

A Content Analysis of Journalistic Framing of Chemical Contamination of the Cape Fear River

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Abstract: Guided by Entman's Framing theory, this content analytic study explores the journalistic framing of the Cape Fear River contamination in North Carolina, USA. Chemours, a spin-off company of DuPont was responsible for the release of a hazardous chemical known as GenX into the river, which caused the contamination. The study involved an inductive analysis of 359 news reports about the issue. The results indicated that 78.83% of the articles framed the problems, 72.7% framed the causes, 60.17% framed the effects, and 55.71% framed the potential solutions. Five principal problem frames (i.e., river contamination, Chemours's involvement, scientific uncertainty about GenX, governmental inaction, and the inability of the water treatment plants to filter GenX), four cause frames (i.e., Chemours's malfeasance, wastewater spillage from Chemours's facility, politics, and a lack of regulatory standards for GenX), six effect frames (i.e., the revocation of Chemours's permit, legal action against Chemours, health effects of GenX, stakeholders' demands for answers, scammers targeting stakeholders, and the potential declaration of Cape Fear River as a swampland), and five solution frames (i.e., stopping the wastewater discharge, securing grants to deal with the issue, using alternative techniques to filter GenX, advancing bills to prevent further corporate contamination, and using alternate sources for drinking water) were identified. By looking at all the four frames together, the current study adds to the framing literature, and can be used in the future to determine how the analyzed news media frames contributed to the formation of public opinion regarding the issue.

Keywords: Cape Fear River, Content Analysis, Framing Theory, GenX.

I. INTRODUCTION

In December 2016, a group of researchers led by Dr. Detlef Knappe of the Department of Civil, Construction, and Environmental Engineering at North Carolina State University, in association with the U.S. Environmental Protection Agency (EPA), issued an alarming report, indicating the presence of high amounts of the chemical GenX in the drinking water sources of some of the counties along the Eastern coast of North Carolina [1]. In addition to being a carcinogen, the chemical acts as an immune suppressant and can impair thyroid and liver function [2], [3]. GenX is a chemical that is used for the manufacture of Teflon

and other products; however, this production process results in a substantial amount of chemical waste [4]. The Chemours corporation has been producing GenX commercially since 2009 for the production of Teflon at a site in Fayetteville, North Carolina, and had been dumping its GenX-laden waste in the Cape Fear River, thus contaminating the source of drinking water for 1.5 million people [1]. Although GenX was first detected in the river in 2012, there was little or no public or media response until June 2017 when the Wilmington, North Carolina newspaper, the *StarNews*, published a series of articles about the contamination and Knappe's research [5]. The issue came to a head in October 2017 when Chemours was ordered to stop all discharges into the water [1], [6]. Since coming to light, the issue of the GenX contamination of the Cape Fear River has been widely covered by the media, and, given that media reports have played such an important role in bringing this issue to light, research on the content of these reports is warranted. Accordingly, this paper focuses on news media coverage of the Cape Fear River contamination. In the following section, I describe the method that I have used. This is followed by a brief discussion of framing theory as well as existing studies on framing of more general environmental issues. Between these two, I briefly layout the nature of the chemical GenX, including its negative health effects. Then I provide some examples of cases of environmental pollution by corporations, and how the media have framed those cases. Finally, I state my research questions.

II. METHOD

The purpose of the study was to identify the media framing of the GenX contamination of the Cape Fear River. In order to do so, I conducted a textual analysis. "Textual analysis is the method communication researchers use to describe and interpret the characteristics of a recorded or visual message" ([7] p. 225). As the frames were embedded within the content of the text, I conducted a qualitative content analysis [7]. Given the lack of previous research on this topic and the nature of my research questions, a qualitative approach was most appropriate. In the following sections, I detail the sampling and data cleaning (or data reduction) procedure as well as my approach to data analysis.

2.1. Sampling

The sample consisted of news articles on the GenX contamination of the Cape Fear River. In order to gather this sample, I used the Lexis Nexis Academic database, which indexes print news and television news transcripts. I used the search terms "GenX" and "Cape Fear River contamination". The reason for using the two search terms is that when using only "GenX", the articles found were quite irrelevant (e.g., articles related to the next generation, articles concerning next generation airplane engines).

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By adding the second search term, I reduced the possibility of turning up such irrelevant articles. Also, I turned the database's duplicate selection to "moderate similarities" in order to eliminate duplicate articles. I conducted the LexisNexis search at the beginning of September 2018, and the search results included articles published between June 2017 and August 2018.

The initial search yielded 509 articles, but, after using Lexis Nexis's "remove duplicates" function, that number was reduced to 387. I saved these articles as PDFs. I then put the article headings in an excel spreadsheet, and cleaned the data further by grouping articles written by the same author and published in the same outlet and on the same date as one single item. For example, on June 8, 2017, there were four articles published in *Star-News* (Wilmington, NC) by Gareth McGrath.

These four articles were combined and treated as a single article. Single articles constituted the unit of analysis. The reduced and regrouped data turned up 360 units of analysis. Each of the units were arranged in chronological order, beginning from June 2017, and ending in August 2018, and then numbered. Research suggests that news frames change over the course of an event [8], [9] which makes it important that my analysis account for possible changes in frame over time. For this, I grouped the sample by publication month.

2.2. Analysis

The dataset was analyzed by two coders, me being the first coder and a second person. For the first research question, the coders read all the units of analysis to get a holistic sense of the data. Then, each coder independently reviewed the data and identified how the problem was framed in each article. Once both coders finished determining the problem frames adopted in each article, they met to construct a master list of problem frames identified. We then separately went back to the data to assess the exhaustiveness of the master list of problem frames and to identify exemplars of each frame for the results section. The coders performed this process for each of the four research questions.

I discuss the theory used in the next section, followed by the findings of the study.

III. THEORY

In this section, I describe the nature of the chemical GenX, including its negative health effects. Then I provide some examples of cases of environmental pollution by corporations, and how the media have framed those cases. Finally, I discuss framing theory as well as existing studies on framing of more general environmental issues.

