Balancing Irrigation and Instream Water Requirements under Drought Conditions: A Study of the Kankakee Watershed

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Presentation Outline

Introduction
Background
River-aquifer system
Model Development
Future Work
Presentation Outline

Introduction
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River-aquifer system
Model Development
Future Work
Introduction

- Safe yield concept does not account for ecological requirements.

- A better model accounts for the hydrogeological-human approach and for the inherent uncertainty.

- Understand better the connection between irrigation water use and low flows to balance those requirements.
Presentation Outline

Introduction

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Model Development

Future Work
Background

Study Area
Background

Groundwater Sources

- Communities
- County Seats
- Sand and Gravel Wells
- Shallow Bedrock Wells
- Deep Bedrock Wells
- Major Sand and Gravel Aquifers
- Major Shallow Bedrock Aquifers (< 500 feet)
- Major Deep Bedrock Aquifers (> 500 feet)

Illinois Community Water Supply, MAP SERIES 2006-01, ISWS
Background

Relevance

• Priority areas for study and planning based on limited resource and population and economic growth:

• Watersheds
  1. Fox River
  2. Kaskasia River
  3. Sangamon River
  4. Kishwaukee River
  5. Kankakee River
Background

Relevance

- Priority areas for study and planning based on limited resource and population and economic growth:
  - Aquifer systems
    1. Deep bedrock aquifer in northeastern Illinois
    2. Sand-gravel and shallow bedrock in northeastern Illinois
    3. Mahomet Aquifer of east central Illinois
    4. American Bottoms of southwestern Illinois

Background

Development Trends

http://www.dnr.state.il.us/orep/ctap/atlas/iroquois.pdf
Background

Development Trends

http://www.dnr.state.il.us/orep/ctap/atlas/kankakee.pdf
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River-aquifer System

Hydrogeologic connection

Kankakee River -riverbed material- near Momence, IL

River-aquifer System

Hydrogeologic Connection

River-aquifer System

Hydrogeologic Connection

May 1988, spatial variability

River-aquifer System

Surface and Groundwater Hydrographs
River-aquifer System

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Surface and Groundwater Hydrographs
River-aquifer System

Surface and Groundwater Hydrographs

[Graph showing discharge data over time]
River-aquifer System

Surface and Groundwater Hydrographs
River-aquifer System

Surface and Groundwater Hydrographs

spatial variability

Presentation Outline

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Model Development

Conceptual Model

- Kankakee River
- Irrigation wells
- Private wells
- 150 feet
- 3 miles
- Potentiometric surface, spring ‘88
- Potentiometric surface, summer ‘88
- Unconfined aquifer
- Aquifer
- Aquitard
- Confined aquifer
## Model Development

### GIS based Model

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</table>

* Top/Bottom Layer Elevation  ** Denotes Time Series
Model Development

Model Summary

MODFLOW via GW Vistas 5.0
3D model, multilayered (Glacial Drift, UB and SD)
625 (ft) finest grid size to 2500 (ft) at the far field stream as RIV, STR or SFR1/2 packages
pumping as WEL package
constant head boundary (Des Plaines River)
overlaps with the Regional Kane County model

Current Status: Under Construction
Model Development

Model Summary

From ArcGIS

To MODFLOW (GW-Vistas)
Presentation Outline

Introduction
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Future Work
Future Work

- Model calibration: PEST
- Input uncertainty
- Impact of pumping in streamflow depletion
- Pumping as human interference
Future Work

Framework

Irrigation and pumping scenarios → Parameter & input uncertainty

Crop yield, prod. & profit evaluation → MODFLOW + River Package Program

Tradeoff curves

Tradeoff curves → Ecological & recreation damage evaluation

Damage (mean) → profit

Damage (90%) → profit

damage
Future Work

Framework

- A win-win solution is expected when irrigation and instream flows are balanced
- Other watersheds will benefit from the current study
- Parameter uncertainty analysis upon input model uncertainty
- Decision makers will be provided with reliable information based on the uncertainty quantification of the stream-aquifer interactions
Thank you.