

Groundwater Management

Syllabus – Administrative Items

Readings

We will incorporate readings from the scientific community, data summaries, news items, technical references and a variety of other sources. We will discuss the findings, purpose, provenance and significance to groundwater management of the technical documents reviewed. Documents will be posted to the course's Gauchospace site, referenced in public sources, and/or reserved for esm226 at the Davidson Library.

Grading

- ◆ 40% - Problem sets (approximately five assignments)
 - › Assignments may require mostly narrative responses (appx 2 pages text), or technical product (e.g., excel data files and graphs), or some combination.
- ◆ 50% - Final Project -- Case Study
 - › Written report is based on a specific groundwater basin
 - › Includes analysis, proposed actions and management criteria
 - › Individual or 2-person effort
 - › Final, written report (appx 15 pages plus any technical appendices)
- ◆ 10% - Final Project Presentation and Class Discussion
 - › Oral presentation of final project study and findings. 10-12 min presentation, and 3-5 min Q&A.
 - › Preparedness for class discussion
- ◆ All submitted materials should be concise and in a style appropriate to a professional client.

Calendar

Regular Lectures: M & W, 9:30-10:45a, BH1424.

First: Weds, Jan 17

Last: Weds, Mar 14

No Class (Holidays): Mon, Jan 15

Mon, Feb 19

Added classes (see introduction email for further explanation):

Tues, Feb 6, 9:30-10:45a, Oak Room (BH1520)

Tues, Feb 13, 9:30-10:45a, Oak Room (BH1520)

Final Project Paper due: Mon, Mar 19, 2:00pm

Final Project Presentations: Weds, Mar 21, 8:00-11:00am, BH1424

Prerequisite

Background coursework or reading in hydrogeology.

Office Hours

[location tbd] After class or by appointment

Contact

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esm226, Winter 2018

Groundwater Management - Lecture Topics

This is not a sequential or comprehensive list of items we will cover during the quarter, but gives you an idea of some topics that will be presented and discussed. There will be weekly readings and reference materials and in-class discussion is welcome.

Part I: Hydrogeological foundation and relevance for groundwater management

- A. Geology, Groundwater Basins and Aquifers
 - 1) Regional geological environments and occurrence of groundwater
 - 2) Basin types and scales
 - 3) Aquifers, hydrostratigraphy, basin/flow boundary conditions
 - 4) Natural water quality conditions and variability
 - 5) Uses and importance of groundwater

- B. Groundwater Recharge and Storage
 - 1) Recharge sources and processes
 - 2) Storage volumes, storativity and confined/unconfined aquifers
 - 3) Time and extent scale differences
 - 4) Methods for estimation
 - 5) Use of groundwater as a drought buffer over wet-dry cycles

- C. Aquifer Characterization and Water Wells
 - 1) Wells and well construction/completion
 - 2) Aquifer/groundwater response to pumping
 - 3) Aquifer characterization
 - 4) Alluvial and "bedrock" aquifers
 - 5) Data sources and types

- D. Yield and Water Balance Calculations
 - 1) Types and importance of differences between different yield types
 - 2) Water balance calculations and Bredehoeft's "water budget myth"
 - 3) Data types and potential errors
 - 4) Estimation methods and biases/sensitivities

E. Overdraft

- 1) Definitions and importance
- 2) Adverse impacts; reversible and permanent changes
- 3) Quantitative methods for determination
- 4) Focus topic: Subsidence

F. Groundwater Quality

- 1) Water quality constituents and different implications for management
- 2) Characterization; data sources and uses
- 3) Seawater intrusion and brackish water

Part II: Topics and Methods in Groundwater Management

G. Goals and Types of Groundwater Management

- 1) Managing for water supply, water quality, or both
- 2) Different management strategies for different hydrogeological characteristics, resource limitations, infrastructure components and other conditions
- 3) Short- and long-term solutions
- 4) Management approaches, authorities and tools. Political, economic, technical, institutional and legal examples from California, US and global basins

H. Hydrogeological Basis of Management Methods

- 1) Basin boundaries, inflows, outflows and charges to groundwater in storage
- 2) Water quality
- 3) Interaction and exchange of surface water and groundwater
- 4) Regional supplies

I. Managed/Artificial Recharge and Conjunctive Use

- 1) Timing and sources
- 2) Surface infiltration characteristics, saturated and unsaturated flow
- 3) Direct aquifer injection; aquifer storage & recovery
- 4) Water quality and compatibility; constituents of concern

J. Supplemental Water and "Physical Solutions"

- 1) Water reuse and recycling
- 2) Desalination
- 3) California's water conveyance infrastructure
- 4) California's water banking infrastructure
- 5) Other regional water transfers; e.g., Colorado River diversions, Colorado west to east slope diversions

K. Groundwater Storage Management

- 1) Aquifer suitability, opportunities and limitations
- 2) Monitoring
- 3) Operations and management methods

L. Water Quality Management

- 1) Contaminant classes and sources
- 2) Regulatory structure and requirements
- 3) Technologies for groundwater quality characterization and treatment
- 4) Local and distributed water quality impacts
- 5) Seawater intrusion and coastal aquifers
- 6) Nitrate contamination
- 7) Management strategies

M. Source Area and Aquifer Protection

- 1) Source and recharge area protections
- 2) Variations based on hydrogeological and potential contaminant characteristics

N. Monitoring and Performance Evaluation of Management Methods

- 1) Monitoring devices and data
- 2) Aquifer behavior for different extraction, injection and hydrogeological regimes
- 3) Numerical evaluations, from simple spreadsheets to complex flow models

Special Topics and Case Studies -- to be interspersed throughout the course

- i.* California Sustainable Groundwater Management law and program
- ii.* Coastal groundwater management and seawater intrusion example(s)
- iii.* Fractured crystalline rock aquifers -- use, analysis and management
- iv.* Hydraulic fracturing for oil and gas development; injection waste disposal wells
- v.* Drought management and California's previous and current droughts
- vi.* Capital interests, water markets and regulatory frameworks