Waterplan Risk Analysis Case Study

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Task

- For various stakeholders explain risk models where risk factors can be reduced by performing Volumetric Benefit Accounting activities
- Focus on Land Conservation and Restoration as well as Aquatic Habitat Conservation and Restoration
- Explain models and how they could be implemented
- Explain how to use Monte Carlo simulations for a model
- Build.

Table of Contents

High-Level Risk Analysis Approach

Risk Assessment

- What can go wrong?
  - Not enough/too much rain
  - Drought
  - Changing water flows
  - Pollution Event
  - Excess Evaporation (dry out or too much rain)
  - Changes in runoff
  - Heavy rains
- What is the likelihood?
  - Distribution of daily rainfall
  - Water treatment rate
  - Recharge rates
  - Depth of stream throughout the year
  - Water/Air Temperature distribution
  - Likelihood of varying storm level
- What are the consequences?
  - Reduced water volumes
  - Reduced water quality
  - Increased water usage
  - Flooding
  - Equipment damage

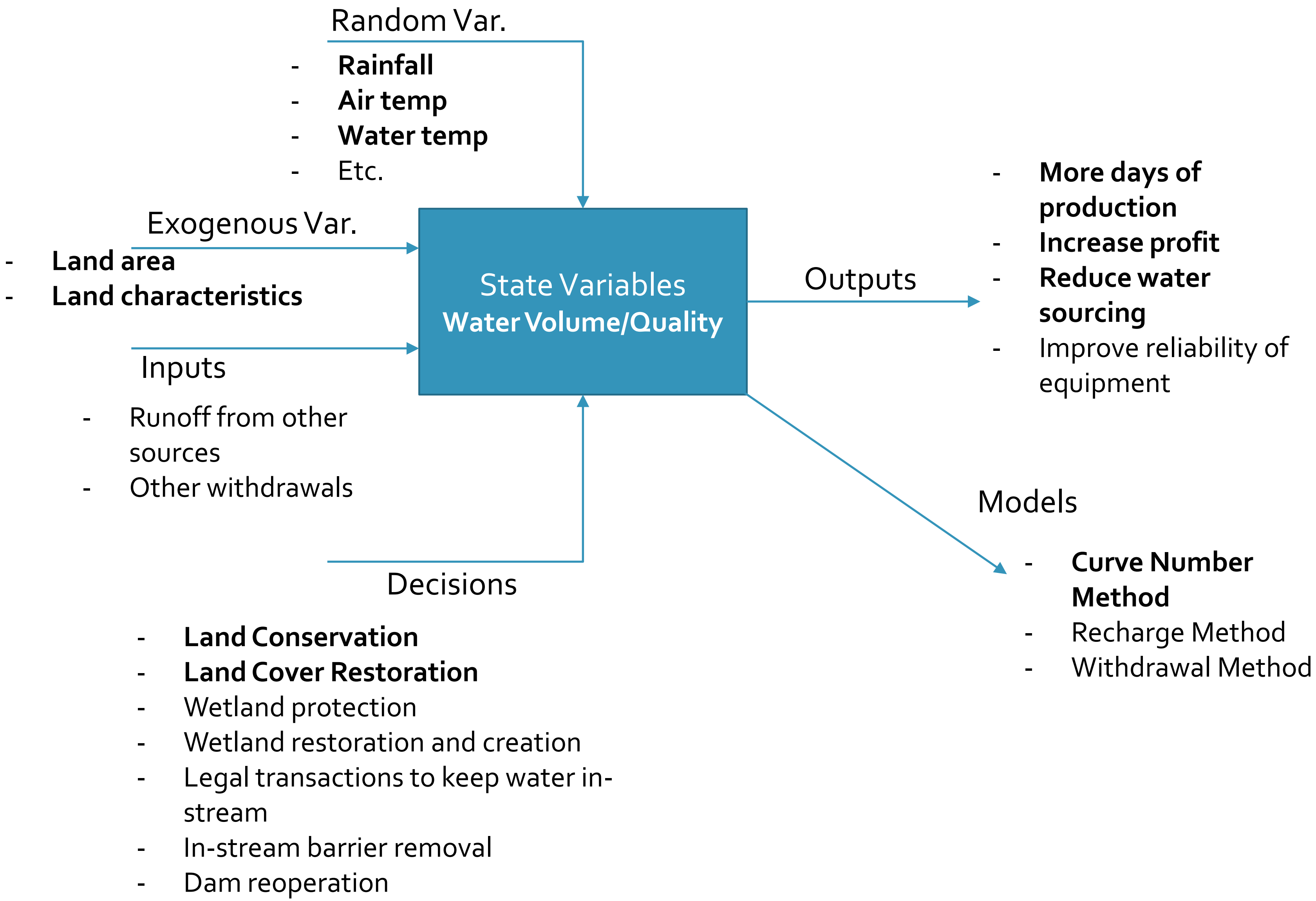
Risk Management

- What can be done?
  - Land Conservation and Restoration
    - Land Conservation
    - Land Cover Restoration
  - Wetland Conservation and Restoration