3.1. The Issues with GenX

GenX is the trade name for the ammonium salt of hexafluoropropylene oxide-dimer acid, a six carbon chain fluorochemical that has been used in place of perfluorooctanoic acid (also known as PFOA or C8) in the manufacture of Teflon and other products, such as firefighting foam and outdoor fabrics [10]. GenX, which had been used since 2010 as a processing aid for fluoropolymer resin manufacturing, was used by Chemours in place of PFOA, when the EPA restricted the latter's use because of its carcinogenic effects [11]. As GenX is a relatively recent

compound, it is not restricted by the EPA [12], [13], [14]. Although the effects GenX might have on the health of humans are still unknown due to the novelty of the chemical, studies have shown that rats exposed to GenX in laboratory tests experienced numerous health problems. For example, they developed cancerous tumors in the liver, pancreas, and testicles. The rats also suffered from kidney disease, liver degeneration, and uterine polyps. The researchers observed changes in the rats' cholesterol levels and blood proteins after exposure to GenX and found that the chemical acted as an immune suppressant. GenX delayed puberty in female rats, and rats exposed to GenX during pregnancy had preterm and/or low birth weight offspring.

A very high dose of the chemical caused the animals to die [3], [4]. Humans may experience similar negative reactions to GenX, as rodents share close resemblance to humans in their genetic, biological, and behavioral characteristics [15]. These potential health problems are even more troubling when one considers the fact that GenX is a very stable compound and is expected to remain in nature for a very long time [11], [16]. It is also difficult to remove from water. This is because the chemical bonds of the compound are extremely strong, making it resistant to the water treatment processes that are used to degrade pollutants and provide a cleaner, safer water supply [13], [17], [18]. These factors underscore the serious problems associated with Chemours's dumping of GenX into the Cape Fear River.

Media outlets have attempted to convey the severity of the issue, and, although there is no previous research on media coverage of the GenX contamination, studies regarding similar environmental health concerns suggest that media can shape audience members' knowledge and beliefs. For example, in [19], researchers studied responses to media coverage of the human trials of the Zika vaccine, and noted that, at the onset of the trials in 2016, there was extensive media coverage of the issue, which led to greater attention and increased trust amongst the audience regarding Zika news. Not only is the amount of media coverage important; how media cover an issue can also affect audience members. For instance, researchers in [20] examined reader responses to different frames adopted in news articles about media effects research.

They found links between particular article frames and the perceived credibility of the author of the article as well as the authors of the media effects studies reviewed in the article. Researchers in [21] paired a content analysis of media coverage of childhood exposure to environmental risks with a survey of mothers regarding their media exposure, beliefs about chemical exposure, and protective behaviors.

The authors found that mothers exposed to these stories perceived themselves as personally responsible for exposure to chemicals, which was the dominant frame found in the content analysis. Taken together, these studies indicate that media coverage, in general, and media framing, in particular, can impact audience members in important ways.



Given these potential impacts, a study of media framing of the GenX contamination of the Cape Fear River is warranted. Although no other studies have examined media coverage of this particular environmental crisis, research on other cases of corporate pollution might be able to inform a study of this kind.

3.2. Environmental Pollution by Corporations

Corporations polluting the environment is nothing new. When intentional, they do so usually to curtail their waste management costs. This has been going on for a long time. For example, starting in the 19th century, there have been conflicts between mining companies and stakeholders regarding the effects of the smelter smoke on health and vegetation [22]. Stakeholders are a group of people who are either favorably or unfavorably affected by a corporation's decision [23], [24]. In many cases, stakeholders do not know about the pollution until it is brought to light by media coverage, but knowledge and awareness do not always translate into action.

3.2.1. Cases of corporate environmental pollution

A recent example is of the Volkswagen Group manipulating its emission tests for diesel engines in Europe and the U.S. This allowed the company-manufactured vehicles to emit exhaust fumes far beyond the legal maximum, thus polluting the environment. Reference [25] estimated the public health consequences from these emissions to be the cause of a loss of 45,000 years of healthy life, and also a financial loss of around 39 billion dollars due to premature deaths from the emissions. Although generally aware of their cars' emission problems, some owners were unconcerned [26]. In this case, awareness was insufficient to motivate consumers to act.

In other cases, stakeholders have taken a more active role. For example, [27] described a campaign organized by the citizens of Addyston, Ohio, against the pollution caused by the plastic-manufacturing Bayer Chemical plant in their town. There, "toxic Release Inventory data showed increased chemical emissions, and OCA's community canvas found that neighbors had concerns about odors, health effects, and the safety of children in the preschool through first-grade school facing the plant" ([27] p. 25).

The mobilization and efforts of these concerned citizens prompted the County to monitor the air for emissions by the company, aided negotiations with the company's managers, and resulted in Bayer Chemical investing in environmental protection. The action by the citizens resulted in the company paying \$112,500 as a settlement [28]. These cases show that citizens can be motivated to act when alerted to environmental health threats but that, in some cases, knowledge of these threats isn't sufficient to motivate action. It is possible that content differences in media coverage of these two cases contributed to these differing responses from community members.

3.2.2. Media coverage of corporate environmental pollution

Studies have looked at how media and corporations have discussed corporate pollution. For example, researchers [29] looked at the environmental messages presented by corporations in *National Geographic* for 30 years. They found that the corporations were inclined towards coming up with solutions to environmental problems rather than preventing them and the solutions they provided were solely

intended for the current generation, not future ones. Reference [30] examined British Petroleum's crisis communication in the wake of the company's involvement in the Gulf of Mexico oil spill of 2010 and found that strategic framing in the company's press releases helped British Petroleum to stabilize a volatile situation. It also allowed the company to take responsibility for future positive developments. Such framing established an image of British Petroleum as an innovative corporation that cares about the environment.

Reference [31] explored the implications of the Flint water crisis for stakeholders from a public relations perspective. The author found that the State of Michigan, which had built the pipelines containing lead, thus polluting the water, had been using strategic framing to pacify the stakeholders. Another famous case of corporate environmental pollution was the chromium-six contamination of ground water in California by Pacific Gas & Electric [32]. The case and the subsequent lawsuit filed against the corporation by a law clerk were the subjects of a major commercial movie, *Erin Brockovich*, which brought to light the way the corporation had been trying to frame the pollution. Corporations polluting the environment has been going on for a long time. From the mentioned studies we see that some stakeholders have taken up action against corporations when their health was threatened by the latter; however, this was not sufficient to motivate action in all cases.

