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Chaos Theory and Emergent Behavior: How Ephemeral Organizations Function as Strange Attractors through Information Communication Technologies

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CHAOS THEORY AND EMERGENT BEHAVIOR: HOW EPHEMERAL
ORGANIZATIONS FUNCTION AS STRANGE ATTRACTORS THROUGH
INFORMATION COMMUNICATION TECHNOLOGIES

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in the
College of Communication and Information
at the University of Kentucky

By
Morgan Colene Getchell

Director: Dr. Timothy Sellnow, Professor of Communication

Lexington, Kentucky

2016

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ABSTRACT OF DISSERTATION

CHAOS THEORY AND EMERGENT BEHAVIOR: HOW EPHEMERAL ORGANIZATIONS FUNCTION AS STRANGE ATTRACTORS THROUGH INFORMATION COMMUNICATION TECHNOLOGIES

Chaos theory holds that systems act in unpredictable nonlinear ways and that their behavior can only be observed, never predicted. This is an informative model for an organization in crisis. The West Virginia water contamination crisis, which began on January 9, 2014, fits the criteria of a system in chaos. Given the lack of appropriate response from the established organizations involved, many emergent organizations formed to help fill unmet informational and physical needs of the affected population. Crisis researchers have observed these ephemeral organizations for decades, but the recent proliferation of information communication technologies (ICT's) have made their activities more widespread and observable. In West Virginia, their activities were indispensable to the affected population and helped restore a sense of normalcy. In this chaotic system, the emergent organizations functioned as strange attractors, helping move the system away from bifurcation and towards normalcy. This dissertation uses a qualitative approach to study the emergent organizations and how their presence and efforts were the mechanism that spurred the self-organization process.

KEYWORDS: chaos theory, emergent organizations, West Virginia water crisis, crisis communication, information communication technologies

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4-28-16

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CHAOS THEORY AND EMERGENT BEHAVIOR: HOW EPHEMERAL
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INFORMATION COMMUNICATION TECHNOLOGIES

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This dissertation is dedicated to the memory of three men who are not here to witness its completion, but have influenced every step of this process. First, to my grandfather for being the first in our family to go to college and making sure you weren't the last. Second, to Tom, the original Dr. Getchell, for your wisdom and dedication to the academy. Finally to Dad, for passing on at least a small part of your perseverance and work ethic.

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Chapter One: Introduction

Crises, regardless of the form they take, present unique and challenging circumstances for those affected to overcome. Be they natural disasters or organizational crises, they are defined by three characteristics that set them apart from other non-routine events. These three characteristics are: threat, surprise, and a short response time (Ulmer, Sellnow, & Seeger, 2010). An environmental disaster in the form of a leak, spill, or contamination certainly meets these requirements to be considered a crisis event. A crisis in this form poses unique challenges, and those challenges are only compounded if the contamination affects the local food and/or water supply. In addition to cleaning up the initial contamination, there are also concerns about the long term effects to the environment and to those individuals exposed to the contaminant.

In January 2014 Charleston, West Virginia experienced its environmental crisis in the form of a chemical spill that contaminated the water supply and left 300,000 residents unable to do anything but flush their toilets with the water in their homes. This water use ban lasted approximately two weeks and required people to find alternate sources for drinking water and ways to perform basic functions like bathe, brush their teeth, wash dishes and clothes, and provide water for their pets. The nature of this crisis event, given its magnitude and scope, makes it an ideal case to study from a risk and crisis communication perspective, and more specifically, to be examined through the lens of chaos theory.

Chaos theory has long been used by scientists and mathematicians to describe the systems and phenomena they observe. Chaos theory, stated simply, holds that systems act in random, unpredictable ways. The behavior they exhibit is dependent on the conditions

surrounding them, and this behavior can only be observed and described, never predicted (Lorenz, 1995). This makes sense when describing complex weather patterns, ecosystems, and difficult mathematical models, hence why chaos theory is widely used by researchers in those fields. However, as of late it has come to the attention of social scientist researchers that chaos theory is a good fit for describing the systems they study. Human systems act in just as random and unpredictable ways as other systems. More specifically, crisis communication researchers see that chaos theory is an excellent model for describing an organization in chaos. The tenets of chaos theory—sensitivity to initial conditions, bifurcation, fractals, strange attractors, and self-organization—can all be observed throughout the lifecycle of a crisis. Thus, crisis communication researchers have created a body of literature that applies chaos theory to crisis events (Murphy, 1996; Seeger, 2002; Sellnow, Seeger, & Ulmer, 2002; Freimuth, 2006; Horsley, 2014). Though chaos theory did not originate in the social sciences, communication scholars see the heuristic value in the application of a scientific perspective to human systems (Berger & Chaffee, 1987)

In examining the West Virginia water contamination, this event also lends itself well to the application of chaos theory as it was a situation that threw the affected stakeholders into a state of bifurcation and it was not until strange attractors appeared in the system that it was able to move towards self-organization and out of chaos. Though certain relief organizations were deployed at the outset of the crisis to help with unmet needs such as alternate drinking water sources, the response as a whole was largely ineffective, and there were several communication failures that exacerbated the crisis and left affected stakeholders wondering what steps to take to protect themselves. As has

been demonstrated through the study of other crisis events, people seek information, particularly instructional messages, to help them reduce the uncertainty brought on by the crisis and help them know what to do to protect themselves and loved ones from harm (Sellnow & Sellnow, 2010). Thus, failing to provide those important messages for self-protection only exacerbates the uncertainty and leaves stakeholders without pertinent information. This situation was further complicated when the ban was lifted. Though this should have been the point at which things began returning to normal, people still noticed the strange smell/taste lingering in the water, causing further distrust and urging many to continue to seek alternate water sources. This was made difficult by the fact that relief organizations had packed up and left town following the lifting of the ban and the end of the disaster declaration. As a result of these failures to provide necessary information and respond to the many voiced concerns about the safety of the water, many citizens became frustrated and took matters into their own hands to lead the continued response and recovery efforts. Building on this frustration and combining that with the inherent desire for communities to help themselves and work towards recovery, there were several observed instances of ordinary citizens coming together to help with the relief effort in different aspects.

This type of emergent behavior has been observed by disaster researchers for decades. It is not uncommon for ordinary citizens to become an integral part of the disaster response effort, despite a lack of formal training or designation as a first responder. Sometimes it is by virtue of being “first on the scene” (geographic proximity to the event) or because of an inherent desire to help their fellow man in a time of distress and great need. Dynes and Quarantelli (1970) created a typology of organizational

behavior in a crisis based on the structures and tasks they perform. They said organizations that are formed by new structures and perform new tasks are considered emergent organizations (Dynes & Quarantelli, 1970). This is the same type of organization that Lanzara (1983) later referred to as ephemeral organizations. According to Lanzara (1983) these ephemeral organizations form in response to a crisis because there are often gaps left by established organizations. These established organizations are often rendered “paralyzed” by the crisis at hand, and are unable to act effectively because the uncertainty of the situation rendered the normal operating procedures ineffective and impossible to carry out. However, ephemeral organizations have never known normalcy nor do they have standard operating procedures. Therefore, they are better able to adapt to the uncertainty of an evolving crisis situation and move easily between tasks and roles (Lanzara, 1983).

Though these researchers observed and recorded the behavior and formation of emergent organizations in response to a crisis, they did so in the years before the proliferation of information communication technologies (ICTs) such as computers, tablets, smart phones, social media sites, GPS devices, etc. In today’s connected, mediated world, emergent behavior post-crisis is still happening, but in different ways. Now, people are harnessing the power of the internet to engage in emergent behavior, regardless of geographic boundaries and proximities to the site of the crisis, making emergent behavior more prevalent and more visible (Palen & Liu, 2007).

This emergent behavior facilitated by social media was evident in the 2014 West Virginia Water Contamination. This incident was unique in that it differed from other disasters where emergent behavior has been observed. Typically, emergence has been

observed following natural disasters or similar events that leave a trail of physical destruction and loss of life and injury (e.g. Hurricane Katrina, 9-11 attacks, and southern California wildfires). Because of their nature, these types of events create a physical “ground zero” where people naturally converge (oftentimes for different reasons) and can form spontaneous organizations that take on tasks such as search and rescue, triage, and cleanup (Stallings & Quarantelli, 1985). However, the West Virginia event was different in that it was an environmental contamination that did not cause destruction to infrastructure or create a large “disaster site.” There was the spill site on the Freedom Industries’ property, but this was closed to the public. However, just because there was not a need to do search and rescue or clear debris did not mean that there were not unique tasks to be handled as necessitated by the event. Also, the lack of physical damage meant no interruption to phone or internet services, which usually accompanies disasters that leave a path of destruction. These distinctive conditions made the West Virginia water contamination ripe for emergent behavior largely facilitated by ICTs. Indeed, there were many observed instances of emergent behavior in cyberspace. People used social media to solicit, collect, and distribute donations of supplies for the affected West Virginians and to share pertinent information and instructional messages for self-protection. Additionally, they used social media to spread the word about activism activities (rallies, petitions to sign, etc.) and provided a space for people to express a wide range of emotions brought on by the event.

In chaos theory terms, the spill and subsequent water ban threw the system into bifurcation. The contamination posed a threat to the affected area and residents and created a large amount of uncertainty about what to do to move forward and out of chaos.

Because the established organizations were caught off guard by the spill and largely unprepared to deal with such an event, they were unable (or in some cases unwilling) to provide the necessary information and messages of self-protection. Thus, the emergent organizations formed and took over the necessary tasks and filled the void. With these organizations now stepping in to provide information and relief, citizens saw the first glimpse of organization and a sense of an eventual return to normalcy. Could it be that the self-organized emergent behavior of these citizens served as strange attractors that brought this chaotic system out of bifurcation? Though it sounds cyclical, it would seem that self-organization spurred self-organization in the case of the West Virginia water crisis. This leads to the overarching question that guided the research undertaken in this case study: can emergent organizations that form in response to a crisis act as strange attractors in a chaotic system that spur the process of self-organization and move the system out of bifurcation?

Thus, this is a unique event that warrants further study and can provide valuable insights about emergent behavior and observe the way these organizations form, operate, and eventually disband via ICTs. Additionally, this event provides an example of how emergent organizations functioned as strange attractors (from a chaos theory perspective) which spurred the process of self-organization that moved this system from bifurcation out of chaos. This is an application and an extension of chaos theory that has not been examined in the literature thus far. This dissertation seeks to do just that: further examine this unique crisis situation to learn more about how emergent organizations form and operate in cyberspace and how emergent self-organization behavior can actually spur the process of self-organization for a system in chaos. This will build on the body of

literature that applies chaos theory to crisis events, and will extend this theory in new ways by demonstrating the connection between emergent behavior and strange attractors. This study also seeks to further explain the phenomena of emergent organizations in cyberspace, which was undertaken through close observation of the behavior as it pertains to the West Virginia water contamination case. Berger, Roloff, and Roskos-Ewoldsen (2010) point to the importance of going beyond observation and striving for explanation of the phenomenon observed. According to them, “communication science practitioners not only wish to identify regularities with respect to communication and its effects, but also fundamentally seek to explain why such regularities occur” (Berger, et al., 2010, p. 8). Therefore in addition to observing and recording the behavior of emergent organizations, further research is undertaken to explain why the behavior occurs. Thus, given those objective and the research needed to satisfy those objectives, the following primary research questions guided this research:

RQ1: To what extent were the tenets of chaos theory apparent during the West Virginia water crisis?

RQ2: What emergent organizations were observed during this crisis?

RQ 3: To what extent did the emergent groups make use of social media to form and carry on operations during the crisis?

RQ 4: To what extent did the unique characteristics of this crisis impact the functions performed by the emergent organizations?

The remainder of this dissertation is structured as follows: I provide a summary of the case and the events of the West Virginia water crisis, then a review of relevant literature,

a discussion of the methods and data collection, analysis of two data sets, and end with the conclusions drawn from this research and their implications.

Summary

The West Virginia water contamination was a unique crisis event that warrants further study for several reasons. First, it is an opportunity to apply chaos theory to a type of crisis that has not yet been examined in the literature, further building the theory. Additionally, there were several observed instances of post crisis pro-social behavior in the form of emergent organizations. Though this type of behavior has been observed in prior events, this event is unique in that the organizations relied heavily and primarily on social media to form and carry out operations. Finally, the presence of these emergent organizations in a system in bifurcation presents the opportunity to test the proposition that emergent organizations can function as strange attractors and spur the chaotic system away from bifurcation and towards self-organization. The remainder of this dissertation provides a thorough case summary of the West Virginia water contamination event, a review of relevant literature, methods and data analysis procedures, description of results and the overall contribution of this study to the body of crisis communication literature.

Chapter Two: Case Summary

This chapter provides a detailed description of the timeline of the West Virginia water contamination crisis. The timeline begins with the date of the spill and discusses major events that occurred in the months following (see Figure 2.1). On January 9, 2014, residents of Charleston, West Virginia and the surrounding counties began noticing an unusual, cloying sweet smell in the air and in their homes, particularly when the water was running. The first formal complaint to this effect was registered with the Department of Environmental Protection at 8:15 a.m., however, the West Virginia Water Company was not made aware of the situation until noon and, at that time, was under the impression that the water treatment facilities' carbon filtration system would be able to handle the problem. However, it soon became apparent that the contamination exceeded the systems capabilities and at 5:09 p.m. the determination was made that the water was unsafe for consumption or use (Ward & Gutman, 2014). Customers were notified of this ban at 5:45 p.m., a full nine and a half hours after the first complaint was registered with the DEP.

It did not take long for the DEP to determine the source of the contamination after receiving several complaints about an odd smell near the Freedom Industries plant located on the banks of the Elk River near the juncture where it connects with the Kanawha River. This company stores chemicals for use in the mining, cement, and steel industries. Workers at the plant noticed a leak coming from a 1-inch hole in a tank that contained the chemical 4-methylcyclohexylmethanol (MCHM). This is a chemical used in coal cleaning process to remove grit and dirt from the outside of coal. Employees of Freedom Industries reported first noticing the leak at 10:30 a.m. and taking all the

appropriate steps to stop the leak and clean up the damage to the best of their abilities (Ward, 2014). However, there was nothing to be done about the 7,500 gallons that had already leaked into the Elk River and were making their way through the various streams and other waterways that fed off of it. To add insult to injury, Freedom Industries did not take any steps to contact West Virginia Water Company or any other the other appropriate organizations and inform them of the spill. The company also denied initial requests from the media for information, and it wasn't until the evening of January 10 that the company made its first official statement through its president, Gary Southern.

When news of the contamination broke, affected residents, estimated to be around 300,000 individuals, were instructed not to drink, bathe, cook with, or wash with the water. While this information was pertinent for self-protection, it came too late for the 122 residents who had already sought treatment for nausea, vomiting, and/or diarrhea, which are common symptoms of exposure to MCHM. By January 14, nearly 700 people had contacted the poison control hotline reporting symptoms including nausea and rashes, and the total number of individuals hospitalized reached 14 (Heyman & Fitzsimmons, 2014). Fortunately, none were in critical condition, and to date, no fatalities have occurred as a result of the contamination.