    - Wetland protection
    - Wetland restoration and creation
    - Legal transactions to keep water in-stream
    - In-stream barrier removal
    - Dam reoperation
- Costs? Risks? Benefits?
    - $ Planting Ground Cover, Legal Fees, Dam removal
    - - Legal Restrictions, Reduction in Energy
    - + Water Quantity, Water Quality, Flow Regime
- How do current decisions impact future options?
  - Binding contracts, limited ground cover to restore

Risk Communication

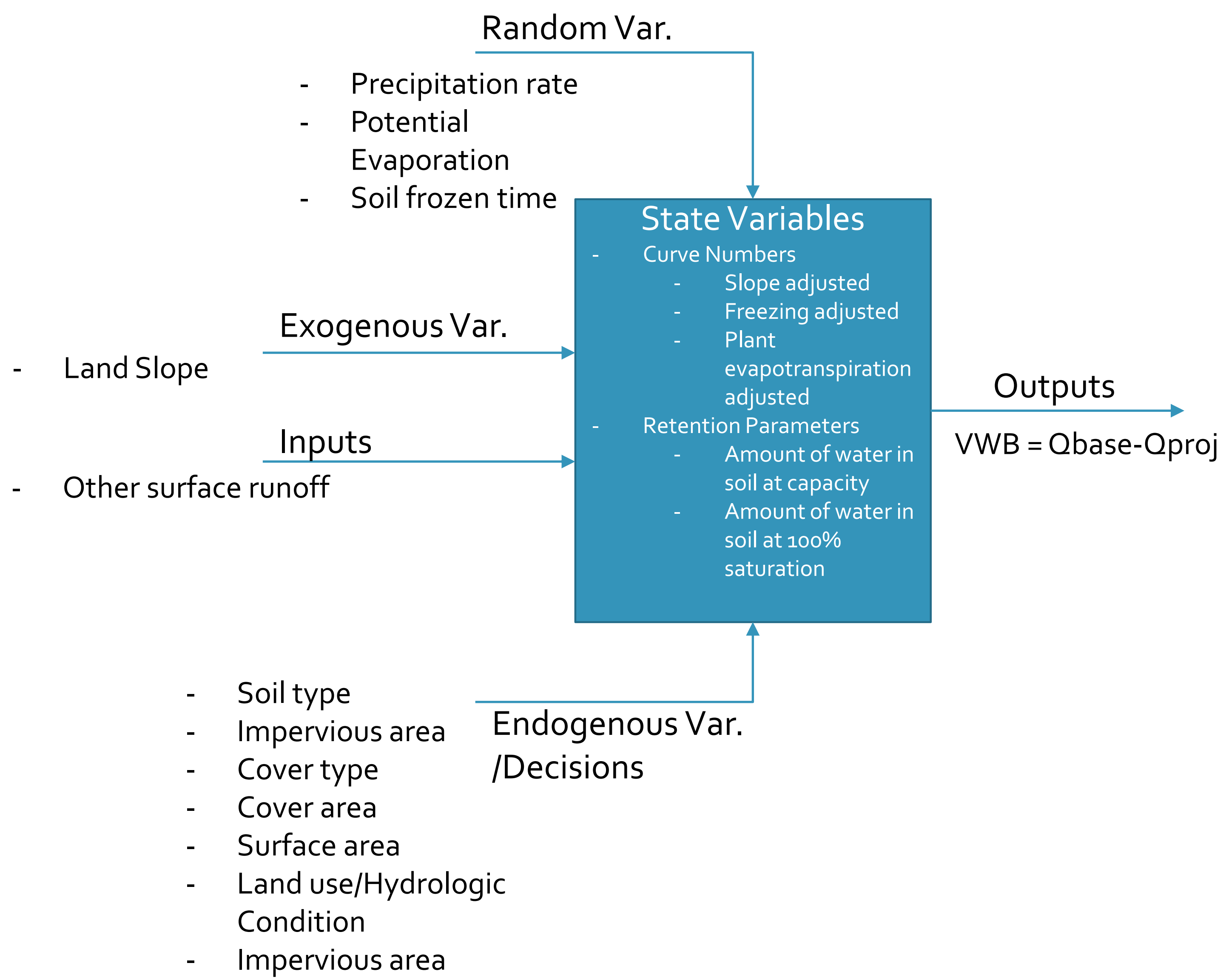
- Investors – Provide funding (abstract level)
  - Stock Price
    - Impact of water stewardship activity announcements on CAAR
  - Credit quality
    - Impact of ESG on credit rating
  - Water futures
- C-Level Executives – Provide leadership and vision (high level)
  - EBITDA
  - Lost Days of Production / Energy Output
    - Scarcity, flooding, pollution
  - Increased Cost
    - Drought triggers
    - Pumping costs
    - Water pollution fines
    - Water sourcing costs
- Marketing – Maintain public relations and increase exposure (low level, distanced)
  - Reputation
    - Social Sentiment Indicator
    - MSCI ESG Rating
- Sustainability – Promote corporate responsibility and stewardship (low level, close)
  - Water footprint
  - Withdrawals

