Hydrological cycle and physiography of groundwater

Lecture outline
- Hydrologic cycle
- Water flow through soils and groundwater
- Threats to groundwater

Hydrologic cycle
- Water moving across a landscape

Connections among aquatic habitats
- A range of habitats occurring across a landscape are linked by hydrology
- Wetlands, streams, and lakes separated by land aboveground are not as distinct as you may think when hydrologic connections underground are considered
- Furthermore, what about ecological connections?

Concerns about isolated wetlands
- CWA protects wetlands connected to “waters of the US”
  - No surface connection? No problem. Migratory bird rule
- 2001 SWANCC decision hates birds
- What to do about geographically isolated wetlands?
Groundwater

- Water at or below the **water table**
- AKA **phreatic zone** or **aquifer**
- Largest source of unfrozen freshwater in the world (≈97%)
- ca. 21% of world’s freshwater

Subsurface habitats

- **Where’s the groundwater?**

![Figure 4.3: Groundwater and Aquifers](image)

Sediments and water movement

- Does this have any effect locally?

<table>
<thead>
<tr>
<th>Material</th>
<th>Particle size (mm)</th>
<th>Hydraulic conductivity (m d$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0.004</td>
<td>0.0002</td>
</tr>
<tr>
<td>Silt</td>
<td>0.004 – 0.062</td>
<td>0.08</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>0.5 – 1.0</td>
<td>45</td>
</tr>
<tr>
<td>Coarse gravel</td>
<td>16 - 32</td>
<td>150</td>
</tr>
</tbody>
</table>

![Table 4.2: Sediments and Conductivity](image)

Lecture outline

- **Hydrologic cycle**
- Water flow through soils and groundwater
- **Threats to groundwater**

![Lecture Outline Image](image)

Surface – subsurface water movement

![Figure 4.6: Surface Water and Groundwater](image)

Mining the Ogallala Aquifer

- Stretches from Nebraska to Texas
- Supplies 30% of irrigation water used in U.S.
- Being used 10 times as fast as being replenished
- Being replenished by threatened playas
- Arkansas River below aquifer is mostly dry since the early 1970s; above almost always flows
- Eventually it will cost too much to pump irrigation water up

![Mining the Ogallala Aquifer](image)

Tim Curtis

Ogallala center pivots from the sky (NASA)
Hydraulic fracturing

Entrenkin et al. (2011)

Floridan aquifer

USGS report

Floridan aquifer usage

USGS report

Hydraulic fracturing

Entrenkin et al. (2011)

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