Math 3550 – Individual Report

For the individual project you will read and comprehend existing work, summarize them, assess them, and develop ideas for other questions that should be addressed.

Find at least two published (refereed) mathematical modeling papers in one of the areas below. Of course, the quality of papers will affect your report's score. You will probably find the listed references lacking and some might be out of date. Expand the scope of your search to find best papers. Use our library resources: contact science librarian Miranda Kispert, mirandakispert@weber.edu.

Your individual report must include the following.

- Executive Summary, preferably only on page
- Describe at least two different or interrelated models. State precisely the problems addressed.
- Explain how the models were developed; assumptions and rationale/justification, model fitting or estimation of the values used.
- How were model verification, sensitivity analysis, including error analysis, etc. conducted?
- Discuss the strengths and weaknesses of each model or approach.
- What are the important questions you think should be answered or you like to investigate?

Your entire submission cannot exceed **15** pages.

Report Areas

1. Water Usage

Utah's population is growing at a rapid rate, http://worldpopulationreview.com/states/utah-population/. In addition to increase in culinary water usage, secondary water, which is suitable for agricultural use, with very little volume restriction, by homeowners for watering lawns and landscaping is increasing. The demand on water resources for industrial and agricultural use is also on the rise. Data centers water needs is a new controversial issue.

State of Utah has considered Bear River Development Project, https://water.utah.gov/bear-river-dev/ and Lake Powell Pipeline, http://lpputah.org/. State has developed and refined water plans over the years; Utah's Water Resources 2001, Water for Utah 2018, Flowing Toward 2050, etc. However, more severe recent drought has brought these plans into question.

Report on models of predicted water demand in Utah and ways to meet it using conservation, recycling, etc. You may also use models for other states, for example, Nevada.

Utah Department of Environmental Quality, *Utah's Drinking Water*, https://deq.utah.gov/drinking-water/utahs-drinking-water.

Utah Foundation, Flowing Toward 2050: Utah's Power outlook, https://www.utahfoundation.org/reports/flowing-toward-2050-utahs-water-outlook

Glad you asked: Does Utah really use more water than any other state? https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/does-utah-use-more-water/

Utah's Drinking Water, https://deq.utah.gov/drinking-water/utahs-drinking-water

https://www.usgs.gov/centers/utah-water-science-center

Utah Division of Water Rights, https://waterrights.utah.gov/

Our Changing Population: Utah, 2022. https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/utah

Hadas, E., & Gal, Y. (2012). Inter-sector water allocation in Israel, 2011-2050: Urban Consumption Versus Farm Usage. *Water and Environment Journal,* 28(1), 63-71. https://doi.org/10.1111/wej.12011

Winslow, B. (2023, November 15). *Utah needs a comprehensive water plan, legislative audit warns.* standard.net. https://www.standard.net/news/environment/2023/nov/15/utah-needs-a-comprehensive-water-plan-legislative-audit-warns/

2. Disappearing Salt Lakes

Salt lakes, and fresh water lakes, are disappearing around the world. As salt lakes dry up, the amount of dust in the air increases, exposing resident to increased level of toxic metals, such as arsenic and mercury, in addition to increase in cases of asthma attacks and lung and heart diseases.

The Great Salt Lake is a very large, shallow, terminal, salt water lake that is highly sensitive to annual precipitation as evident by 1983 flood of Salt Lake City and reaching its lowest level and losing one-half its surface area recently. Lake provides critical wetland/marsh habitat for migratory shorebirds and waterfowls. Due to its high salinity, it doesn't have any fish, but supports brine shrimp whose eggs are harvested and used worldwide. Mineral extraction in the form of sodium chloride, potassium sulfate, and magnesium, is its main industrial usage.

Report on models of predicted Great Salt Lake water level, surface area, health costs, and/or changes in animal (bird) population. You may also use models for other lakes, for example, Lake Urmia in Iran.