High-Level Water Volume Risk Model

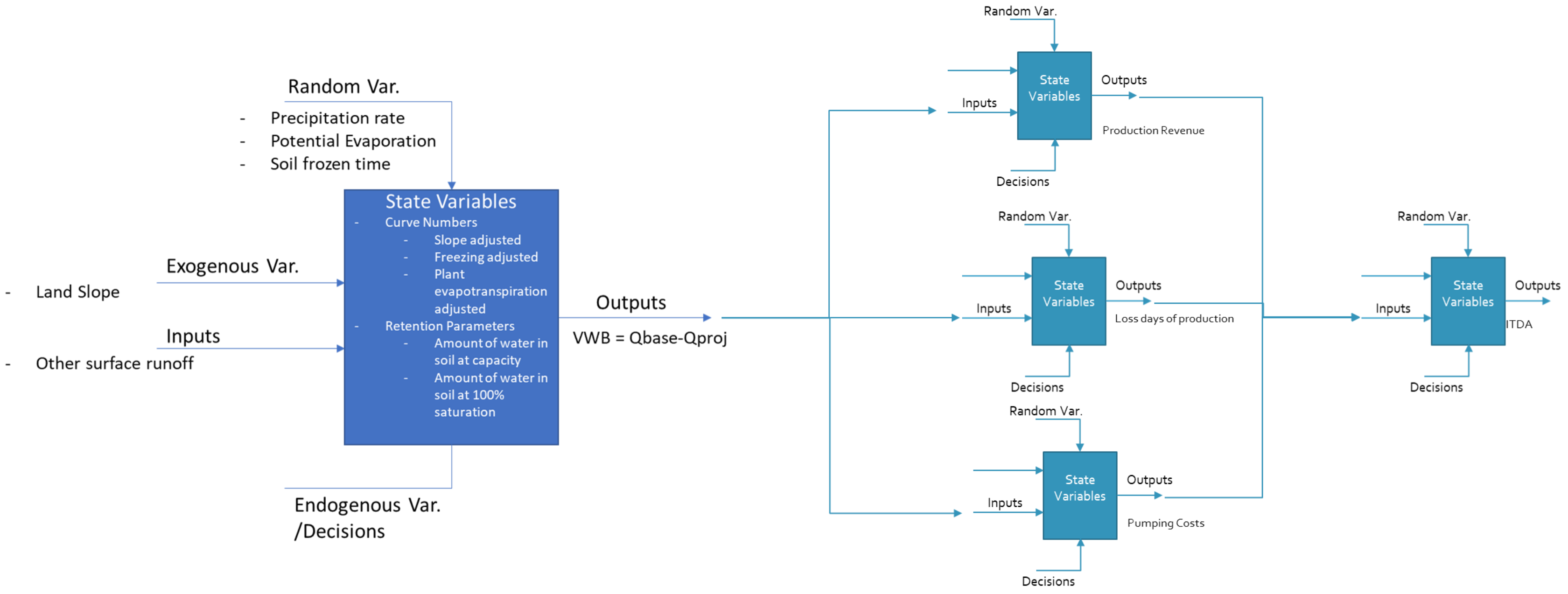


Land Conservation and Restoration Modeling

Land Conservation & Restoration Risk Model



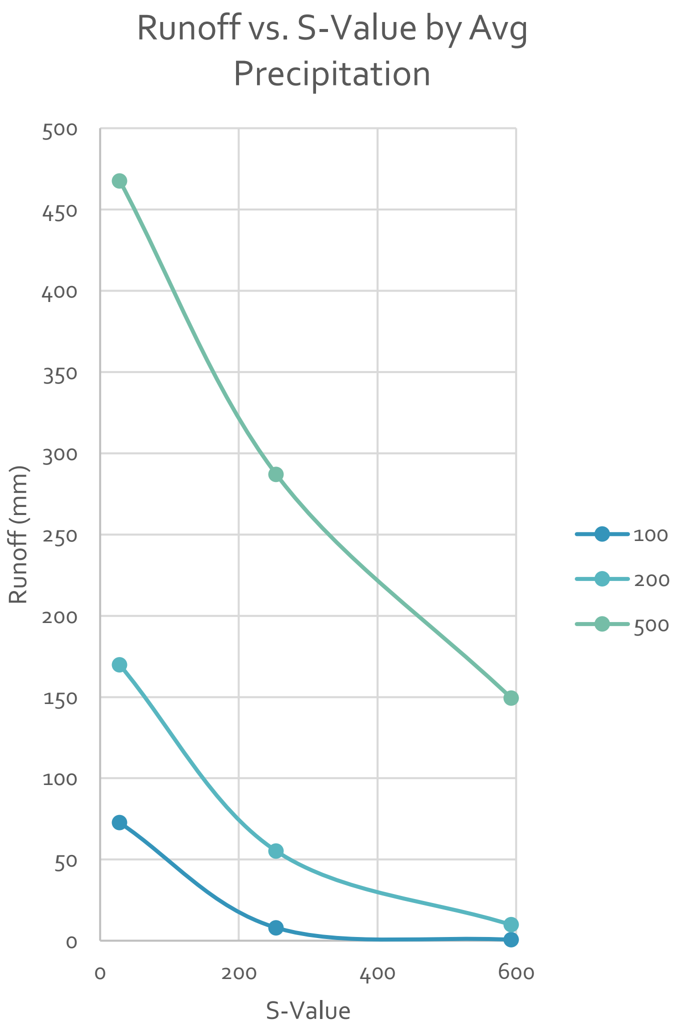
System of Systems Modeling

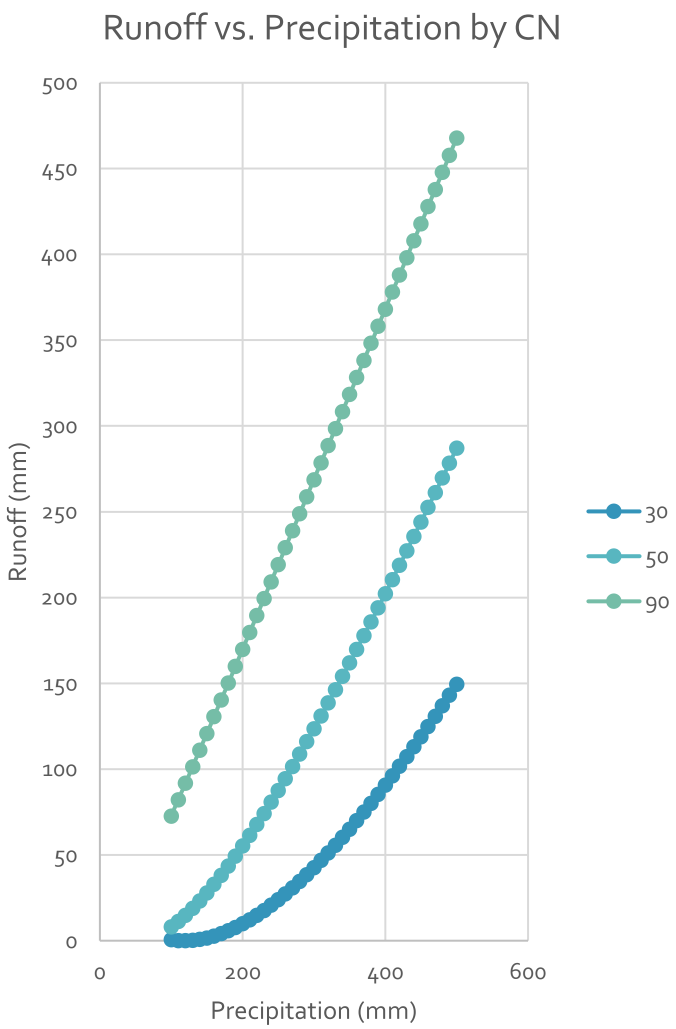


Curve Number Method

- $Q = \frac{(P-0.2S)^2}{(P+0.8S)}$
  - Q = Runoff (mm)
  - P = Daily Precipitation (mm)
  - S = Potential maximum retention after runoff begins (mm)
- $S = \frac{25{,}400}{CN} - 254$
  - CN = Curve number that ranges between 30-98 based on soil type and land cover characteristics

Curve Number Method - Plots





Land Conservation & Restoration Risk Assessment

- What can go wrong?
