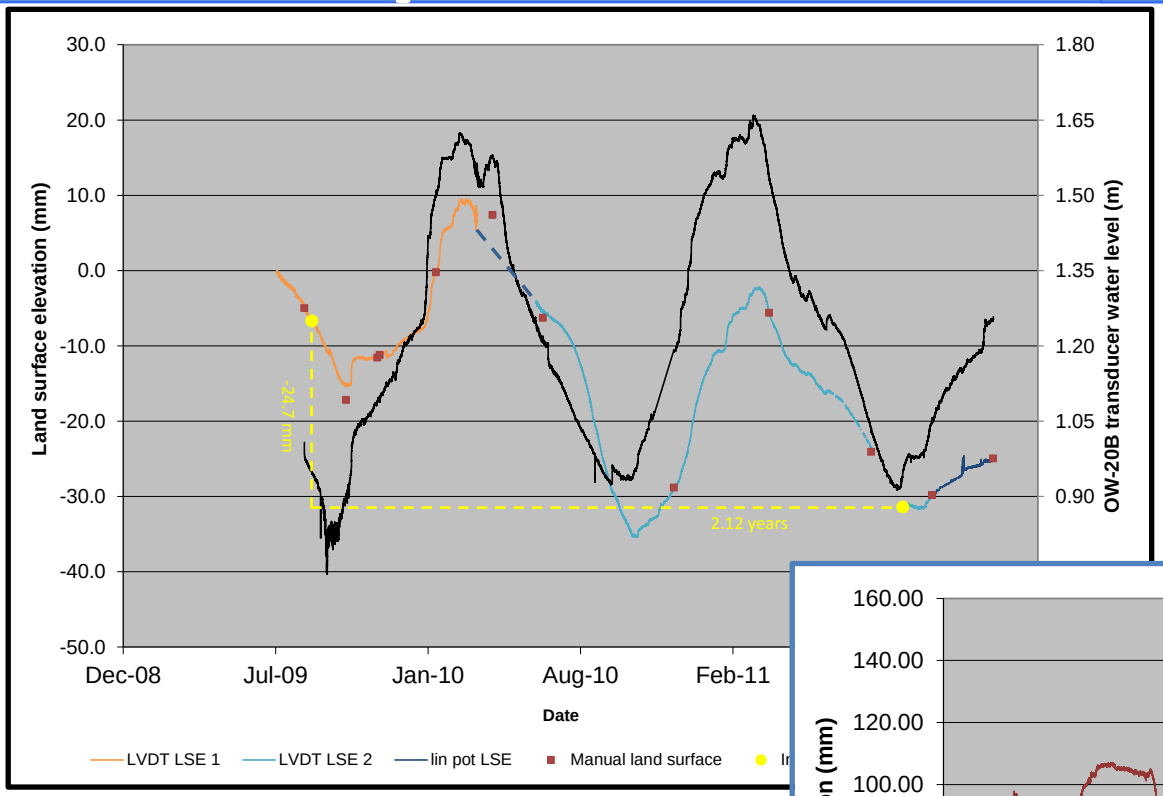
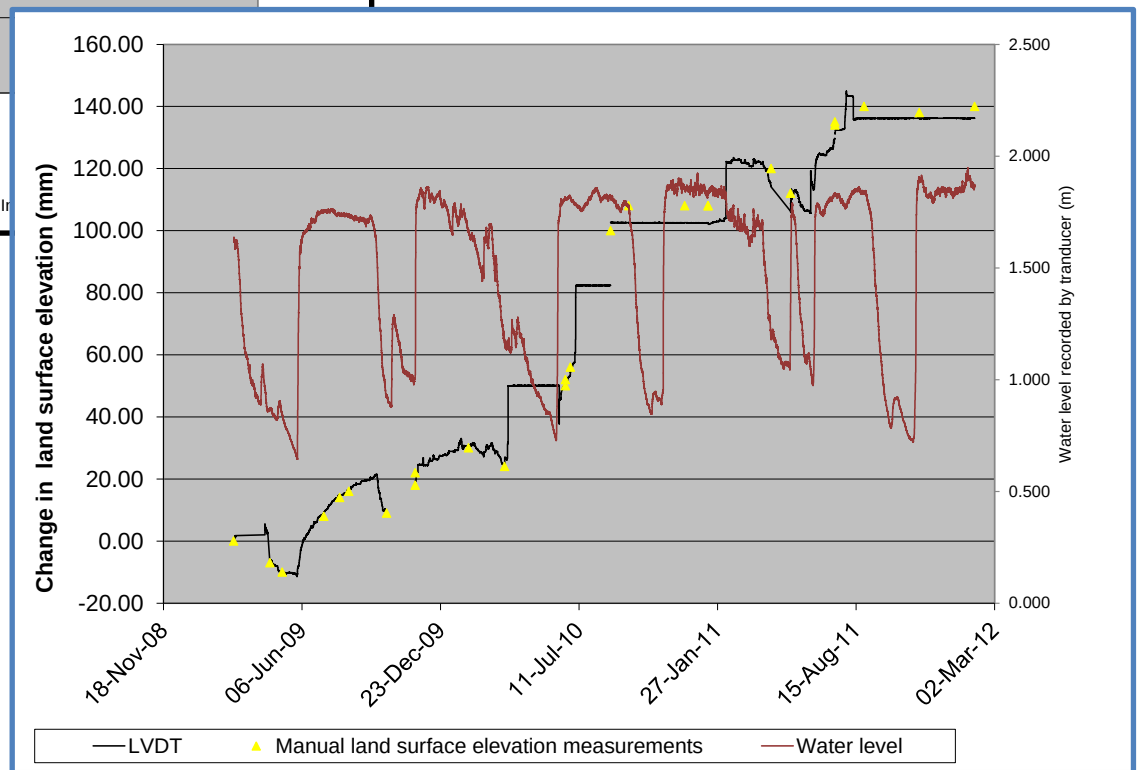


Rice stops subsidence

Conveyance Delta



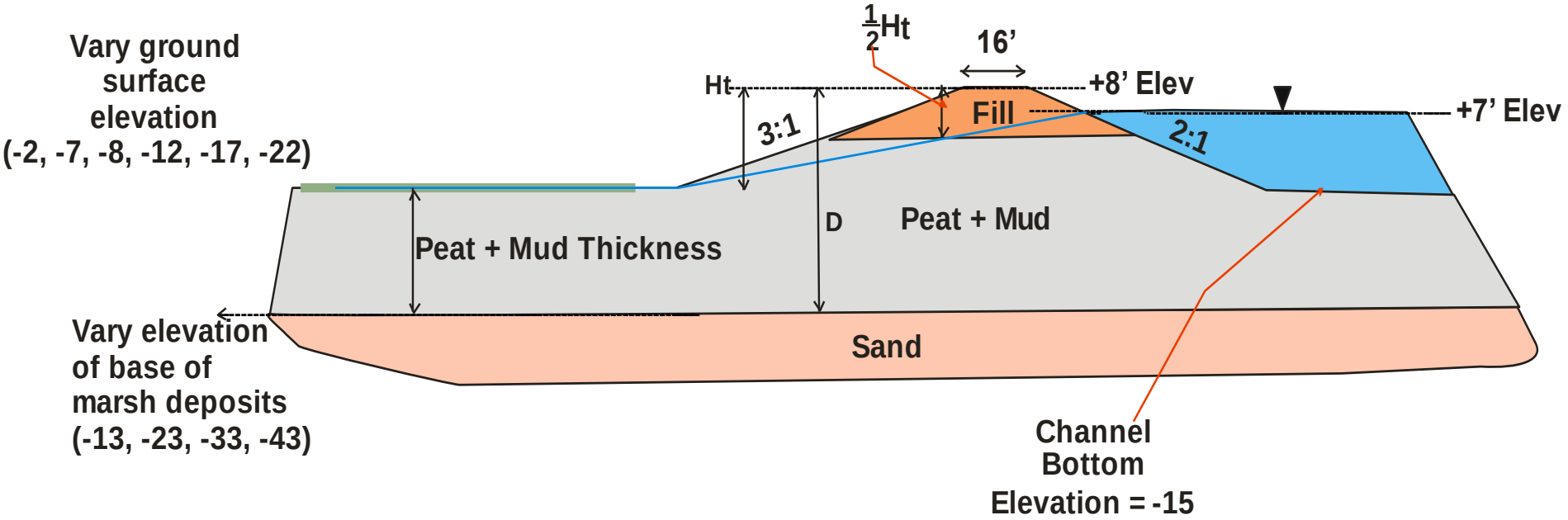


Deverel, et al. 2014

Relative change in risk? Conveyance Delta

Failure Types:
Static slope failure,
Under-seepage

Failure Risks = F() of:
Depth to base of peat/mud
Head difference



D - Depth of peat/mud, measured from crest to mud bottom
Ht - Height of levee, measured from crest to ground surface