It is possible that media framing of these different cases of corporate pollution contributed to these varied stakeholder responses. To determine how stakeholders in Eastern North Carolina might respond to this latest threat, the contamination of the Cape Fear River, further analysis of media coverage of the threat is needed. This study will look at the media coverage of the GenX contamination of the Cape Fear River through the lens of framing theory.

3.3. Framing Theory

Although researchers have yet to explore media coverage of the Cape Fear River contamination, framing theory and research guided by it can inform a study of this kind. Framing theory assumes that human brains are cognitively conditioned to perceive the world according to certain unconscious structures called "frames" or "schemes" [33]. Framing researchers strive to identify these frames or schemes [34]. These frames include "semantic roles, relations between roles, and relations to other frames... These structures are physically realized in neural circuits in the brain" ([33] p. 71).

Every word is defined with the help of the frames that it activates neurologically. According to the theory, all of human thought involves framing. The term "frame" was first used by sociologist Erving Goffman. He argued that these frames were "interpretive designs" that "constitute central elements of cultural belief systems," which humans use to understand everyday happenings in this world and "reconstruct reality" ([34] p. 408). Frames originate in the human minds as part of the socialization process.

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However, existing frames in the human minds can be altered or completely replaced by other frames that have been designed to have a cognitive appeal [33].

In the present day's media-saturated environment, people continually encounter information capable of changing existing frames [34].

The use of framing theory in mass communication research emerged in the 1970s when some media researchers parted ways with the unidirectional media-effects model and started addressing particular kinds of media influence on audiences. One such case was research on shaping, or framing, of political issues by media. Studies were conducted on how media depicted political issues and how these depictions influenced and constrained the audiences' interpretation of the issues [34]; [35]. Reference [36] stated that news framing processes occurred in two main stages: frame-building and frame-setting. The factors that determine how journalists frame an issue are part of frame-building. Frame-setting refers to "the interaction between media frames and individuals' prior knowledge and predispositions" (p. 53).

Approaches to identify frames in news may be inductive or deductive [36]. When approaching inductively, the researcher does not look to the news with prior frames in mind; rather, the frames emerge during the course of analysis. Taking a deductive approach entails investigating frames that have been identified and operationalized in previous studies. For example, several studies have examined media content for evidence of episodic (i.e., a focus on a specific incident or individual) or thematic (i.e., a focus on general trends or the larger context) frames (e.g., [37], [38], [39]). Content analytic studies guided by framing theory follow certain steps, which include the identification of an event or issue, the isolation of a specific attitude towards the issue/event, inductive identification of "an initial set of frames" for the issue in order to "create a coding scheme," and, finally, the selection of sources for content analysis ([40] p. 107).

According to [41], "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described" (p. 52). Although researchers [42] believed that frames that built on these four associations were the most powerful and effective, no studies could be found that examined all four ways of framing. Moreover, more studies focus on the framing of problems and solutions than on the framing of causes and effects. This study will attempt to fill this gap in the framing literature by examining all four ways of framing: problem framing, cause framing, effect framing, and solution framing. Although this has not been done before and there are no previous studies on media coverage of the GenX contamination of the Cape Fear River, research on how other environmental issues have been framed can help guide this study.

3.4. Media Framing of Environmental Issues

There are several studies of media framing of environmental health issues—all of which demonstrate the utility of a framing approach for the present investigation. For example, [43] looked at how media framing aided in the formation of public opinion about nuclear power. After the

meltdown of a reactor at the Three Mile Island Nuclear Generating Station in Pennsylvania in 1979, the media framing highlighted the danger of the nuclear reactors. This made readers ambivalent towards nuclear power. A comparison of news coverage of fracking in New York, Pennsylvania and North Carolina newspapers, over a period of six years, revealed the different frames used by journalists in different states.

The frames reflected the political climate of each state. For example, the stories in the New York papers proved to be a debate over the issue amongst major stakeholders. In North Carolina, where the state legislature was in favor of fracking, however, the media took the role of a "watchdog" by strongly emphasizing the risks of fracking and "offering readers an interpretation largely absent from the legislative discussion" ([44] p. 382). Researchers [45] analyzed the news media coverage of fracking in four newspapers from the U.S. and Canada over a period of five years. They reported that media from both countries framed fracking stories to reflect concerns about water quality and, to some extent, the benefits of fracking. Some newspapers in the U.S. also framed fracking to portray the harm it might cause to the wildlife. However, no stories in either country discussed the dangers of earthquakes and the emissions of greenhouse gases. Reference [46] analyzed 144 articles from a Mexico-City based newspaper to determine the intensity of frames used to portray global warming. The results indicated that only 16.7% of the frames were high intensity. This pointed to the fact that Mexican journalists do not consider global warming to be the most important issue that they report. Although these studies explore the different kinds of frames used in news coverage of environmental issues, they do not point to specific frames that might be found in news about the Cape Fear River contamination, which is the focus of this examination.

My review of existing studies of framing of environmental issues indicates that there have been no studies on the Cape Fear River contamination media coverage and that no framing studies have addressed all four aspects of issue framing—the problem, its causes, its effects, and probable solutions. For this study, I examined news framing of the problems with, causes of, effects of, and solutions to the Cape Fear River contamination with GenX. This study was guided by the following research questions:

3.5. Research Questions

- RQ 1.** What are the frames that are used by the media to portray the problem?
- RQ 2.** What are the frames that are used by the media to portray the causes of the problem?
- RQ 3.** What are the frames that are used by the media to portray the effects of the problem?
- RQ 4.** What are the frames that are used by the media to portray the solutions to the problem?

