Spatial Aggregation and the Value of Natural Capital

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Spatial aggregation and the value of natural capital

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Carl's 4 Questions

- **Is there a scale of measurement that is most appropriate for ecosystem accounting? What factors could be used to determine the appropriate scale?**
  - Without markets there is not a "law of one price"
  - Arbitrage is "difficult to impossible"
  - Biophysical and institutional variation (also other capital)

- **Is the same scale relevant for the measurement of ecosystem extent, ecosystem condition, ecosystem services and valuation in monetary terms?**
  - To the extent we aim for monetary accounts that scale has to drive things.

- **Assuming the scale of measurement is at sub-national level, what steps are required for deriving aggregate results at national level? Do the same issues of aggregation affect the measurement of ecosystem extent, condition, services and values?**
  - Monetary values can be aggregated physical values can't, but even that might raise equity concerns so the accounts must preserve the ability to disaggregate.
  - Without arbitrage you can't aggregate without additional assumptions.

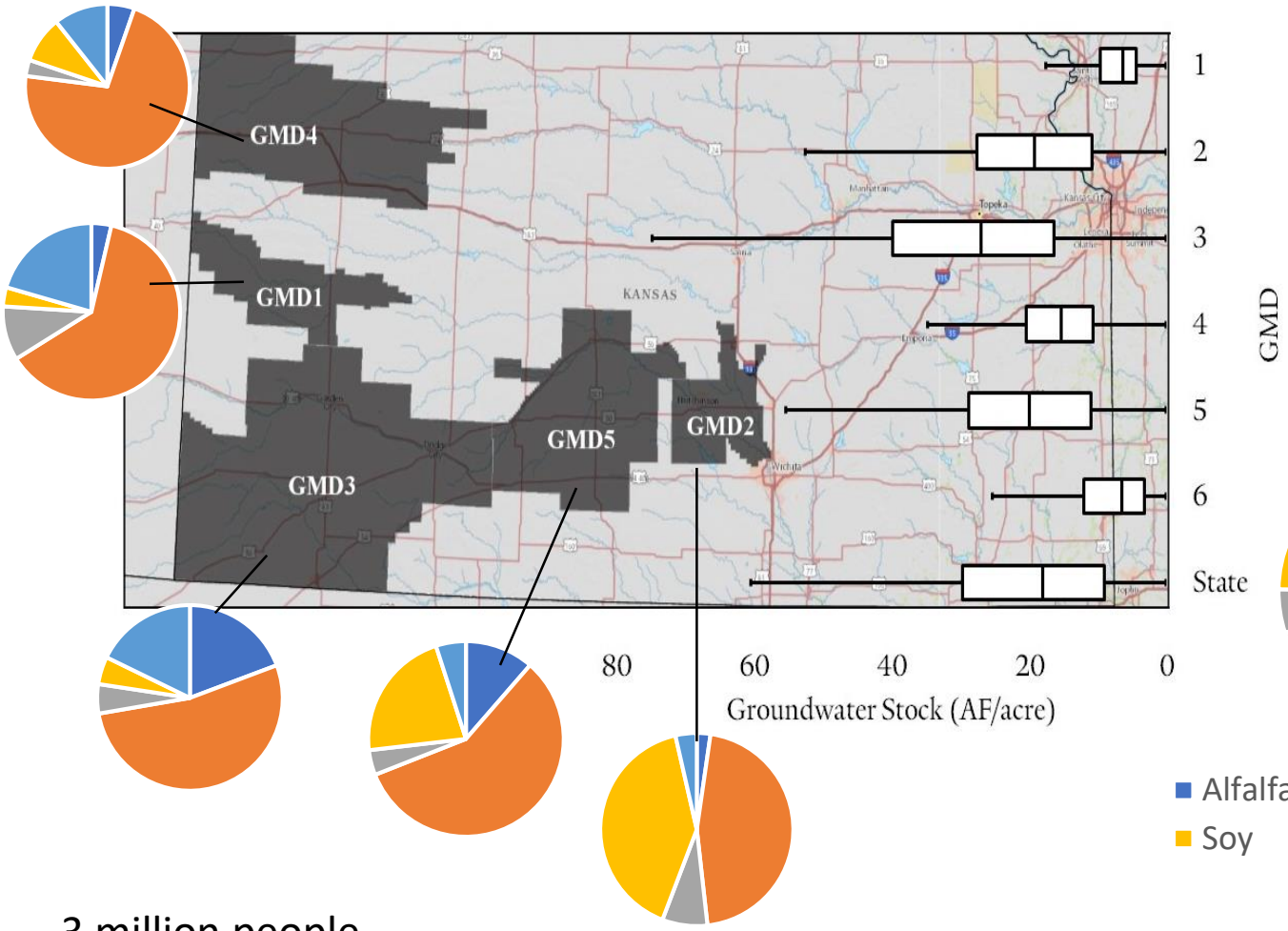
- **What testing might be undertaken to evaluate different approaches to aggregation and scaling for ecosystem accounting purposes?**
  - Do it and see how much it matter?