Relative change in risk? Conveyance Delta

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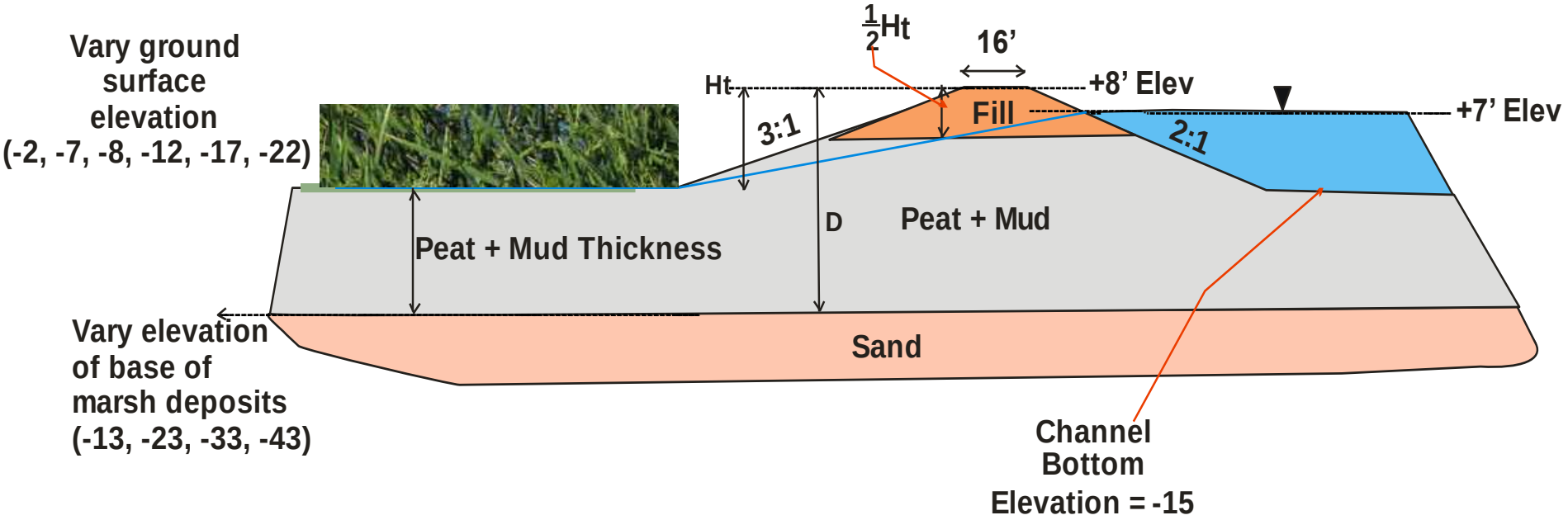

D - Depth of peat/mud, measured from crest to mud bottom
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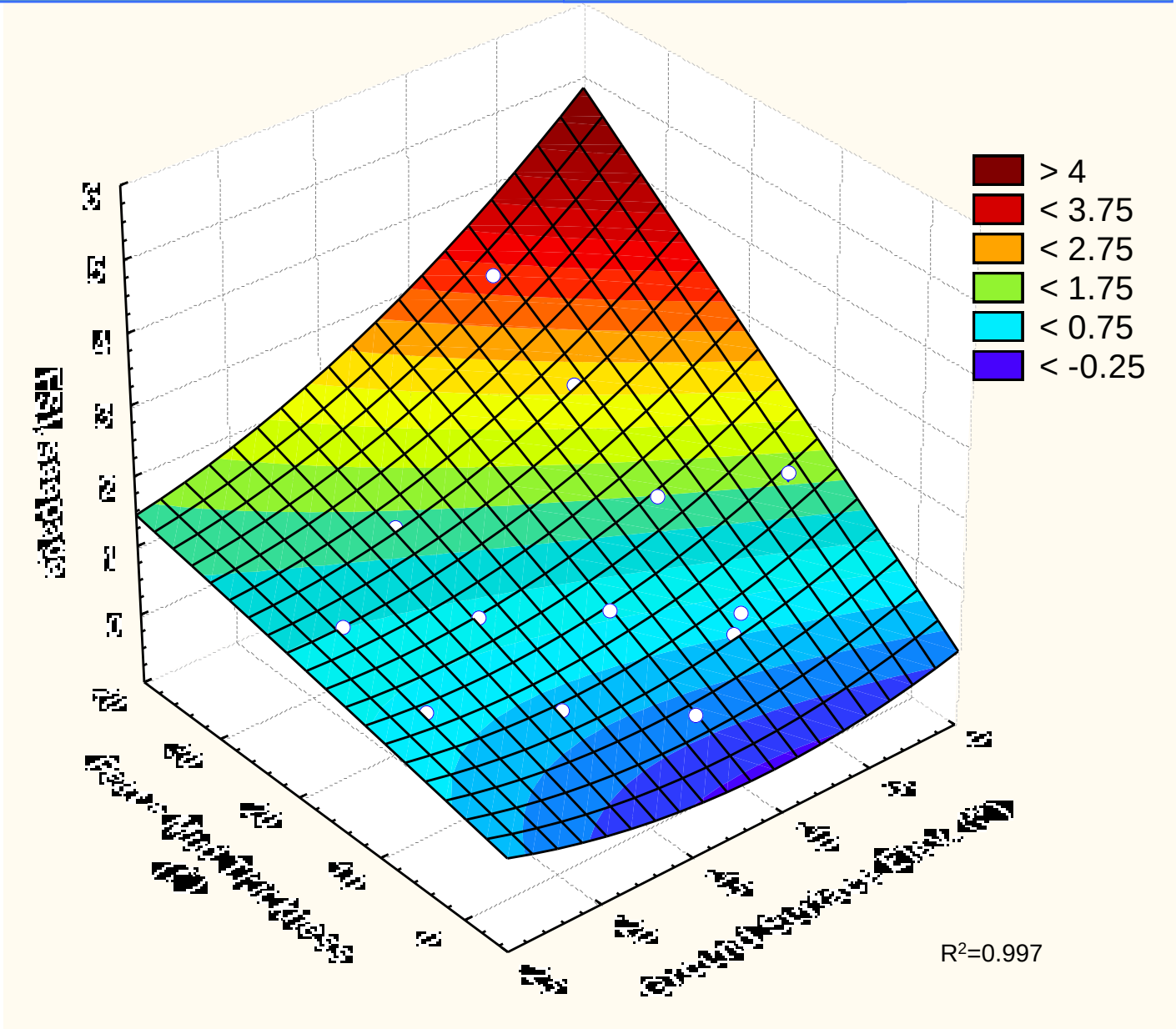
Relative change in risk?

