Groundwater as a capital assets

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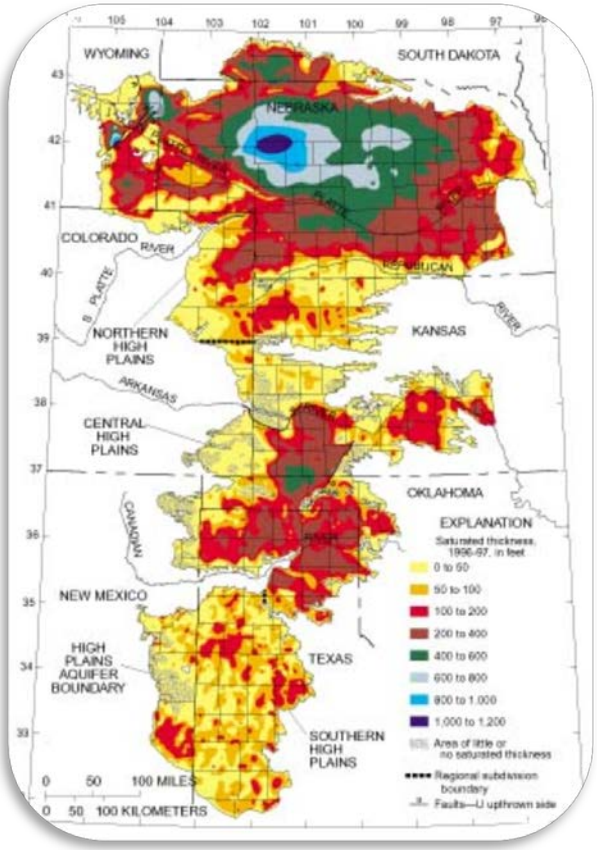
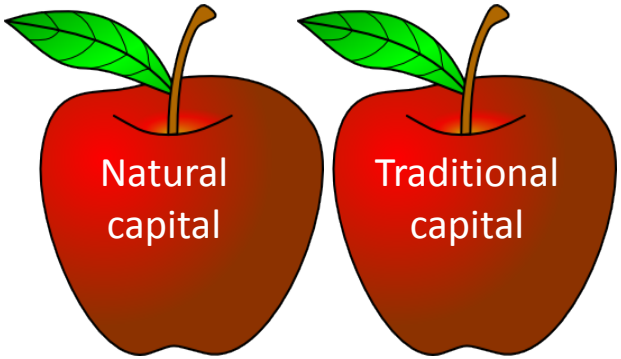