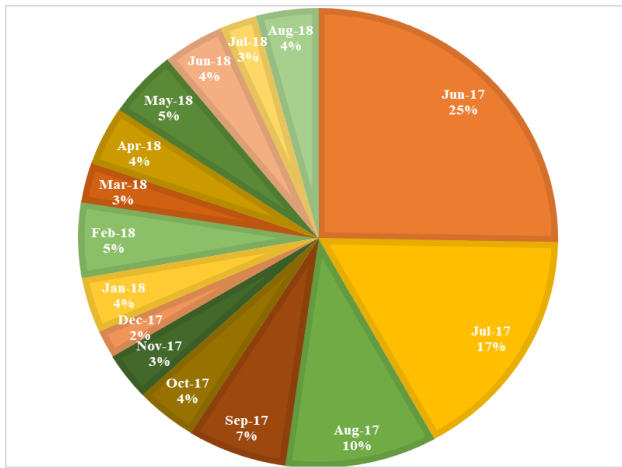


Fig. 1. Month-wise distribution of the units of analysis

IV. RESULTS

There were 359 units of analysis of the sample, spread over a period of fifteen months from June 2017 to August 2018. The most articles (25%) were published in June 2017, followed by June 2017 (17%) and August 2017 (10%). Figure 1 indicates the percentage of the sample published in each month of the sampling frame.

There were 20 news sources (Figure 2). Of these, 65.19% of the articles were reported by Star-News, 16.59% by the Bladen Journal, 15.88% by the U. S. Official News, and 10.58% by the Fayetteville Observer. Other sources were The State Journal Register, Las Cruces Sun News (New Mexico), St. Louis Post-Dispatch (Missouri), Rubber & Plastics News, The Mount Airy News, Dayton Daily News (Ohio), Bangor Daily News (Maine), The Salt Lake Tribune, The Pak Banker, The Nation (Thailand), Charleston Gazette-Mail, North Carolina Lawyers Weekly, Sanford Herald (North Carolina), The Robesonian (North Carolina), The New York Times, and Contify Energy News.

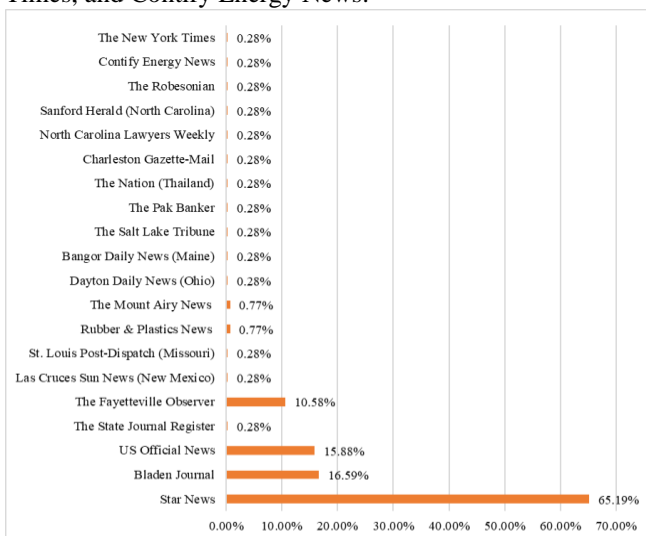


Fig. 2. News sources present (0.28% corresponds to one unit, and 0.77% to three units)

4.1. What are the Frames that are used by the Media to Portray the Problem?

Of the 359 units, 283 (78.83%) were classified as portraying problem frames, and 76 (21.17%) were classified as ones where problem frames were absent. Of the 283 units,

news media coverage of the Cape Fear River focused on five main problems. These were: 1) the River contamination, 2) Chemours’s involvement, 3) scientific uncertainty about GenX, 4) governmental inaction, and 5) the inability of the water treatment plants to filter GenX.

4.1.1. Cape Fear River contamination

This was the dominant problem frame that appeared in most of the articles. The articles classified in this section pointed to the presence of contaminants in the Cape fear River, a major source of water in the “Bladen, Brunswick, New Hanover and Pender counties” [47], in the Southeastern part of North Carolina. That GenX was one of the primary contaminants appeared in nearly all these articles. These articles highlighted the contamination itself, and not the source of the contamination.

This frame is exemplified in the following quotations from articles that focused on the problem of the contaminated river: “GenX ... was reported to be contaminating the Cape Fear River in southeastern North Carolina. The river is a major source of drinking water there. The contamination is downstream of Fayetteville...” [48]; “For about 30 years the Cape Fear River has been contaminated with GenX...” [49]; “In early 2017, GenX was detected in North Carolina's Cape Fear River, which serves as a drinking water source for around 300,000 residents...” [50].

A group of the articles also mentioned that the ground water of this region had also been contaminated. Although these articles were not primarily concerned with the contamination of the river, we grouped them in this section as they dealt with the problem of contamination. Some examples of this are: “Chemours has preliminary test results for 32 residential wells near the plant ... of these, 11 were above the threshold” [48]; “GenX has been found in the Cape Fear River and in private and public wells near the Chemours facility” [51]. Another example is: “505 wells have been sampled by Chemours contractors or DEQ staff, with 206 showing GenX below the 140 parts per trillion health goal set by the N.C. Department of Health and Human Services last year, 151 testing for GenX above the 140 ppt level and 148 showing no detection” [52].

4.1.2. Chemours’s involvement

These articles portrayed Chemours to be the problem. Not only did these articles mention the contamination of water source(s), they also indicated that the problem was due to the actions of the company. For example, one article stated: “Officials from DuPont spinoff Chemours Co. also admitted the GenX compound found in some North Carolina public water supplies is likely coming from the Fayetteville Works plant, south of Fayetteville along the river” [53]. Another article that adopted this frame said, “For about 30 years the Cape Fear River has been contaminated with GenX ... The chemicals come from discharges into the water and air from the Chemours Co. (formerly DuPont) plant near Fayetteville” [49]. A third mentioned waste “...discharged by the Chemours company at Fayetteville Works ... found in raw water from the Cape Fear River and finished drinking water from the CFPWA” [54].



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Articles that blamed Chemours for air pollution were included in this group, as they dealt with contaminants originating from Chemours. An example quotation from such an article is: "Chemours released a potentially harmful chemical into the air at its Bladen County plant last year" [55].

A point worth mentioning here is that, although Chemours's involvement is also one of the cause frames we identified, some articles focused on Chemours as the problem, necessitating its inclusion in the list of problem frames, too.

4.1.3. Scientific uncertainty about GenX

Articles that adopted this frame focused on how little was known about GenX. These articles explained that, although scientists know that the chemical can persist in the environment for a long time, they do not know much about its long-term effects on the human body. For example, one of these articles stated: "We need to be concerned about the scant and initial toxicology data about GenX" [56]. Another article explained, "As an emerging contaminant, there is not a significant body of research into how GenX affects human health" [57].