Conveyance Delta

Preliminary findings

Predicted change in seepage failure FSI with changes in

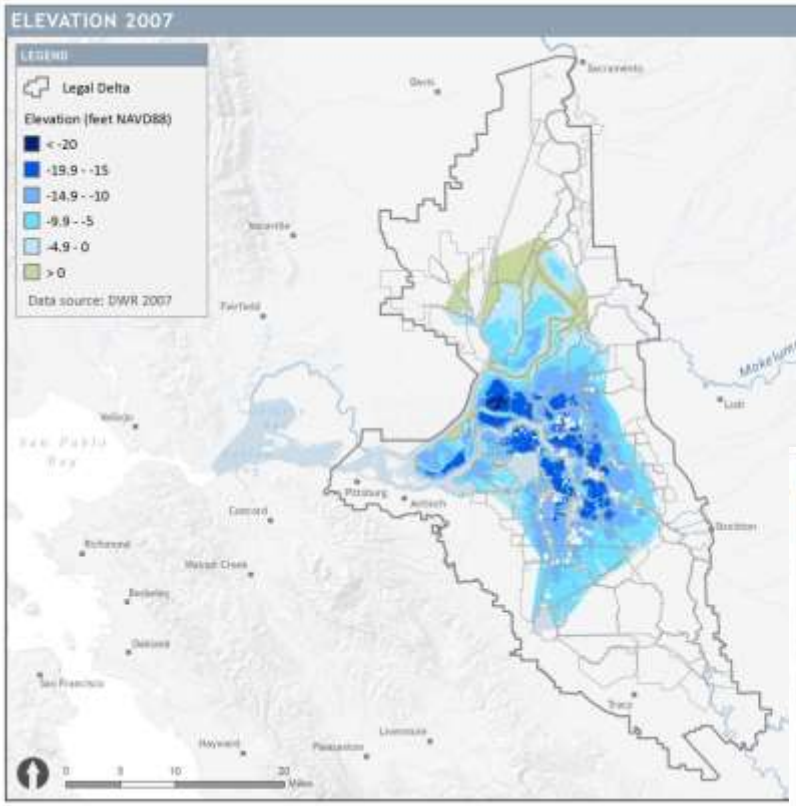
- peat thickness
- surface elevation

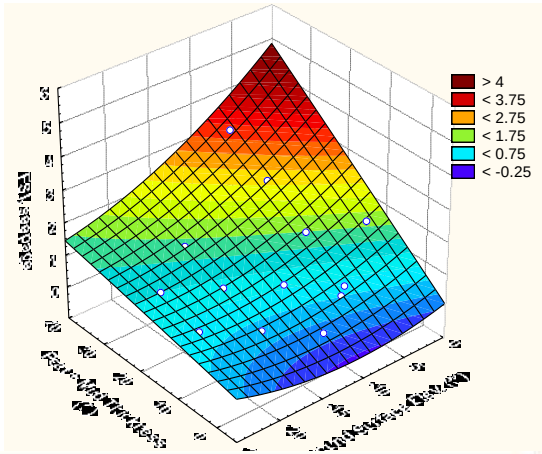


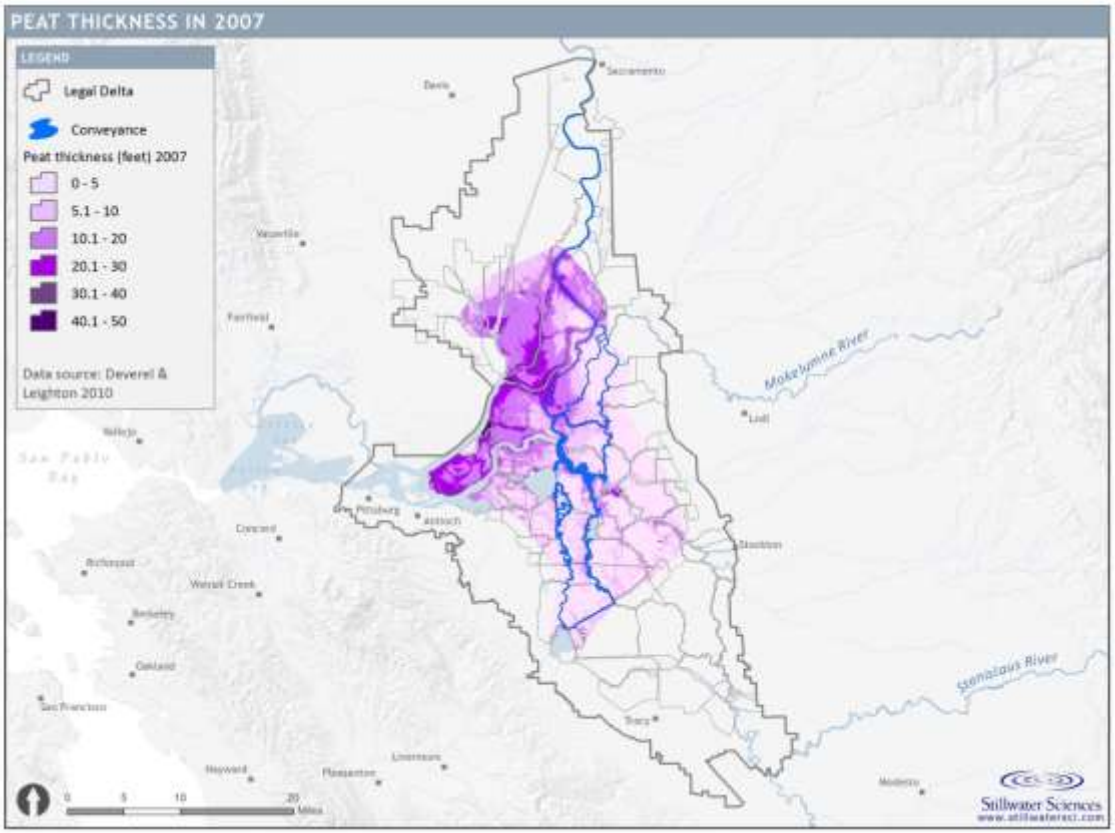
Bachand, S. and R.K. Tillis, A. Merrill, P. Bachand, S. Siegul

Where could rice help?

Conveyance Delta







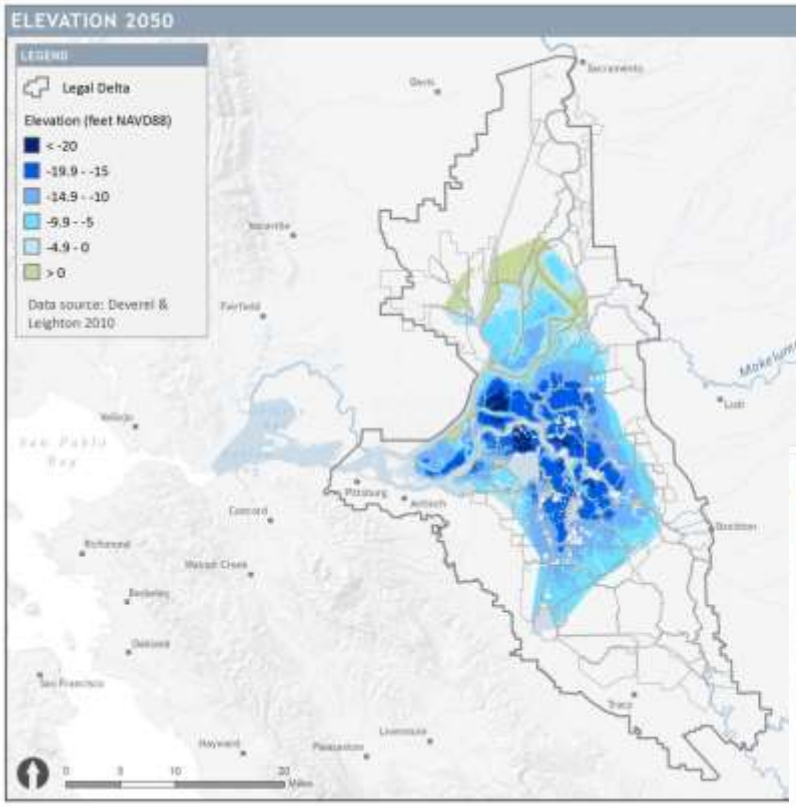
2007 Conditions

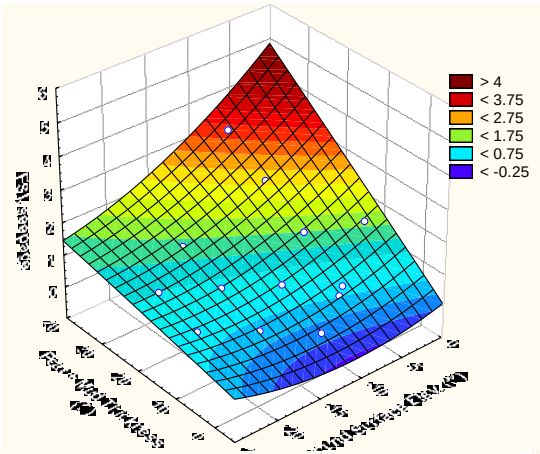
Levee Factor of Safety = F()

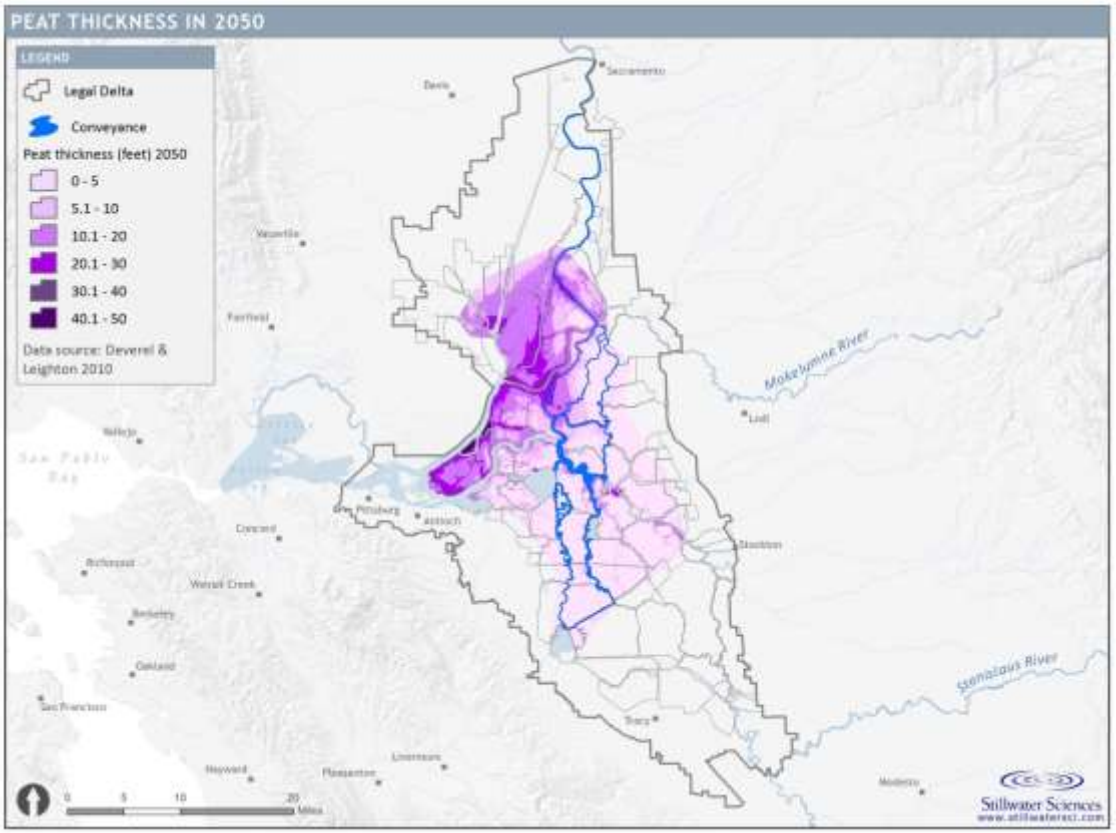
- Peat thickness
- Surface elevation

Where could rice help?