West Virginia's governor declared at state of emergency shortly after the contamination (and its magnitude) was realized. Schools and businesses closed and hospitals began emergency water conservation practices. Shortly thereafter, President Obama declared a federal state of emergency for the affected area and FEMA was instructed to provide ground assistance as well as funding for the state's emergency management efforts. On January 13, a temporary restraining order was issued by a

Kanawha county judge to preserve the evidence at the Freedom Industry facilities where the leak originated. Further inspection of the tank that leaked revealed damage from frozen water and the unseasonably cold temperatures (White, 2014). On January 25, Freedom Industries was ordered to empty all of the chemical holding tanks at its Charleston facility and begin the process of removing all above ground tanks, with work to begin no later than March 15 (Raby, 2014).

Authorities began lifting the ban on January 13, beginning with hospitals and working outward from there. However, shortly after announcing the lifting of the ban, officials quickly amended the statement based on recommendations from the Centers for Disease Control and Prevention (CDC) to exclude pregnant women and the immune-compromised “out of an abundance of caution” (T. Frieden, personal communication January 15, 2014). Though they were cleared to resume drinking, cooking with, bathing and washing in the water, residents were informed that they first needed to flush their pipes to ensure that all the contaminated water had been cleared out of their systems (Plummer, 2014). This is where the confusion began, as clear, explicit instruction on how to properly flush one’s pipes was not given. For example, how long should the water run? Should I open my doors and windows while doing this? What about external spigots? Given the extreme cold and winter weather conditions, some residents were less than willing to go outside and run freezing cold water for any given period of time. It was also imperative that the residents shut off their hot water heaters before beginning this process, but this instruction was not always explicit (Whelton et al., 2015). Thus, when people ran their hot water taps, the MCHM was transformed into a noxious gas that filled people’s homes, causing headaches, nausea, and nosebleeds. The ambiguity of the

information given only served to heighten uncertainty among the affected population, precisely the opposite of what was intended as well as the opposite of the primary goal of emergency/crisis communicators responsible for disseminating the information.

Despite the fact that the ban was lifted and all federal aid in the form of bottled and potable water deliveries had ceased, six weeks post contamination, many residents still refused to drink or use the water in their homes. When they attempted to resume regular use, the odd smell and funny taste remained, thus continuing the distrust in the safety of the water (Goldenberg, 2014). Besides the obvious frustrations of having to use bottled water for consumption and for all basic household functions, West Virginians also faced the added challenge of finding the bottled water on their own. Naturally, most grocery stores and supermarkets could not keep shelves stocked with water, further complicating matters and driving some residents to take matters in to their own hands.

Unfortunately for all parties involved, this contamination was not a “quick fix,” so to speak. In addition to the unclear instructions about pipe flushing, on January 21 Freedom Industries revealed that it withheld information about the chemicals contained in the leaking holding tank. Initial reports stated only MCHM was in the tank and was the only source of contamination, however, it soon came to light that a second chemical, known as stripped PPH, was present in the leaking tank. Although the company did not report this to government officials and other appropriate authorities, it did send an email to employees immediately with full details of the spill and the chemicals involved (Matisse, 2014). Stripped PPH was mixed in with the other chemicals at a level of 6 percent concentration and according to the MSDS sheet, can cause severe skin and eye irritation, and individuals who work with it are required to wear safety goggles and

protective gear. Little else is known about the chemical composition of this substance because, according to a company safety document dated October 15, 2013, it is being withheld as a “trade secret” (Upton, 2014).

The company at the center of the crisis, Freedom Industries, is perhaps the biggest offender of all. Before the leak occurred, the plant had only been inspected three times and was not required to be inspected more regularly because it only stored, rather than processed chemicals. This was despite the fact that these chemicals were stored next to a river that was the main water source for a large number of West Virginia residents. To add insult to injury, Freedom Industries declared bankruptcy rather quickly after the spill and subsequent ban began, a move that essentially prevents it from facing lawsuits as laws are in place to prevent companies that have filed Chapter 11 bankruptcy from being sued. Naturally, given the negligence on the part of the company and its deceptive and unethical practices in the days following the spill, there are several parties who wish to see the company pay, literally and figuratively, for what it has done. Not just those 300,000 residents who went days without being able to use the water in their homes, but also business owners who claimed lost profits due to the contamination attempted to bring suits (Atkin, 2014). Their efforts to see justice served have been thwarted by this underhanded move on the part of Freedom Industries and its legal team.

On July 3, 2014, OSHA leveled fines against Freedom Industries that totaled \$11,000. The company was fined \$7,000 for not having a liquid tight wall surrounding its tanks and \$4,000 for not having standard railings on an elevated platform (Boucher, 2014). Given that the leak on January 9 was about 10,000 gallons, the company is being fined a little more than a dollar for every gallon that leaked and contaminated the

drinking water supply for 300,000 West Virginia Residents. On February 17, 2016, Gary Southern was sentenced to 30 days in jail and was ordered to pay a \$20,000 fine for his negligence and role in the Elk River spill. Four other Freedom Industries officials received probation only sentences (Ward, 2016).

Figure 2.1 Timeline of Events

Date/Time	Event
January 9	Leak begins at Freedom Industries
January 9/ 8:15 am	DEP receives complaint of funny smell
January 9/10:30 am	Freedom Industries employees discover leaking tank
January 9/11:15 am	DEP discovers leak at Freedom site
January 9/12:00 pm	West Virginia American Water Company is informed about spill
January 9/5:45 pm	Water Company issues “do not use” ban to 300,000 customers
January 10	President Obama issues Federal Emergency Declaration
January 10	FEMA arrives with bottled water/aid
January 13	Water ban lift is started by zones
January 18	Do not use order is 100% lifted
January 18	Freedom Industries declares bankruptcy
January 21	Freedom Industries reveals second chemical in tank-stripped PPH
January 24	Freedom Industries is ordered to remove all above ground storage tanks
January 27	Federal relief and bottled water distribution officially ends
July 13	OSHA fines Freedom Industries
February 16, 2016	Gary Southern sentenced to 30 days and \$20,000 fine

Summary

The West Virginia water contamination began as a small hole in a tank containing MCHM and stripped PPH located on the banks of the Elk River. The tank began leaking in the early morning hours of January 9, 2014 and by 5:45 p.m. the West Virginia American water company realized that its filtration system could not handle the contaminated water and issued a do not use ban for 300,000 of its customers. For the next two weeks, the affected residents were unable to do anything with the water other than flush their toilets and the governor made an emergency declaration for the state. Aid came in the form of bottled water and other necessary supplies delivered by the National Guard, Red Cross, and other relief organizations. The ban was fully lifted two weeks after it was implemented and people were told it was safe to resume normal water use after flushing their pipes. However, even after flushing, people still noticed the odd smell and taste and continued to distrust the water and seek alternate drinking water sources.

Chapter Three: Review of Literature

This chapter provides a review of relevant literature. First a summary of the stages and lifecycle of a crisis. Then, chaos theory and its tenets are explicated and a review of other crisis communication literature applying chaos theory is summarized. Next, the literature on emergent/ephemeral organizations is reviewed with a particular focus on emergent behavior in the social media environment. For the purposes of this study, the terms ephemeral and emergent are used interchangeably. Finally, a review of literature on communication science is provided.

Crisis Lifecycle

A crisis is defined by three characteristics that set it apart from other non-routine events. These characteristics are threat, surprise, and a short response time (Hermann, 1963). In addition to having those unique characteristics, a crisis has its own lifecycle that allows the event to be divided into stages. Fink (1967) was among the first to propose a model for crisis, and his model divided the crisis into four stages. The first being prodromal, where warning signs are evident, then the acute phase where the trigger event occurs, next is the chronic phase where assessment and recovery begin, and finally the resolution phase is reached when the problem is resolved and the crisis is no longer concerning to stakeholders (Fink, 1967).

Mitroff (1994) built on this to create his five phase model of crisis management. The first phase, like Fink's model, deals with warning signs and is called the signal detection phase. Following detection of a potential issue, the probing and prevention phase attempts to mitigate harm and damage caused by the potential event. The next phase, damage containment, occurs because some crises are inevitable and cannot be

prevented despite the best monitoring and prevention practices. The goal of damage containment is just that, to prevent the crisis from spreading and causing more harm. The fourth phase, recovery, focuses on a return to normalcy. Finally, Mitroff's model deviates from Fink's in the added fifth phase, which he termed the learning phase. The goal is to closely examine the event and response to determine what was done well and what can be improved upon for future events (Mitroff, 1994).

Seeger, Sellnow, and Ulmer (2003) simplified their crisis cycle into three phases: pre-crisis, crisis, and post-crisis. They argued that an organization was constantly experiencing one of these phases. After the post-crisis recovery and learning is complete, the organization is automatically moved back into the pre-crisis phase, monitoring and preparing for the next potential event.

Finally, Coombs' (2012) model builds on the three stage model, but focuses on four key components: prevention, preparation, recognition, and revision. The prevention and preparation phases are, like the other models described, focuses on detecting vulnerabilities, mitigating them if possible, and preparing for the inevitable. Recognition is the acknowledgement of a crisis situation and involves the response and recovery activities (Coombs, 2012). The revision phase is about the "development of an institutional or organizational memory, which can improve the effectiveness of crisis management by expanding the organization's perception of crises and its response capacity" (Coombs, 2012, p. 6).

Though these models use different terms to describe and delineate the phases of a crisis, they share many similarities. Organizations that are not currently experiencing a crisis are considered to be in the pre-crisis phase and should be focused on scanning for

warning signs and doing everything possible to mitigate threats. However, once a crisis manifests, the focus shifts to response and containing the threat. Finally, the post-crisis phase is not just about recovery but also learning from the experience and turning it into recommendations for dealing with future incidents.

Chaos Theory

Chaos theory originated in the math and science disciplines. One of its first uses was by the scientist Edward Lorenz, who used it to try and map and explain complex weather patterns and systems. The main tenet of chaos theory is that systems act in non-linear and random ways. Because of their inherent random behavior, it is impossible to accurately predict the behavior of a chaotic system. Perhaps the best known tenet of chaos theory is the system's sensitivity to initial conditions, which is often referred to as the "butterfly effect." Put simply, this supposition implies that something as small and seemingly insignificant as the flapping of a butterfly's wings can have a much greater impact and can start a chain of events that leads to a large scale event like a tidal wave that devastates a coastal area.

This theory fits well when describing complex systems like the weather, biological systems, and complex mathematical models, but as of late, social scientist researchers are seeing the applicability of chaos theory and the idea of random, unpredictable behavior to the systems they study. As Murphy (1996) stated "chaos theory attempts to understand the behavior of systems that do not unfold in a linearly, predictable, conventional, cause-and-effect manner over time" (p. 96). Murphy wrote her seminal piece that was published in *The Journal of Public Relations* and showed the clear connections between the tenets of chaos theory and the systems often studied by social

scientists and made a call for researchers to extend this body of literature and use chaos theory in their future research. Seeger echoed her sentiments in a follow-up piece published in the same journal in 2002. He argued that organizations experiencing a crisis are an ideal model of a chaotic system and said the field of risk and crisis communication was ideal for the application of this theory. He pointed to each element of chaos theory—fractals, bifurcation, strange attractors, and self-organization—and showed how an organizational crisis contained each element across the crisis lifecycle. Below, each of these components will be defined, explained, and expanded--particularly in regards to strange attractors and self organization. Finally, chaos theory is applied to the 2014 West Virginia water contamination as an example of an ideal case that clearly exhibited all tenets of a system in chaos.

Fractals. Generally speaking, fractals are concerned with the measurement of systems. This concept is often explained with the example first posed by Mandelbrot when he asked his students to measure the coast of Britain. When it was measured in miles, there was a different measure than when done in feet, inches, centimeters, grains of sand, etc. etc. This example demonstrates the importance of scale/perspective. As Murphy (1996) said “the difficulty of perceiving pattern in chaos relates to the scale at which one views a phenomenon...chaos theorists note significant differences in the very structure and dimensionality of an object depending on the observer’s standpoint and measuring tools” (p. 98). Thus, the pattern can look very different depending on the standpoint of the individual. Horsely (2014) described fractals as changing with each successive iteration, but by looking at the whole picture, the pattern of changes and the evolution from beginning to end can be observed. In her examination of the DC sniper

attacks, she said that at first it was difficult to determine a fractal pattern among the sniper victims because they were of different genders, ages, races, etc. and the killings happened at random times and in different places. However, by observing the fractals from the point of view of the sniper who was targeting his wife (who had a restraining order against him), it became clear that he was targeting places like shopping malls and craft stores where he thought she would be, thus revealing the pattern to his attacks (Horsley, 2014). Sellnow, Seeger, and Ulmer (2002) noted the key difficulty with fractals by observing their role in the case of the historic Red River floods that affected residents in North Dakota and Minnesota. According to them, the problem was “the communication of excessive confidence in a measurement system that lacked the precision needed” (Sellnow et al., 2002, p. 276). In this case, they referred to the imprecise measurement tools and system that had been previously used to estimate flood levels, but in this case did not account for the sensitivity to initial conditions like ice blockages that had rendered the measurement system imprecise and irrelevant. However, because all the predictions had shown that flooding would be at a certain level, this was communicated with confidence by meteorologists and a number of other officials. Because of this, the area was wholly unprepared to deal with the record setting flood levels, exacerbating the chaos and representing a failure of viewing a fractal pattern from the wrong perspective.

Bifurcation. According to Freimuth (2006) “bifurcation is associated with a collapse of sensemaking. At these points, observers realize that the routine ways of operating have collapsed” (p. 145). These are points at which the system deviates from the established path and heads in a totally different direction. In relation to the crisis

lifecycle, bifurcation could be considered the beginning or initial phases of the crisis and the point at which the system begins to act in a chaotic, unpredictable way. As Seeger (2002) stated “organizational crises are points of system bifurcation or radical change where a systems direction, character, and/or structure is fundamentally disrupted or departs from the previous path” (p. 332). In some cases, this collapse in sensemaking can result in what Weick (1993) referred to as a cosmology episode. A cosmology episode is one in which people feel that “I’ve never been here before, I have no idea where I am, and I have no idea who can help me” (Weick, 1993, p. 634). In some instances, people and organizations try to resist the effects of bifurcation by comparing the current conditions to previous experiences, but as history and the literature have shown, for a system to pull itself out of bifurcation/chaos, it must acknowledge that the current conditions are new and unfamiliar, and the old ways of operating and functioning must be abandoned before the system can begin the process of self organization. This was true of the TVA after it experienced a disaster in the form of a coal ash spill that rained down tons of coal ash on the town of Kingston, Tennessee, destroying many homes, displacing many residents, and creating a sense of chaos for the affected area. In hindsight, Tom Kilgore and others at the TVA were able to recognize six points of bifurcation that took them off the established path and eventually led to the spill. Most of these bifurcation points dealt with information siloes and a lack of communication between departments within the organization. Because they were able to recognize how these bifurcation points put them on the path to disaster, the organization went through a self-organization process and established new procedures and practices that would (hopefully) prevent the same thing from happening in the future.

Strange Attractors. Strange attractors are “fundamental points of connection and order...that exert a continual regulation on the form and behavior of a system...They are the points to which a complex system naturally and continually returns” (Seeger, 2002, p. 334). Strange attractors are elements that help a system in chaos begin the process of self-organization and start to emerge from bifurcation. Strange attractors can come in many forms. Seeger (2002) said attractors can take many forms, including family, community, and economic ties that lead to rebuilding after a disaster. As Freimuth (2006) said, “an attractor is an organizing principle such as a common set of values to which a system will return even as it moves through bifurcation” (p. 145). In this sense, strange attractors are those things present in the chaotic system that help it find a new order and begin the process of self-organization. It is because of strange attractors that a chaotic system begins to move away from bifurcation. Murphy (1996) refers to attractors as “an organizing principle, an inherent shape or state of affairs to which a phenomenon will always tend to return as it evolves, no matter how random each single moment may seem” (p. 98). Thus, organizations that experience a crisis which throws them into chaos and bifurcation should seek out those strange attractors that can help them begin self-organization and moving out of chaos.