The problem of scientific uncertainty is closely linked to the next two problem frames: governmental inaction and the inability of water treatment facilities to remove the chemical. The lack of scientific data has contributed to a lack of governmental regulation of GenX. It also limits the ability of those working in water treatment plants to safely and effectively remove the chemical from the water. Because nothing much is known about the chemical, there have been demands for funds to study it, but those demands have gone unanswered due to political maneuvering.

4.1.4. Governmental inaction

According to these articles the problem was the government's inaction in establishing regulatory standards for GenX. These articles did not center around the lack of knowledge about the chemical or Chemours's involvement. One article that adopted this frame stated: "There are no U.S. regulatory guideline levels for GenX" [58]. Another added, "In the United States, chemicals are routinely released into the environment without permits, and without federal, state, or local government approval" [59].

Some of these articles went further and framed the government's indolence as the problem. An article that framed the problem in this way is, "When the scientific paper was accepted for publication in November, 2016, Knappe sent emails to many state and local government officials sharing the results and stating his fears about the chemicals. He got no response. Zero. When the scientific paper won the Environmental Science & Technology Letters' Best Paper award in March 2017, he sent out a new round of emails. Again, silence. Nobody among the many people who are supposed to monitor and control the quality of our drinking water would even acknowledge receipt of alarming information from a fully qualified research team" [60].

4.1.5. Inability of water treatment plants to filter GenX

Some articles indicated that the problem with the Cape Fear River contamination was that water treatment plants were unable to filter out the chemical. This inability was mainly due to the scientific uncertainty surrounding the

chemical. One article that focused on water treatment issues mentioned: "Researchers in 2013-14 found a compound called GenX in the Cape Fear River and the treatment system of the Cape Fear Public Utility Authority, which is unable to filter GenX from water sent to taps" [56]. Another article stressed that "...utilities have no way of removing the compound known as GenX so it is in the water that about 250,000 area people drink" [59]. This problem frame suggests a need for better water filtration technology to keep GenX out of the drinking water as a potential solution frame.

4.2. What are the Frames that are used by the Media to Portray the Causes of the Problem?

Of the 359 units, 261 (72.7%) were classified as portraying cause frames, and 98 (27.29%) were classified as ones where cause frames were absent. Of the 261 units, news media coverage of the Cape Fear River focused on four main causes of the problem. These were: 1) Chemours's malfeasance, 2) wastewater spillage from Chemours's facility, 3) politics, and 4) lack of regulatory standards for GenX.

4.2.1. Chemours's malfeasance

This was the chief cause frame that was found in the articles. The articles that adopted this cause frame focused on how Chemours's manipulative and duplicitous actions led to the problem. Instead of focusing on Chemours's dumping of chemical waste, these articles centered on how Chemours responded to pollution accusations. Some of these articles also indicated that the company tried to hide facts about GenX and thwart regulations. Articles that adopted this cause frame usually framed the problem as Chemours's involvement.

One article that framed Chemours's malfeasance as the cause of the problem stated: "Chemours officials did not respond with research or other evidence to show GenX is not like the cancerous C8. They did not welcome an interview to reassure us that the water is safe. In the past week, the multi-billion-dollar company issued one statement and wouldn't even answer the simplest of questions: Are you aware GenX is in the CFPWA water system and that the utility can't remove it?" [61]. Another indicated, "...the company failed to comply with its permit and failed to report an October spill" [62]. These articles also indicated that Chemours's violation of federal regulations caused the problem. An example of this is: "When the EPA gave DuPont approval to make it in 2009, the agency specifically said the chemical giant had to keep it out of the water" [61]. The hiding of facts by Chemours also included the company's trying to hide its wastewater spill. An example: "The spill came to light one month after it occurred when DEQ officials questioned Chemours about state water quality results indicating elevated concentrations of GenX at Chemours' primary wastewater discharge outfall" [62].

4.2.2. Wastewater spillage from Chemours's facility

According to these articles, the cause of the problem was the wastewater spillage from Chemours's factory in Fayetteville. These articles did not blame Chemours for the spill and, instead, suggested that it was accidental.



Articles that adopted this cause frame usually framed the problem as the contamination of the Cape Fear River. One article that framed the cause as accidental wastewater spillage stated: “The company told DEQ a spill had occurred Oct. 6 involving dimer acid fluoride, a precursor to GenX, during planned maintenance at the facility. The result was GenX levels 26 times higher than the state’s health goal” [63]. Another stated, “State officials believe elevated concentrations of GenX found at a water treatment facility along the Cape Fear River can be attributed to an Oct. 6 spill from a manufacturing line at Chemours’ facility in Fayetteville” [64].

4.2.3. Politics

Some articles argued that the problem was caused by bickering politicians who were unable or unwilling to address the issue. Quite a few of these articles blamed the Republican Senate of North Carolina for choosing not to grant the funds that the state’s Democratic Governor demanded to handle the issue. These articles suggested that there would not be a problem with the contamination if politicians acted to solve it. For example, one article mentioned “... Republican lawmakers reflexively slapping down anything the Democratic governor stands for” [65]. Another went on to explain:

The Republican majority forced itself to believe they had done enough to cope with the GenX pollution... What the legislators did is what they usually do: They thwarted Democratic Gov. Roy Cooper, overriding his veto of a bill that, among other things, sends \$435,000 to UNC-Wilmington and the Wilmington area water utility to further study pollution from the industrial chemical used in producing Teflon. [66].

A third indicated, “Republican legislative leaders opposed a proposal from Democratic Gov. Roy Cooper that would have added 16 staff to DEQ for the purpose of addressing emerging contaminants and created a water safety unit in DHHS” [67]. An effect frame stemming from this political cause frame is the desire of the regulatory agencies to declare parts of the Cape Fear River as a swamp. This is discussed later.

4.2.4. Lack of regulatory standards for GenX

Several articles indicated that the problem stemmed from the lack of regulatory standards for GenX. These articles suggested that the lack of governmental regulation of this relatively new compound contributed to water treatment plants’ inability to filter it from the water (a previously identified problem frame). For example, one article stated: “GenX is relatively new, and few studies on health effects are available. That means there are no state or federal standards that set safety thresholds for its existence in drinking water” [68]. Another explained, “A fundamental challenge facing regulators is that no standards exist to set thresholds at which concentrations of GenX in drinking water are safe mainly because the chemical is relatively new and few studies on health effects are available” [69].

