Will climate change affect the aquifers of Texas?

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Talk outline

• IPCC report and Texas
• IPCC report and groundwater
• Climate change and groundwater
• Climate change and Texas groundwater
• Future work that needs to be done
• Conclusions
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IPCC Report and Texas

• 4.5 to 6° F increase in temperature over next 100 years
• mean annual runoff may decrease 0 to 10 percent by 2050
• flow seasonality may increase with more rainfall during the wet season and less rainfall during the dry season
• number of extreme drought events per 100 years are expected to increase 2 to 6 times by the 2090s

Kundzewicz and others (IPCC), 2007
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IPCC Report and Groundwater

“there has been very little research on the impact of climate change on groundwater”

Kundzewicz and others (IPCC), 2007

“there is no ubiquitous trend in groundwater systems that can be directly correlated to climate change, primarily because of the lack of data”

Kundzewicz and others (IPCC), 2007
IPCC Report and Groundwater

“quantitative projections of changes in precipitation, river flows, and water levels at the river-basin scale remain uncertain”

Kundzewicz and others (IPCC), 2007

• climate projections from global climate models are not easy to incorporate into hydrological studies because of significant uncertainties in the modeling process

Kundzewicz and others (IPCC), 2007
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climate change and groundwater: direct influences

**input**
- diffuse recharge
- direct recharge

**output**
- groundwater evapotranspiration
- pumping

- seawater inundation

**aquifer**
**diffuse recharge**

- Time lag
- Integrated recharge
direct recharge
"effective" recharge

Recharge

Springflow and baseflow

effective recharge

Regional flow
IPCC Report and Groundwater

• recharge is expected to increase 2 percent worldwide
• recharge in the western US is expected to increase by 30 percent
• recharge in West Texas could increase or decrease by 30 percent

Kundzewicz and others (IPCC), 2007

We’re 9 kinds of skeptical on these results… “Just like politics, all recharge is local.”
An expected overall decrease in evapotranspiration

“Just like recharge, all evapotranspiration is local.”
pumping (direct)

• the increase in municipal and industrial use is likely to be less than five percent by the 2050s

  Kundzewicz and others (IPCC), 2007

• for South Central Texas area:
  – 1.5 to 3.5 % increase in municipal demand
  – ~31% increase in irrigation demand

  Chen and others (A&M), 2000
pumping (indirect)

• overall greater demand for groundwater?
  – less surface water = more groundwater pumping
  – biofuels = more groundwater pumping
  – Lower CO2 emissions for power plants = more water use

• pumping of groundwater affects surface water…
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on the recharge side of things…

• **Most likely affected:**
  – Fractured and karstic (e.g. Edwards, Hill Country Trinity, Bone Spring-Victorio Peak)
  – Shallow high-permeability clastics (e.g. Lipan-Kickapoo, Seymour)

• **Not so affected:**
  – Lower permeability unconfined clastics (e.g. Ogallala, Pecos Valley)
  – Dipping aquifers (e.g. northern Trinity, Carrizo-Wilcox, Gulf Coast)
Humans have already affected recharge

Seymour Aquifer
on the **pumping** side of things…

- **All of them could be affected**
  - Especially those pumped for irrigated agriculture (direct effects)
  - And those near large municipalities (indirect effects)
Total water level declines in the major aquifers

Humans are already pumping aquifers
Major aquifers
Edwards aquifer and climate change

• Loáiciga and others (1996)
  – Edwards vulnerable

• Loáiciga and others (2000)
  – affects on recharge and springflow

• Chen and other (2000)
  – affects on pumping, recharge, and springflow
spring flow at Comal Springs with historical pumping
spring flow at Comal Springs with current critical period management
Edwards pumping and springflow
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Future work

- Fundamental studies on recharge
- Quantify surface-water/groundwater interaction
- Summarize downscaled models
- Climate change and drought in Texas
- “Simple” vadose zone models to quantify time to recharge
- Run GAMs with different climate scenarios
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Conclusions

• Higher temperatures, less runoff, more seasonality, more droughts
• Little research on climate change and groundwater
• Climate change directly affects recharge and pumping
• “Rapid response” aquifers most affected
• Need more work!
More about groundwater in Texas

Groundwater in Texas:
www.twdb.state.tx.us/groundwater

The Aquifer Monitor

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