Conveyance Delta







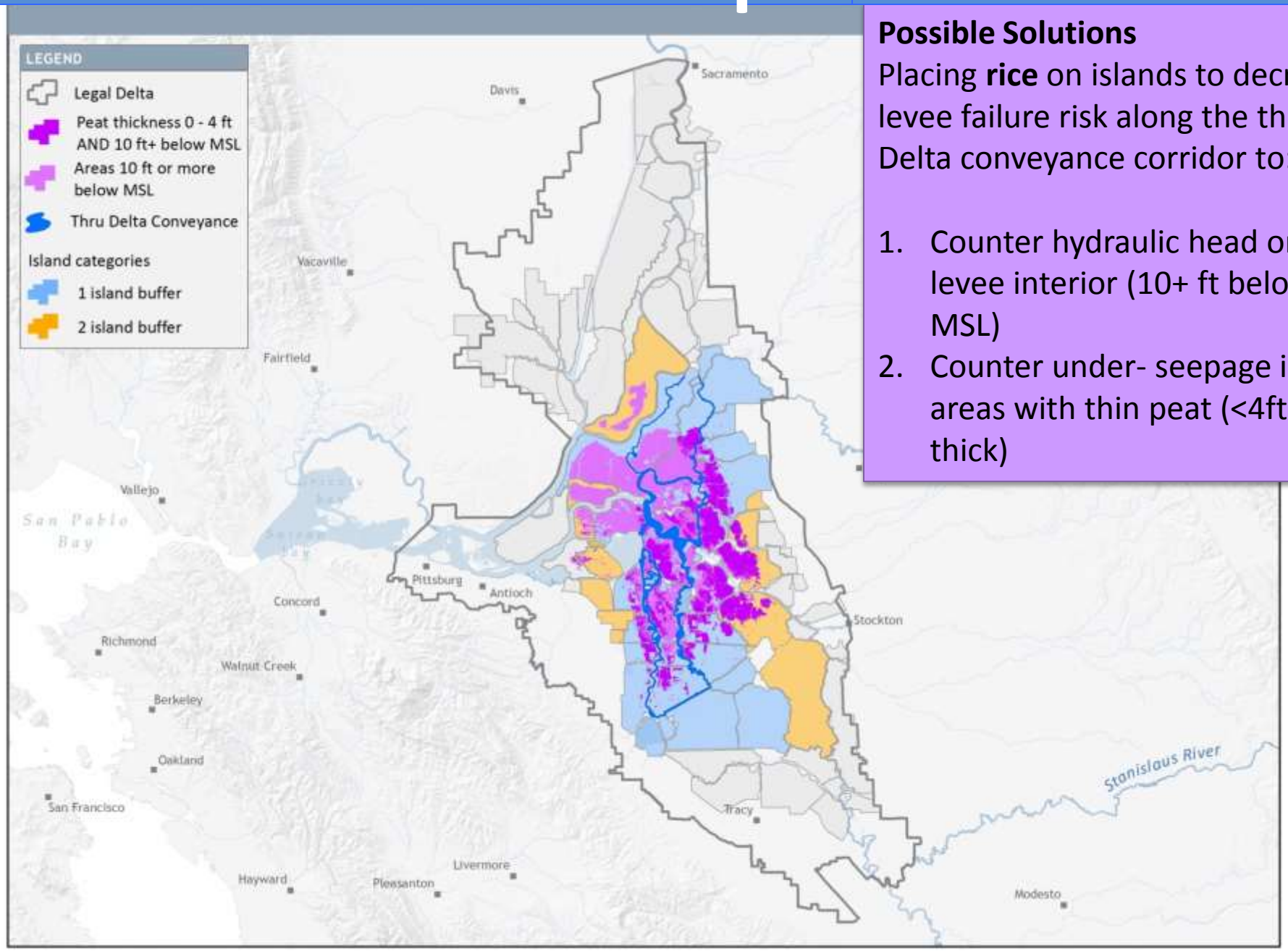
2050 Conditions

Levee Factor of Safety = F()

- Peat thickness
- Surface elevation

Where could rice help?

Conveyance Delta



Possible Solutions

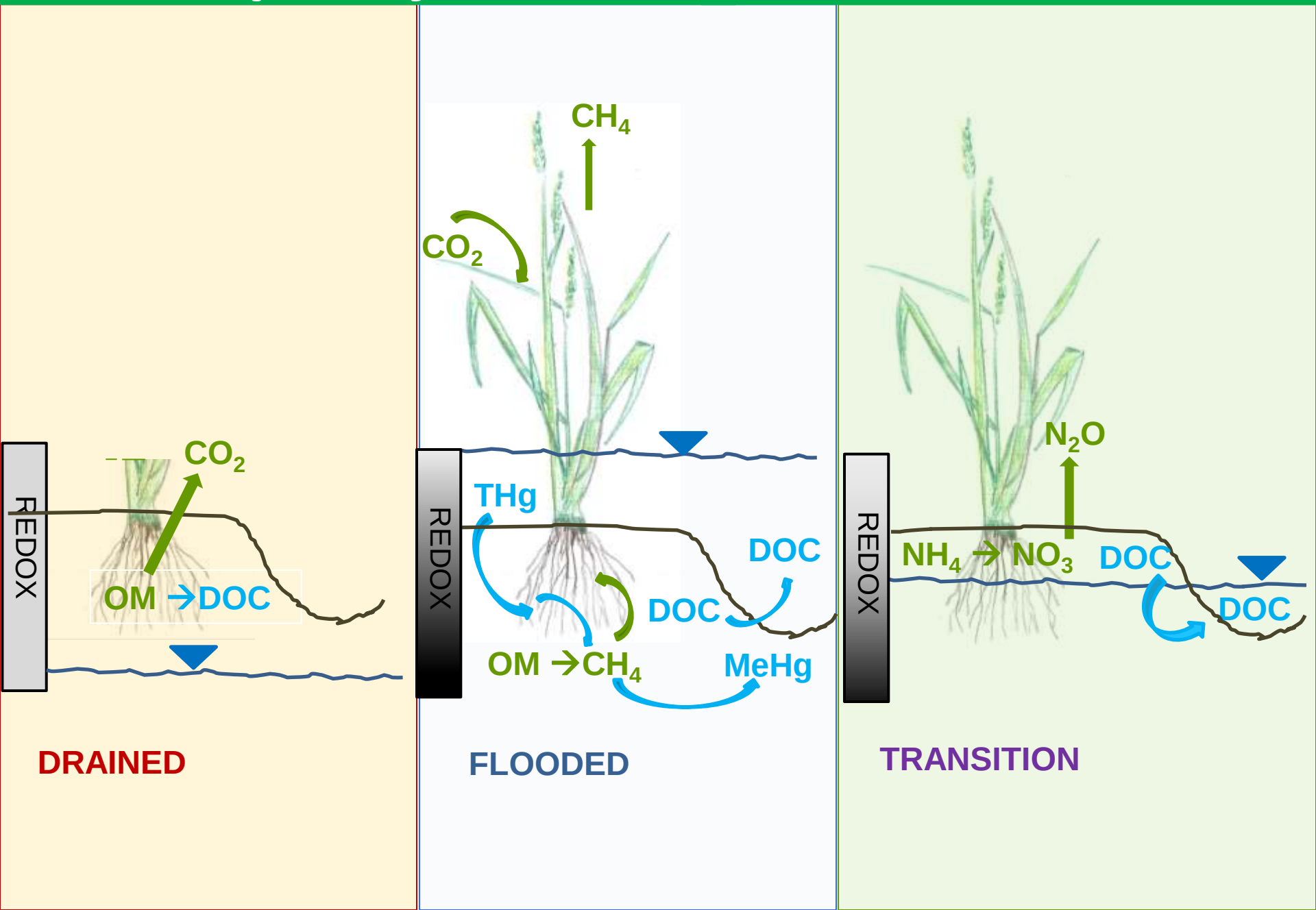
Placing **rice** on islands to decrease levee failure risk along the through Delta conveyance corridor to:

1. Counter hydraulic head on levee interior (10+ ft below MSL)
2. Counter under- seepage in areas with thin peat (<4ft thick)

Optimizing the Commons

- **GHGs** (CH_4, N_2O, CO_2)
- **Water quality** (DOC, MeHg)
- **Subsidence** effects on land use
- **Levee stability** (protect local communities, and economy, [habitat])

Water quality and Rice Optimizing Commons



Water Quality Effects: Sources of Variation

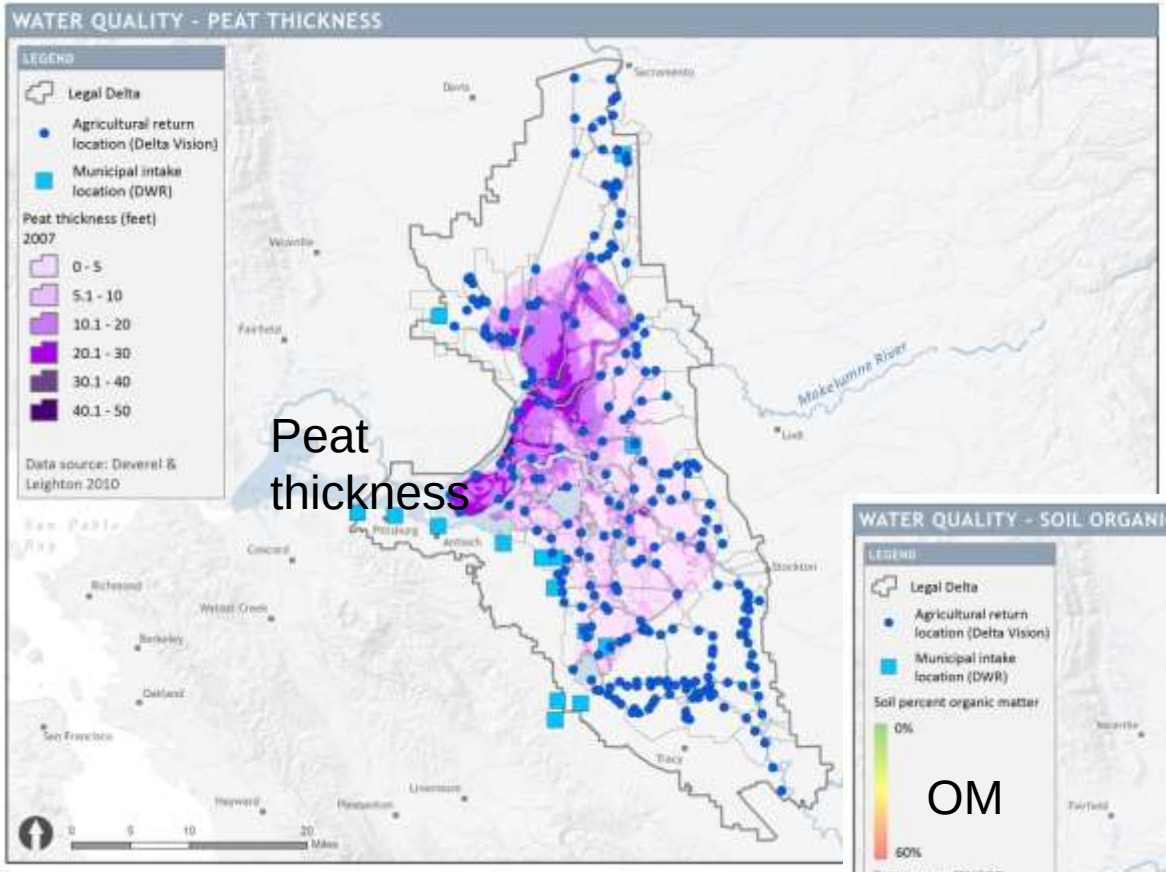
Management

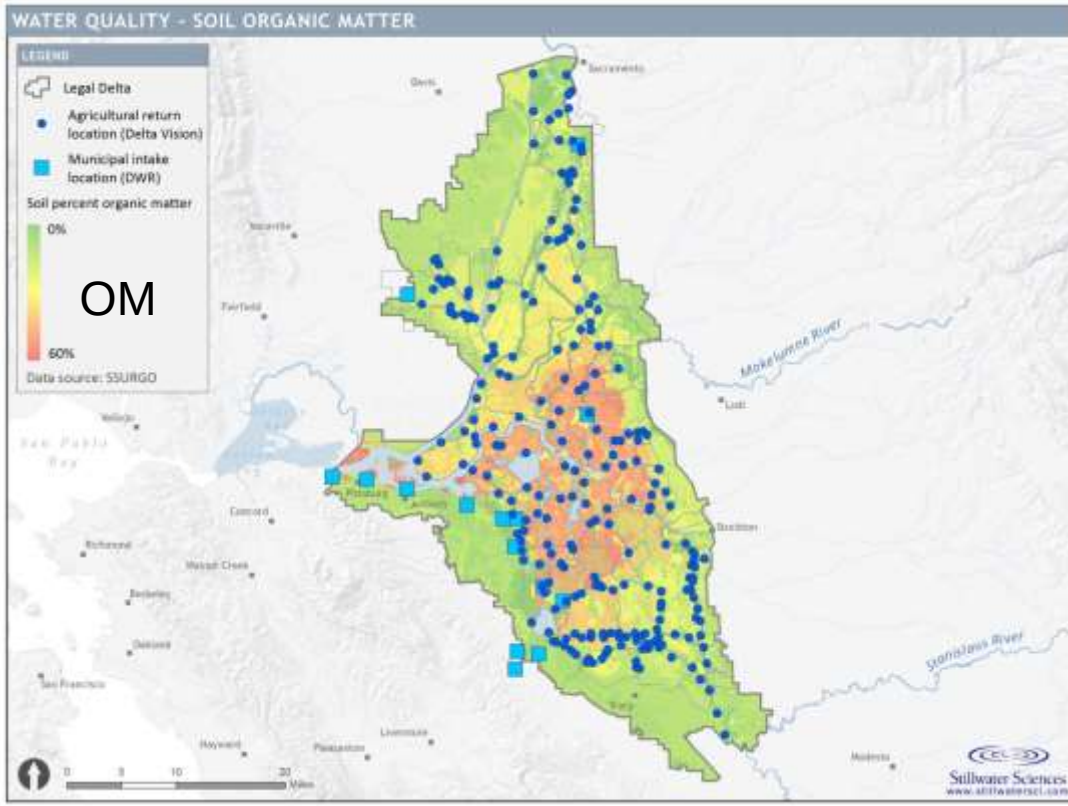
- Raise drain levels
- Recycle irrigation water
- Drain/Flood-up rates

Location

- Soil carbon
- Peat thickness
- Proximity btw
  - Drains,
  - Municipal intakes

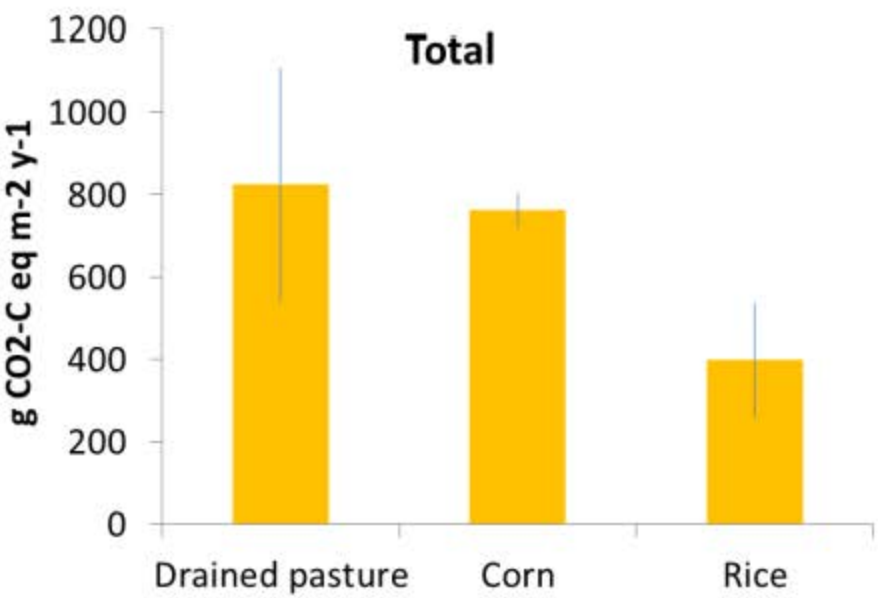
Water quality and Rice Optimizing Commons