  - Freezing weather
  - Too much rain
  - Not enough rain
  - Plant death
  - Plant overgrowth
- What is the likelihood?
  - Distribution of daily rainfall
  - Distribution of water temps
- What are the consequences?
  - Too much runoff
  - Not enough runoff? -> not enough rain -> impact other systems

Modeling and Simulations

- Monte Carlo
  - Precipitation Rate
  - Accumulated water captured over time
- Time series
  - Future water temp
  - Days frozen

Building the Model

What are we building?

- New surface water system that will collect water for a new production facility
- Water system will be based on a land cover restoration project
- Water system starts with no water and relies on rainwater for supply
- Production facility wants to open one year from project completion date
- Facility requires 13,000 m^3 of water to start production

Model Inputs, Variables, and Decisions

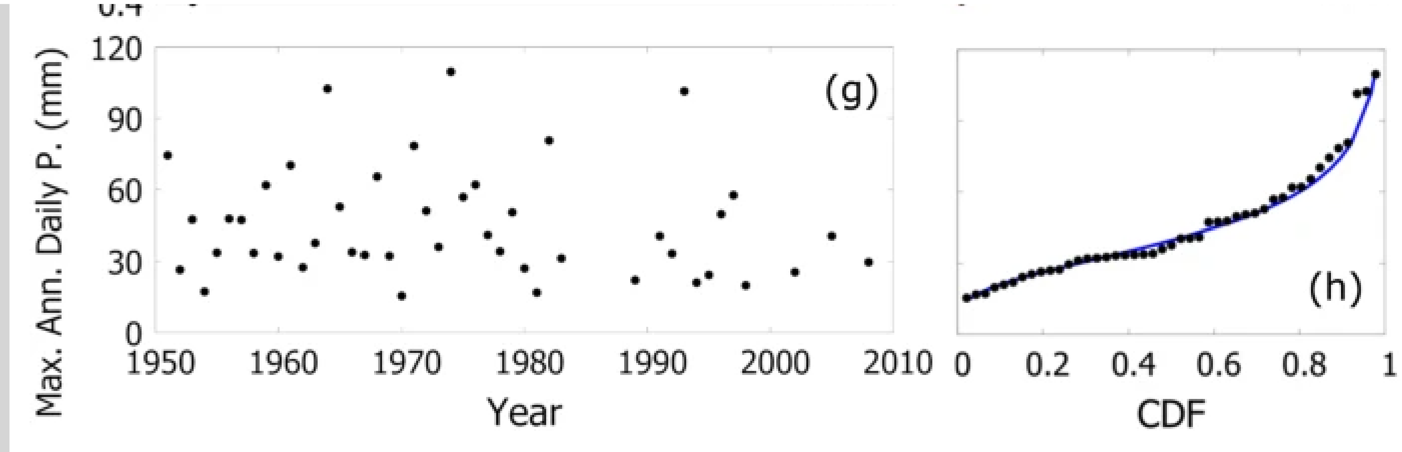
- Assumptions
  - Water never freezes
  - Ignore plant evapotranspiration effect
- Decisions
  - Impervious area: 0%
  - Land use: Pasture
  - Hydrologic Condition : Poor
  - Soil Group: A
  - CN: 68
- Inputs
  - No external runoff
- Exogenous Variables
  - 5% land slope
  - Surface area: 40,000 sq. meters (~100 acres)
  - Cagliari, Italy

Table 2:1-2: Runoff curve numbers for other agricultural lands (from SCS Engineering Division, 1986)