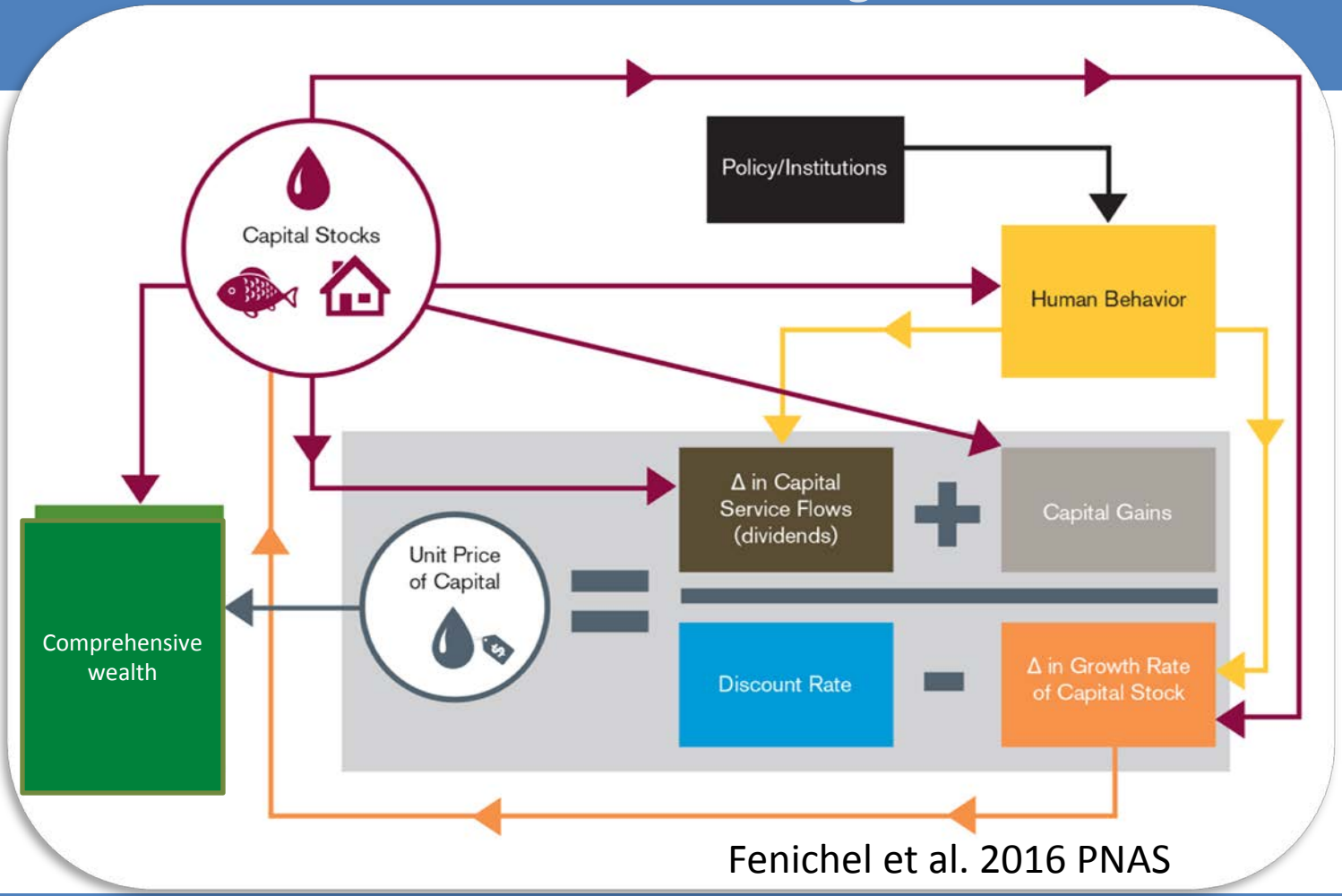
Groundwater



"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value."
THEODORE ROOSEVELT, speech to the Colorado Live Stock Association, Denver, Colorado, Aug. 29, 1910

Natural capital can be valued symmetrically with traditional capital

Fenichel & Abbott 2014 JAERE:: Jorgenson 1963 AER



Fenichel et al. 2016 PNAS

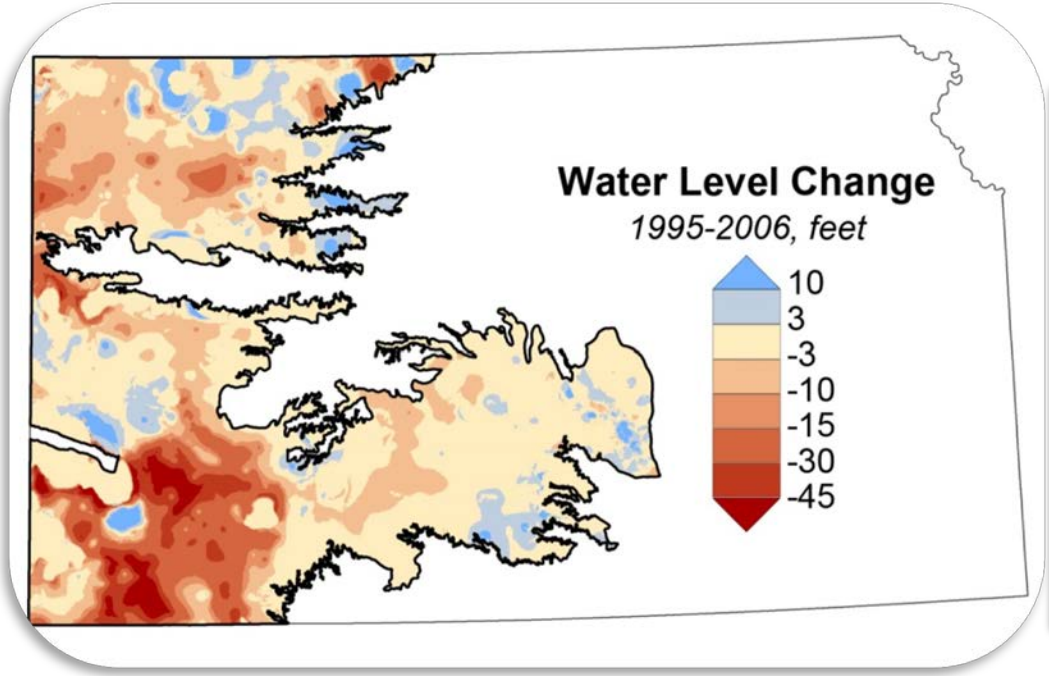
Integrates all concerns to develop credible prices

