Introduction

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

Background

Coal is one of the most dangerous combustible fuels which is being burned in all across the world as one of the largest methods of obtaining energy. Yet, although it is a fossil fuel which is naturally abundant and easy to utilize, it is comprised of a long list of dangerous chemicals including – but not limited to: arsenic, radium, boron, and a large list of other chemicals which prove to be dangerous to humans and animals alike. [@Kelderman2019]

Power plants produce electricity by burning this coal, and as a result of how prevalent it is within the US - over 100 million tons of coal ash are produced every year. This side-product as a result of the coal combustion is often disposed by directly being dumped into landfills and waste ponds. [@Kelderman2019]

Only recently have these complaints and lawsuits regarding the disposing practices made by non-profit environmental organizations been heard. Due to the onslaught of pressure put on the Environmental Protection Agency – the Coal Ash Rule was bor in 2015. [@Kelderman2019]

This rule has forced over 265 coal power plants – about 3/4 of all coal power plants in the US - to make data regarding chemical concentrations publicly available to the general population. [@Kelderman2019]

In their analysis using this data, the Environmental Integrity Project – a non-profit organization dedicated to issues involving environmental justice have concluded that essentially all groundwater under coal plants are contaminated. [@Kelderman2019]

However, is this really the case? There are many naturally occurring chemicals existing in groundwater as as such, perhaps their claims are overstated.
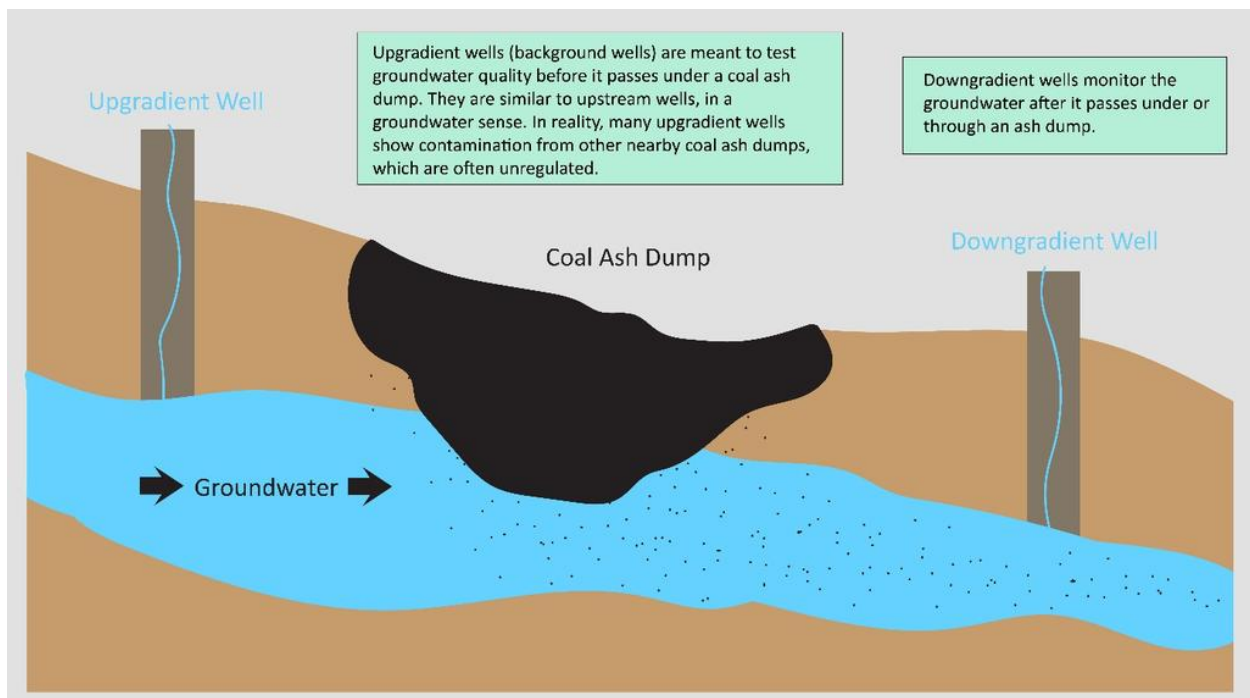

Figure 1: Difference Between Upgradient and Downgradient Wells

Typically in a coal ash plant, there exists two types of wells: upgradient wells and downgradient wells. These wells are essential to measure the amount of contamination being caused by coal ash. Upgradient wells, also known as background wells, measures the concentrations of chemicals in groundwater before it passes through an coal ash dump. Conversely, downgradient wells measure the concentrations of chemicals in groundwater after it passes through a coal ash dump.

With this information, typically – one estimates the amount of chemical contamination caused by a coal as dump by subtracting the upgradient concentration from the downgradient concentration of a chemical (downgradient concentration - upgradient concentration).

However, due to the lack of proper reporting guidelines prior to the enactment of the Coal Ash Rule, we believe that there may be retired or even unregulated upgradient wells which can cause the concentrations of chemicals being recorded from these upgradient wells to be inaccurate or even completely wrong.

Our end goal remains the same as the EIP: to identify contaminated groundwater in coal plants – but to attempt to find a way to effectively correct the improper/inaccurate values resulting from LOD errors and other factors which the EIP may not have considered.

The limit of detection problem stems from the measuring devices' inability to obtain chemical concentrations smaller than a certain threshold amount, thus affecting the measurements recorded.

Our plan is to utilize bootstrapping and imputation techniques to correct for these measurements by accounting for the innate contamination which may be caused by factors such as retired and unregulated wells that were mentioned before.

Data

Coal Ash Rule

- A large coal ash spill at the Tennessee Valley Authority (TVA) which occured on December 22, 2008 in Kingston, TN – prompted the Environmental Protection Agency (EPA) to propose a set of standardized regulations and procedures to address the concerns regarding coal ash plants nationwide in the US [@Car2020]

- This was known as the Coal Ash Rule, passed on December 19, 2014 [@Car2020]

- Changes were made to the Coal Ash Rule over the years in the form of 'amendments,' one of which made required facility information and data to be made publicaly available to the public (April 15, 2015 rule change) [@Car2020]

Source of Data

- the data used in the study are from the results published in "Annual Groundwater Monitoring and Corrective Action Reports" which were made available to the public in March 2018 [@EIP2020]

- these reports are in PDF format and are thousands of pages long, which makes it difficult for individuals to look through the data in a meaningful way [@EIP2020]

- the EIP wranged the data into a more accessible machine-readable format which contains information from over 443 annual groundwater monitoring reports posted by 265 coal ash plants [@EIP2020]

- they obtained the data from an online, publicly available database containing groundwater monitoring results from the first "Annual Groundwater Monitoring and Corrective Action Reports" in 2018 which was collected from coal plants and coal ash dumps under the Coal Ash Rule [@EIP2020]

Variables

- a coal ash site consists of multiple disposal areas

- within these disposal areas lie multiple wells

- each observation represents a well

- wells are split into 2 different types - upgradient and downgradient wells

- variables consist of information regard chemical contaminant concentrations and specifics regarding the well

- from the 19 different contaminants (antimony, arsenic, boron, etc. ...) a major problem is that some wells only have measurements for certain chemicals and don't have them for others

- we are currently using information from plants within illinois but there is data for all the states in the US