# My amazing title

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of the requirements for the degree of
Bachelor of Arts with honors.

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# Abstract

The abstract should be a short summary of your thesis work. A paragraph is usually sufficient here.

# Acknowledgments

Use this space to thank those who have helped you in the thesis process (professors, staff, friends, family, etc.). If you had special funding to conduct your thesis work, that should be acknowledged here as well.

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# Chapter 1 Introduction

The introduction should provide an overview of the work you set out to do and provide structure for the remainder of the document.

## 1.1 Background

- (coal ash report - car) coal one of the most dangerous combustible fossil fuels is comprised of a long list of dangerous chemicals – including substances such as arsenic, radium, other carcinogens, metals that can impair developing children's brains, toxins dangerous to aquatic life, etc (Kelderman et al., 2019)
- power plants produce 100mil tons of coal ash every year, which is dumped into landfills and waste ponds (Kelderman et al., 2019)
- only recently (2015) have complaints and lawsuit arisen in which certain ecological organizations have attempted to sue the EPA to regulate disposal of coal ash (Kelderman et al., 2019)
- this coal ash rule has forced power companies to make publicly available data regarding chemical concentrations in 265 coal plants containing ponds and landfills (about 3/4 of all coal power plants across the US) (Kelderman et al., 2019)
- environmental agencies have concluded that the groundwater under basically all coal plants are contaminated (Kelderman et al., 2019)

- HOWEVER this might be overstated? we wanted to investigate whether or not if this was true.
- wells are split into 2 different types - upgradient and downgradient

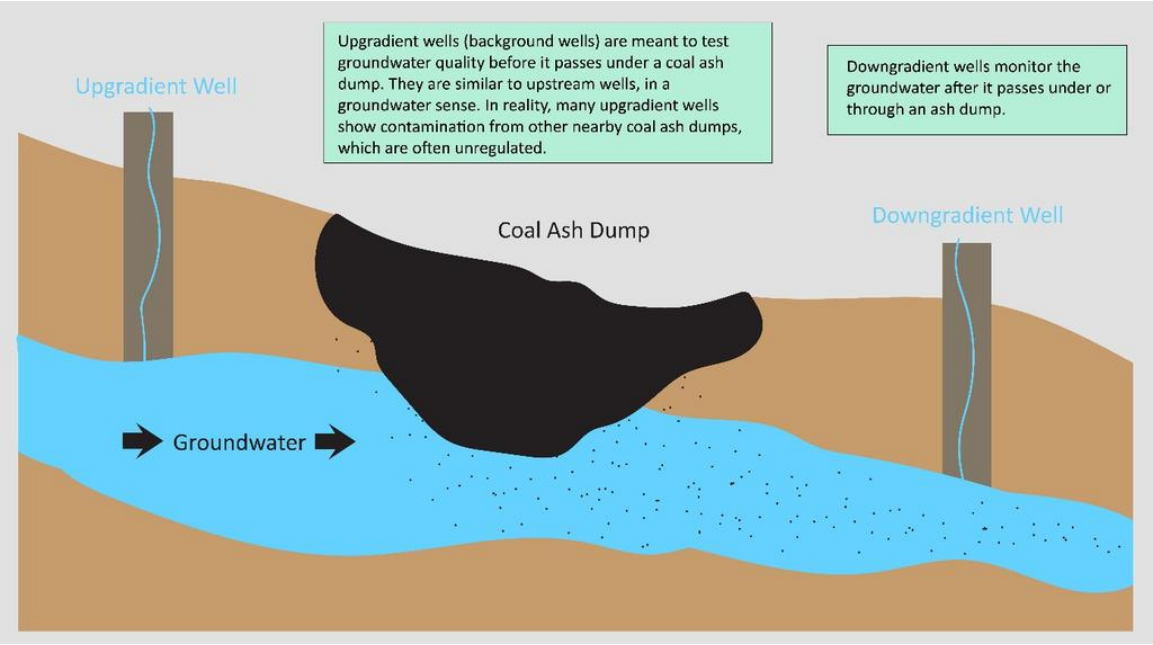


Figure 1.1: Difference Between Upgradient and Downgradient Wells

- upgradient wells (background wells) measures groundwater chemical levels BEFORE passing through a coal ash dump while downgradient wells monitor the groundwater AFTER it passes through an ash dump
- we have reason to believe that many chemicals are NATURALLY OCCURING and as such, the statement made my environmental agencies regarding all groundwater being contaminated may be overstated
- typically, we would estimate the amount of chemical contamination, for this example – arsenic – caused by a coal ash dump with the equation: downgradient arsenic concentration minus upgradient arsenic concentration

- however, because there may be retired/unregulated upgradient wells that are occasionally contaminated already, this might be inaccurate

# Chapter 2 Methodology

## 2.1 Plan of Action

- we wanted to identify these contaminated upgradient wells and then "correct" these measurements

- firstly, we used agglomerative hierarchical clustering to identify contaminated upgradient wells in our 'illinois' dataset (thoughts, maybe we want to expand/use a bigger dataset) using Ward's Method

- then, we separated our data into two parts – one dataset containing these contaminated upgradient wells and another dataset containing UNcontaminated upgradient wells

- then, we randomly sampled (with replacement) (500) times from the measurements of the chemical from non-contaminated upgradient wells to create an empirical distribution of naturally occurring chemical levels. this serves as the set of imputed "corrected" measurements of the chemical for each contaminated upgradient well

- then, we identify the specific 'disposal_area' that the contaminated wells belong to and FILTERED to have a dataset contain only the downgradient wells that corresponded to the upgradient wells – calculating the average of the downgra-

dient wells (for the illinois dataset, we only had contaminated upgradient wells from TWO disposal areas)

- finally, we subtracted each of the (500) imputed upgradient measurements from the average downgradient measure. This creates a distribution of (500) values of the contaminant concentrations caused by the disposal area.

- we can then take the median of these (500) values as the estimate of the contamination caused by the disposal area (for the given chemical) and then use the 2.5 percentile and 97.5 percentile of the distribution as a bootstrap-type confidence interval.

- we found that the first disposal area didn't have any obvious contamination b/c the difference that we calculated (upgrad - downgradient) was mostly 0, while for the second disposal area the different was much greater than 0

# Corrections

A list of corrections after submission to department.

Corrections may be made to the body of the thesis, but every such correction will be acknowledged in a list under the heading "Corrections," along with the statement "When originally submitted, this honors thesis contained some errors which have been corrected in the current version. Here is a list of the errors that were corrected." This list will be given on a sheet or sheets to be appended to the thesis. Corrections to spelling, grammar, or typography may be acknowledged by a general statement such as "30 spellings were corrected in various places in the thesis, and the notation for definite integral was changed in approximately 10 places." However, any correction that affects the meaning of a sentence or paragraph should be described in careful detail. The files samplethesis.tex and samplethesis.pdf show what the "Corrections" section should look like. Questions about what should appear in the "Corrections" should be directed to the Chair.

# References

Kelderman, K., Kunstman, B., Roy, H., Sivakumar, N., Mccormick, S., & Bernhardt, C. (2019). Coal's Poisonous Legacy: Groundwater Contaminated by Coal Ash Across the U.S.