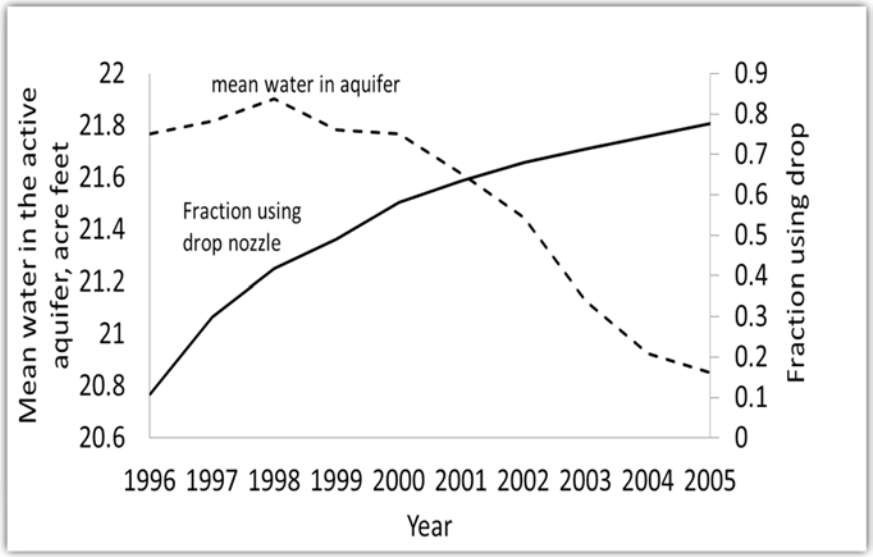
Groundwater in KS 1996-2005

Fenichel , Abbott, Bayham, Boone, Haacker, and Pfeiffer 2016 PNAS

Groundwater in Kansas

- Know there were big changes between 1996 & 2005
- Measure the change in value held in the Kansas groundwater "account"
- Put this value in context.





The hard work

Detailed hydrological measurement,

Based on Haacker et al. 2016. *Groundwater*.

Saturated thickness and specific yield give $s(t)$.

Crop growth, yield and budget information,

Kansas State Univ. Cooperative Extension. Prices, costs, and yields

USDA and BEA provided crop subsidy and crop specific PPI

Field level pumping and crop choice data,

Water Information Management and Analysis System (previously used by Pfeiffer).