The lack of regulatory standards stems from the problem of the dearth of scientific data on GenX. It led to the problem of the inability to filter the chemical from water and also motivated the stakeholders to demand answers, which the media has portrayed as an effect frame (discussed later).

4.3. What are the Frames that are used by the Media to Portray the Effects of the Problem?

Of the 359 units, 216 (60.17%) were classified as portraying effect frames, and 143 (39.83%) were classified as ones where effect frames were absent. Of the 216 units, news media coverage of the Cape Fear River focused on six main effects of the problem. These were: 1) the revocation of Chemours’s license, 2) legal action against Chemours, 3) health effects of GenX, 4) stakeholders’ demands for answers, 5) scammers targeting stakeholders, and 6) potential declaration of Cape Fear River as a swamp.

4.3.1. License revocation

One of the primary effect frames was regarding the decision to revoke Chemours’s wastewater disposal license. The reason this was considered an effect frame and not a solution frame was that it resulted directly from the problem and could lead to a solution: stopping the spillage. For example, one article noted:

In addition to moving to revoke Chemours’s wastewater permit, DEQ officials also notified Chemours the state will suspend its permit to discharge process wastewater from its manufacturing area including the areas where GenX and other fluorinated compounds are produced. The suspension will take effect Nov. 30. Chemours is still required by the state to divert wastewater containing GenX and transport it out-of-state for disposal. [62].

The revocation of Chemours’s wastewater discharge permit leads to the solution frame of stopping the illegal discharge by Chemours, which will be discussed later.

4.3.2. Legal action against Chemours

According to these articles, the primary outcome of the spillage was legal action taken against Chemours. The company was “held criminally and civilly liable” [70] and taken to court by the regulatory agencies in charge of the stakeholders’ safety. An article that framed the effect as legal action stated, “The county has filed a formal legal action against Chemours and DuPont, and management expects that the costs of long-term water testing and treatment methods will eventually be recovered from litigation proceeds” [71]. Another example of legal action as an effect frame is: “The N.C. Department of Environmental Quality (DEQ) filed a proposed court order Monday in Bladen County that would require Chemours Company to reduce air emissions and address contamination caused by GenX around the Fayetteville Works plant”, which “seeks to limit air emissions from the Chemours plant by 97 percent by August and 99 percent by the end of 2019” [72]. A third example of this effect frame is:

Despite Chemours’ efforts to prevent additional contamination of water and air around its Fayetteville Works facility, Cape Fear River Watch and the Southern Environmental Law Center filed suit Wednesday in federal court alleging long-term contamination of groundwater seeping from beneath the complex means the company remains in violation of the federal Water Act. [73].

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This effect frame is also exemplified in:

“North Carolina residents are suing a chemical manufacturer who they say intentionally dumped dangerous chemicals into their drinking water. A consolidated complaint filed Jan. 31 on behalf of several residents living in the Cape Fear river basin says that the Chemours Company, a division of DuPont, knowingly put cancer-causing chemicals into the Cape Fear River and lied about it to government regulators. [74].

4.3.3. Health effects

Many of the articles framed the effects in terms of those on human health. The potential harm that GenX may have on human health was discussed here. Such a frame was noted in, “Existing research (including animal testing done by DuPont/Chemours) shows that GenX has many of the same biological effects as C8, including liver damage and tumors. Also, GenX has the same environmental stability that C8 did” [61]. Another example stated:

In 2006, DuPont reported that a 1963 study of the substances (that make up GenX) showed that adult rats given 7,500 milligrams died gasping, convulsive deaths within three hours. Those that received smaller doses survived with slightly enlarged livers. A 2013 DuPont report stated that rats given a much lower dose of GenX developed tumors in some organs. The report stated that these tumor findings are not considered relevant for human risk assessment. [61]

Another article indicated that “the National Institute for Public Health and the environment in the Netherlands analyzed the research and concluded it was justified to categorize GenX as a suspected human carcinogen” [75].

Stakeholders’ demand for answers. These articles adopt the effect frame of the demand of answers from the stakeholders. An example of this effect frame is evident in, “Less than a week after learning from a StarNews report that the regions water contains an unregulated chemical that has concerned some scientists, county and city officials have started asking chemical giant Chemours for answers” [75]. Statements, such as “Federal officials must set limits for GenX and other emerging contaminants so that North Carolina can permanently control its discharge and ensure the safety of its drinking water” [47] in articles, stress the effects that the problem has had on stakeholders and how it has motivated them to demand answers.

4.3.4. Scammers target stakeholders

Another media frame focused on the effect of potential scams run on stakeholders. These articles focused on how the problem created a unique context in which scammers could profit from community members’ fears. An example of such an effect frame is:

The state Attorney General's office is warning residents to beware of companies offering free water testing relating to a potentially harmful chemical. Some residents who live near the Chemours plant have gotten mail that appears to be aimed at enticing them to buy a water filter system...Scammers are trying to capitalize on people's fears about GenX in their water. [76].

4.3.5. Potential declaration of parts of the Cape Fear River as a swamp

In order to save themselves from taking up action against Chemours and establishing regulatory standards for GenX, the regulatory agencies decided to rename parts of the Cape Fear River as “swamp.” This effect frame is evident in, “The N.C. Department of Environmental Quality and the federal Environmental Protection Agency want to declare a 15-mile stretch of the Cape Fear River -- basically from Snow's Cut to Navassa -- as swamplands” as “scientists have proved that swamps (or marshlands or wetlands) serve a vital purpose as breeding grounds and nurseries for commercial fish and as natural filters, keeping bad stuff out of our water” [77]. Another example stated that the government “would designate the Lower Cape Fear River, from Snow's Cut to Toomers Creek near Navassa, to both swamp water and a river designation for aquatic life, secondary recreation and saltwater” [78].

4.4. What are the Frames that are used by the Media to Portray the Solutions to the Problem?

Of the 359 units, 200 (55.71%) were classified as portraying solution frames, and 159 (44.29%) were classified as ones where solution frames were absent. Of the 200 units, news media coverage of the Cape Fear River focused on five main solutions to the problem. These were: 1) stopping the wastewater discharge, 2) securing grants to deal with the issue, 3) using of alternative techniques to filter GenX, 4) advancing a bill to prevent further corporate contamination, and 5) relying on an alternate drinking water source.