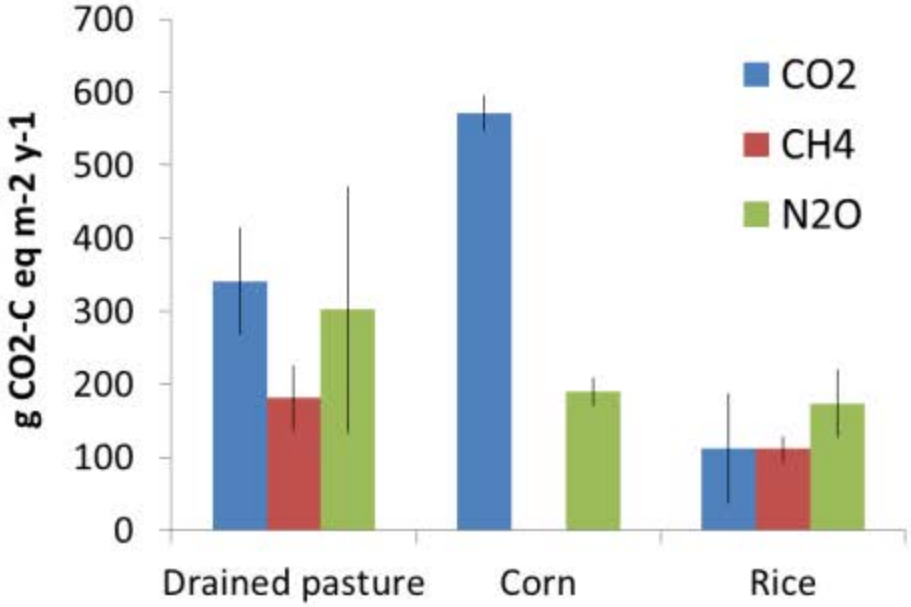




GHG's and Rice

Optimizing Commons

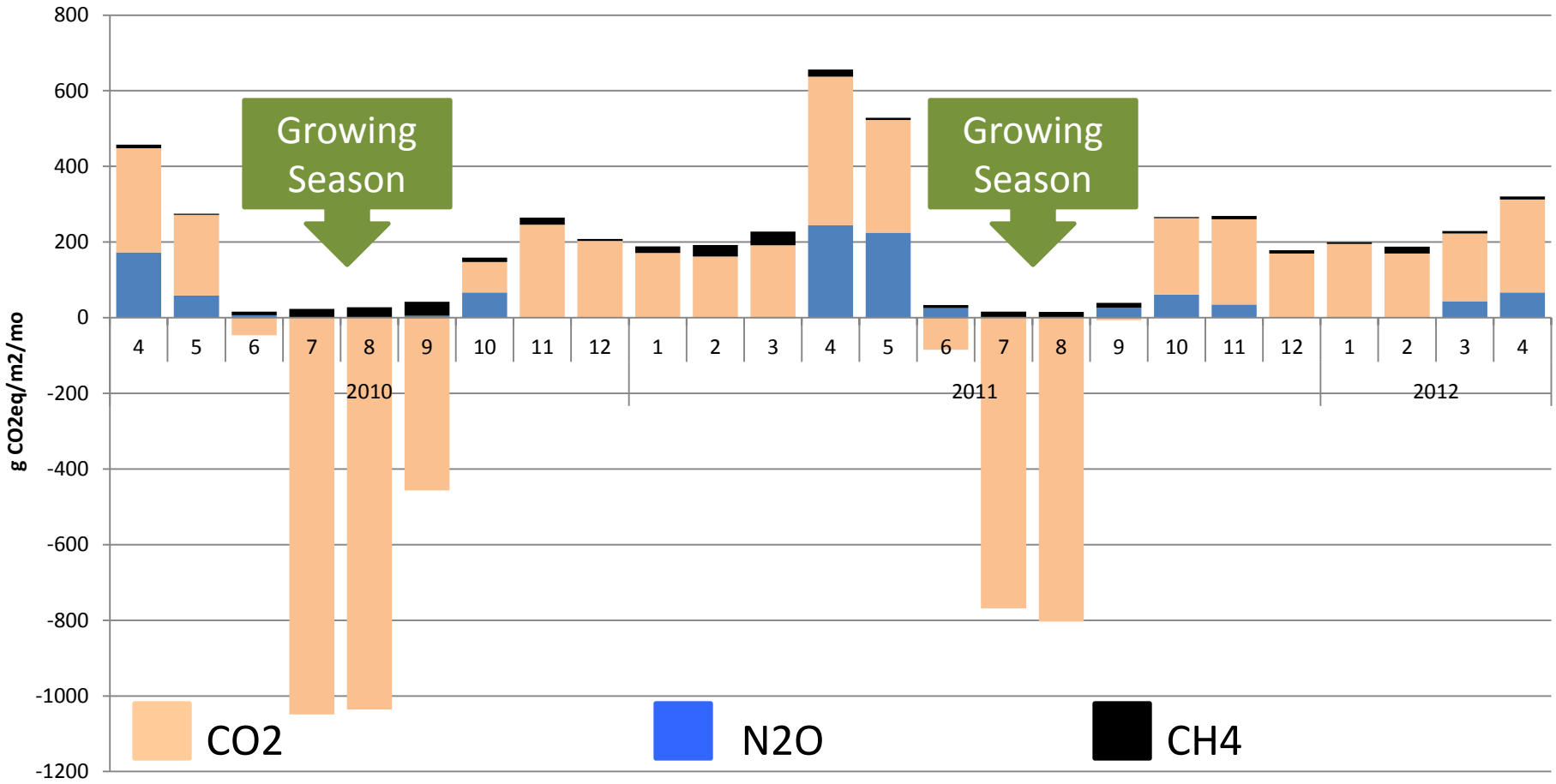




Sources:
Knox, Baldocchi et al. 2014
Morris, Horwath et al. 2014
.Teh, Silver et al. 2011