Sellnow et al. (2002) described the presence of the National Guard and FEMA after the historic Red River floods as two strange attractors that helped citizens begin to move from bifurcation to self-organization. As they described it, the presence of these two organizations gave the confused, disoriented citizens something/someone to look to as they began the recovery and rebuilding phase. Also, the presence of these organizations gave credibility to city officials who were trying to coordinate the recovery

process among several organizations in several locations, with sometimes differing goals (Sellnow et al., 2002). Horsley (2014) pointed to a similar strange attractor in her analysis of the chaos surrounding the DC area sniper attacks. She claimed that the police chief at the helm of the case, Chief Moose, functioned as a strange attractor as he was the one leading the case, handling the press conferences and media interactions, and using his position of authority to speak directly to the suspects. His presence was reassuring and helped give the community a sense that things would return to normal eventually (Horsley, 2014).

Regardless of the form that they take, strange attractors are those things that help a system begin the process of moving from bifurcation and a cosmology episode into the process of self organization that eventually pulls the system out of chaos and return to a sense of “normalcy.” However, this is very often a “new normal” because of the changes that the system underwent during the chaos and self-organization periods, which will be described below.

Self-Organization. Self-organization is often referred to as the “anti-chaos” mechanism. In the crisis lifecycle, this is the point at which the recovery and renewal phases begin as the system moves away from chaos/bifurcation and towards stability. Seeger (2002) defined self organization as “a natural process whereby order re-emerges out of the chaotic state brought on through bifurcation. This reordering process is sometimes characterized as the antithesis of chaos and as the outgrowth or consequence of bifurcation” (p. 332). Wheatley (2006) describes the nature of self-organizing systems as adept and “it uses available resources more effectively, sustaining and strengthening itself” (p. 83). Vicki Freimuth was at the helm of the CDC when the 2001 anthrax attacks

occurred, and she described the self-organizing process that organization had to go through to handle such an unprecedented event. Though the CDC handles disease outbreaks and epidemics regularly, never had such an instance (what many felt was the first major instance of bio-terrorism on American soil) occurred that required such a large response. Freimuth (2006) described how every part of the CDC communication branch underwent a change—from the way calls from the public were received and handled to the way media requests and statements were handled. In some instances, entire new teams/organizations/structures needed to be assembled to handle new tasks never before handled by the organization. These emergent structures were created in response to meet these new needs. As she stated “the other new structures created were not modifications of previous ones but were new and filled gaps made apparent during the anthrax crisis...new structures emerging out of the chaos” (Freimuth, 2006, p. 146). Self-organization very often results in the emergence of new structures and organizational policies. Horsley (2014) also saw this in her analysis of the DC sniper shootings. She described new behaviors such as citizens standing between car doors as they pumped gas, schools going into lockdown mode, people cancelling extracurricular activities, and avoiding going outside unless absolutely necessary. These behaviors emerged in response to the unique situation.

A system in bifurcation cannot pull itself out of chaos without going through self organization. The process of self organization is largely dependent on the nature and type of strange attractors present in the system, and can sometimes be generated from within (e.g. the CDC restructuring during the anthrax attacks) or can be spurred by external strange attractors (e.g. the National Guard and FEMA’s presence during the Red River

floods). Regardless of the nature, self-organization must occur to get the system back on track. As Wheatley (2006) stated

the viability and resiliency of self-organizing systems comes from its great capacity to adapt as needed...neither form nor function alone dictates how the system is organized. Instead they are process structures, reorganizing into different forms in order to maintain their identity...it is capable of organizing into whatever form it determines best suits the present situation (p. 82).

Chaotic systems do not remain in chaos forever because of the process of self organization and the presence of strange attractors. These concepts are closely related, and they are the reasons why organizations emerge from bifurcation, often looking very different than they did before the chaos began. As was described above, the nature of strange attractors and the process of self-organization results in new organizational forms, and in some cases, entirely new organizational structures/groups. These new forms are closely related to the idea of ephemeral organizations. Ephemeral organizations are, according to Lanzara (1983) organizations that form in response to a crisis, fulfill a variety of needs as dictated by the situation, and eventually disband after the crisis is over. They are ephemeral in the sense that they did not exist in any shape or form before the crisis, they have no established rules or procedures, there is no defined leadership and the hierarchy is largely flat, the roles they assume are defined by the needs of the situation, and once the crisis has passed (i.e. the system has moved on from bifurcation) the organization disbands and largely has no history or record of ever existing. Lanzara (1983) argues that this organizational form is largely effective in chaos because its lack of established procedures, practices, and leadership allows it to function well in the

uncertainty and unpredictability of the chaotic system. Established organizations are often paralyzed by chaos and unsure of how to act because their “normal” way of doing things is rendered ineffective by bifurcation. This is not true of ephemeral organizations because they have no “normal.”

Ephemeral/Emergent Organizations

For decades disaster sociologists and others who study crises have observed a recurrent phenomenon of ordinary citizens banding together at the scene of the event to perform a myriad of tasks related to disaster response. In some instances, it is these individuals who, because of their geographic proximity, are first on the scene of the event and begin doing the work of first responders before the trained first responders arrive. In addition to performing the initial response tasks of search and rescue, and clearing debris, in many cases these emergent groups stick around through the response and recovery phases of the event and adjust their behaviors to fit the needs of the situation. They collect and distribute supplies, help disseminate information, and other tasks as dictated by the unfolding situation. Because these organizations largely consist of individuals who had little to no prior connection to each other and no formal structure, they form what Stallings and Quarantelli (1985) termed emergent organizations. This is one of the four typologies developed by researchers at the Disaster Research Center (DRC) to describe the forms that organizations take during a crisis. The first type, established organizations, performs routine tasks with a routine structure. An example of this is firefighters who routinely deal with fires and frequently work together responders. The second type, extending organizations, perform new tasks with a routine structure, such as a school that becomes a makeshift shelter for displaced residents during a natural disaster. Expanding

organizations perform a routine set of tasks, but take on a new structure depending on the situation. The Red Cross is a good example of an expanding organization because it performs a similar set of tasks related to disaster response (providing medical attention, food, clothing, shelter, etc.) but the group of volunteers that assembles at each site is different. Finally, the emergent organizations are defined by a new structure and a new set of tasks dictated by the situation at hand. The individuals who form this type of organization have not worked together before and there is no formal leadership or hierarchy to the organization. They simply emerge in response to an event and fill needed roles as dictated by the situation. These organizations form for several reasons and the literature suggests they most often form when demands/needs are not being met by established organizations, when traditional structures are insufficient or inappropriate, and when the community feels it necessary to become involved in the response to a crisis situation (Wenger & Prater, 2013; Drabek & McEntire, 2003).

Ephemeral organizations during crises. According to Lanzara (1983) established organizations are often left paralyzed in the wake of a crisis because they cannot cope with the uncertainty of the situation, and their normal ways of doing things and standard operating procedures are not effective in this evolving disaster situation. However, ephemeral organizations have never known normalcy nor do they have standard operating procedures, therefore, they are much better able to cope with the uncertainty of the crisis and easily fluctuate between tasks and roles. Though Lanzara used the term "ephemeral" to describe these organizations in his 1983 publication, this same idea is represented in the DRC typology they defined. Stallings and Quarantelli (1985) provide a succinct definition of emergent organizations as

"private citizens who work together in pursuit of collective goals relevant to actual or potential disasters but whose organization has not yet become institutionalized" (p. 94). This kind of behavior has been documented for years by disaster sociologists and it is in direct opposition to the idea of the "panic prone public," or the idea that people panic in the face of a disaster and act in incomprehensible and sometimes damaging ways. Drabek and McEntire (2003) state "studies over the past 15 years reaffirm there is very little panic or anti-social behavior during the immediate response period. Instead, there is an outpouring of concern on behalf of the victims and the affected community" (p. 107). Rodriguez, Trainor, and Quarantelli (2006) observed this and echoed these sentiments in their studies of emergent groups following Hurricane Katrina. Though the media tended to focus on the looting and other illegal activities happening in the area, what the researchers observed was many more instances of pro-social behavior and people with no previous ties coming together for no other reason than a strong desire to help and participate in a positive way.

Though emergent organizations are often most visible and active during the response phase of the crisis lifecycle, they can have a presence in all phases. Sometimes, it is an emergent citizen group that alerts the established organizations to the situation. Stallings and Quarantelli (1985) defined these as damage assessment type groups and said they "often provide public officials with their first information about the actual extent and location of disaster damage" (p. 94). This was the case in the 2014 West Virginia water contamination as it was a concerned citizen who noticed an odd smell in the air and reported it to the

Department of Environmental Protection, prompting it to investigate and discover the spill site. The organization at fault, Freedom Industries, had discovered the spill and done what it could to clean it up, but made no effort, and had no plans to alert the appropriate authorities. Thus, without the tip from the local, it might've increased the time before the spill was discovered, thus exacerbating the harm done by it. Sebastian and Bui (2009) also recognize the importance of geographic proximity in emergent behavior, "local volunteers from the affected populations are the first potential helpers in close proximity to the most urgent needs. They have detailed knowledge of the area and possible needs, which enhances their ability to improvise and respond effectively" (p. 2). Obviously, this geographic proximity makes them more likely to be "first on the scene" even before established emergency response groups can arrive, prompting them to begin tasks like search and rescue and clearing debris.

As the crisis moves from the impact to response phases, emergent organizations persist, though often change roles. If there is no longer search and rescue to be done, they help in other ways, sometimes forming what Stallings and Quarantelli (1985) termed operations groups which, "form to collect and distribute food and clothing to disaster victims...or transmit messages through ham or citizen band radio networks" (p. 95). These kinds of tasks are often dictated by the nature of the crisis being experienced. Finally, when the response phase ends and the cycle moves into the recovery phase, there is usually a decline in observable emergent behavior because there is less work that can be done by informal groups and more work that is undertaken by established organizations.

However, there are instances where emergent groups persist into the recovery phase as coordinating groups, that often take the form of impromptu citizen committees which "have less to do with the immediate assessment or operational activities and more with setting direction, resolving domain disputes, and assuming responsibility for certain community-wide problems" (Stallings & Quarantelli, 1985, p. 95). This was evident in Hurricane Katrina, when new structures/committees were needed to coordinate temporary housing, rebuilding efforts, and a number of tasks associated with the recovery from such a large scale, devastating disaster (Rodriguez et al., 2006). In many instances, the response organizations pave the way for recovery organizations. As Wenger and Prater (2013) said "the recovery emergent groups are dependent on the response teams to lay down the groundwork for further work and the manner in which they have done their tasks deeply influences the extent and nature of functions that the recovery emergent groups would be expected to fulfill" (p. 9). In other words, the actions performed by the emergent response groups, and the perceived helpfulness of their presence, could have an impact on the existence and involvement level of recovery phase emergent groups.

Perhaps Lanzara (1983) put it best when he said "ephemeral organizations are simply what people do when no one tells them what to do" (p. 88). This emergent phenomenon has been observed in the wake of disasters for decades. Whether they form because established organizations leave unfilled gaps that need filling, or because there is an inherent psychological need to help, it is not a question of whether or not emergent groups will form in the wake of a crisis,

but rather what tasks they will undertake as part of the response. Thus, researchers suggest that practitioners plan on the formation of emergent groups, and use them to their advantage in a disaster response situation, rather than seeing them as a hindrance or getting in the way of more formal response groups.

Most of the researchers who wrote about ephemeral/emergent organizations did so in the decades before the proliferation of the internet, smart phones, and Web 2.0 technologies such as social media. Stallings and Quarantelli (1985) and Lanzara (1983) described the behaviors that these spontaneous groups exhibited when people gathered together in a physical location (usually the ground zero of a disaster site) and were performing the tasks face to face. However, in today's mediated and uber-connected world, geographic proximity is no longer a requirement for participation in disaster response and recovery. Thus, the question is, how have social media and the proliferation of technology changed the way ephemeral organizations form, operate, and disband?

Emergent Organizations in a Social Media Environment. As the body of literature demonstrates, emergent behavior post crisis has been observed and researched by disaster sociologists and crisis communication scholars for decades. However, the body of literature that observes emergent behavior in the new technological landscape is not as robust. Yet there is a growing body of literature demonstrating the increasing frequency with which people are turning to ICTs for seeking information and pertinent messages for self-protection during a crisis. At their foundation, social media and the internet are connectors. They connect people to other people and people to information. As Spence, Lachlan, Lin, and del Greco (2015) state “Social media has evolved to become an

interactive, collaborative, conversational, and community-based platform for crisis communication” (p. 172). These functions only become more important and essential when coping with the uncertainty and threat posed by a crisis situation. Because they have been shown to be reliable and effective tools for crisis communication, they are gaining credibility with both those charged with disseminating pertinent messages as well as those searching for those messages (Lachlan, Spence, and Lin, 2014). This is not only true for established organizations, but for emergent organizations as well. “Conventional wisdom concerning the best ways to reach multiple publics is changing, and scholars are beginning to argue for multi-message campaigns that utilize both mediated and grass-roots information campaigns” (Lachlan & Spence, 2011). Thus, the use of ICTs for carrying out crisis communication tasks such as information sharing and seeking is now a central function for emergent organizations.

Realizing its importance as a communication tool, Facebook recently debuted its “Safety Check” feature that uses location tracking to determine which users might be in an area affected by a disaster and gives them the option to check an “I’m safe” button to let the user’s Facebook network know that they are ok. This is especially useful when infrastructure is damaged and phone towers are down, preventing communication via phone call or text message. Google, also recognizing the power of the Internet to help in a crisis situation, has been using its “Crisis Response” feature since Hurricane Katrina struck in 2005 by building tools to collect and share emergency information, and by supporting first responders in using technology to help improve and save lives. This trend is also recognized by academic researchers who study crisis communication and response. Traditionally, research on emergent

behavior required the researchers to be on site, rapidly deploying to the location of the disaster and directly observing the activities taking place. However, the increased reliance on and use of ICTs by emergent organizations is changing this. According to Palen, Vieweg, Liu, and Hughes (2009) “the nature of emergency response is fundamentally changing...The virtual is an arena of interaction in crisis response that gives rise to new social structures and activities that need their own analytical attention” (p. 3). This call for analysis of these online social structures is addressed by this study and the focus on online emergent groups formed in the wake of the West Virginia water crisis.

Traditionally, it is proximity to an event that urges people to take action. Sometimes they are confronted with a crisis in their backyard, or they happen to be first on the scene of an event, or they live nearby and just feel an urge to help. Regardless of motivation, it has previously been the case that geographic closeness to an event was necessary for involvement. However, the internet and social media have dissolved geographic boundaries. Individuals no longer have to live near a disaster site to participate in the response and recover efforts. Now, they can use the internet for things like information sharing, soliciting and collecting of donations, raising awareness, and sharing media coverage. Palen and Liu (2007) addressed this directly when they said

ICT supported communications, however, add another powerful means by which this kind of organization can occur. No longer do people need the benefit of physical proximity to coordinate and serendipitously discover each other...the involvement of people well outside the impact, filter, and

surrounding community areas was made possible by nation-wide grassroots coordination on web sites” (p. 733).