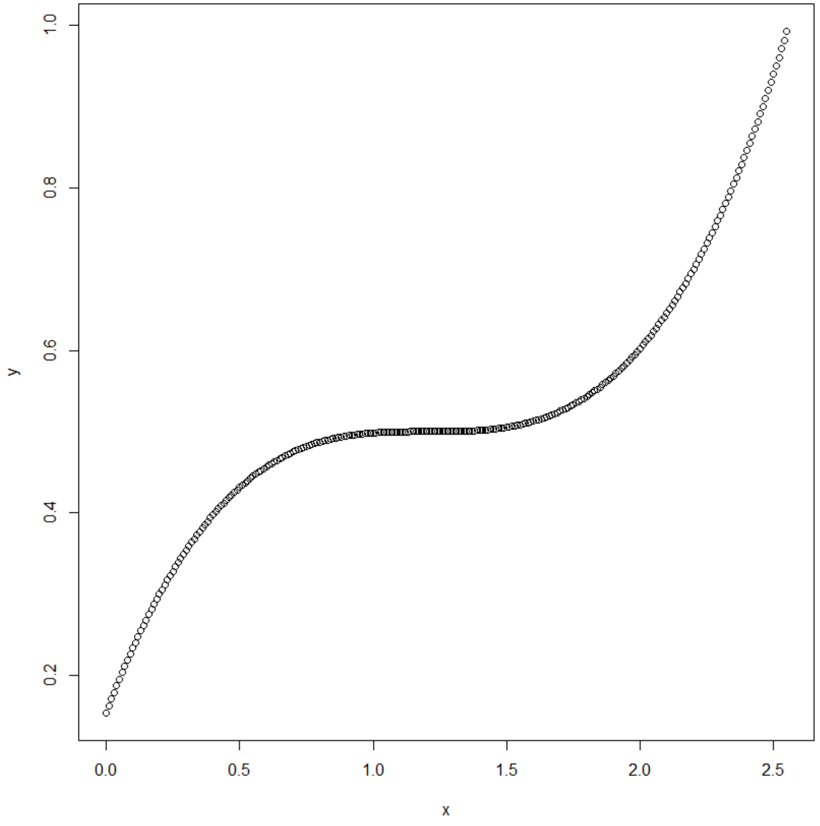
Cover		Hydrologic Soil Group			
Cover Type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing[1]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay	- - - -	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element[2]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods—grass combination (orchard or tree farm)	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[3]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	- - - -	59	74	82	86