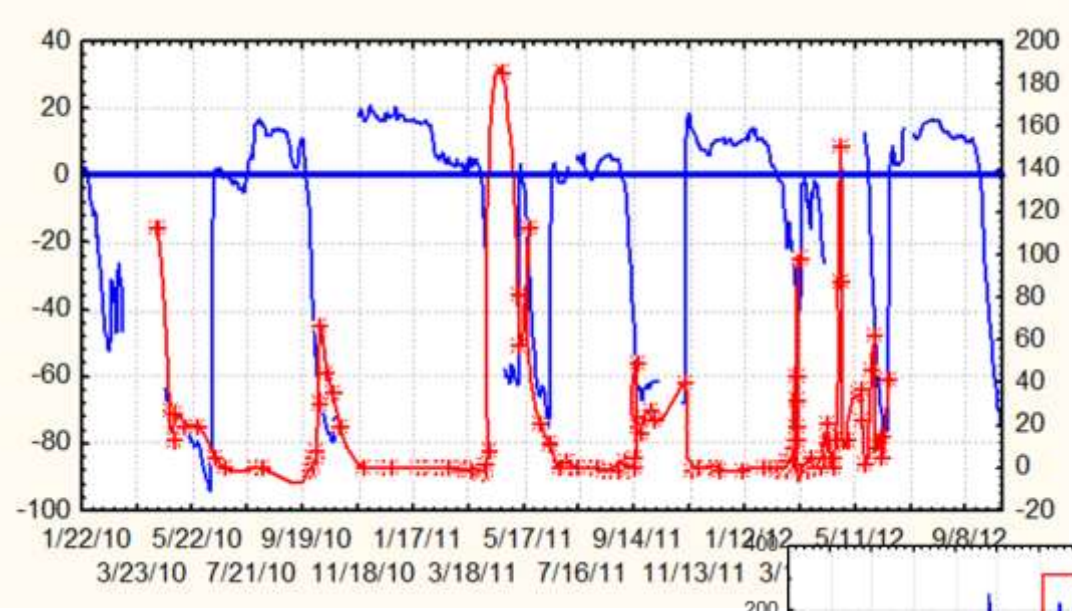
GHG's and Rice

Optimizing Commons



Water quality and Rice Optimizing Commons

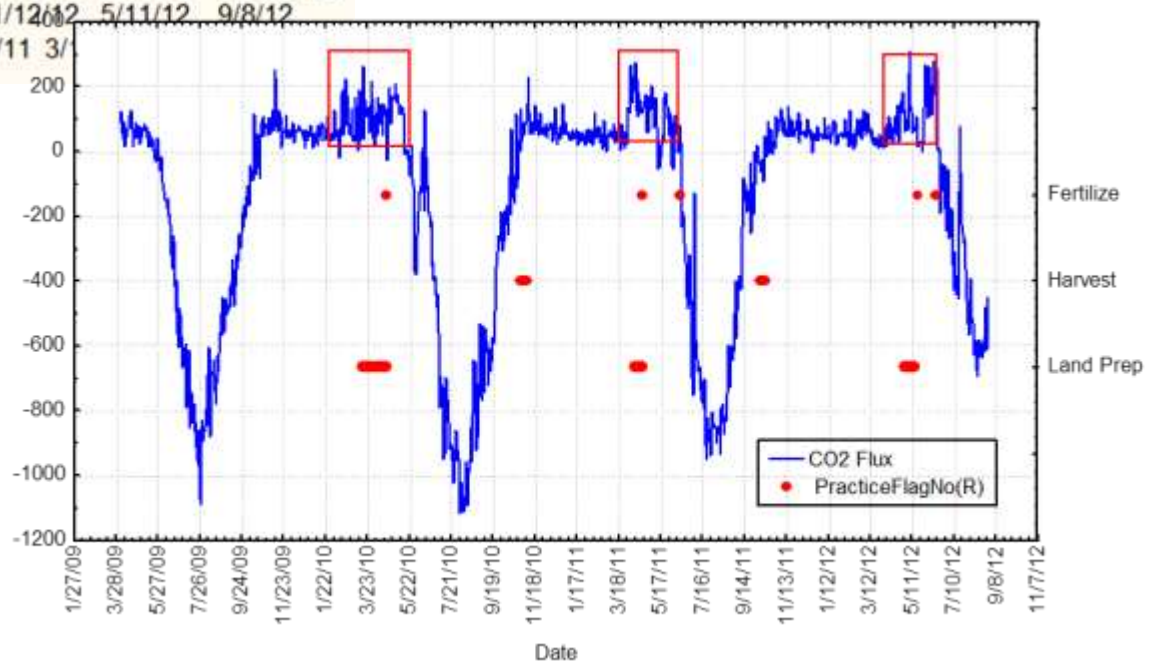
Nitrous Oxide Emissions



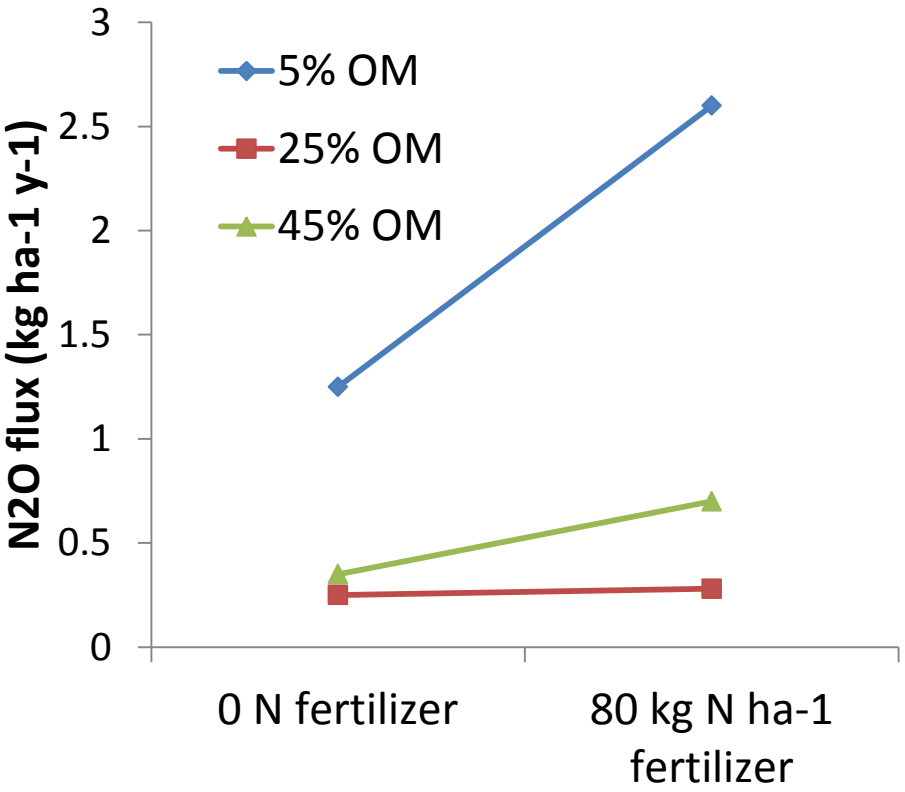
Water Table
N2O ug/m2/s

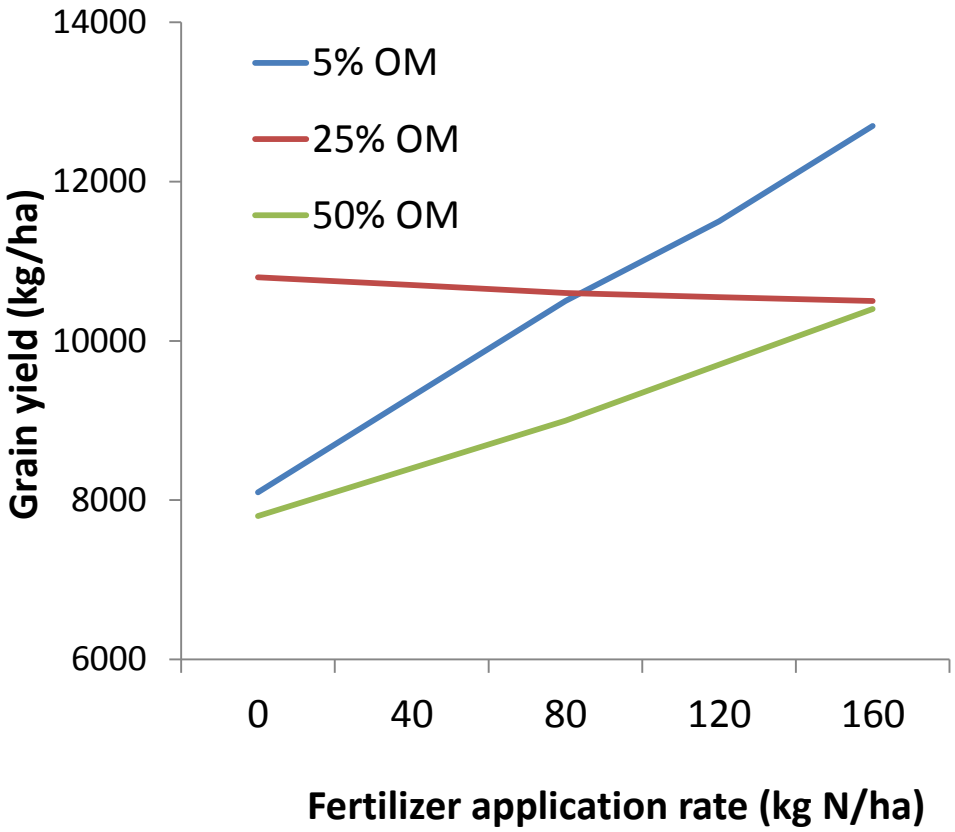
CO2 Emissions

Water Table
Mgmt Actions



N2O emissions can be minimized with management and soil O.M.