4.4.1. Stopping the wastewater discharge

The main solution frame advanced by the media involved stopping the wastewater discharge by Chemours. For example, one article stated that “...regulators worked to limit the discharge of wastewater containing GenX into the Cape Fear. It was announced in June that Chemours would capture and destroy wastewater it believed contained GenX” [79]. Another example of this frame is:

The agency has filed three notices of violation against the company for activities at its Fayetteville Works, resulting in a shutdown of GenX discharge into the Cape Fear River and the possibility of further action against the company's air permit. [79]

A third article stated, “That number fell to 3,300 ppt on July 12, the day DEQ inspectors checked the plant to ensure the company had stopped previously undiscovered discharges of the chemical” [80]. Some of the articles also framed the solution as stopping all kinds of GenX discharge by Chemours, not just wastewater. One article stressed the need “to force Chemours to halt all air emissions and discharges of perfluorinated compounds from the plant about 100 miles up the Cape Fear River” [81].

4.4.2. Securing grants to deal with the issue

In order to clean the contaminant from the water, investment is required. Some of the articles suggested the need to secure investments and grants to clean up the River. This has been exemplified in:

Brunswick County Commissioners have approved a resolution supporting a loan application to help fund the Northwest Water Treatment Plant expansion and water treatment system improvements ... The application is for low-interest loans from the State Revolving Fund program, which provides loans for county investment in water and sanitation infrastructure. [82].

This frame is also evident in: "The Brunswick County Commissioners Thursday unanimously approved moving forward with a \$99 million low-pressure, reverse-osmosis (RO) system at the county's Northwest Water Treatment Plant" [83]. Another example is:

Very little is publicly known about GenX's toxicity in relation to humans, how it is stored in the body, or how long the chemical will remain in the environment. Researchers hope to fill in those gaps should a \$275,000 National Institute of Environmental Health Sciences rapid grant be approved later this summer. [80]

That the regulatory agencies have agreed to utilize funds to combat the contamination is evident in:

Last week, the Cape Fear Public Utility Authority (CFPUA) announced it has agreed to spend \$1.77 million on contract services to address GenX and other emerging contaminants. Thus far, the CFPUA release said, the organization has spent \$843,115 of that. [57]

The regulatory agencies are relying on funds in the form of loans to fight the problem of contamination. Exemplifying this is:

The application is for low-interest loans from the State Revolving Fund program, which provides loans for county investment in water and sanitation infrastructure ... Brunswick County Commissioners have approved a resolution supporting a loan application to help fund the Northwest Water Treatment Plant expansion and water treatment system improvements. [82]

4.4.3. Using alternative techniques to filter GenX

Quite a few of the articles discussed the use of water filters working with various technologies as a solution frame. Of these technologies, the most discussed one was reverse osmosis filtration technology. An article that exemplifies the use of filters working with reverse osmosis filtration technology as a solution frame is: "Reverse-osmosis filtration systems may be effective in removing it. Home systems are a couple hundred dollars and are highly effective if used properly" [84]. As seen from this analysis, the use of filters working with reverse osmosis technology is one of the solution frames that the media portrayed.

Another technology suggested by this solution frame is an activated carbon filtration system, as noted in, "a granular activated carbon filtration device is the most effective method to keep GenX and other perfluorinated contaminants out of the area's drinking water" [85].

4.4.4. Advancing legislation to prevent future corporate pollution

Another solution frame adopted by the articles states was that legislators need to vote for bills to prevent pollution by corporations in the future. This push for legislation regarding corporate pollution is a direct result of the Cape Fear River contamination. An article that adopted this frame stated that a:

provision in the Republican bill would give North Carolina's governor the power to shut down a facility responsible for the discharge of a per- or poly-fluoroalkyl substance -- such as GenX, in the event DEQ has been unable to stop discharges violating clean water standards or DHHS health goals within a year of first learning about it. [86].

4.4.5. Using alternate sources for drinking water

A few of the articles described the use of alternate drinking water sources as the solution frame. One such article discussed how Chemours was asked to provide bottled water to the stakeholders. This is seen in, "The state has told The Chemours Co. to provide bottled water to 11 homeowners near the company's Fayetteville Works plant because tests have found the GenX chemical in their drinking water wells" [48]. Another alternate source of water that the articles state is the use of ground water. This is noted in,

The Cape Fear Public Utility Authority (CFPUA) this week installed "permanent" taps of free water at Ogden and Veterans parks. Spigots were installed last year after revelations that drinking water sourced from the Cape Fear River contained GenX and other contaminants.... The Ogden tap, near the tennis courts, was installed in July 2017, about a month after the StarNews reported the presence of the unregulated chemical GenX in drinking water sourced from the Cape Fear River. Ogden, Murrayville, Porters Neck and areas south of Monkey Junction are the only parts of the county that receive CFPUA groundwater rather than treated river water. The treated groundwater used in the northern part of the county comes from the Richardson nano-filtration plant. [87]"

To summarize, the analysis of the 359 articles revealed that news media framed the problem in five ways: river contamination, Chemours's involvement, scientific uncertainty about GenX, governmental inaction, and the inability of the water treatment plants to filter GenX. Four cause frames were identified. These were: Chemours's malfeasance, wastewater spillage from Chemours's facility, politics, and a lack of regulatory standards for GenX. The media framed the effects in one of six ways. These were: the revocation of Chemours's license, legal action against Chemours, health effects of GenX, stakeholders' demands for answers, scammers targeting stakeholders, and the potential declaration of Cape Fear River as a swamp. As for the solution frames, there were five. These are: stopping the wastewater discharge, securing grants to deal with the issue, using alternative techniques to filter GenX, advancing bills to prevent further corporate contamination, and using alternate sources for drinking water.

V. DISCUSSION

Of Entman's [41] four frames (i.e., problem, cause, effects and solutions), the problem frame was the most common frame found in the current study. Over seventy-eight percent of the articles were found to have framed the problem, a little over seventy-two percent framed the cause, about sixty percent framed the effect, and over fifty-five percent framed the solution.