These researchers observed this phenomenon in the aftermath of Hurricane Katrina when people used the internet to solicit donations, provide information about lost or missing persons, and offer up their homes as temporary shelter for those displaced by the storm.

Sebastian and Bui (2009) echoed this idea of transcending geographic boundaries. “ICT reveals the role that citizens have always taken as first responders in emergency situations...emergent behaviors observed on social networking sites and blogs may be catalysts of change for future disaster response” (p. 1). Because the need for geographic proximity is eliminated, it also creates a larger population/network from which to recruit members. Anyone with an account on said social media platform being leveraged can now become a member of the emergent organization. This technology allows for greater participation in emergent behavior by creating several new roles. The first of these is the idea of the “citizen journalist.” According to Palen & Liu (2007) “this technology in the hands of the people further pushes in boundaries between informal and formal rescue and response efforts, and has enabled new media forms that are broadly known as citizen journalism” (p. 729). With the power of cameras and smartphones, anyone at the site of a disaster can take photos or videos and upload them to the internet, share them via social media, and provide a stream of content and updates, similar to that which the media would be doing. This was the case in the 2005 London Tube bombings as citizens were stuck underground until a path could be cleared for their rescue, they were able to take photos of their

surroundings that were later provided to the police and were helpful to the investigation (Palen & Liu, 2007).

A second role that emerges from ICT supported emergent behavior is that of “digital volunteer” or “voluntweeter.” These terms describe the activities of individuals who use their personal social media/microblogging profiles to participate in crisis response activities such as information sharing (Starbird & Palen, 2011). According to Starbird (2011) “Digital volunteerism is becoming an established feature of the online ecosystem after disaster events. It has begun to stabilize, somewhat, as volunteers establish commonly understood ways of doing things and organize into formal virtual volunteer organizations” (pp. 9-10).

A final role is that of “slacktivist” which is used to describe those who participate in activism opportunities in cyberspace (Mozorov, 2009). This term is used to imply that these activists are slackers because their participation does not require them to leave the comfort of their homes or step away from their computers. However, Veil, Reno, Freihaut, and Oldham (2015) reject this “slacktivist” moniker as inappropriate and claim that a large number of people supporting the same issue, even online, can bring about change.

Taken together, this body of literature shows that the emergent pro-social behavior that is witnessed in the aftermath of a disaster is not a new phenomenon. However, this phenomenon is being changed and expanded by another new phenomenon: the ever changing technological landscape. Sutton, Palen, and Shklovski (2008) sum these changes up in this way “The ability of people to improvise in disaster with flexible technology increasingly at their disposal creates

conditions for change in the social structures and, subsequently, the institutional arrangements of disaster response” (p. 7). This research builds on the foundation laid by these studies to continue to observe the way ICTs are changing emergent behavior.

Summary

There are many models that attempt to delineate the phases of the crisis lifecycle. Though they may use different terms to describe the various phases, they share the underlying structure of a pre-crisis, crisis, and post crisis phases. Chaos theory has been applied to a wide range of incidents as a model for how organizations in crisis act in random and unpredictable ways. Bifurcation occurs when the system deviates from the norm, but the system will not remain in chaos forever because of the presence of strange attractors within it. The strange attractors help move the system away from bifurcation and towards self-organization and a new normal.

It is not uncommon to observe ordinary citizens responding to crises and performing a variety of disaster related tasks. This type of pro-social behavior brings people together who had no previous connection to each other to form emergent organizations. These groups can provide a sense of organization and normalcy in an otherwise unstable and chaotic system.

Chapter Four: Methods and Data

This chapter outlines the data collection methods used in this study. This study qualifies as a robust and in-depth case study of an event. According to Yin (2013) a case study approach is most appropriate when three conditions are met: the main research questions are “how” and “why,” the researcher has little to no control over behavioral events, and the focus of the study is a contemporary rather than a historical phenomenon.

The West Virginia case, and the lens through which it is viewed, meet these three qualifications. Referring to the research questions outlined in Chapter 1:

RQ1: To what extent were the tenets of chaos theory apparent during the West Virginia water crisis?

RQ2: What emergent organizations were observed during this crisis?

RQ 3: To what extent did the emergent groups make use of social media to form and carry on operations during the crisis?

RQ 4: To what extent did the unique characteristics of this crisis impact the functions performed by the emergent organizations?

All four questions, though phrased in different ways, address how and social media was used by emergent organizations and why this situation was a unique example of this behavior. As the researcher I observed the events as they unfolded, and I had no control over the behavior of the subjects. Finally, though the observance of emergent behavior post-crisis is not a contemporary phenomenon, observing such behavior on social media sites is indeed a contemporary phenomenon taking place via a contemporary medium. As stated in the rationale, the purpose of this study is to

build on chaos theory by demonstrating how emergent self-organizations can act as strange attractors and begin to move a chaotic system out of bifurcation.

As was outlined in chapter three, though the spill and subsequent water ban only lasted approximately two weeks, the consequences of the event have been felt for more than two years. Because of its impact, the event garnered national news coverage, in addition to the large amount of social media activity surrounding it. The behavior of individuals and groups observed in response to this event make it optimal for study from a social science case study perspective. According to Yin (2013) “whatever the field of interest, the distinctive need for case study arises out of the desire to understand complex social phenomenon...a case study allows investigators to focus on a ‘case’ and retain a holistic and real-world perspective” (p. 4).

Tracking of this event began the week after the spill happened, and has continued for the two years following. In addition to monitoring coverage of the event in traditional news media outlets, the event has also been tracked on social media. One of the primary research questions focused on how emergent organizations self-organized on social media. Therefore, the social media accounts (Facebook pages and blogs) created by emergent organizations were closely monitored and data was collected in the form of status updates, pictures, comments, and posted updates from followers.

Data Collection

The case study was tracked by observing the traditional media for updates about the unfolding event, as well as the popular social media sites Facebook and Twitter. Through those observations, additional sites such as a blog dedicated to the

event were discovered and tracked. Due to the focus of the study, special attention was paid to virtual organizations. As was stated in the literature review, emergent behavior post-crisis is a common and oft-observed occurrence. The recent proliferation of ICT's has allowed for the creation of emergent organizations in cyberspace, thus the focus of this dissertation is how those virtual organizations operate in cyberspace and perform relief and recovery tasks related to a crisis.

To identify emerging organizations, the following definition was employed: an organization that did not exist prior to the contamination of the Elk River on January 9, 2014, but was formed in response to that event and used some form of ICT to carry out the majority of its functions. Using this definition, the tracking process revealed five ephemeral organizations. These included Dr. Andrew Walton and his civil engineering students, Kristal Byron, creator of the West Virginia Water Crisis Blog, and three Facebook pages: West Virginia Moms for Safe Water, the West Virginia Clean Water Hub, and the Easy Action of the Day for WV Water.

Data was collected for each ephemeral organization in two ways: a) an analysis of the Website content; and b) interviews with one of the ephemeral organization's moderators or organizers.

Interpreting Website content. First, the sites were monitored closely and all information posted was saved by collecting screen shots of all posts made to the page from its founding through the end of the calendar year 2014. The content from the Websites was analyzed in four steps as recommended by Creswell (1998). First, each ephemeral organization, its purpose, and services provided are described in detail. This description provided a "categorical aggregation" reflecting the nature of

ephemeral organizations in response to the West Virginia crisis (Creswell, 1998, pp. 153-154). After describing each organization, “direct interpretation” was conducted by applying the research questions created for this study to each ephemeral organization (Creswell, 1998, p. 154). Particular attention was paid to literature focusing on self-organization and ephemeral organizations in response to crises. This direct interpretation focused exclusively on each organization independently. Third, “patterns” of “correspondence” among the ephemeral organizations were identified. In other words, the commonalities and distinctions among the ephemeral organizations are noted (Creswell, 1998, p. 154). Finally, the conclusions are structured in terms of the “naturalistic generalizations” about the West Virginia case and what was learned that can be applied to other crisis events in the future.

Interviews. In addition to the data gathered from social media sites, semi-structured qualitative interviews were conducted to provide an additional perspective on the communicative response to the water contamination crisis. According to Kvale and Brinkmann (2009) “the qualitative research interview attempts to understand the world from the subjects’ point of view, to unfold the meaning of their experiences, to uncover their lived world” (p. 1). Interviewees were those individuals who were directly involved with the water crisis and who participated in the self-organized emergent organizations. These interviews were conducted via phone, recorded, and later transcribed. The questions focused on organizational learning throughout the lifecycle of the crisis and on how social media was leveraged as an organization and communication tool. As the researcher, I took a postmodern approach to the interview process, viewing it as a “production site of knowledge [focusing] on its linguistic and

interactional aspects....and the narratives constructed in the interview” (Kvale & Brinkmann, 2009, p. 53). Thus, the purpose of the interview was to allow interviewees to share their narrative surrounding the event, and engage in co-creation of knowledge about the experience.

Participants: Four individuals were interviewed. These four were members of an emergent organization that formed solely in response to this contamination event. One interviewee created a blog that allowed victims to share their stories and experiences. A second interviewee was a civil engineer who willingly came to Charleston, West Virginia to offer his services as scientist who researches contaminations and their effects on plumbing systems. The third interviewee was one of several operators of a Facebook page created the day of the spill to provide information, solicit donations and assistance, and distribute supplies. The final interviewee was an administrator of a Facebook page created to promote a daily activism opportunity for individuals who wanted to ensure a safe water system for the future.

Recruitment and Interview Procedures: The participants were identified by observing social media and participation in emergent self-organization. The participants were contacted via an email requesting their participation in an interview about their experiences with the West Virginia water contamination. In addition to a request for participation, they were also informed of the study’s compliance with the University of Kentucky’s Institutional Review Board (IRB) guidelines and received a copy of the informed consent form. After agreeing to participation and setting up an interview time, the participants were telephoned and gave verbal consent over the

phone. A straightforward interview guide was used (see Appendix A). However, follow up and probing questions were employed and were based on the interviewees' responses. The interviews lasted between 20 and 45 minutes and were recorded and I later transcribed them. All names have been changed in this write up to protect the anonymity of the individuals who participated in the interviews.

Coding and analysis: The data gathered from both the in depth qualitative interviews and the social media sites were coded using a thematic analysis. Coding qualitative data allows the researcher to identify passages or content that exemplifies a similar concept or theme, and group them together under a common code or category (Gibbs, 2008). Coding data in this way allows for two forms of analysis. First the researcher can isolate all data labeled with the same code in order to provide examples of the same phenomenon, activity, or idea. Secondly, the researcher can use the codes for further analytic questions, examine relationships between the codes, and make comparisons on a case by case basis (Gibbs, 2008). I employed a “data-driven” coding technique, which calls for the coder to refrain from creating codes or categories before reading through the data. In other words, the codes are not imposed on the data, but rather the categories emerge from the data (Gibbs, 2008).

In order to strengthen the consistency and reliability of this data set, a second coder examined the data sets and code book. Because this is a thematic, data driven analysis, the codes emanated from the data itself, and having two researchers discuss those emerging themes strengthens the accuracy and exhaustiveness of the code book. After both coders had surveyed the data sets, they discussed emerging themes and how those related to codes. Where there were points of disagreement about a theme or

application of a code, the researchers engaged in more in depth discussion and returned to theory to resolve the issue. For example, the initial code book had separate codes for describing instances of philanthropy (e.g. people donating water and supplies) and a separate code for community impact (e.g. people sharing stories or discussing experiences). However, there were not sufficient numbers of each to merit them standing on their own, so these two themes became sub-themes of the larger human interest code. Both researchers determined that posts that highlighted the community impact or involvement, either as victims or as contributors, would fall under this category.

Summary

This study employs a close case study methodology and examines the West Virginia water contamination from multiple perspectives. Specifically, attention was paid to the ephemeral organizations that used social media to form and operate. For this analysis, five organizations were identified and constituted the primary focus of the case study. Data collection will be in two forms: tracking and recording of data from emergent organizations posted on social media, and in depth qualitative interviews conducted with individuals close to the event and the ephemeral organizations that emerged in its wake. The social media data will be coded using the four step method outlined by Creswell (1998). The qualitative interviews will be recorded, transcribed, and analyzed using the data driven technique that allows the codes and themes to emerge from the data, rather than having a predetermined coding scheme imposed upon it.

Chapter 5: Analysis

This section provides an analysis of the data as described in Chapter four and addresses the four research questions introduced in Chapter 1. To address RQ 1, the chapter begins with a case study description of how the tenets of chaos theory are exemplified by this event. RQ 2 is answered by providing a categorical aggregation of each emergent organizations. First, a description of each group and how it fits the criteria for definition as an emergent organization as outlined in Chapter 4 is provided. Next, their impetus for formation and their use of social media is discussed. This categorical aggregation is followed by a direct interpretation and a qualitative thematic analysis of each group's online posts. According to Creswell (1998) in direct interpretation, "the case study researcher looks at a single instance and draws meaning from it without looking for multiple instances" (p. 154). Therefore, this section looks at each emergent organization individually and draws meaning from their behavior and activities to address RQ 3.

Finally, the chapter ends with a discussion of the thematic analysis of the data gathered via in depth qualitative interviews. Because a data driven thematic analysis procedure was used, the themes emerged from careful reading of the data. These themes are defined and exemplars from the interviews are provided. Patterns of correspondence and similarities and differences among the groups are drawn from this data. This level of careful analysis directly answers RQ 4.

RQ1: To what extent were the tenets of chaos theory apparent during the West Virginia water crisis?

Chaos theory holds that systems act in random, non-linear, and unpredictable ways (Murphy, 1996). Chaos theory is comprised of several components: sensitivity to

initial conditions, bifurcation, fractals, strange attractors, and self-organization. Each of these plays a part in the lifecycle of a system in chaos. As has been established, an organization experiencing a crisis is an excellent fit for the application of chaos theory (Seeger, 2002). The West Virginia water crisis is no exception. There are unique facets of this incident that align clearly with the tenets of chaos theory and demonstrate how this system experienced several points of bifurcation and descended into chaos before strange attractors appeared and spurred the process of self-organization and anti-chaos.

Sensitivity to initial conditions. Because of a system's sensitivity to initial conditions (i.e. the butterfly effect) simple things that might seem insignificant (like the flapping of a butterfly's wings) can have a much larger impact on the system (Murphy, 1996). For example, in the West Virginia crisis, the hole that developed in the bottom of the tank was not due to corrosion from the chemical it held, but rather from rainwater that entered through the top of the tank. This water induced corrosion paired with a hard freeze caused by unseasonably cold temperatures led to a crack in the tank becoming the larger hole that allowed thousands of gallons of the chemical to leak out (Mattise, 2014). Thus, two commonplace natural phenomena (rainwater and freezing temperatures) set off a chain of events that resulted in the largest drinking water contamination in American history.

Bifurcation. Bifurcation, as defined by the chaos theory literature, are the points at which the larger system begins to deviate from the norm and head down another path (Murphy, 1996). It is at these points that the system begins its descent into chaos. In West Virginia, there are several points of bifurcation to note. First, the point at which the hole developed in the bottom of the storage tank marks the beginning of the problems.

Obviously, these tanks are meant to contain the chemicals, so the failure to do so marks a departure from the norm. A second point of bifurcation occurred when the chemical that leaked from the tank overtook the containment dike and flowed freely over the banks of the Elk River. The containment dikes are put in place as a mechanism to further prevent this type of contamination from occurring, but the speed at which the chemical was leaking from the tank and the volume of liquid that was released was too much for the system to handle. Thus, this represents another failure to perform normal operations and a point of bifurcation. Because of the dike failure, the chemical flowed freely into the Elk River. At this point, the system being affected had grown to include not only the Freedom Industries site, but also the surrounding area, including a body of water used as an uptake source for drinking water. The third major point of bifurcation came at the point when the West Virginia American Water Company decided to issue the do not use order to 300,000 of its customers. Again, this chaotic system grew to include more components.

