

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 and provenance of technical documents used. Documents will be posted to the course's GauchoSpace site, referenced in public sources, and 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 hydrographs), 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 (no more than 10 min presentation, format tbd based on size of course enrollment). Presentations will be made during the assigned final exam period during the week of December 5.
 - › Preparedness for class discussion
- ◆ All submitted materials should be concise and in a style appropriate to a professional client.

Prerequisite

Background coursework or reading in hydrogeology.

Office Hours

[location tbd] After class or by appointment

Contact

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Groundwater Management - Lecture Topics

This is not a strictly 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) Flow field and water quality interfaces and boundaries in aquifers
- 2) Interaction and exchange of surface water and groundwater
- 3) Flow velocities and travel times

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 slope to east slope diversions, etc

K. Groundwater Storage Management

- 1) Aquifer suitability, opportunities and limitations
- 2) Potential adverse impacts and storage management monitoring

L. Water Quality Management

- 1) Contaminant classes and sources
- 2) Regulatory structure and requirements
- 3) 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

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

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

- O. California Sustainable Groundwater Management law and program
- P. Coastal groundwater management and seawater intrusion example(s)
- Q. Fractured crystalline rock aquifers -- use, analysis and management
- R. Hydraulic fracturing for oil and gas development; injection waste disposal wells
- S. Drought management and California's previous and current droughts
- T. Privatization and water markets