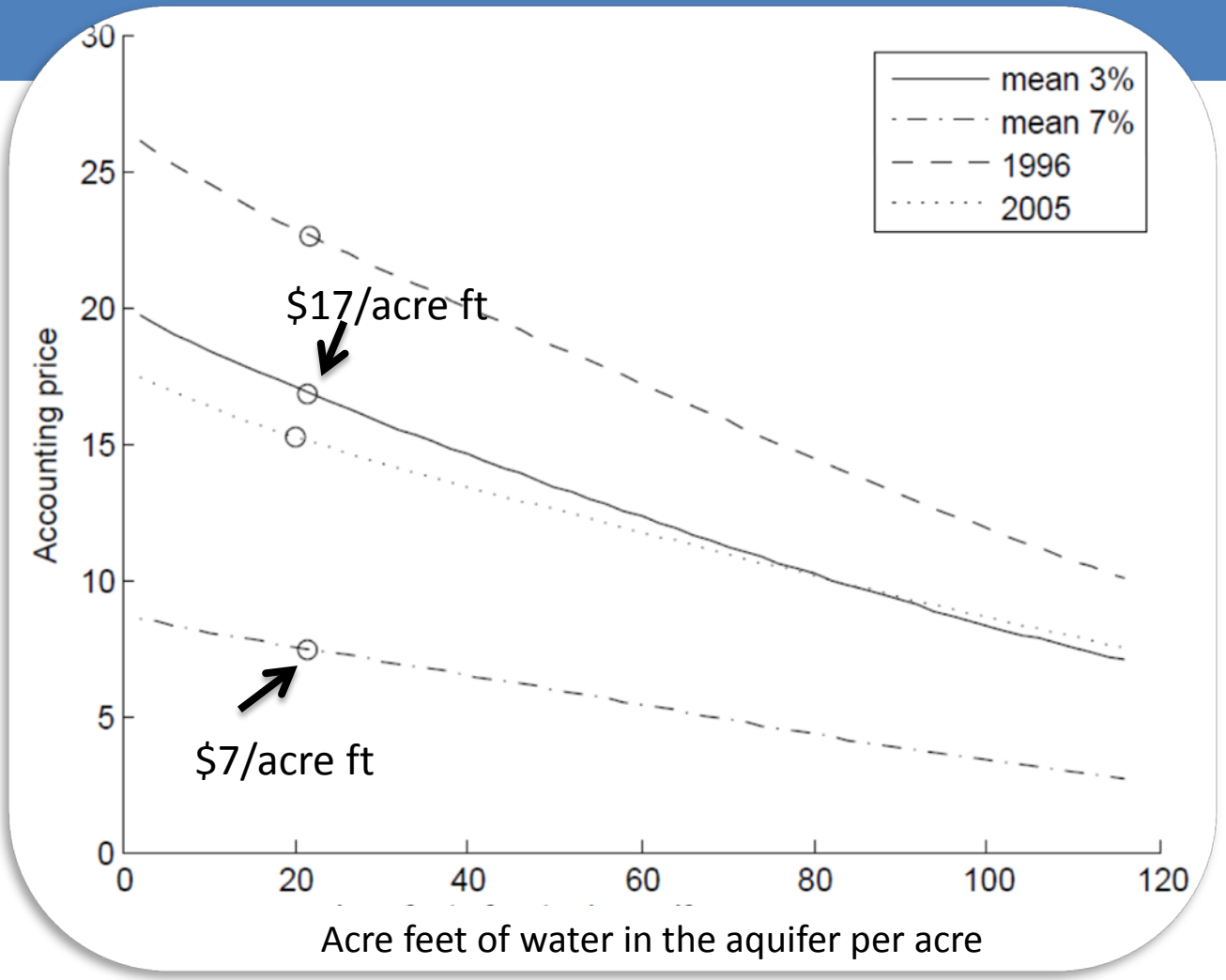
Estimate the behaviors of the famer managing the *average* field (all regression highly significant)

- **Planting mix**

  25 planting types various combinations Alfalfa, Corn , Sorghum, Soy, Wheat, Unirrigated (fallow), gives the expected acres per field.
- **Water withdrawal**
- **Net revenue (less subsidies)**

Use OMB discount rates, prefer 3% also investigate 7%.