The issuing of the do not use ban also marks a cosmology episode for the affected residents. Cosmology episodes are a condition spurred by bifurcation. They occur when a person is in uncharted territory, does not know how to respond to this unknown situation, and does not know where to seek help. Weick (1993) described these incidents as a collapse in sensemaking and notes that individuals typically make sense of events by comparing them to past events. However, crises are unique events that often do not bear much resemblance to prior events. Instead of feeling *déjà vu* (I feel like I have been here before) a cosmology episode causes feelings of *vu jade* (I have never been here before). This was indeed the case in West Virginia. For the 300,000 residents, it is highly unlikely that many (if any) had experienced a water ban like this before. Boil water advisories are

more common and are easier to contend with than a complete and total inability to use the water in their homes for any purpose other than flushing their toilets. Thus, this was likely a new and unsettling situation the stakeholders found themselves in and one which caused great uncertainty and left them with few options of where to turn for answers.

Approximately 10 days after it had been introduced, officials began lifting the do not use ban. Affected residents were told it was safe to resume normal water use as long as they flushed their pipes for a certain amount of time to ensure the stagnant contaminated water was cleaned out of the system. People followed the instructions that were given by the established organizations. However, even after flushing they found that their water still had a funny smell and odd taste. This represents yet another point of bifurcation. What was meant to be the point at which things began to return to normal, actually became a point at which things continued in chaos. Because the odd smell and taste lingered, many people chose to continue using bottled water and did not resume normal use of their tap water as the established organizations had expected them to do.

Fractals. A third component of chaos theory is the idea of fractals. Fractals are concerned with the measurement of systems and are the larger observable patterns within the overall system (Murphy, 1996). Fractals are sometimes difficult to observe and are largely dependent on perception. When the Department of Environmental Protection alerted the Water Company to this chemical contamination, the company's initial response was to downplay the severity of the event and rely on its water filtration system to do its job and purify the water to an acceptable level. However, this decision was based on a pattern and measurement that only applies in normal operating conditions and did not take into account the multiple points of bifurcation that had already occurred, thus

creating abnormal conditions. Therefore, the incorrect assumption that the filtration system would be able to purify the water was caused by a failure of perspective and the inability to see the larger pattern of abnormalities. Relying on standard operating procedures is largely ineffective in a chaotic system. It wasn't until several hours later after observing the failure of the filtration system to operate effectively in these abnormal conditions that the company recognized its error in judgment and issued the do not use ban. Unfortunately, the amount of time that had elapsed before people were warned meant a greater number of people exposed to and harmed by this chemical.

A second example of reliance on an imprecise measure revolves around the creation of an acceptable threshold for MCHM in drinking water. No such threshold existed prior to this event, thus the CDC and several other organizations worked together to try to quickly come up with a recommendation for an acceptable level of MCHM in drinking water. The original recommendation the team gave was one part per million (Ward, 2014). However, after publicly announcing that as an appropriate level, they had to quickly amend that statement to exclude pregnant women, infants, and the immune-compromised “out of an abundance of caution” (T. Freiden, personal communication, 2014). They had been relying on an imprecise measure when they made the original recommendation. After more time was devoted to testing, the team made a more appropriate recommendation of one part per billion as an acceptable threshold for the presence of MCHM in drinking water. This is the same issue experienced by officials making predictions about the flood levels for the Red River, who used the traditional measurement methods without accounting for the sensitivity to initial conditions. As Sellnow et al. (2002) state “the key problem associated with fractals in this case involved

the communication of excessive confidence in a measurement system that lacked the precision needed” (p. 276). This was also the issue in West Virginia and was compounded by the fact that little was known about this chemical as it had never been the culprit in a contamination event such as this one. Because of the time constraints and the lack of any pre-existing test to measure MCHM levels in drinking water, the teams charged with creating such a test made the mistake of relying on imprecise measures, which ultimately did more harm than good and exacerbated the uncertainty surrounding the situation.

Strange attractors. Strange attractors are those things which “emphasize order and pattern within chaos. An attractor is an organizing principle such as a common set of values to which a system will return even as it moves through a bifurcation” (Freimuth, 2006, p. 145). For as much as a system is sensitive to initial conditions and seemingly minuscule events can cause it to descend into chaos, it is also susceptible to the presence of those things which cause it to move out of bifurcation and towards a more organized and less chaotic state. Strange attractors can take many forms. In the Red River flooding crisis, Sellnow et al. (2002) noted that it was the presence of the National Guard and FEMA that were the organizing principle for the affected stakeholders. In the Washington DC sniper attacks, it was the constant and reassuring presence of the chief of police handling the case that gave people the sense that there would be a return to normalcy (Horsley, 2014). However, in West Virginia, there was no immediately observable force that was able to provide the reassurance necessary for the affected stakeholders to move towards a sense of normalcy. Freedom Industries had closed its doors, and its officials refused to cooperate with the media or investigators and never

offered an official apology. The West Virginia American Water Company was focused on shifting blame, constantly reminding stakeholders that it was not the source of the spill and therefore was just as much a victim of Freedom Industries as they were. While its lack of fault for the spill is true, the victims were looking for answers and help getting clean water, not more corporate blame-shifting. As for the state government, it too failed to meet the needs of the people. In a notable and cringe-worthy press conference on January 12, 2014, Governor Earl Ray Tomblin fumbled and failed to provide satisfactory answers to questions about how the spill happened and what was being done to make it right (Vingiano, 2014). Again, an established organization that should've been prepared to handle the event more effectively proved to be incapable of doing so.

When Governor Tomblin and President Obama declared an emergency at the state and federal level respectively, the affected area was given access to special funds and services set aside for use in such a disaster. Immediately following these declarations the National Guard arrived on site with tanker trucks full of potable water and other supplies. Additionally, the Federal Emergency Management Agency (FEMA) was dispatched to the area. These organizations worked alongside local FEMA and Red Cross chapters to distribute water and provide necessary aid to the victims. While they were on site, these organizations performed many of the necessary relief operations and gave the victims reassurance that their needs would be met and things would eventually return to normal. When the water company began lifting the “do not use” ban and provided flushing instructions, this signaled the end of acute phase of the crisis. However, as was described previously, people found that even after following the flushing guidelines the water still had the funny smell and taste that was present at the outset of the crisis. Therefore, they

continued to distrust the water and sought alternative sources for water. However, a new obstacle was now introduced because the National Guard and other relief organizations had left the area. When the water company proclaimed the water to be safe again and the “do not use” order was lifted, so too were the emergency declarations put in place by Governor Tomblin and President Obama. Thus, the state’s access to disaster relief funds and the reassuring presence of FEMA and the National Guard and their trucks full of bottled water had vanished. At this point, the chaotic system experienced another period of bifurcation and the organizations that could have functioned as strange attractors and created points of self organization were no longer present in the system. Thus, the affected West Virginians found themselves with a set of unique needs precipitated by a crisis that those in power felt was no longer an issue.

Self-organization. Self organization is referred to as the anti-chaos mechanism. It is the antithesis of bifurcation. It is because of self-organization that a system in chaos does not remain in chaos indefinitely. One cannot discuss self-organization without discussing strange attractors. According to the literature, self-organization cannot happen without the presence of strange attractors in the system. Eventually, the strange attractors present within the system will begin the self-organization process that moves the system out of chaos and into a new normal (Seeger, 2002). In West Virginia, the self-organization process happened in a unique way. Typically, established organizations express the values that represent strange attractors. However, the established organizations in West Virginia failed to do this and therefore did not spur the self-organization process. To compensate for this, West Virginians self organized in such a way as to represent these strange attractor values and become the catalyst for self-

organization. While this sounds redundant, when one takes a closer look at the emergent self organizations that formed in the wake of the crisis, it becomes more clear the role they played in moving the chaotic system away from bifurcation and towards self organization.

Because they could not rely on the established organizations to do their part nor could they rely on the reassuring presence of the relief organizations, they had to find alternate ways to respond and create order within the chaotic system. They did this by self-organizing into emergent organizations that performed a variety of relief functions and worked to meet the previously unmet needs of the affected stakeholders. They harnessed the power of social media and other information communication technologies to form quickly and coordinate efforts for maximum effectiveness. These groups provided necessary information and instructions for self-protection, solicited donations of supplies, and disseminated them among victims. These activities were necessary for those affected to not only get the water they desperately needed, but also to feel like there was a proverbial light at the end of the tunnel. These roles were no longer being filled by the relief organizations and were being ignored by the established organizations.

Chaos theory has been applied to a number of different crisis events and this case represents another instance where the tenets of chaos theory are present through this crisis lifecycle. This application builds on the existing body of literature discussed in Chapter 2 and extends it to a new crisis type. When the tank at Freedom Industries began leaking on the morning of January 9, 2014 it marked the first in a series of points of bifurcation that would set this system off of the normal path and into chaos. Because the established organizations were largely unaware of these points of bifurcation, they failed

to respond appropriately or effectively. On two occasions, a failure of perspective caused them to misread the fractal patterns and rely on imprecise measures. The first occasion was when the water company learned that its water uptake source had been contaminated, but did not shut the system down because it felt the purification system would be sufficient to handle the contamination. This was later proven to be an incorrect assumption. The second instance occurred when the CDC, working in conjunction with the National Guard and the water company, made an initial recommendation of one part per million as an appropriate threshold for MCHM in drinking water. Further research proved this to be imprecise and incorrect. Thus, they amended their recommendation to be one part per billion. However, the damage to their credibility was already done and people continued to distrust the water and rely on alternate sources. This kept the system in bifurcation rather than moving it towards self-organization, which was contrary to the goals of the organizations.

Strange attractors are common values and points of organization to which a system in chaos is naturally drawn. These values are usually represented by the established organizations, and they provide stakeholders with a sense of order and the reassurance of an eventual return to normal. In West Virginia, the established organizations failed to represent these values and sense of order. Freedom Industries failed to cooperate and offer any helpful information or even a simple apology. The water company failed to acknowledge the lack of normal operating procedures and made several missteps that sent the system back into bifurcation. Though the National Guard and FEMA were able to provide relief for a short period of time, they left the system before order was restored and the crisis had ended. Because of these failings, it fell to the

stakeholders to take on this role. Motivated by community ties and strong values, they self organized into emergent groups and became the strange attractors that spurred the system towards self-organization and away from bifurcation. They represented the strange attractor values and provided the much needed sense of order. Because of this, they connected as strange attractors and precipitated self organization. These groups and their functions are described in more detail below.

RQ 2: What emergent organizations were observed during this crisis?

The data used for this analysis and to address this research question comes from social media. As stated in Chapter 4, this definition was used to characterize the emergent organizations present in West Virginia: an organization that did not exist prior to the contamination of the Elk River on January 9, 2014 but was formed in response to that event and used some form of ICT to carry out the majority of its functions. Thus, five emergent organizations were discovered through the tracking process. This section describes how each organization fits this definition, each group's mission, and how it used ICTs to operate (see Table 5.1).

West Virginia Clean Water Hub. The Clean Water Hub was one of the first groups to emerge on social media. This page was created on January 10, 2014, the day after the spill occurred, and the group performed a variety of functions throughout the crisis. Its page description reads

We have been coordinating deliveries of water and needed supplies through direct response to requests from community members...We know that the water crisis in West Virginia will not end when the water in the 9 counties affected by the

chemical spill stops smelling like licorice...Your donation will go towards water supplies [and] help support our volunteers”(WV Clean Water Hub, 2014).

These statements highlighted not only the spill as the impetus to form, but also acknowledged that this situation did not lend itself to an easy solution or quick recovery.

In the early stages, there were posts requesting donations of supplies, bottled, water, money, etc. and information about distribution of those donations and other supplies. In addition, community members could make posts to the page themselves requesting assistance, sharing information about the situation, or offering aid in other ways. When posts requesting aid were made, the people behind this Facebook page used the powers of social media and community to see that the needs were met as best as they possibly could. The group continued to perform these functions long after the established relief organizations left town. Acknowledging the unique circumstances of this crisis allowed this organization to establish its clear mission of continuing to provide bottled water and seek long term solutions from the outset.

Dr. Walton and engineering graduate students. A second emergent organization was the team of engineers lead by Dr. Andrew Walton, at that time a professor at the University of South Alabama. Walton and a group of civil engineering students, having heard about the crisis, packed up and drove to Charleston, West Virginia, without prompting and without monetary compensation. They simply felt their skills, particularly in scientific testing of piping systems tainted by chemicals, would be useful to the affected community. After arriving in town on January 17, 2014, one week after the spill occurred, the team collected samples and performed tests on household plumbing systems affected by the contamination (Smith, 2014). They reported their

results and made recommendations for proper flushing procedures. Because these operations were so desperately needed at the time, the West Virginia governor, Earl Ray Tomblin, requested that Walton take on a more permanent role as part of the West Virginia Testing and Assessment Project (WVTAP). This project was created as a way to do more home testing on different types of plumbing materials and report results, as well as to establish an odor threshold for MCHM and evaluate the safety factor of MCHM (Office of the Governor, 2014). Though this group did not have an official social media page used by all members to provide updates and share information, Dr. Walton did share frequent updates via his personal Twitter account and also formed a partnership with the creator of the West Virginia Water Crisis Blog and used that as an outlet for sharing information and communicating with affected stakeholders. This sharing of resources between two emergent organizations is discussed in more detail below.

West Virginia Water Crisis Blog. A third emergent organization is the West Virginia Water Crisis Blog, which was created by West Virginia native and self-described Appalachian advocate, Kristal Byron. Kristal, at the time of the spill a PhD student at Ohio University, created the blog as a space for affected individuals to share their stories and experiences. Shortly after the spill, she traveled back to her home state, video camera in hand, and began interviewing people. She posted their video interviews or written accounts to this blog, which over time became a narrative account of the event and its aftermath as told and experienced by the victims themselves. Its creator, a native of the affected area, was able to see the impact on individuals and the unique emotional needs that were brought about by this crisis. Therefore, her blog primarily served as the medium for people to express emotions and share their stories and experiences.

The second important function that this blog performed was information sharing. Several of her updates shared information about when and where she would be conducting interviews, but she also posted several pertinent informational updates regarding Erin Brockovich's investigation and preliminary findings, as well as information from Dr. Andrew Walton, the civil engineer. A blog post from January 19, 2014, featured a video of Dr. Walton providing information about flushing piping systems. Six days later, on January 25, a second post featuring Dr. Walton gave the instructions for pipe flushing in written form and also answered the ten most common questions that he had received from residents since arriving on scene. A third informational update was posted on April 1 and featured a video of the March 28 public meeting at which the WVTAP gave the preliminary results of its testing. This coordination between the two groups is important to note and will be discussed in more detail below.

West Virginia Moms for Safe Water. The West Virginia Moms for Safe Water created its Facebook page on February 6, 2014, less than a month after the spill. The first post to the page was a request for signatures to a petition requiring the schools to use bottled water for the remainder of the school year. Though the page included posts with information about all aspects of the water crisis, it had a clear focus on how the contamination was affecting schools and school-aged children. In the "about" section of the page, the moderators self-described the group as "a group of moms who are demanding accountability and transparency for the WV water crisis. We demand SAFE water for our children!!" (West Virginia Moms for Safe Water, 2014). Based on this description, it is clear that though the dissatisfaction might have been present to some

degree before the spill, it was this contamination event that spurred the creation of this Facebook page for coordination and taking action.

