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Should I Stay or Should I Go: Coal Ash in North Carolina

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In February 2014, 39,000 tons of coal ash spilled through a storm pipe break at the Dan River Steam Station in Eden, North Carolina. Awareness of the potential environmental and health impacts of coal ash skyrocketed.

Recent hurricanes have again raised fears of contamination, this time from breaches at two sites in the state. Here, we offer an economist's perspective on North Carolina's coal ash challenges – and potential solutions.

Coal has seen a recent, rapid decline as a source of electricity in North Carolina. Accounting for 86 percent of all electricity production in the state in 1981, coal's use had dropped to 26 percent by 2018. The decline is due in large part to lower natural gas prices – Duke Energy, the largest power generator in the state, switched electricity production from its aging coal plants to cleaner, newer and more efficient natural gas plants.

Unfortunately, coal's legacy lives on in ash ponds and landfills scattered across the state.

How Did We Get Here?

Before it is burned to produce electricity, coal is pulverized into a fine dust. When the dust is burned, it leaves residual particles like the leftover ashes and buildup in a home fireplace. When coal residuals are removed, they become industrial waste that is recycled or stored in ponds and dry landfills.

Today, the coal ash waste stream is recycled into products like cement or stored in lined landfills – but historically, it was stored in unlined pits on site.

"About 110 million tons of coal ash are stored at 14 facilities in North Carolina."

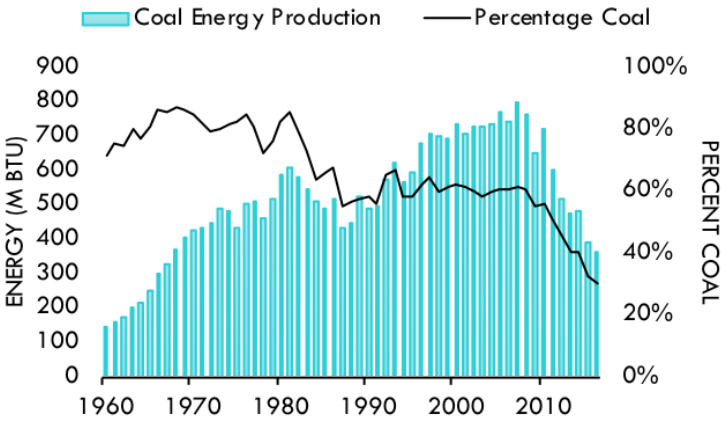

Figure 1: Total coal energy production and percentage of electricity mix coal comprised over time in North Carolina (source: EIA).

As is clear from Figure 1, North Carolinians have received the majority of their electricity from coal for decades. As a result, coal ash has accumulated near power plants across the state. These "legacy" coal facilities contain pollutants that can cause human health problems and pose a significant challenge to the state's water quality.

Compounding the problem, coal-fired power plants are usually located near large rivers because they require water for cooling. Even after a coal plant is retired, the site continues to house potential contaminants, often in areas prone to flooding. Today, there are approximately 110 million tons of coal ash stored at 14 facilities in North Carolina, as shown in Figure 2 and described in Table 1.

Where Are Coal Ash Sites Located

Monitored by the Department of Environmental Quality (DEQ), large storage facilities are located near major North Carolina cities, including:

- Charlotte
- Wilmington
- Asheville
- Goldsboro

The close proximity to population centers makes it critical to understand the links between coal ash and human health.