An asset price curve for groundwater



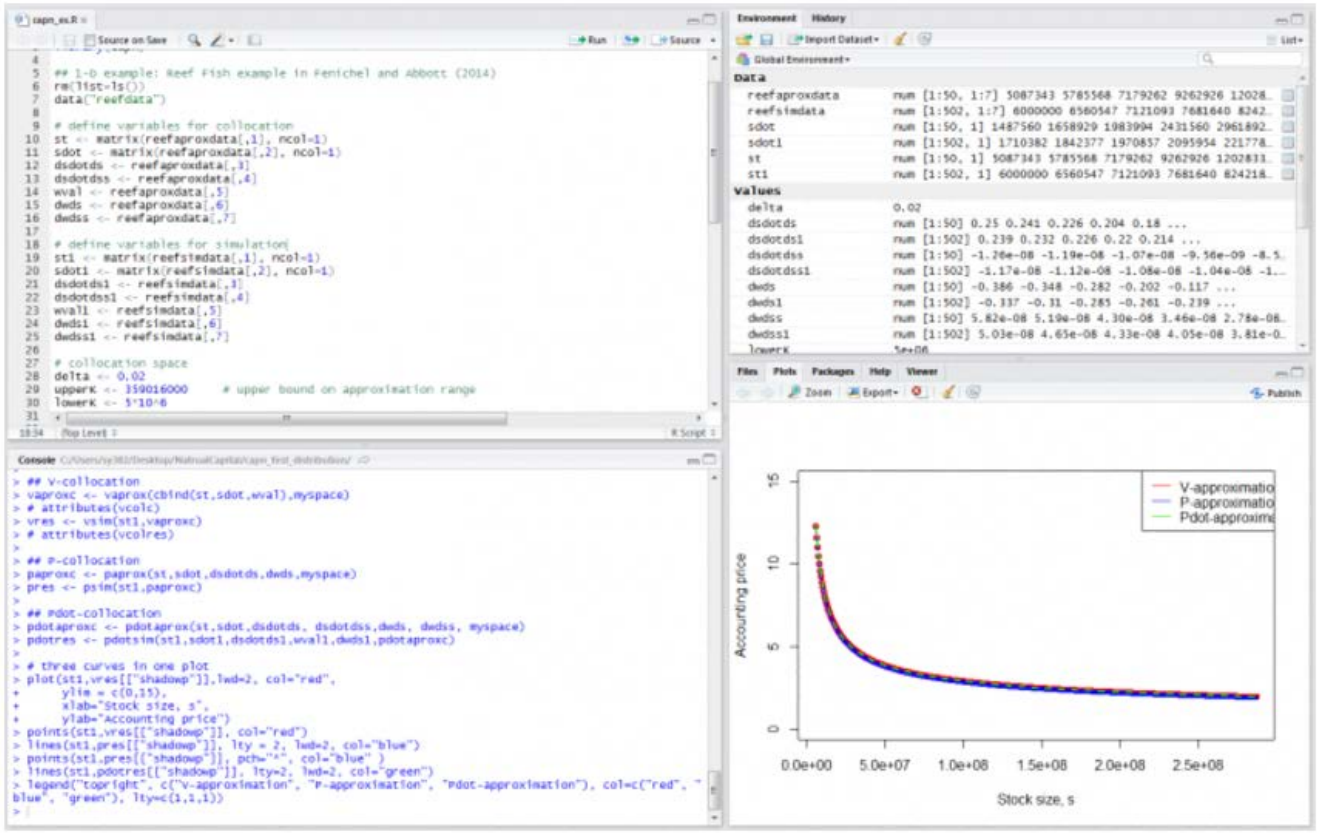
The average acre's water is worth $396 (3% DR) ≈ 33% of value per acre of KS irrigated farmland in 2005. This number falls to $173 (7% DR).

Kansas Groundwater Position

1. Value seems to be declining much more rapidly than quantity.
2. Sustainability requires constant or increasing real wealth
   - The value KS stored in water declined about $110M/ yr, (3% DR)
   - Ag investment in KS declines in real terms over the decade (increased slightly in nominal terms).
   - $113M KS budget surplus projected in 2005 - sustainability is feasible, it is an investment decision.
   - One possibility would be to set up a water driven sovereign wealth fund.
3. Attempting total valuation of aquifer not that meaningful. There may be big non-marginal effects going to zero water.

Valuing natural capital assets with {capn} R package (beta test version)

R Package for capN (Beta)
0.25 MB (03/28/2016)



http://environment.yale.edu/profile/eli-fenichel/software