Easy Action of the Day for WV Water. Two Facebook pages created and monitored by the same group were formed within a few months of each other. The first page was entitled Easy Action of the Day for WV Water and it was created on February 1, 2014, less than one month after the spill occurred. It explained its mission as “We post exactly one action each day that takes <5 minutes and helps prevent another water crisis. Don't just "like" us, sign up for notifications!” (Easy Action of the Day for WV Water, 2014). It provided daily posts with one simple activity that would take users less than five minutes, but would be a step towards safe, clean water in West Virginia. These daily posts suggested things like signing a petition, contacting a congressional representative, or simply sharing a post with information on their personal Facebook pages. The second Facebook page created by the same group is entitled Advocates for a Safe Water System. This was also created shortly after the spill, but with a different goal than the Easy Action page. This was formed with longer term goals in mind that centered on the West Virginia American Water Company. According to the page description, “New Jersey-based West Virginia American Water is still refusing to invest in a safe, reliable water system, while letting our infrastructure fall apart and raising our rates. In September 2015, we launched the Our Water campaign for a public takeover of the Kanawha Valley's water system.” (Advocates for a Safe Water System, 2014). This page serves as a way to keep people informed about activities related to forcing the current water company out and creating a locally owned water municipality. The Facebook page links people to the official website and provides updates about community activities. Though the two groups are run by the

same people, the Easy Action of the Day was the original emergent organization that formed as a direct result of the water crisis. Therefore, this analysis focuses only on posts made to the original Easy Action page, and not on those posts made by the Advocates for Safe Water page.

Table 5.1 Emergent Organizations and Defining Criteria

Organization	Date of Formation	Use of ICT
WV Clean Water Hub	1-10-14	Created Facebook Page
WV Moms for Safe Water	2-6-14	Created Facebook Page
Easy Action of the Day for WV Water	2-1-4	Created Facebook Page
WV Water Crisis Blog	1-11-14	Created Blog site
Dr. Walton and engineering students	Arrived in WV 1-16-14	Personal Twitter acct, WV water crisis blog

RQ 3: To what extent did the emergent organizations make use of social media to form and carry out operations during the crisis?

Each organization formed within a month of the spill, so the initial/founding post from each group fall between January 10, 2014, and February 6, 2014. Traditionally, emergent groups only remain active during the initial response phase of the crisis. However, in some instances they linger into the recovery phase and alter their activities to fit the needs of the situation (Stallings & Quarantelli, 1985). This was the case in West Virginia. In fact, four of the five groups discussed are still actively posting at the time of writing this dissertation. Therefore, rather than focusing just on posts made during the “acute” phase of the crisis, or selecting a specific range of dates from which to gather

posts, this data set includes all posts made by the group in the year 2014. Covering the full calendar captures the full variety of activities performed by each group from the very beginning stages when urgency and needs were high to nearly a year after the spill occurred when needs were still present, but different.

Using a thematic coding technique, each post was assigned a certain code based on its content. The coding scheme consisted of four themes: information sharing, requests for aid, the human interest angle, and activism opportunities. The information sharing code describes those posts that provide the audience with necessary information whether it be in the form of links to news articles, instructions for self-protective measures, or details about supply drop offs and deliveries. The request for aid code applies to the posts made by those requesting donations of supplies or money, and those posts requesting help with pick-ups and deliveries of supplies. These pages served as a way to raise awareness for the needs of the victims. The human interest angle is a major theme consisting of two sub themes: philanthropy activities and the impact on the community. This theme highlights both instances of people in an out of the affected community donating their time and talents to the cause as well as the human interest aspect of the event. This applies when the posts described the impact on an individual or a community, or posts where the individuals themselves described their personal experiences and opinions. The final theme, opportunities for activism, describes those posts that encourage people to take some form of action in response to the water crisis (e.g. signing a petition, emailing a representative, etc.). What follows is a description of the thematic analysis of the posts made by each group. For a visual representation, see Figure 5.1.

WV Clean Water Hub. The West Virginia Clean Water Hub page posted 79 updates to its Facebook page in 2014. Of those 79 updates, the majority (n=37) were coded as information sharing, followed by human interest (n=17), requests for aid (n=15), and activism (n=10) (see Figure 5.1). As stated before, this page was created with the primary goal of helping affected stakeholders get the supplies that they needed. Many of the information sharing posts were about water drop off points and which grocery and convenience stores in the area had bottled water in stock. The requests for aid and human interest/philanthropy posts often went hand in hand on this page as the moderator would post about a unique need (e.g. a homebound individual who couldn't make it to a distribution point and instead needed a delivery) which was usually followed up with a post featuring the individuals who helped meet that need. This underscores the importance of this particular emergent organization and the roles it assumed. When the established relief organizations left town but there was still a clear need for bottled water distribution, many individuals were unable for health or other reasons to make it to a distribution point or go to the store and purchase it themselves. Without its primary focus on water and supply distribution, many would've been unable to get the things they needed to endure the water ban, and this would've only exacerbated the negative effects of the crisis and caused more harm in an already hazardous situation.

West Virginia Water Crisis Blog. The West Virginia Water Crisis blog published its first 15 posts on January 11, 2014. Altogether, it published 46 posts in January 2014 and 60 total posts in 2014. All 15 posts that were published that first day were personal stories from impacted individuals. These appeared in either written or video form and consisted of an individual talking about his or her experiences in the days

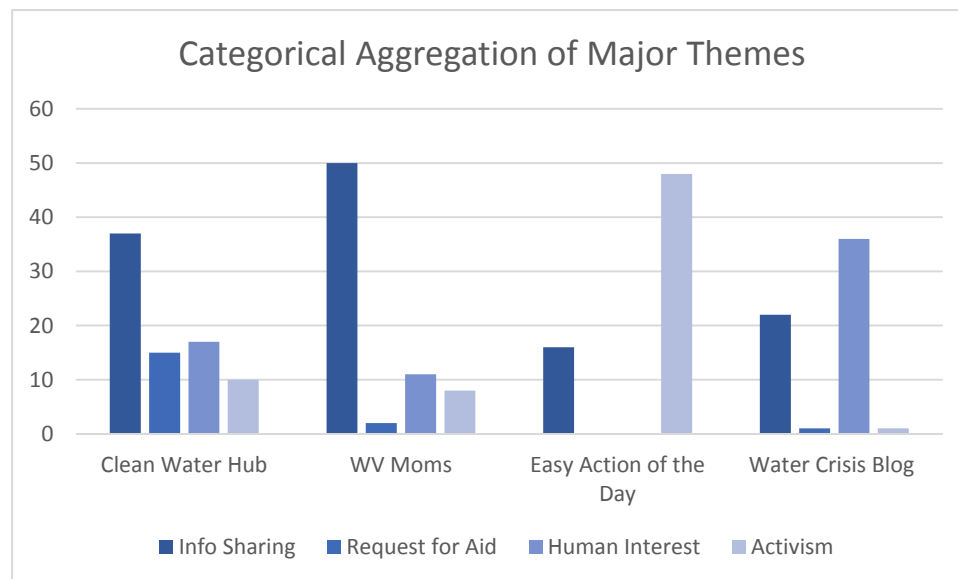
following the spill and the issuing of the do not use order. More than half of the posts (n=36) are in this format and were coded as human interest, more specifically the sub theme of community impact. The remainder of the posts were coded as information sharing (n=22), request for aid (n=1), or activism (n=1) (see Figure 5.1). The large number of community impact posts again highlights the unique mission of this page and its ability to help people process their feelings surrounding the event, and to create a community narrative of the event as told by the victims themselves. The second highest category, information sharing, again reveals the symbiotic relationship between Byron and Walton as she used her platform and following to give him a medium for communicating the pertinent information and messages for self-protection he had for the stakeholders. Closer attention is paid to this relationship in the conclusions.

WV Moms for Safe Water. The West Virginia Moms posted to its page 73 times in 2014. The majority of these posts (n=50) were coded as information sharing, with human interest as the second highest category (n=14). The third category was activism (n=8), and request for aid (n=2) was the smallest category (see Figure 5.1). This page was started with the intention of focusing on how the water crisis affected children, therefore, much of the information that was shared focused on how school districts were handling the crisis, and the activism posts related to a petition circulating that would require the school districts to use only bottled water for the remainder of the school year. This page was also used as a recruiting tool to find parents of school aged children who had been negatively impacted by the spill to participate in an interview with CNN.

Easy Action of the Day for WV Water. The Easy Action of the Day page posted 64 updates to its page in 2014. Of those updates, 48 were coded as an opportunity for

activism and the remaining 16 were coded as information sharing (see Figure 5.1). This abundance of activism posts is logical when considering that the page was created with intention of providing followers with a daily easy action they could take to ensure a safe water system for the state. The information sharing updates that were posted were usually in regards to actions suggested in previous posts, such as an update on legislation that they had asked followers to contact their representatives about. Additionally, the page shared informational updates from other Facebook pages with a similar mission, such as the Friends of Water page.

Figure 5.1 Categorical Aggregation of Major Themes



RQ 4: To what extent did the unique characteristics of this crisis impact the functions performed by the emergent organizations?

In depth interviews were conducted with four individuals considered to be the founders or organizers of one of the emergent organizations described above. Each interview lasted between 20 and 45 minutes, were recorded, and later transcribed by the

author. A thematic analysis was performed on the transcripts and the researcher observed four themes emerging from the interview data: failure of established organizations, the human interest angle, the shift to new media, and inter-organizational coordination. This section discusses and describes each of those themes, and provides data in the form of quotes pulled from each interview that exemplify that theme. Discussing each theme individually, rather than each interview individually, demonstrates the prevalence of these four themes in each interview and the similarities in the thoughts expressed by each interviewee as they related to these themes.

The failure of established organizations theme represents the sentiment shared by several of the interviewees that the organizations that should have been leading the response (e.g. Freedom Industries, the West Virginia American Water Company) failed to do so and did not meet the informational or physical needs of the affected stakeholders. Dr. Andrew Walton, the civil engineer, who after seeing the event drove to Charleston with a group of graduate students, said “the federal government basically butchered the response and we went up there to assist people with flushing their plumbing systems and kind of help out the community that was affected.” According to him, a primary failing was the lack of common voice among all organizations, “we had a science battle, we had a risk communication, even with the organizations that were supposed to be responding effectively...but when we got engaged we brought everybody together and said this stuff has to stop and you need a common voice.” Because of this lack of cooperation, Dr. Walton was able to step into his official role with WVTAP and help unify the diverse groups involved in the response.

Byron shared a similar anger with the federal government's failed response. "A lot of people were very angry with the state government" she said, "but come to find out that they were really clueless about what to do and they had no plan in place. That's the job of the federal government to give each state emergency plans for things like this." Further, when the state government turned to federal authorities for assistance, she said they were given conflicting messages. She highlighted a notable instance of this when the CDC made its initial recommendations about drinking water safety but then quickly amended the statement to exclude pregnant women. According to her, "people were very upset about that. I talked to several mothers as well. I think that it's assuming people are ignorant...what I wanted to do with the video with Andy was to give the people scientific information that they needed to make their own decisions." Her comments highlight not only the failure of the established organizations to take appropriate action, but also their failure to know their audiences and how their mistaken assumptions about literacy and informational needs exacerbated the problems. Dr. Walton echoed her frustrations and criticized the CDC for making what he considered to be an irresponsible recommendation. "The safe exposure levels that the CDC announced was not based on inhalation or dermal exposure, they only considered if you ingested the water," he said. Again, an example of an organization that failed to act responsibly.

In addition to the government's failed response, Byron also noted that one of the relief organizations sent to help with the response and recovery, the National Guard, failed to carry out its duties properly when it came to testing the water for the presence of the contaminant. "The National Guard was not using laboratories that could test chemicals at the very small level that they were testing them. So they just didn't even use

the resources that they needed,” she said. This lack of appropriate response was not just noticed by these organizers, but by the community as a whole. According to Nicole of the Clean Water Hub, “[the citizens] were so angry, they were so outraged about the government and the lack of response and the complete abandonment by the state and federal governments.”

In addition to the failures of the governmental organizations, there was also frustration with the West Virginia American Water Company for its failure to respond appropriately. Kathy, of the Easy Action of the Day page, said “[the] unwillingness of the water company to share certain information from the past made us think that really this is a company that’s priorities are not in line with ours.” According to Kathy these convoluted priorities stemmed from the water company’s defensive attitude about the event. She said “they fancy themselves a victim of Freedom Industries and when public sentiment turned against them, they, I think at first, were actually baffled by it and then they were very defensive about it.” Dr. Walton pointed specifically to the water company’s initial hesitation to change its filters as a major point of failure, “instead of acknowledging that yes they were contaminated they said yes they were going to change the filters simply because of other reasons. So they didn’t ever acknowledge it,” he said.

Nicole highlighted how this company’s failure in particular impeded the water hub’s efforts to maximize effectiveness. “No matter how much willpower and how many resources a group of concerned citizens has, we are not able to replace a municipal water source...the larger infrastructure was not there to actually give these people the clean safe drinking water,” she said. This also points to the failures of the water company to respond effectively. Despite the fact that it was not responsible for the spill, public sentiment still

put blame on the water company for the actions it took (or in some cases did not take) in the days and weeks after the spill. Taken together, these interviews highlight the failures across the board of the established organizations (federal and state government, relief organizations, and the water company) to respond appropriately and effectively.

The community involvement angle is prevalent in the interviews. This theme encompasses the idea that many in the affected community were willing to participate in response and recovery activities. In an interview with an organizer from the WV Clean Water Hub, she expressed her surprise at the number of people both in and out of the state who wanted to help. She said, “we were...flooded with people calling us and asking us how they could help...they wanted to come to west Virginia and they want to help move water and they want to bring us water. We were flooded with people asking how they could help.” She also reported people helping in a major way by helping spread the word about the Clean Water Hub and its mission. “At one point it started becoming word of mouth. One person would get the phone number and then they would start giving it out...[or announced it] in church the Sunday before...so it was a lot of word of mouth and it was a lot of people moving information around their communities themselves,” she said.

This desire to help her community was the primary reason Byron formed her blog. As a West Virginia native who no longer lived there, she struggled to find a way to help her affected fellow community members. According to her “it was very difficult to process what was happening and the thought that I could help other people process it better by allowing them to tell their stories and allowing them to see other people’s

personal stories was really important to me.” That desire to help with processing guided her choice of medium and the type of content she posted.

Kathy said that the Easy Action page was created as a result of a community meeting, “in the immediate weeks and months following the leak, through a series of community meetings, one group broke out to focus on the actual water utility.” Thus, they took advantage of the existing desire of those community members to participate and applied it to their desired goal of changing the water utility for the state and they channeled that into action. “Our first action was to teach people how to file formal complaints with the public service commission, and in doing that our focus became about the utility,” she said. Because of the prevalence of these feelings, this group was able to take advantage of it and turn it into a high level of productive community involvement in seeking lasting change.