Case Study: Kansas High Plains Aquifer

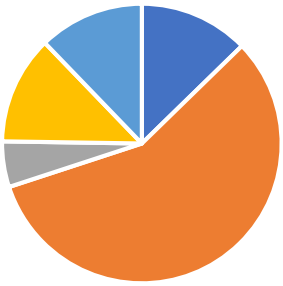
- Fenichel et al. 2016 (PNAS) estimated changes in the value of groundwater in the Kansas High Plains Aquifer (KHPA) from 1996-2005
  - Assumed field characteristics and stock relationship to water withdrawal and crop choice do not vary across KHPA

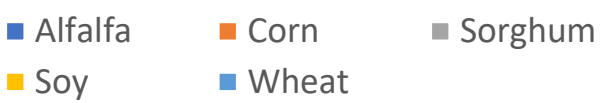
- Now, we observe the impact of aggregation assumptions:
  - Compare shadow price of groundwater statewide to price by GMD
  - Unique value and accounting price functions by GMD reflects local scarcity

Local Variation



6. Out group





3 million people

213,000 km^2 About the size of Belarus

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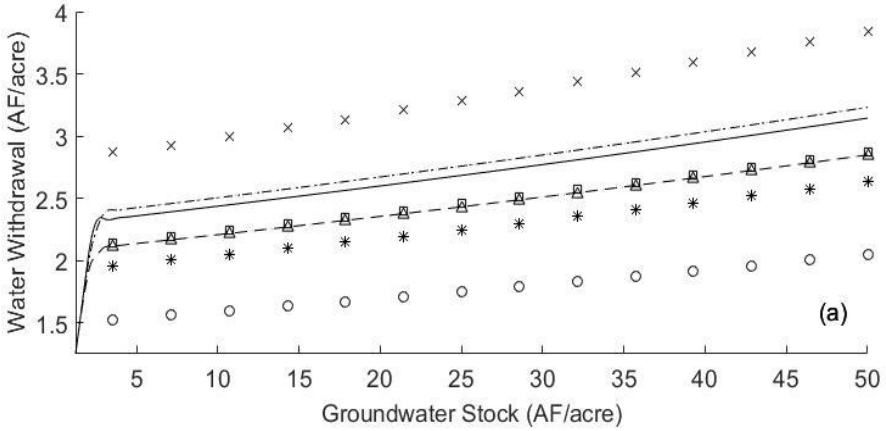
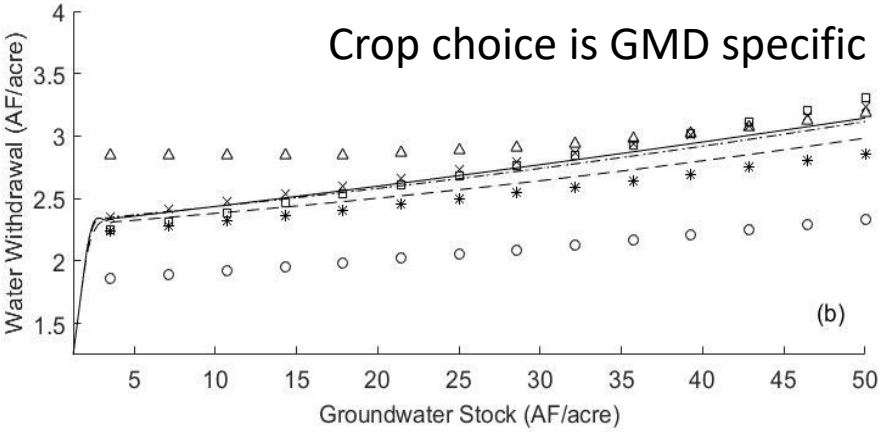
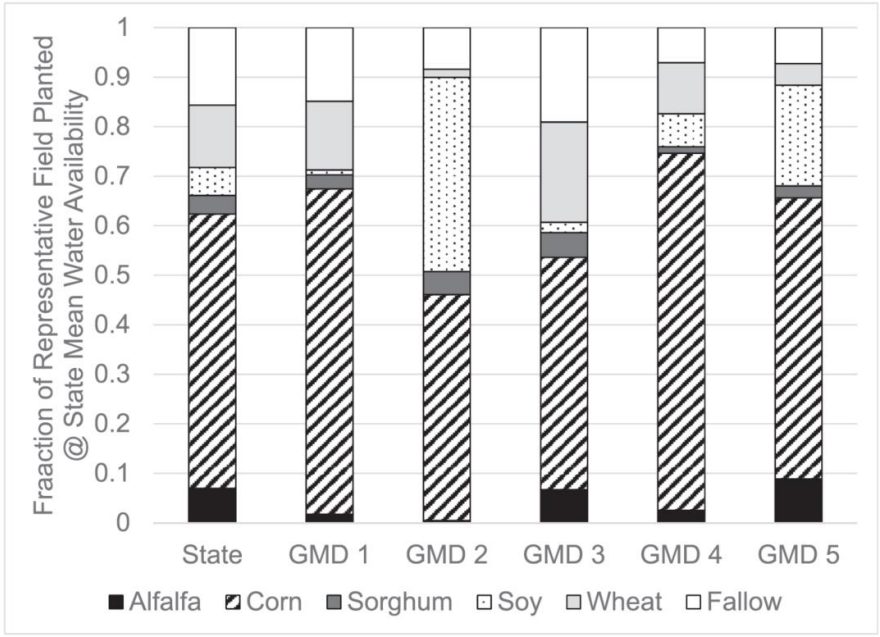
More Local Variation