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The articles adopted one of five problem frames. The problem was framed as the river contamination, Chemours's involvement, scientific uncertainty about GenX, governmental inaction, and the inability of the water treatment plants to filter GenX. Four cause frames, including Chemours's malfeasance, wastewater spillage from Chemours's facility, politics, and a lack of regulatory standards for GenX, emerged from the analysis. If they adopted an effects frame, the articles focused on one of six effects: the revocation of Chemours's license, legal action against Chemours, health effects of GenX, stakeholders' demands for answers, scammers targeting stakeholders, and the potential declaration of Cape Fear River as a swamp. Finally, slightly over half of the articles talked about some sort of solution. Solutions offered included stopping the wastewater discharge, securing grants to deal with the issue, using alternative techniques to filter GenX, advancing bills to prevent further corporate contamination, and using alternate sources for drinking water. Possible explanations for these frames and their implications are discussed further below.

As is evident from the frequencies, most of the articles included a problem frame. Only 55.71% framed the solution. Presence of fewer solution frames can lead to an enhanced sense of the severity of the issue and susceptibility towards the threat. According to the extended parallel processing model, the presence of this increased level of threat, without proper solution, i.e., efficacy, according to [88], would provoke fear in the stakeholders. Without proper solutions evident, stakeholders may seek to control their fear, rather than taking action to nullify the threat of contamination. For the fear appeal to motivate the stakeholders to act, the perceptions of solution (efficacy) must be higher than the perceptions of threat of contamination [88], [89], [90], [91]. An increased sense of threat or fear of the contamination resulting from the dearth of solution frames may lead the stakeholders to blame Chemours or the State's regulatory agencies [92], without taking up action to solve the problem.

However, the presence of an increased number of cause frames (72.7%) than solution frames is in line with some existing research. For example, a content analysis of diabetes news also found that there is a "high presence of cause" ([93] pp. 106) frame about diabetes in the media and that fewer articles frame possible solutions. Reference [94] explain this reliance on cause frames, arguing that, during a crisis, "news media tend to assign specific blame to the individual or organization and to attribute responsibility for the crisis to one or the other, in particular, in coverage of preventable crises such as organizational misdeed/mismanagement and misdeed with injuries" (pp. 111). This blame-game is evidenced in the four cause frames in the current study. The news media has blamed Chemours directly for their malfeasance, which was the primary cause frame in the current study. Another factor that was framed as the cause was the accidental spillage of wastewater from the company's factory at Fayetteville. This happened after Chemours was forced to stop its wastewater discharge into the Cape Fear River and began collecting and storing it in reservoirs. The spillage was from these reservoirs. The news media also blamed politics and the lack of regulations in the current study.

The US media has been known to use cause frames attributing responsibility to the individual. The current study, however attributed Chemours's malfeasance to be the cause. This is inconsistent with earlier existing research on framing of health issues. But, attributing the cause to politics is somewhat similar to the results of the framing study of the 3/11 disaster in Japan, where the media placed bulk of the blame on the government [95].

Some of the problem frames were also used as cause frames. For example, there was overlap between the problem frame of Chemours's involvement and the cause frame of Chemours's malfeasance. Coders also noticed that certain problem frames beget particular cause, effect, and solution frames. For instance, articles that described politics as the cause frame tended to focus on the governmental inaction problem frame and usually mentioned solutions involving securing grants to deal with the issue. This indicates that the way media frames any one aspect of the issue, such as the problem, has implications for how they can frame other aspects of the issue, such as the cause. This interdependence between the four frames has alluded earlier researchers as no previous studies have looked at all four of the frames together. The current study extends framing research by demonstrating how inter-related the frames are of different aspects of an issue.

Researchers [10] conducted a study where they found that that reverse osmosis technology succeeds in removing GenX from the water. This study suggests that reverse osmosis works for GenX removal in a small scale. However, the researchers expressed concerns about the use of the technology on a large scale. The reason for their worry is that, in water treatment facilities, huge membranes would be required for the reverse osmosis process to work effectively, the management of which would be extremely difficult. The results of the current study indicated that the use of reverse osmosis filters (as part of alternate technique filters) has been a solution frame that the media is putting forth. This indicates that, even though the media has been suggesting the correct technology, it has not been portraying the entire picture.

One strange finding of this study was that, although the first press release about the presence of GenX in Cape Fear River was in December 2016 [1], the issue was not found in the articles studied from the Lexus-Nexus Academic database until June 2017. The articles point to the fact that the research team had been writing to the regulatory agencies about the presence of GenX in the drinking water, but to no avail. The news reached the public when *Star-News* broke it on June 8. This may represent a science communication breakdown and is worthy of further investigation.

VI. CONCLUSION

This inductive content analytic study exploring the journalistic framing of the Cape Fear River contamination by an industry, indicated that the issue has been primarily framed as a problem by the journalists. This study is one of a kind, as no studies have looked at problem, cause, effect and solution frame together, and may be used in the future to determine how the analyzed news media frames contributed to the formation of public opinion regarding the issue. Also, the study indicates that the frames regarding one issue are inter-dependent.



The study had a few drawbacks. The major limitation was its lack of replicability. The study was a qualitative content analysis, where the two coders looked at the data individually to come up with the frames, then met and discussed their individually found frames to come up with a master list of frames. Other coders may not agree to the frames this study found and may come up with an entirely new set of frames. Another problem was that the data analysis was an extremely lengthy process. After reading seven or eight articles together, it became difficult to differentiate the changes seen in the frames. This made the analysis process very time-consuming.

This study just looks at the framing of the issue, without trying to understand why the frames arose in their current form. This may be because of the culture (or subjective norm) of the news-media institution, or its geographical location. These reasons may lead to changes in framing strategy. A future study may look at how culture (or subjective norm) of a news organization itself, and its location, contributed to the frames that they adopted.

DATA STATEMENT

The data was collected from LexisNexis Academic database sourced through the North Carolina State University library. The data saved in pdf, and the author has the file saved.

DECLARATION OF COMPETING INTEREST

The author has declared that no competing interests exist. The paper is part of the Masters thesis work of the author and had not been published in any journals or presented in any conferences. There is no known competing financial interests or personal relationships that have influenced the work reported in this article.

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