The shift to new media represents a trend that has been observed in the crisis communication literature for several years: people are turning to new media technologies during a crisis with increasing frequency. This held true in West Virginia and was amplified by the lack of information coming from traditional sources. Thus, the emergent organizations realized that to be effective and reach the majority of their intended audience members, they needed to reach them through mediums they were familiar with and already used on a regular basis. Dr. Walton’s comments exemplify this phenomenon “we used social media effectively and I also engaged the media too because when there is no credibility in any of the organizations that are responding, everybody will turn to the media.” This was also expressed by Kathy, who said that using social media to communicate with stakeholders and share information was an easy decision for her

group. “That is our reality today: if you want to promote something you use social media and that’s just the way it is across the board. But also, as it pertains particularly to the water crisis, again it seems like it was a way for people to get information that they weren’t getting otherwise or that they were having to wait for,” she said. Nicole echoed these sentiments about the public turning to ICTs for information sharing and gathering, “The vast majority of our...interfacing with the general public came from Facebook.” However, she did acknowledge that while it has its benefits, it also has drawbacks. “The Facebook page, though it was really excellent for sort of getting people to notice us and to interface with us...it became really cumbersome to make sure we checked every facet of the Facebook page to make sure we didn’t miss a single request,” she said.

While social media platforms like Facebook proved to be a popular and effective way to aggregate and share information, Kristal Byron opted to use a blog because of its ability to aggregate information. “For me it made sense to collect all of that on the blog. It was quick and easy and a lot of people were posting reposting articles or they were posting little quick videos of bad water or images of bad water on the Facebook groups, which I think is good but it’s not searchable [and] it’s hard to really take a broad a more organized view,” she said.

The final theme that emerged from these interviews was the theme of communication and coordination among groups. It is interesting that most of the organizers had worked with each other at some point and had knowledge of the other emergent groups’ operations because of the visibility afforded by the use ICTs. Perhaps the best example of inter-group coordination is the symbiotic relationship formed between Dr. Andrew Walton and Kristal Byron of the water crisis blog. As mentioned

previously. Dr. Walton and his group of engineering students was the one emergent group to not create a new social media page as part of its response. Instead, Dr. Walton provided updates via his personal Twitter account using the hashtag #wvwatercrisis. He provided a lot of useful information and timely updates, especially as it related to water and water systems safety, but as an outsider, he did not have a large local following. On the other hand, Byron was a local and her blog had several thousand visitors within its first week of existence. According to Byron, she was connected to Walton via a third party, and first contacted him through email. She said “I emailed Andy and they were testing, so I went down to West Virginia and he said ok we can meet in the lobby of our hotel and I came in and there’s this whole team and they’re planning their testing for the day.” After that initial meeting, it became clear that Walton had pertinent information to share with stakeholders and Byron had the platform and following to facilitate information dissemination. Thus, the symbiotic relationship began, and Walton was featured in several blog posts giving updates about his team’s testing results, proper flushing procedures, and general informational updates.

Walton commented on the success of the relationship as well. “We teamed up with Kristal to create that flushing video and I think we had...3,000 hits in the first 20 hours or something,” he said. He also said that this publicity and increased visibility led to him being contacted by residents seeking answers, “we started receiving around 600 emails a week from residents and people affected asking for advice and stuff like that,” he said. This represents to emergent groups coordinating and sharing resources in such a way as to maximize effectiveness and connect the stakeholders with the information and resources the needed.

Kathy from the Easy Action of the Day group also described the focus on coordination and division of labor. In particular she described one large group meeting where those interested in participating in the response were able to find the group that best fit with their abilities

imagine a big church basement with community members who wanted to do something at different tables and it was like ok if you want to work on legislation go to that table and if you want to work on our women's health or the health implications of this go to that table. And some of us went to multiple tables. This level of coordination helped to avoid duplication of efforts and match up people with certain skills to the group that could best utilize those skills.

Nicole attributed this successful coordination between groups to everyone's willingness to put aside differences in political beliefs and focus on the tasks at hand. "We were very determined to not politicize the water, and I believe that really helped...I think that it brought a lot of trust between the different groups of people and sort of crossed some of those political boundaries and that's what we really wanted," she said.

Taken together, these interviews and emerging themes paint a clear picture of how and why the ephemeral organizations formed in response to this water crisis. The established organizations that should have lead the charge failed to do so and did not meet the physical and informational needs of stakeholders. The relief organizations that were present at the outset left when the crisis ended and the official ban was lifted, even though this did not mark the end of the crisis in the minds of the victims who did not trust the water and sought alternate sources. These failures and distrust created frustration and a desire to do something to help within the community. These values are usually

expressed by the established organizations, but they failed to do so. As a result of these feelings, emergent organizations formed and took it upon themselves to self-organize and perform tasks required to meet the unique needs of those affected by this disaster. Because they realized the prevalence of ICTs in our increasingly networked and technology dependent society, chose to use social media and other platforms to form and operate. The efficiency of these mediums for rapid communication and information exchange meant that they could form quickly, recruit followers from a larger network, and efficiently disseminate messages across a geographically diverse system. These mediums also allowed for a great deal of coordination could occur among and between the groups to maximize efficiency and avoid duplication of effort.

Summary

Four data points are analyzed in this chapter. First, an in depth description of the case shows how this is an ideal fit for chaos theory. Each tenet of chaos theory (sensitivity to initial conditions, bifurcation, fractals, strange attractors, and self organization) is related to one or more events or phenomenon present in West Virginia. Special attention is paid to the link between strange attractors and self organization because of the unique way these manifested in West Virginia. The self-organization was spurred by strange attractors in the form of emergent organizations. By relating the tenets of chaos theory to the events and details of this case, I demonstrate the appropriate application of the theory.

Data gathered from social media is used for a categorical aggregation of each emergent organization to provide an in depth description of each group and its goals and activities. Additional social media data is used for a thematic analysis of all posts made

by the group in 2014, which covers the immediate response as well as the recovery phase of the water crisis. The thematic, data driven coding revealed four themes: human interest, information sharing, requests for aid, and activism opportunities. By providing the visual representation of the coding results in figure 5.1, it is easier to see the similarities and differences in the groups' functions and posting activities. All of the groups participated in information sharing to varying degrees. Several groups also focused on requesting aid and highlighting the human interest aspects of this crisis while others built on the growing feelings of dissatisfaction to spur people to take on an activist role. Taken together, these two types of analysis provide a clear picture of each organization's defining characteristics and goals and allow the researcher to make comparisons and draw conclusions about emergent behavior in this crisis.

The final analysis involved data collected from in-depth interviews conducted with four individuals associated with the emergent organizations, which focused on their experiences, the use of new media, and the lessons learned from the event. The themes that emerged from that data set are the failure of the established organizations, high level of community involvement, the shift to new media, and the coordination among groups. Quotes from each interview both exemplify the themes and show the prevalence of them across all four interviews.

Chapter 6: Conclusions and Implications

This chapter describes the conclusions drawn from this research and the larger implications that result from it. I address the research questions laid out in Chapter 1 with the intent to provide answers to those questions revealed through the data analysis procedures described in Chapter 5. By returning to the literature discussed in chapter 3, I discuss how this research expands the theories and contributes to this body of literature. Specifically, I refer to Creswell's (1998) naturalistic generalizations as a guideline for the discussion. By using an in depth case study method, I was able to observe themes in this case that can be generalized to other contexts. After providing the answers to each RQ and the conclusions that relate, this section ends with a discussion of the limitations of this research, suggestions for future directions, and a final conclusion.

RQ 1: To what extent were the tenets of chaos theory apparent during the West Virginia water crisis?

Organizations that experience a crisis fit the model of a system in chaos. The body of literature cited in Chapter 3 shows its successful application to a number of different crisis events, from natural disasters to criminal activity (Seeger & Sellnow, 2001; Freimuth 2006; Liska et al., 2012; Horsley, 2014). However, this case is the first application of chaos theory to an environmental contamination event of this nature, and the first application to a water contamination crisis. Thus, this work builds on the existing body of literature and applies the theory in a new context.

From the moment that the hole developed in the bottom of the tank at Freedom Industries, a chain of events and points of bifurcation began that set the system into chaos. When the water company issued the "do not use" ban to its 300,000 customers, it

created a large amount of uncertainty and fear for those individuals. Given that most, if not all, had not experienced a water ban of this magnitude before, they most likely experienced a collapse in sensemaking for these victims. Weick (1993) refers to this as a cosmology episode because people experience the feeling of having never been in that situation before and having no idea where to turn for answers.

Fractals allow the observer to see the overlying patterns in an otherwise chaotic and disordered system. However, observing the pattern is difficult if one relies on an imprecise measurement system. This was the case in West Virginia on two occasions. First, the water company failed to issue the do not use ban immediately after learning of the contamination because it assumed the filtration system would take care of the problem. However, this failed to realize the absence of normal operating conditions due to the multiple points of bifurcation that had occurred to that point. The second failure occurred when the team charged with creating an acceptable recommended threshold for MCHM in drinking water made an initial recommendation of one part per million. The team quickly retracted this recommendation when they realized it did not take in to account the safety of pregnant women, small children, and the elderly. After adopting a more precise measurement pattern, they made a new recommendation of one part per billion.

Strange attractors and self-organization go hand in hand in a chaotic system. Strange attractors are those things present within the system that spur the self-organization (anti-chaos) process. In previous studies strange attractors have taken the form of official relief organizations such as FEMA and the National Guard, or a top law enforcement officials (Sellnow et al., 2002; Horsley, 2014). In West Virginia, the

established relief organizations and top officials who should have lead the response and functioned as strange attractors failed to perform their duties effectively. Therefore, the system had to create other strange attractors to pull itself out of chaos. This process occurred through self-organizations among the concerned citizens and victims themselves. These emergent groups self-organized by using the networking and information sharing capabilities of social media and other ICTs. Because they performed the duties and met the needs of stakeholders being neglected by the established organizations, these groups represented the strange attractors that spurred self-organization into emergent organizations.

RQ 2: What emergent organizations were observed during this crisis?

Emergent behavior after a crisis has been observed by disaster sociologists and researchers for decades. Quarantelli and Dynes (1985) disaster typologies clearly define the emergent organizations as those which perform new tasks using a new structure. Lanzara (1983) labeled the same phenomenon using the term ephemeral organization to describe those groups which he observed coming together in response to a crisis, having never existed in any format prior to the event, and performing a myriad of tasks as dictated by the situation at hand. This is in contrast to the “myth of the panic prone public,” which purports that people behave erratically and irrationally in a crisis. What years of observation have shown is quite the opposite, while there is some panic amongst victims, there are often more examples of pro-social emergent behavior, of ordinary citizens coming together to help out their fellow man in a time of need (Rodriguez et al., 2006). This process is only amplified when established organizations fail to respond properly (Drabek & McEntire, 2003).

This was certainly the case in West Virginia. Using a definition as guided by the DRC typologies (Quarantelli & Dynes, 1985) five emergent organizations were identified (see Table 5.1). These groups were: WV Clean Water Hub, WV Moms for Safe Water, Easy Action of the Day for WV Water, the WV Water Crisis Blog, and the group of engineers lead by Dr. Andrew Walton.

These organizations were visible in all phases of the crisis because of their reliance on ICTs to help them form, recruit members, share information, and perform other important group functions. While a great deal of research has been done on emergent organizations in crisis, less research has been done on emergent organizations in networked, technology based world that is the current reality. This study focuses extensively on the emergent organizations' use of ICTs to form and operate. Because of the nature of the crisis in West Virginia, there was no centralized physical location that made sense for people to gather. Therefore, ICTs provided a virtual space for emergent behavior to occur. These observations add to a small but growing body of literature that describes how ICTs are changing emergent behavior in all phases of a crisis.

Several unique characteristics of this event made it ripe for emergent pro-social behavior. First, this event was different from other disaster in that it did not leave a path of physical destruction or a "ground zero." Previous observations of emergent groups have shown that they gather at these physical disaster sites to coordinate and work. In West Virginia, there was no such space, therefore, cyberspace became the logical "meeting place." A second and related characteristic is the fact that the lack of damage to infrastructure also meant no damage to utilities and no interruption in power, internet, or cellular services. When a disaster damages power lines and takes down cell towers, it

interferes with internet service and access to social media and other ICTs. Again, this water crisis did not wreak havoc on those systems, so people did not have to worry about power outages and could freely participate in online emergent organizations without interruptions to their services. Taken together, these characteristics demonstrate why ICT enabled emergent organization was so prevalent in this case.

RQ 3: To what extent did the emergent groups make use of social media to form and carry on operations during the crisis?

An important aspect to note is the fact that each of these emergent organizations formed with a unique purpose and carried out a unique mission separate from the other emergent organizations present in the system post crisis. These clear distinctions were evident in the coding of the data (see Figure 1). The Water Hub page posted more requests for aid (n=15) than the other pages, reflecting its focus on soliciting, collecting, and disseminating necessary supplies and highlighting those unique physical needs of community members that were not being met. The Easy Action of the Day page had more activism related posts (n=48) than any other group. Naturally this aligns with its self-described primary function of posting one simple action each day that people could take to advocate for a safe water system. More than half of the posts to the water crisis blog exhibited the human interest theme (n=36) because it was a dedicated space for storytelling and narrative building. Finally, the WV moms page featured more information sharing posts (n=50) than the other groups.

Because there was little to no duplication of effort, these organizations were better able to effectively serve the affected community and meet the wide variety of needs. Using social media allowed them to be visible not only to those they served, but also to

each other. This allowed for easy scanning of social media to observe the groups in action and to help guide the activities for other groups moving forward. This is a benefit of using ICTs and an example of how they have changed emergent behavior. Extending previous literature on emergent organizations, the increased level of visibility and ability to rapidly share information makes it easier to coordinate responsibilities and avoid duplication of effort. This ultimately benefits the victims because there are more groups performing a variety of tasks and meeting unique needs.

While this distinction in the major functions of each group is clear, it is also important to highlight the commonalities. All four social media pages were used to perform information sharing and activism opportunity functions. Three of the four also posted requests for aid and highlighted the human interest aspect. This demonstrates that while each organization had a clear focus, they all recognized the importance of performing a variety of functions in the wake of the event. Also, all of these pages remained active and continued to post updates on a regular basis through the end of 2014. Because this time frame spanned much of the crisis lifecycle, it is natural that the organizations would have adapted their behavior to fit the needs of the situation (Stallings & Quarantelli, 1985).

The commonality in medium choice also bears discussing. Three of the four organizations used Facebook exclusively as the medium and platform for operation. The water crisis blog used the blog site as the primary platform, however, founder Kristal Byron did create a Facebook page that linked to the blog and was updated each time a new post was made to the blog itself, including the informational posts featuring Dr. Walton. The importance of using both traditional and new media was also highlighted in

the interviews with the organizers. This reveals one of the major ways ICTs have changed emergent behavior and is discussed in the context of each individual organization.

The Clean Water Hub used social media to form and legitimize itself as an organization as it did not exist prior to the spill. As was established in the categorical aggregation, this group engaged in more requests for supplies and aid than the other groups. This primary function was aided by its use of ICTs in two ways. First, it changed the way in which it solicited donations. Secondly, it allowed the group to cast a wider net geographically from which to share its mission and make the requests for aid. Without the aid of ICTs to break those geographic boundaries, the group would've been limited to those who were local and heard about the group through word of mouth or other traditional media forms.

In addition to changing the way the group itself operated, ICTs also changed the way the stakeholders interacted with the group. Because of its use of a two way communication medium, victims can use ICTs as a way to communicate with different organizations. Palen et al. (2009) observed this phenomenon in the aftermath of the Virginia Tech campus shooting as those who were on campus were able to communicate information about the event and other victims to officials via ICTs. In West Virginia, people were able to not only share information about their personal situations, but also could make posts to the page with specific requests for aid in the form of supplies or information. When the Water Hub group learned of a unique need in the community, it was usually able to effectively meet that need in a short time frame. Without the use of Facebook as an efficient and instantaneous communication tool, those needs might've

gone unmet for some time or indefinitely. This case provides an excellent example of how ICTs have changed emergent behavior by providing a two way communication tool used by both organizers and victims.