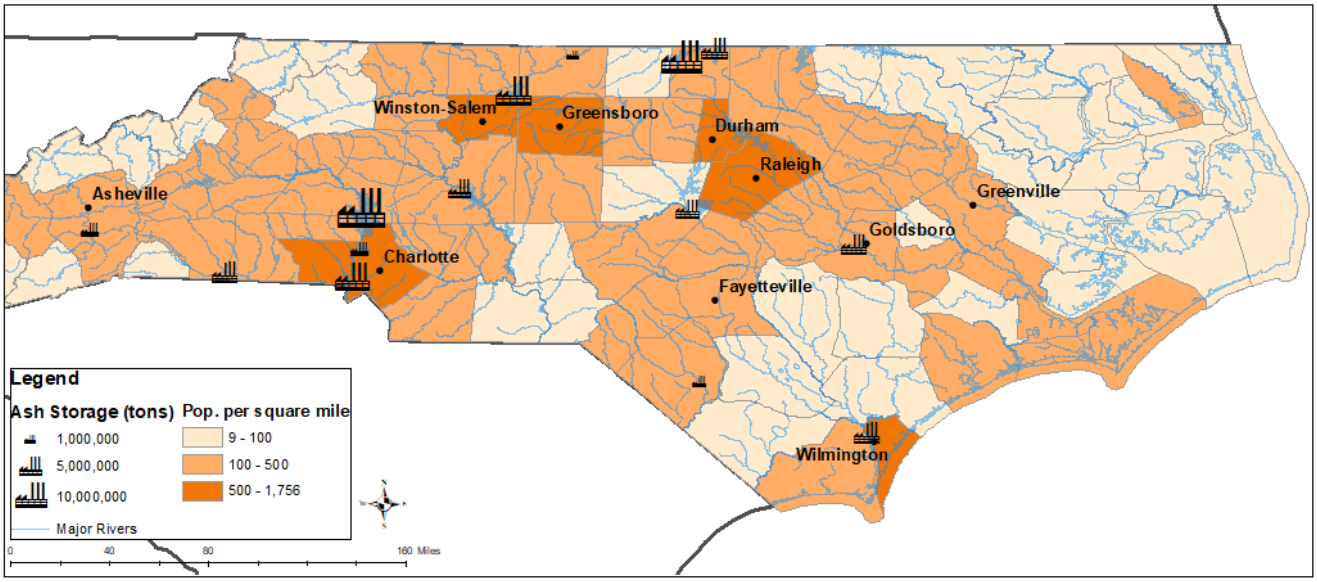

Figure 2: The location of North Carolina's 14 coal ash sites, scaled by amount of ash, and their relation to county populations and major waterways.

Table 1: Key Characteristics of North Carolina's Coal Ash Storage Locations

Name	County	Pop. Density	Coal Ash (tons)	Type of Storage	Electricity Produced (MW)
Asheville Steam Station	Buncombe	363	3,000,000	2 Ponds	376
Sutton Steam Station	New Hanover	1,058	6,320,000	2 Ponds	Retired
Lee Steam Station	Wayne	222	5,899,000	5 Ponds	Retired
Roxboro Steam Station	Person	101	16,440,000	4 Ponds / 1 Landfill	2,558
Cape Fear Steam Station	Chatham	93	5,670,000	5 Ponds	Retired
Dan River Steam Station	Rockingham	166	1,170,000	2 Ponds	276
Buck Steam Station	Rowan	271	5,060,000	5 Ponds	369
Riverbend Steam Station	Gaston	579	2,730,000	3 Ponds	454
Allen Steam Station	Gaston	579	11,580,000	3 Ponds / 1 Landfill	1,140
Marshall Steam Station	Catawba	387	22,270,000	1 Pond	2,090
Cliffside Steam Station	Cleveland	211	6,540,000	6 Ponds / 1 Landfill	1,387
Weatherspoon Steam Station	Robeson	141	1,700,000	2 Ponds	Retired
Belews Creek Steam Station	Stokes	106	12,610,000	1 Pond / 3 Landfills	2,240
Mayo Steam Station	Person	101	6,900,000	2 Ponds / 1 Landfill	745

Environment and Health Effects of Coal Ash

Coal ash is a potential environmental contaminant and carcinogen. The first-ever documented cases of occupational cancer occurred in the chimney sweeps of England circa 1775, through direct, prolonged skin contact to coal soot. Absent that kind of direct inhalation or contact, however, the environmental and health consequences of spills and leaks from coal ash containment facilities are not well-documented.

Air and water contamination are possible due to the metal content of coal ash and polycyclic aromatic hydrocarbons. Coal ash has been shown to contain high concentrations of metals linked to serious medical issues: arsenic, mercury, lead cadmium, vanadium, chromium, nickel and zinc. It also harbors other elements with unstudied medical effects: beryllium, phosphorous, tungsten and molybdenum. However, there are no studies directly measuring the exposure and health status of communities directly adjacent to coal ash facilities (Kravchenko and Lyerly 2018).

What Do We Know About Coal Ash And Health?

While the direct health consequences of coal ash have not been studied, the sites themselves have. There is evidence that coal ash has contaminated waters near coal power stations in North Carolina, both through direct discharges of water that has come into contact with coal ash, and through seepage into groundwater through unlined landfills and ponds.

- A 2012 study by researchers at Duke University and the North Carolina Division of Water Quality tested 300 water samples from eight active plants and found elevated levels of contaminants which in many cases exceeded United States Environmental Protection Agency guidelines for clean water (Ruhl et al. 2012).
- A 2016 study by Duke University researchers found elevated levels of many of the contaminants described above in groundwater and shallow surface water samples taken around coal ash sites across the southeastern US, including 14 sites in North Carolina (Harkness et al. 2016).

Spills, Breaches and Conflicting Data

In addition to slow leaching into nearby water supplies, larger coal ash releases have also occurred.

The third largest coal ash spill in the U.S. occurred in North Carolina at the Dan River Steam Station, spilling 39,000 tons of coal ash over a 70-mile stretch of the river. Hydraulic dredging was used to vacuum the stream bed, but only around 10 percent of the discharged waste was ultimately recovered. The spill significantly affected the appearance of the Dan River. In 2015, Duke Energy pled guilty to nine Clean Water Act violations and paid $102 million in fines and restitution for illegal discharges across its facilities in North Carolina.

"39,000 tons of coal ash spilled over a 70-mile stretch of the Dan River; around 10 percent was recovered."

Flooding also poses a threat to coal ash storage. In September 2018, two of North Carolina's Duke Energy coal ash facilities were compromised as a result of Hurricane Florence. Duke Energy confirmed that there were numerous breaches in containment ponds at its Sutton facility near Wilmington.