Crop choice is a general state wide model



Crop choice is GMD specific

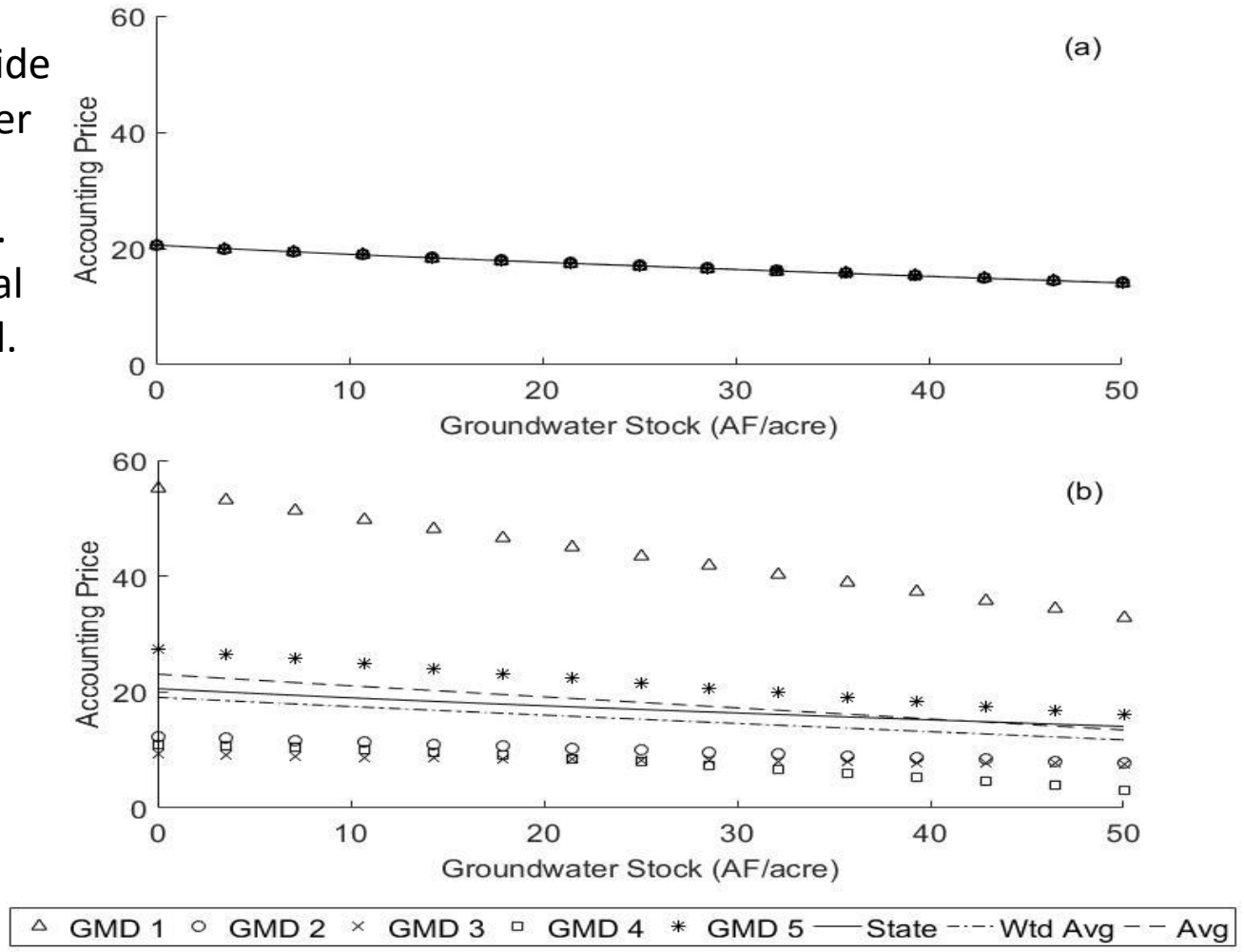




Variation in the accounting price function

Crop choice is a general state wide model, but water withdrawal is regions specific. (Almost identical to Fenichel et al. 2016 PNAS).

Crop choice is GMD specific



Changes in groundwater wealth over a decade

	State Crop Choice	GMD Crop Choice	State – GMD Crop Choice
Region	Total Welfare Change (millions)	Total Welfare Change (millions)	Change in Losses (millions)
GMD 1	-$792.9	-$436.9	-$356.1
GMD 2	-$355.5	-$292.7	-$62.8
GMD 3	-$4,891.4	-$6,184.2	+$1,292.9
GMD 4	-$1,056.7	-$878.0	-$178.6
GMD 5	-$1,374.4	-$1,220.5	-$153.9
(Outgroup) GMD 6	-$375.0	-$322.8	-$52.3
State	-$8,894.4	-$8,894.4	-
Sum GMD	-$8,845.9	-$9,335.0	+$489.2

- ~5% difference in the value difference accounting for local institutions.
- Failure to measure locally and then aggregate could lead to undervaluing scarce resources and overvaluing plentiful ones, which biases wealth accounts in favor of passing the non-declining wealth sustainability test.
- There is an interesting tradeoff related to having variation in the data to estimate quantities, behavioral response, and value and local precision.
- Aren't likely to solve the modifiable unit area problem.