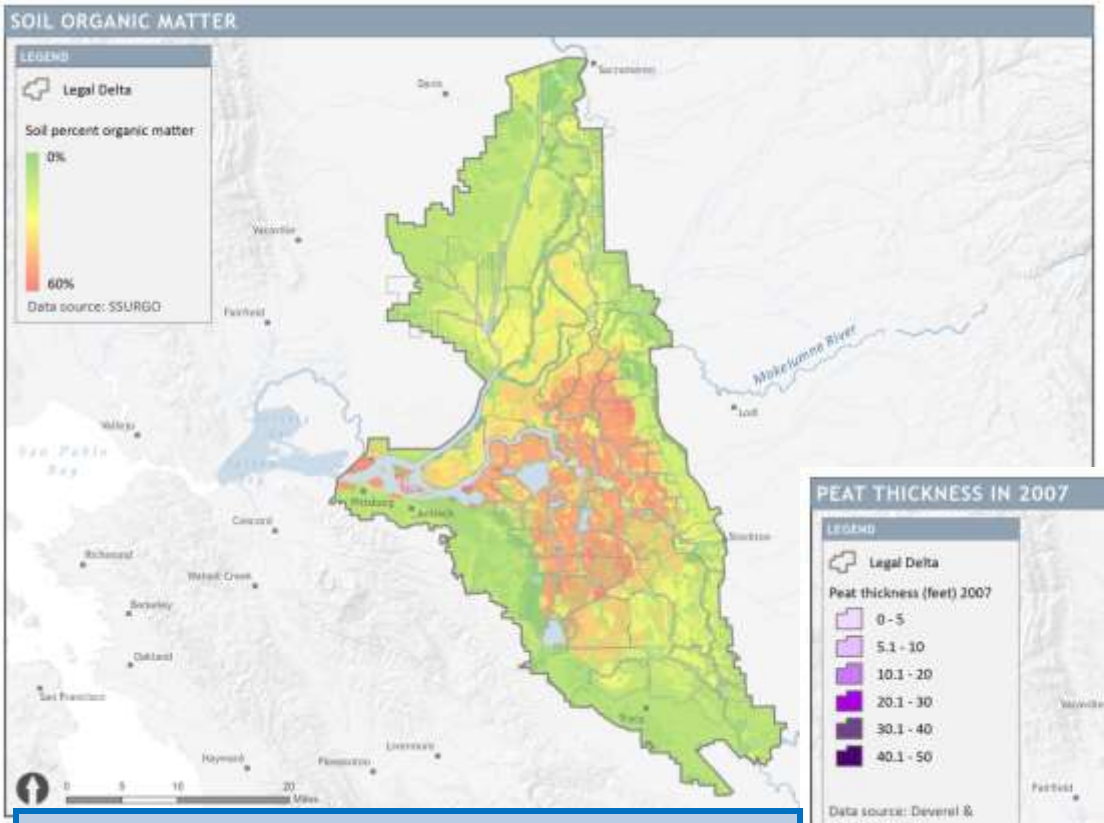




Ye, Horwath, et al. 2014

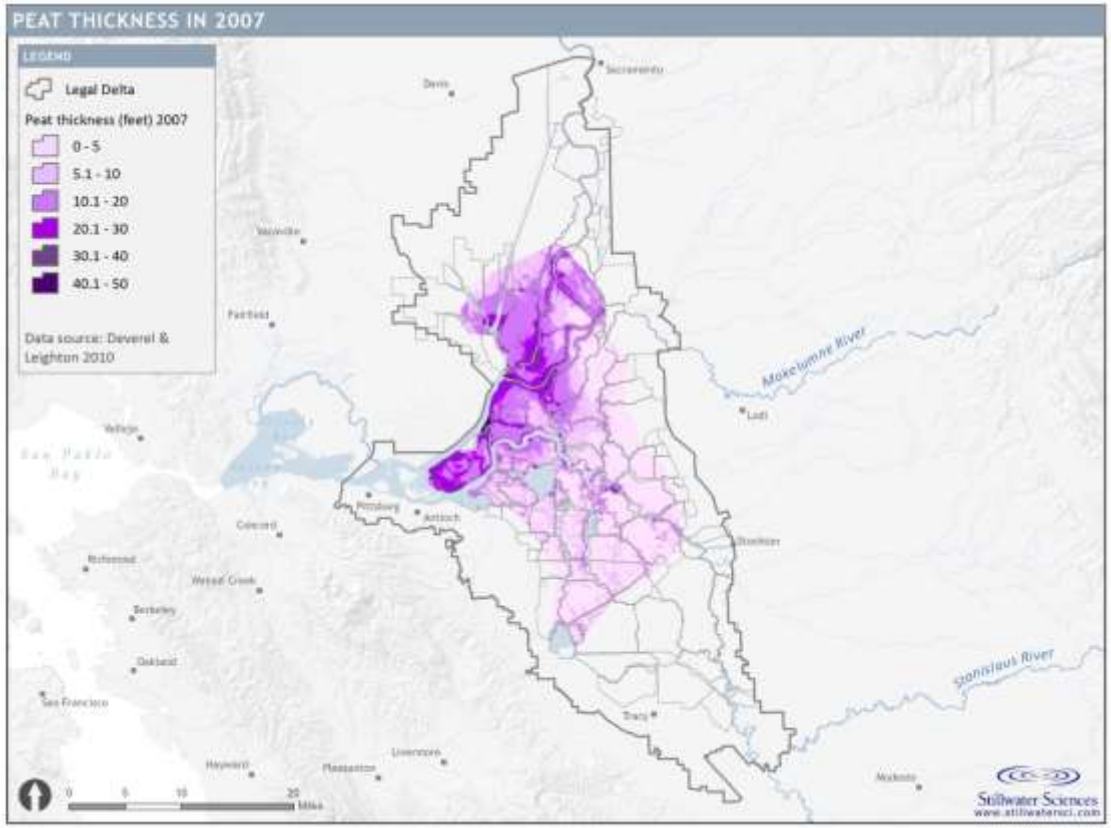
Kirk, Linquist et al. 2013
Espe, Horwath, et al. 2014,
Morris, Linquist, et al. 2014

Scaling GHG and Rice Optimizing Commons



Location

- Soil carbon
- Peat thickness
- Temperature (?)
- ET (?)



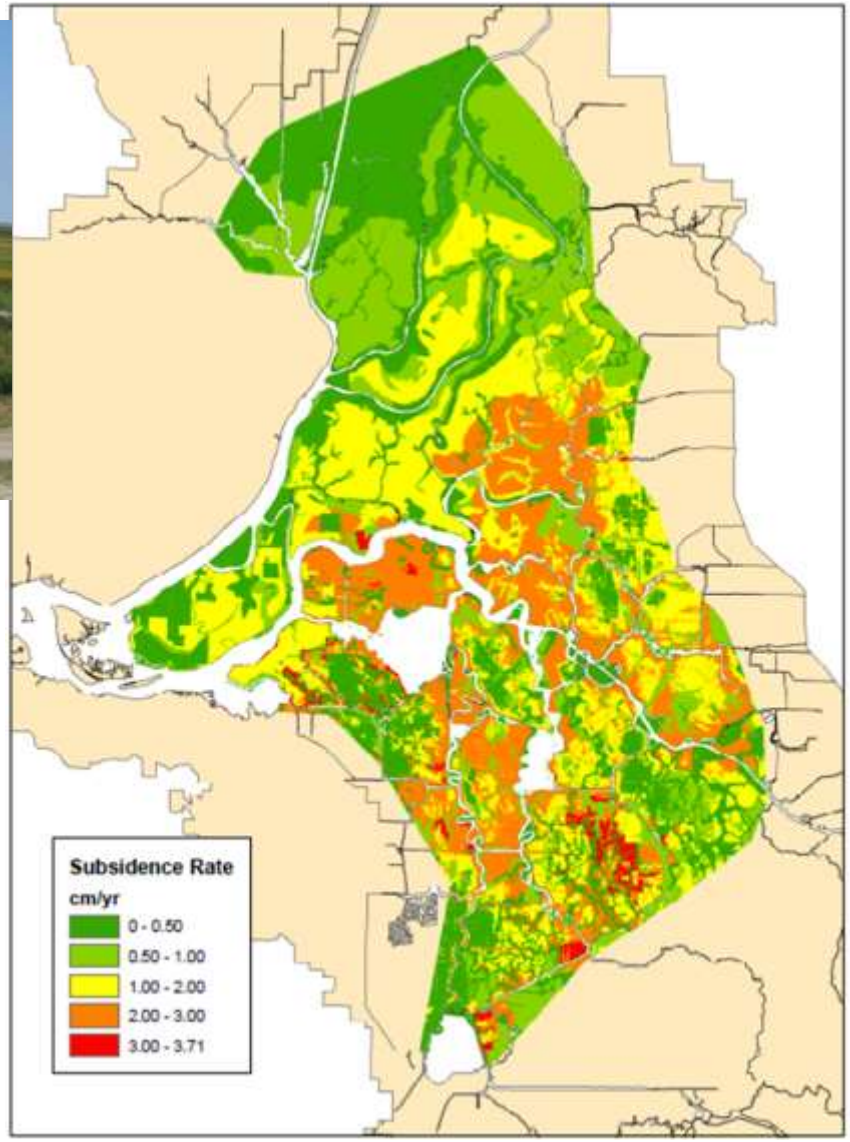
Management

- Crop choice
- Production
- N fertilizer & org matter
- Rapid flood and drain

Wet spots and Rice

Optimizing Commons

Increased extent of wet spots in Delta
Reduced agricultural lands



Place rice in areas where non-flooded crops are no longer viable. Cut pumping costs for whole island.

Deverel, Steven J. & Leighton, David A. 2010.

Next Step:
Hand-off to Economists

<table>
<tr><th></th><th>BAU</th><th>Conveyance Delta</th><th>Optimize Commons</th></tr>
<tr><td>Agronomic Sustainability</td><td colspan="3" rowspan="5">Effects per acre of rice
Optimal acres of rice
Critical mass of rice</td></tr>
<tr><td>GHG Emissions</td></tr>
<tr><td>Water Quality Effects</td></tr>
<tr><td>Subsidence reduction effects</td></tr>
<tr><td>Effects on relative levee safety</td></tr>
</table>

Questions?

Thank you!