Hydrology
(Water Resources Management)

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  - Forest Hydrologist
- San Bernardino National Forest
  - Cal State San Bernardino
    - February 18, 2014
Career Path

- 1987 – Boy Scouts, Soil & Water Conservation Merit Badge
- B.S. Environmental Hydrology, 1994 (interned with 2 professors: stream quality study, groundwater modeling study)
- M.S. Groundwater Hydrology, 1997 (research asst with Nat’l Lab team; field work and written Thesis)
- Post-graduate Research Fellowship (1.5 yr term)
- Idaho State Environmental Regulator – 4.5 years
- U.S. Forest Service – 9 years
Today’s Presentation

- Subject Matter needed (Slides 4-8)
- Issues needing hydrologists (Slides 9-25)
- How much $$ can be made? (Slides 26-29)
- What I do with the Forest Service (Slides 30-37)
Time to go to School
Academic Requirements for Water Movement – lower division

- Mathematics (2 years minimum) – Differential & Integral Calculus, Vector Analysis, Differential Equations, Linear Algebra
  - If you don’t know the basic math, how will you understand Fluid Mechanics and multi-phase flow and what the models are computing?
- Statistics – Descriptive, Probability, Nonparametrics, Geostatistics
- Calculus-based Physics (1 year minimum)
- Chemistry – General, Physical, Organic, Inorganic, Thermodynamics
- Computer Programming
Subjects for Understanding Surface Water, Groundwater and their Interactions

- Hydrology – Fluid Mechanics, Surface Water, Groundwater, Hydrogeochemistry, Vadose Zone
- Geology – Physical, Structural, Sedimentary, Geophysics
- Soils – Classification, Physics, Chemistry
- Biology – Microbiology, Limnology, Fisheries, Plant-Water-Soils
- Modeling: Folks like having answers to complex questions. How good are they? Input → Black Box → Output (Assumptions, processes, sensitive parameters, what is the question, etc)
  - You should know the general answer before you sit at the computer. Building your conceptual model is key.
Many Environmental Consultants do contaminant cleanups with mapping, field work, analysis, and report writing

- Organic Chemistry
- Environmental Toxicology
- Dose and Risk Assessment
- Hydrogeology and Contaminant Transport
- Environmental Analysis using GIS
- Technical Writing
- Field Methods in Hydrology
It’s not all physical science

- Economics
- Water Law and Environmental Law
- Ethical Issues in Environmental Policy
- Geology and Soils in Land Use Planning
- Cultural Ecology
- Debate or Public Speaking
- Public Lands Management
There are so many issues needing hydrologists
• 0.00936% of Earth water is in lakes, streams, and rivers
• Population keeps growing, development leads to pollution, climate change may reduce available water
Depleting Groundwater

- Groundwater is the source of nearly 40% of fresh water in the U.S.
  - On a local level, withdrawing water faster than it can be replenished leads to a cone of depression in the water table,
  - On a broader scale, heavy pumping can deplete an aquifer (referred to as mining)
  - Current concern with surface water droughts
Depleting Groundwater
INCREASING WATER SUPPLIES

- **Dams and Reservoirs** - Trap excess water in rainy season and deliver it in dry season.
  - Extremely valuable in areas with highly seasonal rainfall
- **Canals** - Capture water in areas of excess and transfer it to areas of deficit.
Why are Dams and Reservoirs so hard to build?

- People are displaced
- Species living in wetlands, rivers, and streams lose habitat
- Change in water temperature
- Deposition of silt (siltation)
- Evaporation
- Loss of free flowing rivers, fish cannot swim upstream
Municipal Sewage Treatment

(a) Primary
- Bar screen
- Grit chamber
- Primary sedimentation tank

(b) Secondary
- Aeration tank
- Final settling tank

(c) Tertiary
- Tertiary filter
- Disinfection tank

Sludge is incinerated, composted, or used as soil amendment.
WATER QUALITY TODAY

- **Clean Water Act (1972)**
  - Established a National Pollution Discharge Elimination System, which requires a permit for any entity dumping wastes in surface waters.
  - Established rules against degradation by non-point source pollution, such as stormwater, farm and open space erosion, through Total Maximum Daily Loads (TMDLs)
Inorganic Pollutants

• **Metals**
  - Highly toxic, Highly persistent and tend to bioaccumulate in food chains.

• **Nonmetallic Salts**
  - Salt spread on roadways can dehydrate and kill plants and can contaminate drinking water; Natural dissolved salts from drinking water sources

• **Acids and Bases**
  - Changes aquatic conditions to detriment of biota.
  - Leach toxic metals from rock.
Organic Chemicals

• Thousands of natural and synthetic organic chemicals are used to make pesticides, plastics, pharmaceuticals, pigments, etc.