There are several reports in USGS, https://www.usgs.gov/news/state-news-release/new-one-stop-shop-webpage-all-things-great-salt-lake

Mercury Level in GSL, https://web.archive.org/web/20131029201307/http://www.ksl.com/?nid=148&sid=10121605

The Great Salt Lake is getting a little less great – here's why, The Great Salt Lake is shrinking - NASA satellite images | World Economic Forum

Utah Division of Water Resources, Great Salt Lake – Utah Division of Water Resources

Historic low stand of Great Salt Lake, Utah, 2021. 15 Oct. 2022
https://link.springer.com/article/10.1007/s42452-021-04691-5

Utah's Great Salt Lake has lost half its water, thanks to thirsty humans, 2017,
https://www.science.org/content/article/utah-s-great-salt-lake-has-lost-half-its-water-thanks-thirsty-humans

Modeling the Great Salt Lake by Ibrahim Nourein Mohammed, 2006.
https://hydrology.usu.edu/dtarb/ibrahim_thesis.pdf

Simplified versions for the Penman evaporation equation using routine weather data, 2006.
Simplified versions for the Penman evaporation equation using routine weather data - ScienceDirect

Effect of Water Surface Salinity on Evaporation: The Case of a Diluted Buoyant Plume Over the Dead Sea, 2018. Effect of Water Surface Salinity on Evaporation: The Case of a Diluted Buoyant Plume Over the Dead Sea - Mor - 2018 - Water Resources Research - Wiley Online Library

Ghost Towns and Toxic Fumes: How an Idyllic California Lake Became a Disaster, 2021.
https://www.cnbc.com/2021/11/06/californias-salton-sea-spewing-toxic-fumes-creating-ghost-towns-.html

Isolation and characterization of halophilic bacteria with the ability of heavy metal bioremediation and nanoparticle synthesis from Khara salt lake in Iran, 2021.
https://link.springer.com/article/10.1007/s00203-021-02380-w

Effective rhizoinoculation and biofilm formation by arsenic immobilizing halophilic plant growth promoting bacteria (PGPB) isolated from mangrove rhizosphere: A step towards arsenic rhizoremediation, 2021. https://www.sciencedirect.com/science/article/pii/S0048969717319502

Prospecting metal-resistant plant-growth promoting rhizobacteria for rhizoremediation of metal contaminated estuaries using Spartina densiflora, 2013.
https://www.sciencedirect.com/science/article/pii/S0048969717319502

3. Green Energy

For the first time, Utah got more power from solar energy than any other source, https://grist.org/energy/utah-solar-power-coal-generation/. In 2023, Iowa generated about 64% of its electricity from wind turbines, https://www.iaenvironment.org/webres/File/Wind Energy Fact Sheet - 2023.pdf. There is a significant unaccounted amount of pollution and health costs in energy production using fossil fuels, https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(24)00098-6/fulltext. No significant progress has been made in dealing with waste from nuclear reactors and energy production from nuclear fusion is still in experimental stage.

Take any US state, preferably Utah, if possible, or any country, and report on mathematical models predicting future green energy production. You may consider energy costs and health costs or benefits.

Utah State Profile and Energy Estimates, https://www.eia.gov/state/?sid=UT

https://www.power-technology.com/features/wind-energy-by-country/

https://energy.economictimes.indiatimes.com/news/renewable/worlds-top-10-countries-in-wind-energy-capacity/68465090

https://en.wikipedia.org/wiki/Wind_power_in_Utah

Utah's Energy Sources, https://utahcleanenergy.org/

Wind Power in Utah, USU Extension Sustainibility, https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1318&context=extension_curall

Berry, J. (2009). Energy News: Utah's Renewable Energy Zone Assessment. Utah Geological Survey- Survey Notes, 41(2), 8–13. https://geology.utah.gov/map-pub/survey-notes/energy-news/energy-news-utahs-renewable-energy-zone-assessment/

Siting Study – Working with UGS and USU to Identify Renewable Energy Sites that Won't Disrupt Utah's Military, https://www.energy.utah.gov/energy-information/siting-study/

Teyabeen, A., Akkari, F., & Jwaid, A. (2019). Mathematical modeling of wind turbine power curve. *International Journal of Simulation: Systems, Science & Technology*. https://doi.org/10.5013/ijssst.a.19.05.15

U.S. Wind Turbine Database, *U.S. Geological Survey,* https://eerscmap.usgs.gov/uswtdb/viewer/#3/37.25/-96.25

Wiser, R., Rand, J., Seel, J., Beiter, P., Baker, E., Lantz, E., & Gilman, P. (2021). Expert elicitation survey predicts 37% to 49% declines in wind energy costs by 2050. *Nature Energy*, *6*(5), 555–565. https://doi.org/10.1038/s41560-021-00810-z

Dates

Week of Sept 14:	Choose your individual area. Collect many relevant articles, information, data, etc. **Our science librarian Miranda Kispert**, mirandakispert@weber.edu **can be helpful.**
Week of Sept 21:	**Each student must meet me to discuss their individual area, information collected, etc.** Plan the write-up for your individual report.
Week of Sept 28:	Start writing your individual project.
Mon, Oct 19:	**Individual reports are due.**