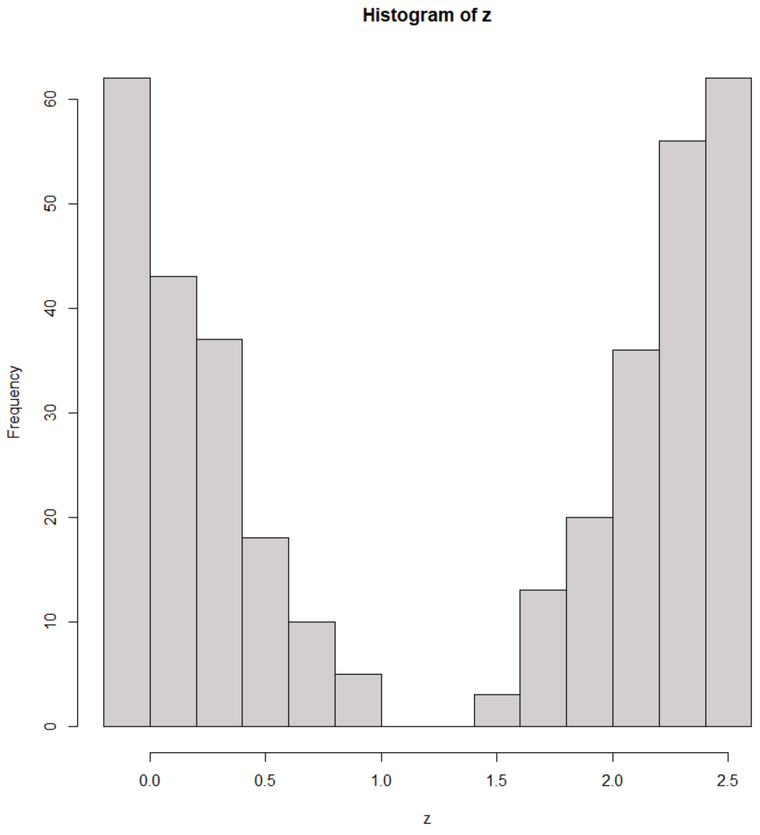
Random Variables

- Precipitation

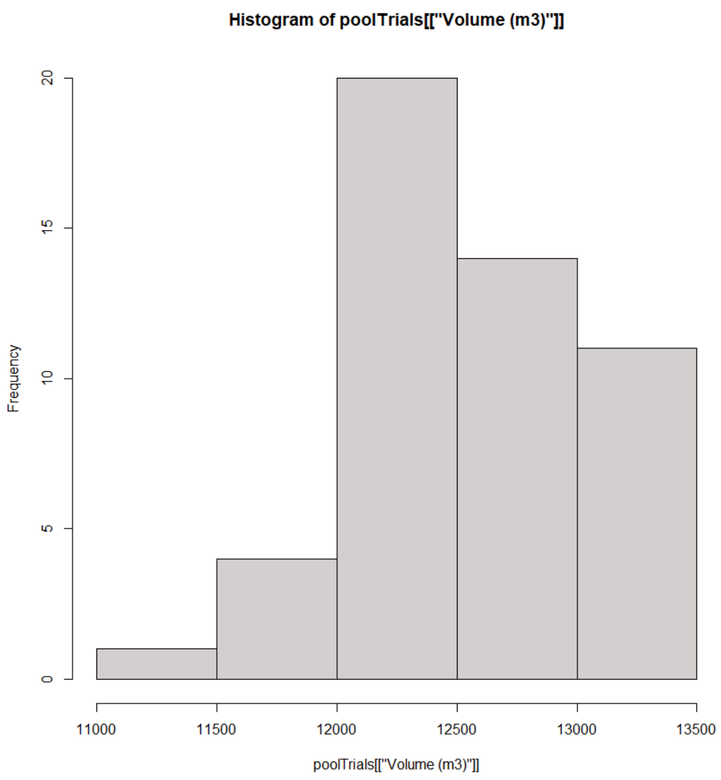


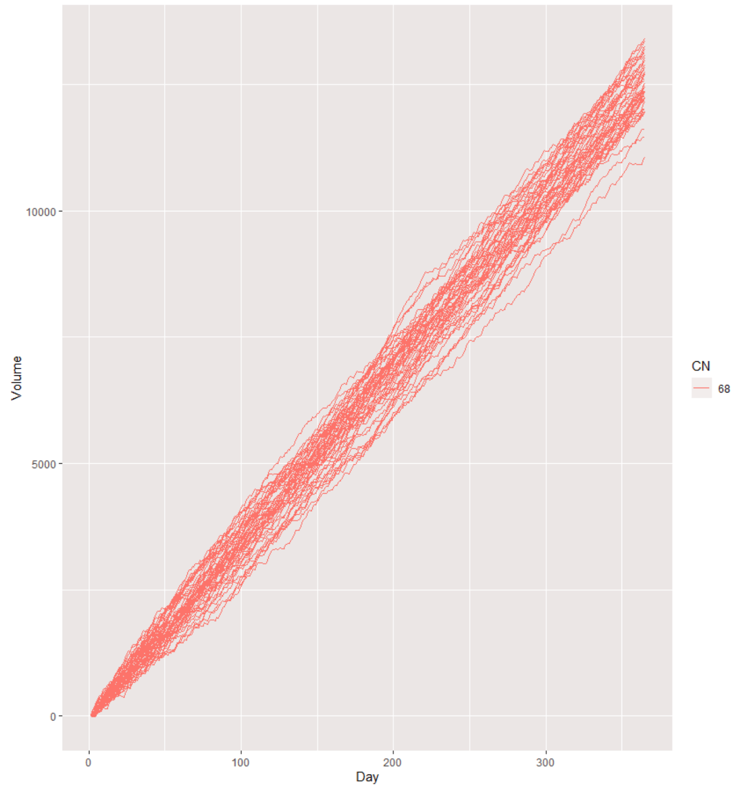
Rainfall Probabilities





Outputs


Histogram of poolTrials[["Volume (m3)"]]
Frequency
0
5
10
15
20
11000
11500
12000
12500
13000
13500
poolTrials[["Volume (m3)"]]


Volume
0
5000
10000
0
100
200
300
Day
CN
68

Improved Land Restoration Project

Table 2:1-2: Runoff curve numbers for other agricultural lands (from SCS Engineering Division, 1986)