The Sutton Coal Plant was retired in 2013, but the site continues to house two coal ash pits and a cooling pond which sit adjacent to the Cape Fear River. Water quality tests have generated conflicting results: those conducted by the DEQ suggest arsenic and other contaminant levels well below the threshold for drinking water, while those conducted by environmental groups report elevated readings at up to 70 times the drinking water standard for arsenic.

In addition, three coal ash pits at the retired Lee Station coal facility near Goldsboro were inundated with floodwaters. Again, the DEQ and environmental groups released divergent results of water quality tests on the nearby Neuse River. DEQ results suggested low levels of arsenic and other contaminants – well below drinking water thresholds – while environmental groups suggested arsenic levels 18 times over the drinking water standard.

The conflicting results may indicate that different criteria were used in selecting sampling locations. Future testing should provide a better indication of the amount of coal ash deposited in these waterways and to what extent it is causing water contamination. The effect of this type of contamination on ecosystems, fish and even agriculture have also been raised as areas of concern. Recent work shows that largemouth bass cheeks in North Carolina lakes receiving water containing coal ash residuals have similar elevated levels of Strontium contamination as the lakes themselves (Brandt et al. 2018). In general, the ecosystem effects of coal ash have not been studied extensively.

Solutions

There are a variety of solutions for dealing with legacy coal ash in North Carolina.

- **On-site Storage**
  One storage method requires the temporary removal of ash and the lining of the storage site, followed by refilling. Another, labeled "cap-in-place," keeps the ash in unlined pits but caps them to prevent water percolating through. While this is the most cost-effective option, the bottom of the pits remain open, potentially allowing coal ash to interact with groundwater. If groundwater contamination becomes a significant concern, a costly solution involves shipping the coal ash to off-site, lined landfills. Two retired mining sites in Chatham County are now used for this purpose.

- **Recycling**
  About 26 percent of Duke Energy's current yearly coal ash production goes to concrete production, and another 14 percent goes to unencapsulated reuse for road-fill and embankments. One successful reuse of legacy ash occurred at the Asheville Airport, where 4 million tons were successfully transported and used in a runway project.

The excavation and recycling of legacy coal ash, however, offers additional challenges. While Duke Energy is able to recycle a good portion of the ash it produces each year, this only amounts to around one million tons. Demand for coal ash as an input is limited relative to the 110 million tons of legacy ash currently sitting in North Carolina landfills. Opportunities for large-scale recycling projects -state are limited; neighboring states may be willing to import coal ash, but several regulatory hurdles must be overcome.

Recycling coal ash requires the excavation and transport of ash, as does the removal of ash to off-site lined landfills. Both these solutions offer greater protection from future water contamination, but with large economic and environmental costs.

Case Study

Dominion Energy in Virginia, which also has legacy coal ash, solicited bids to remove ash from four facilities containing about 55 million tons. Bids ranged in price from $2.4-$5.6 billion, with 45 percent of the ash recycled and the remainder stored in lined landfills. Moving all this ash would require a combined 570-700 truckloads per day from the four facilities for up to 15 years, with commensurate air pollution and local road safety concerns.

Regulation

North Carolina's Coal Ash Management Act of 2014 required Duke Energy to de-water and close all its unlined coal ash pits by 2029. Whether the ash should be capped in place or moved to lined landfills has been left to state regulators to determine on a case-by-case basis. The original law, however, did mandate that coal ash at the Dan River and Sutton plants be moved to lined landfills.

From what we know about coal ash and human health, the primary concern is drinking water contamination. Local drinking water utilities are already required to test for many potential contaminants and provide a Consumer Confidence Report to their customers **(go.ncsu.edu/ConsumerConfidenceCoalAsh)**. For well users, Duke Energy is required by North Carolina law to provide clean water to any home within a half mile of a coal ash storage area, as well as to any well users whose supply has been contaminated by their facilities. Free water testing kits are available at **go.ncsu.edu/FreeWaterTesting**.

While local engineering factors play a role in what options are viable for closing and cleaning coal ash storage sites, economic factors also help dictate what methods are adopted. Duke Energy must receive permission from the North Carolina Public Utilities Commission to pass the costs of coal ash cleanup through to its electricity customers. In 2018, the firm requested $1.5 billion over five years to close its legacy coal ash facilities. Ultimately a $475 million increase was approved, increasing electricity rates by around 5 percent. This funding is primarily designed to cap the facilities in place. Based on the Virginia estimates, removal and recycling of North Carolina's coal ash will cost in excess of $4 billion, and would require a correspondingly larger increase in electricity prices.

For decades, North Carolina electricity customers have benefitted from electricity without paying for the cost of the air and water pollution its generation created. Recent spills have led to new legislation that address the coal ash problem, but key questions remain.

North Carolinians must determine the extent to which coal ash in its present locations can be tolerated and its damage mitigated – or how much money should be spent on removal. To paraphrase The Clash's classic 1982 hit song: "Should I stay or should I go now? If I stay, there will be trouble. If I go it will be double."

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