ASSESSING THE QUALITY OF THE NATION’S GROUNDWATER: WHAT IS IT TODAY AND WHAT MIGHT IT BE IN THE FUTURE?

Modeling & Mapping Water Quality – Sandy Eberts

May 8, 2015
OUTLINE

• Why map water quality
• Planned map products
• Foundation for mapping
• Future directions
MOVING FROM DATA TO MAPS

SHALLOW GROUNDWATER

GROUNDWATER AT DEPTH
USED FOR DOMESTIC SUPPLY

Nitrate Concentration, mg/L

<table>
<thead>
<tr>
<th>Color</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>1-5</td>
</tr>
<tr>
<td>5-10</td>
<td>&gt;10</td>
</tr>
</tbody>
</table>

Nolan and others (2006)
WAYS IN WHICH WATER-QUALITY MAPS CAN BE USED

• Anticipate water quality in unsampled areas or depth zones [not necessarily individual wells]

• Design monitoring programs

• Inform protection practices

• Plan for treatment

• Locate new wells

• Evaluate sustainability of a groundwater source of drinking water
PLANNED NATIONAL-SCALE MAPS
DOMESTIC & PUBLIC-SUPPLY WELL DEPTH ZONES

- Trace elements (arsenic, uranium, boron)
- Nutrients (nitrate, phosphorus)
- Nuisance constituents (iron, dissolved solids, manganese)

Nolan and others (2006)

Intermediate Depth
Used for Domestic Supply

Deeper Depth
Used for Public Supply

Nitrate Concentration, mg/L

<1  1-5  5-10  >10

Nolan and others (2006)
PLANNED PRINCIPAL-AQUIFER SCALE MAPS
DOMESTIC & PUBLIC-SUPPLY WELL DEPTH ZONES

• Trace elements (arsenic, uranium, boron)
• Nutrients (nitrate, phosphorus)
• Nuisance constituents (iron, manganese, dissolved solids)
• Others

Central Valley Principal Aquifer (2013 – 2018)
Mississippi Embayment Principal Aquifer (2016 – 2021)
Northern Atlantic Coastal Plain Principal Aquifer (2015 – 2020)
Glacial Principal Aquifer (2014 – 2019)
WATER-QUALITY MAPS ARE BASED ON UNDERSTANDING
FACTORS THAT AFFECT GROUNDWATER QUALITY

MOBILITY & PERSISTENCE

INPUT
- Geology
- Contaminant source

SUSCEPTIBILITY
- Hydrogeology
- Climate

Groundwater quality

Geochemistry
STATISTICAL MODELS IDENTIFY WHAT’S IMPORTANT WHERE

EXPLANATION

16% Percentage of basin area with estimated arsenic concentration in groundwater ≥10 micrograms per liter

Basin margin
- Basins with low recharge: 48%
- Basins with high recharge: 7%

Middle basin
- Basins with low recharge: 57%
- Basins with high recharge: 16%

Basin lowlands
- Basins with low recharge: 65%
- Basins with high recharge: 33%

Thiros and others (2014)
SPATIALLY-CONTINUOUS VARIABLES NEEDED FOR MAPPING

Arsenic concentration
- Low
- High

Southwest Principal Aquifers study area boundary

Anning and others (2012)
SPATIALLY-CONTINUOUS GEOCHEMICAL INFO BEING DEVELOPED

Depth at which dissolved oxygen is no longer present, in meters:
- < 10
- > 80

Chesapeake Bay Watershed

Tesoriero, written commun. (2015)
IMPROVED INFO ON SUSCEPTIBILITY NEEDED

Central Valley Principal Aquifer

Intermediate Depth
Used for Domestic Supply

Deeper Depth
Used for Public Supply

Nitrate Concentration, mg/L

<1  1-5  5-10  >10

Nolan and others (2014)
Average Age of Water, In years

- 0 – 10
- > 100

Kirkwood-Cohansey Aquifer System, Near Glassboro, New Jersey

Kauffman and others (2001)
Kirkwood-Cohansey Aquifer System, Near Glassboro New Jersey

GROUNDWATER-AGES ARE BEING MAPPED

Average Age of Water, In years
- 0 – 10
- > 100

Pumped wells
Stream cells
Confining unit

Kauffman and others (2001)
THE CHALLENGE OF GROUNDWATER-AGE MIXTURES

Cone of depression
Public-supply well
Monitoring wells
Domestic well
Recharge

YEARS
DECADES
CENTURIES

Predevelopment water

Eberts and others (2013)
PATTERNS IN GROUNDWATER-AGE MIXTURES

Proportion of Young and Old Groundwater from Public-Supply Wells

Less than 60 yrs

Greater than or equal to 60 yrs

Eberts and others (2013)
Linking modeled geochemical conditions and groundwater ages with:

- Groundwater-quality data
- Contaminant inputs

3-D GROUNDWATER VULNERABILITY ASSESSMENTS

to assess:

- Contaminant concentrations in unsampled areas and depths
- How quickly contaminants move to wells and streams
- Predict if contaminants can reach levels that might impact drinking-water supplies
ASSESSING THE QUALITY OF THE NATION’S GROUNDWATER: WHAT IS IT TODAY AND WHAT MIGHT IT BE IN THE FUTURE?

Modeling & Mapping Water Quality

QUESTIONS?

Sandra Eberts
smeberts@usgs.gov