The West Virginia Moms group also used Facebook to form and legitimize and gain followers/members. It performed all tasks exclusively through its Facebook page. As mentioned in the categorical aggregation, the majority of its posts were related to information sharing. Even those who did not participate in fundraising or supplies donations were able to participate in emergent behavior through information sharing. These individuals, termed by the literature as “digital volunteers” or “voluntweeters,” perform important crisis related functions and are likely to be observed, influential figures in future crises (Starbird & Palen, 2011; Starbird, 2011). Facilitating this role is an important function of emergent organization that bears closer observation. People who have a desire to provide assistance following a crisis but are limited by their physical location, socioeconomic resources, or physical abilities can still perform an important post crisis function by participating in this dissemination of pertinent information and messages for self-protection.

The Easy Action of the Day page was created with promoting activism as its primary goal. Given that to achieve those goals, large numbers of people are needed to join the cause, the use of a Facebook page was a wise choice. The page administrators recognized this, and not only asked people to follow the page themselves but also to share it on their own personal pages to attract more followers. Though the rapid information sharing capabilities are often touted as the most useful aspect of ICTs, it bears noting that in the case, the connectivity and networking capabilities were just as vital. According to

Farnham, Pederson, and Kirkpatrick (2006) “[it is not uncommon to use] preexisting social relationships, or the relationships they had recently developed, to secure resources...it was a common theme that tapping into one’s informal social network elicited results that were not available through traditional channels” (p. 42). This is an example of an emergent organization using social media to amplify a message and take advantage of its wide reach. This also exemplifies a form of activism that, when it occurs in cyberspace, is referred to as “slacktivism” because it is perceived as activism with little to no real action (Mozorov, 2009). However, recent studies reject the notion that engaging in online activism is somehow less than engaging in more traditional forms. According to Veil et al. (2015) “the notion that online activists are lazy ‘slacktivists’ should be dismissed...this case demonstrates that when you get enough people challenging a corporation, even online, change can occur,” (p. 107). Two examples from the West Virginia case support the notion that “slacktivism” is a misnomer for this behavior. Within a year of the spill, an important piece of legislation known as the “spill bill,” which contains the Aboveground Storage Tank Act and the Public Water Supply Act, was approved by the legislature and signed into law. Additionally a campaign known as Our WV Water was launched in September 2015 to remove the corporate owned water company and create a local water municipality. The successful passing of the “spill bill” and the strong support for the campaign rely largely on the overwhelming support shown online by these “slacktivists.”

The West Virginia Water Crisis Blog is unique among these groups not only for its choice of medium (a blog rather than a Facebook page) but also the primary function it performed. As discussed in the thematic analysis, the majority of the blog posts focused

on the human interest angle of this crisis, and more specifically featured individuals telling their stories, and sharing their emotions and experiences. Previous literature on emergent organizations focuses on their ability to help with the physical and informational needs as dictated by the situation, but little attention is paid to their ability to help alleviate some of the mental and emotional needs of the victims. Therefore, the narrative created by the posts to this blog is not only a clear example of an emergent organization using ICTs to perform a new function, but it also creates a digital record of the crisis from the point of view of the victims. All of those stories combine to create a unique and personalized account of the event, and the use of a blog facilitated the aggregation and posting of those personal narratives.

The second major function performed by the blog was information sharing. This was facilitated by the relationship formed between blog creator Kristal Byron and Dr. Andrew Walton. This collaboration between the two emergent organizations shows a wise sharing of resources. Dr. Walton's group was the only group observed in this study that did not create a new social media page as part of its formation. The Water Crisis Blog gained a steady following shortly after its creation, but had focused primarily on the human interest aspect of the story and less on providing pertinent informational messages. Dr. Walton, as the civil engineer performing tests on the affected piping systems, had the information that the people wanted and needed, and the blog had the medium necessary to reach people. By combining their resources these two emergent organizations were able to provide a large audience with important information for self-protection.

RQ 4: To what extent did the unique characteristics of this crisis impact the functions performed by the emergent organizations?

Creswell (1998) defines naturalistic generalizations as “generalizations that people can learn from the case either for themselves or for applying it to a population of cases” (p. 154). In essence, what were the lessons learned by observing emergent organizations and their use of ICTs in this crisis that can be applied to future cases? With this larger goal in mind, the interviews with the organizers of the emergent organizations focused on the lessons learned throughout the process, the choice to use social media, and how it dictated the messages disseminated by the group. Taken together, these four interviews reveal several themes and point to important lessons learned that can be used by future emergent organizations dealing with similar crisis events.

The first theme, as demonstrated by the interview data, was a consensus among s interviewees that the established organizations (federal government, state government, Freedom Industries, West Virginia American Water Company) did not do what they should have as part of the response efforts. This collective failure of the established organizations spurred many of the emergent organizations to form in the first place and is a contributing factor to why several emergent organizations are still active and posting more than two years after the spill. In addition to providing informational updates about the ongoing court case involving several Freedom Industries top officials, the organizations have shifted their focus to the long term goal ensuring a safe water system and avoiding a repeat of a water crisis such as this one.

Each of the interviewees stressed the importance of using social media and ICTs as communication tools. They all acknowledged that in todays networked, technology-

driven world, the use of social media is not so much a luxury but a necessity for those charged with communicating in a crisis. Additionally, they acknowledged that in this unique situation where the established organizations were failing to disseminate pertinent information via any media channel, people were turning to social media with greater frequency to try and find the information they desperately needed. These two factors contributed to the emergent organizations heavy reliance on ICTs to form, communicate with stakeholders, and carry out important functions thus changing our perceptions of emergent organizations in the future.

The nature of the crisis that occurred in West Virginia is unique and expands our understanding of emergent organizations to a new context. Previous studies of emergent behavior have largely been in the context of natural disasters such as hurricanes or wildfires (Sutton et al., 2008; Rodriguez et al., 2006). These types of events leave a trail of physical destruction and a “ground zero” that provide a natural place for people to gather and perform various tasks. In the case of West Virginia, this contamination did lead to a lot of damage, but not in a centralized location. The Freedom Industries plant was closed to the public, so it was impossible to gather there, but there were 300,000 individual households that could be considered damage sites. Using ICTs provided a virtual space for people to gather to accomplish the work of the emergent organization, and the lack of a physical gathering place naturally lead to emergent behavior in cyberspace.

Another unique aspect of this crisis, besides its nature, is the larger context of repeated environmental contaminations this state has experienced for decades. Though this water contamination event was the largest and perhaps most devastating in terms of

impact, it is certainly not the first time West Virginia has experienced an environmental disaster because of the coal mining and natural gas fracking that happens there. The region where the majority of this activity takes place has been nicknamed “Chemical Valley” for years. The Elk River spill was the fifth major industrial accident in eight years (Osno, 2014). This unfortunate history has contributed to the fact that many of these emergent groups are still active more than two years after the spill. As Kristal Byron said, “I also think you have to look at the history of the region and you have to look at people’s relationships with the government and extractive industries over the last more than a century now to really get a sense of why people might be distrustful to begin with.” This pattern of repeated crises has become an unfortunate reality for West Virginia residents, which has only contributed further to their desire to create lasting change and ensure a safe water system.

This pattern could also be a good indicator of why all of these emergent organizations are still relatively active more than two years after the spill happened. This is one characteristic of emergent behavior that does not fit with the previous literature. Because they are ephemeral in nature, these organizations typically perform necessary functions for a period of time until the crisis has moved from response to recovery and then disband when their services are no longer needed, often leaving no trace of their existence (Lanzara, 1983). However, each Facebook page and the water crisis blog are still active and posting, albeit not with as much frequency as in the early days of the crisis, but they have continued nonetheless. The group of engineers lead by Dr. Walton are no longer on the ground and doing testing work, but Dr. Walton continues to do research on MCHM and its effects in a more official role through the WV TAP.

Because these pages are still active and because there are long term goals regarding water safety over that the acute phase of the crisis, the public has been able to participate in the response to unprecedented levels. This is another unique characteristic of emergent organization in cyberspace. Previously, participation in an emergent organization was bound by geographic proximity to the disaster site. However, anyone with an internet connection can be part of an emergent group that uses ICTs to form and operate. In addition to breaking geographical boundaries, emergent behavior in cyberspace also allows participation regardless of physical ability or economic resources. The creation of roles such as “slactivist,” “voluntweeter,” and “digital volunteers” means that people can contribute by sharing information, circulating petitions, and showing their support in cyberspace.

The final theme that emerged from the interviews was the large amount of coordination that occurred between the emergent groups. Kathy of the Easy Action of the Day page mentioned the meetings in a church basement that allowed the groups to define roles. However, large scale meetings like this are not feasible or practical for all coordination activities. Again, social media changes and streamlines the process. Creating these public pages on the internet not only made the organizations visible to followers and stakeholders, but also to each other. Being able to not only use the networking capabilities but also the information sharing capabilities meant that these groups could stay informed of each other’s activities and avoid duplication of effort. Additionally, this knowledge of everyone’s “areas of expertise” is helpful when a group is approached by a stakeholder with a need that group cannot meet. Instead of turning

them away, they can point them in the direction of a related emergent group that is more suited to meeting that unique need.

Though emergent behavior post crisis for decades, the intersection between emergent organizations and ICTs is a newer area of research, but ripe for closer examination. Observation of the groups that formed in West Virginia show that a physical disaster site/gathering place and geographic proximity to it are no longer prerequisites for membership in an emergent organization. People can participate in emergent behavior such as information sharing regardless of location, physical ability, and economic and other resources. ICTs have changed emergent behavior by allowing for the creation of a digital record of its existence. This also presents a new and unique aspect of emergent behavior for future study. These organizations typically disband and leave no trace or organizational memory apart from that experienced by its former members, however, when ICTs are involved, a “digital history” is created. As long as Facebook pages remain public, even if no active posting is occurring, the page still exists as a record of the group’s existence, its activities, and its interactions. Finally, ICTs have simplified coordination among emergent organizations and made their activities and goals more public. This helps the other groups responding to the event to know what territory is already covered, avoid duplication of effort, and point stakeholders in the right direction of an organization that can help them meet a particular need.

Limitations

This was a closely examined in-depth case study that provided information about how emergent organizations currently function in a chaotic, crisis situation. However, the study is limited by the fact that it is a single case focusing on a specific type of crisis that

might not generalize to other crises. An additional limitation is the failure to interview an organizer from the West Virginia Moms for Safe Water. Though multiple messages were sent, the attempts to schedule an interview with someone from this group failed. While this interview would have only enhanced this research, the completion of four successful interviews resulted in a rich data set from which many conclusions can be drawn.

Future Research

The nature of this crisis made it one of the first to be studied from this perspective, however, at the time of writing this dissertation a second large water crisis is taking place in Flint, Michigan. This instance is not an accidental contamination, but a governmental oversight that allowed residents to drink water contaminated with large amounts of lead. This event has brought the topic of water quality and safety to the forefront of political debates and has shone the light on the importance of ensuring the safety of our water supply. Given the multitude of conversations surrounding Flint and water safety in general, this is an ideal avenue for further research on this topic. Several instances of the active West Virginia specific Facebook pages posting messages of support for Flint and sharing information related to the Flint situation with their own followers have occurred recently. An interesting avenue for future research would be to examine if a knowledge transfer can occur between emergent organizations responding to similar crisis events that occurred in different places/times. For example, could those groups responding to the Flint disaster look to the Facebook pages used by the West Virginia groups for information and guidance for their own response efforts? This question certainly bears closer examination.

Additionally, the application of chaos theory to organizations in crisis is a budding area of research that calls for more widespread use and careful observation. Particularly, this study calls for more exploration of the self organization component of chaos theory and how crisis communication messages can help or hinder that process. Observing messages that are successful at meeting the informational needs of stakeholders and how they can move the system away from bifurcation can strengthen the link between effective communication and self organization.

Finally, researchers should continue to observe the emergent behavior post crisis, particularly the ways social media is used in this process. While work has already been done in this area, the ever evolving and changing nature of our technological landscape means there are new channels and modes for communication that can be used by individuals and groups in response to a crisis. Studies could examine emergent groups' use of newer technologies, new applications of older technologies, and how the technologies are changing the formation, operation, and prevalence of emergent organizations post-crisis. One specific question to be addressed by future studies is defining emergent organization "membership" in cyberspace. Does simply following or "liking" a page qualify you as a member, or is participation in the group's activities or collaborating in some way a better definition for membership? Additionally, examining how the "digital history" left in cyberspace by the groups can have an impact on future emergent organizations is a unique opportunity for future study. Finally, looking at how stakeholders interact with emergent groups via ICTs to make their needs and wants known and how effective it is for that type of interaction warrants closer examination.

Final Conclusion

When the water tank and Freedom Industries began leaking in the early hours of January 9, 2014, it set off a chain of events that would result not only in the largest drinking water contamination in American history at that time, but also an unprecedented level of community response and involvement in the relief and recovery efforts. In the immediate aftermath, there were five emergent organizations that formed in response to this event and were observed through their use of ICTs. They performed a variety of functions in the absence of a coordinated, effective response from the established organizations. Their use of ICTs allowed them to break geographic boundaries, establish two way communication with stakeholders, coordinate with other groups, and create a digital history of its activities.

Examining these emergent organizations through the lens of chaos theory helps to build the theory by connecting the chaos theory concept of strange attractors to the self-organized emergent groups that formed in this chaotic system. As was shown in the interviews with the organizers of the emergent groups, this failure of the established organizations to fulfil their duties was an impetus to form. That, coupled with the realization that social media and other ICT's are the new norm for information seeking and sharing, including during times of crisis, spurred them to use those technologies to form and perform many of their operations. Because they formed at a critical time in the crisis lifecycle and did the work that so desperately needed to be done, they became the strange attractors in the chaotic system. Though there were multiple points of bifurcation that sent this system into chaos, there was a strong enough desire within the system to move past bifurcation and into self-organization. This research demonstrates the

increasing complexity of crises and how that is compounded when organizations fail to respond properly. Emergent organizations are able to respond to this increasing complexity by using the networking and information sharing capabilities of ICTs to their fullest. When these groups use ICTs to form, gather followers, and operate, they are able to efficiently perform a number of vital crisis response tasks from sharing pertinent messages for self-protection to encouraging people's participation in online activism to bring about lasting change. These self-organized emergent groups exemplified the values of the strange attractors present in the chaotic system that helped spur the self-organization process and move the system out of bifurcation and towards a new normal.

Appendix A: Interview Questions

You are being invited to take part in a research study about organizational learning and change. You are being invited to take part in this research based on your role as an organizational spokesperson of an organization that has recently experienced a crisis directly or within your industry and implemented or proposed some type of policy or procedural change demonstrating organizational learning. You will be asked a number of questions about the incident experienced by your organization and how that incident was handled.

1. What lessons did you learn from the incident?
2. How did the response to the incident change the organization?
3. How did you seek to communicate those changes to the public?
4. What communication channels did you employ, and why (e.g., social media)?
5. What were the successful messages, what messages would you have changed?
6. What recommendations do you have for other orgs facing similar incidents?
7. May we contact you again for follow up questions?

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