• Two sources of toxic organic chemicals in water are:
  - Improper disposal of industrial and household wastes.
    - Perchlorate in Rialto’s groundwater
  - Runoff of pesticides from high-use areas.
    - Fields, roadsides, private lawns
Groundwater and Drinking Water

- EPA estimates 4.5 trillion liters (3.65 million AF) of contaminated water seep into the ground in the U.S. every day.
  - MTBE - Gasoline additive, and suspected carcinogen, is present in many urban aquifers.
  - In agricultural areas, fertilizers and pesticides commonly contaminate aquifers and wells.
- Cleanup of 300,000 sites over next 30 years could cost $1 trillion (=job security)
Groundwater Pollution
Sediment

- Human activities have accelerated erosion rates in many areas.
  - Cropland erosion contributes about 25 billion metric tons of suspended solids to world surfaces each year.
- Sediment can either be beneficial (nourish floodplains) or harmful (smother aquatic life).
- Sediment production after a wildfire can be 10 to 100 times higher than a vegetated condition.
Climate Change

- All Federal agencies required to take this into account
- Different effects in different parts of country
- How will it affect flood control, streamflow capture, drought, intense storm surges, sea level rise?
- Modeling is critical.
Types of Hydrologic Models (Surface, Groundwater, Atmospheric-Climate Change all use 3 types)

- Lumped
  - Basin-averaged hydrologic and meteorological inputs are used
- Semi-Distributed
  - Collection of smaller sub-basins
- Distributed
  - Grid based hydrologic and meteorological representation
  - More computationally intensive
WATERSHED CONSERVATION

- If you want to control water quantity and quality in a river or stream, control what goes on in that watershed.
  
  - Fixing all the degraded meadows in the Sierras would produce more water than all of the Governor’s/Water Bond proposed Dams.

- Forest First program: partnerships with downstream water districts; forest management provides sediment and wildfire avoidance insurance to protect water supplies (Denver Water, New York, much of Europe)
EPA – WaterSense (Domestic usage)

- America (on average): 400 gpd/person
  - SoCal (MWD average): 189 gpd/person
- Largest in-home domestic use is toilet flushing (up to 27% of in-home use).
- 50-70% of residential use is outside landscaping
- Significant amounts of water can be reclaimed and recycled.
  - Purified sewage effluent (used all over America after outputs from one city become inputs for another)
The Practical ($$) Questions
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<th>Job</th>
<th>Entry Level Education</th>
<th>Median Pay (thousands/yr)</th>
<th># of current jobs</th>
<th>Job Outlook 2012-22 (10% is average)</th>
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Public or Private Sector?

- In general, private consulting is more $$ (generally salaried) and less security and variable benefits, and requires more time at office (short deadlines, late work, weekends, being a salesperson)
- State and Local Gov’t is generally less $$ (depending on State), lots of security, great benefits, and is 40 hours a week
Public or Private Continued

- Good to have a wide variety of experiences
  - Many in gov’t all career lack understanding of ‘real’ world
- Easiest to get into Federal Gov’t through a student internship program
  - At age 32-34, it took me 100 resumes over 2.5 years to get 3 interviews and 1 job offer
- Having the ability to move/relocate will help a gov’t career advance
- Gov’t is best for home life [beyond 40 hr/wk is OT]
What do I do for the Forest Service?
Half my job is dealing with Clean Water Act compliance.

- Section 303d (Total Maximum Daily Loads): lists are added to every 2 years [Water Quality Control Boards and EPA in charge]:
  - Big Bear Lake, Upper Santa Ana, Middle Santa Ana, Lytle Creek, Mountain Home Creek, Lake Fulmor, Crab Creek, Holcomb Creek

- All engineering (mainly roads) and hazardous fuel reduction projects must be field monitored for sediment production and control

- Being a conduit between regulators and decision makers
What do I do other than maintain water quality on the Forest?

- National Environmental Policy Act (NEPA) requires that every Federal Action evaluate results on the environment.
  - Work in an interdisciplinary fashion (watershed, biology, botany, heritage, fire, fuels, fish, engineering)
  - Requires meetings (internal and external), field work, scientific analysis, and specialist report writing
WILDFIRE – Burned Area Emergency Response (BAER)

- The fire isn’t over until the grass is green
- Post-fire landslide risk assessment
- Identify life, property, and resources that could be impacted by rain induced slides
- Implement erosion control measures to lessen the risk

- I have been on 36 fires in 9 years
BAER Assessment from the air (Hathaway 2013)
Fire allows travel to exotic places
As my mom always told me – “Find something you like to do and are good at. If someone will pay you for it, all the better.”
Other Resources

- EPA Watershed Training: http://www.epa.gov/watertrain/