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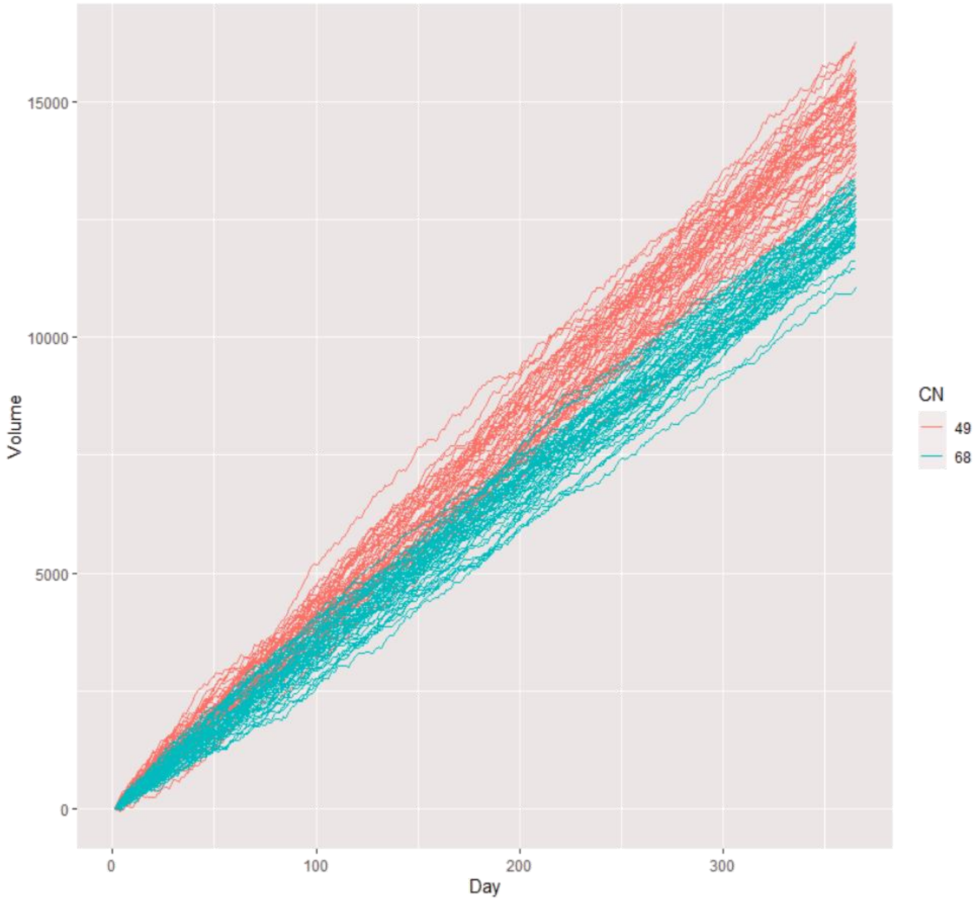

Resources

Model Related Research

- VWBA Accounting: https://files.wri.org/d8/s3fs-public/volumetric-water-benefit-accounting.pdf
- CN Number and S-Value Calculation and Variables : https://oaktrust.library.tamu.edu/bitstream/handle/1969.1/128050/TR-406_SoilandWaterAssessmentToolTheoreticalDocumentation.pdf?sequence=1
- Historical Rainfall Data Source: https://www.nature.com/articles/s41598-018-31838-z

General Research

- https://www.triplepundit.com/story/2017/corporate-water-stewardship-slow-market/20426
- https://www.globalwaterintel.com/news/2019/31/from-corporate-water-risk-to-value-creation
- https://waterriskfilter.panda.org/en/Value/ValuePotentiallyAffectedTool
- https://awsassets.panda.org/downloads/understanding_water_risk_iv.pdf
- https://www.investopedia.com/terms/s/social-sentiment-indicator.asp
- https://www.cnbctv18.com/environment/water-risk-likely-to-be-three-times-higher-than-carbon-risk-barclays-9829981.htm
- https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/water-report/ImpactSeries_WaterReport_Final.pdf
- https://www.investmentbank.barclays.com/our-insights/rising-to-the-water-challenge.html
- https://www.investmentbank.barclays.com/our-insights/esg-sustainable-investing-and-bond-returns.html
- https://www.investmentbank.barclays.com/our-insights/3-point-perspective/calculating-the-true-cost-of-water-for-the-consumer-staples-sector.html
- https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-water-resources_.html