Estimating Global Groundwater Resources

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Objective

- Incorporate non-renewable groundwater extraction cost-curves into GCAM
- Under what circumstances could deep, potable groundwater serve as a feasible alternative resource for drinking water or agriculture?
Overview

- Estimate global groundwater availability
- Construct depletable resource cost curves for non-renewable groundwater
- Apply resource cost curve methodology at the river basin level across the globe
- Generate GCAM inputs based on groundwater extraction costs
Estimate Global Groundwater Availability

Groundwater Volume = Saturated Thickness x Aquifer Areal Extent x Porosity

GLobal HYdrogeology MaPS (GLHYMPS)  Gleeson et al. (2014)
Estimate Global Groundwater Availability

Groundwater Volume = Saturated Thickness x Aquifer Areal Extent x Porosity

DeGraaf et al. (2015)
Results: Available Groundwater Volume

Previous Estimates

- Nace (1969): 1-7
- Nace (1971): 4-60
- Garmonov (1974): 23.4 (3.6 active)
- L'Vovich (1974): 60 (4 active)
- NRC (1986): 15.3
- Gleeson et al. (2016): 22.6 (0.35 young)

Total Volume: 5.85 Million km$^3$

Preliminary Results – Please do not cite or quote
We’ve generated a framework that defines a cost function for production from a single well based on an analytical GW flow solution.

Current costs reflect the cost of electricity to produce water and well drilling/installation.
Unit Cost Breakdown

Preliminary Results – Please do not cite or quote
Unit Cost Comparison

USGS study evaluated groundwater unit prices for the North Atlantic Region (Cederstrom, 1970)

• Included capital costs, maintenance costs, and power costs.
• Evaluated production costs in variable geologic materials: coastal plain, consolidated rocks, and glacial deposits.
Element

- Optimize well spacing based on maximum production.
- Hydrologic units are assumed to be identical.
- The solution scheme calculates production and unit costs ($/m^3 water) for one hydrologic unit.
- We apply the solution to the entire aquifer of interest.
  - The unit cost is the same
  - Total volume produced is sum of all production
Results: Global Unit Costs of Groundwater Production

Preliminary Results – Please do not cite or quote
Conclusions and Next Steps

- Global aquifer properties from previous studies were combined to estimate the volume of groundwater available within range of reported global values.
  - Specific regional studies may replace broad global property assumptions.

- A framework was created defining a cost function based on an analytical GW flow solution.
  - Unit costs reflect the cost of electricity and well drilling/installation.
  - Results were compared to groundwater unit cost estimates from other methods.
  - Initial results calculated groundwater unit costs based on a relatively dense network of production wells over a fixed amount of time. Next steps will reduce number of wells and prolong the duration of production.
  - Other capital costs (the pump, water treatment, and transport) may be added.
Questions?

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