

THE COSMOS AND THE EARTH:
CONTENT AND QUALITY OF ENVIRONMENTAL RISK COMMUNICATION IN
COSMOS (1980) AND *COSMOS* (2014)

A Thesis

by

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ABSTRACT

Cosmos: A Personal Voyage (1980) and the remake *Cosmos: A Spacetime Odyssey* (2014) have sparked widespread public interest in science and educated viewers about science. Both series cover many scientific topics, including the environment. Because of their large viewership, the series have the potential to influence public awareness about environmental issues, and by using best practices, *Cosmos* could also potentially incite action to mitigate environmental risk.

This study posed two research questions: (1) Do the topics and themes related to environmental risk differ between the two *Cosmos* series? If so, in what way(s)? (2) How do the environmental risk communication strategies used in the two *Cosmos* series compare to best practices for inspiring appropriate action among viewers? This study used content analysis to determine differences between the two *Cosmos* series in the topics, frames, approaches, images, and visual language, such as metaphors.

There was an overall increase in environmental risk content from *Cosmos* (1980) to *Cosmos* (2014). The most mentioned environmental topics in *Cosmos* (1980) were “Pollution,” “Nuclear,” “Climate Change,” and “Greenhouse Gas/CO₂”; in *Cosmos* (2014) they were “Energy,” “Pollution,” “Greenhouse Gas/CO₂,” and “Climate Change.” In *Cosmos* (2014), “Climate Change/Global Warming,” “Greenhouse Gas/CO₂,” and “Energy” often appeared together, solidifying the association between these topics. Additionally, framing of content shifted from “Disaster” and “Security” in *Cosmos* (1980) to “Opportunity” *Cosmos* (2014). Both series used similar approaches; however,

Cosmos (1980) more often used the approach of “Presenting a negative alternative reality/Warning” whereas *Cosmos* (2014) used more “Storytelling.” Both *Cosmos* series relied heavily on visual images and comparative language, such as analogies and metaphors.

Cosmos (2014) more often used strategies recommended by scholars as being effective for inciting environmental action than *Cosmos* (1980). Specifically this was evident in the increase in environmental risk content, narratives, “Health” and “Opportunity” frames, and associations between related topics as well as the decrease in “Disaster” frames and “Presenting a negative alternative reality/Warning.” Although differences exist between the series, they both seem to communicate environmental risk in ways that are interesting and relevant to the public.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

When *Cosmos: A Personal Voyage* aired in 1980 on PBS, it sparked widespread public interest in science and became the channel's most widely viewed series (KCET, 2014). In 13 episodes, astronomer Carl Sagan led viewers via the "Spaceship of the Imagination" to explore scientific discoveries, current science-related issues, and explanations of scientific processes. *Cosmos* used visualizations and narratives to illustrate complex scientific concepts. The series became iconic and remained popular even as it aged. The show's popularity inspired the 2014 reimagining of the series titled *Cosmos: A Spacetime Odyssey*, hosted by astrophysicist Neil deGrasse Tyson. According to its creators, the *Cosmos* remake shared the original's goals: to educate its audience and inspire interest in science (Keveney, 2014). Ann Druyan, the late Sagan's wife and co-writer of both *Cosmos* series, told *USA Today* about the similarity between the two series, stating:

Both series combine rigorous scientific skepticism with a soaring sense of the romance of life in the cosmos. We tell different stories in the new series, and we have greater capabilities in terms of how much more visually stunning we can make the experience than we could back then (Keveney, 2014).

Like Sagan's *Cosmos*, Tyson's *Cosmos* brought many scientific concepts and issues to the public's consciousness through narratives and visuals. But unlike its predecessor, *Cosmos* (2014) employed modern digital graphics. Also, rather than being broadcast on PBS, the show appeared on two television networks, National Geographic and Fox, and online via Hulu. Although many of the topics covered remain the same or similar, *Cosmos* (2014) provides a more current view of the subjects discussed.

Sagan and Tyson as Science Popularizers

Through television, scientists and science educators can communicate with the public. In *Cosmos*, Sagan and Tyson serve as guides and are knowledgeable on the topics they present. Both are portrayed as leading a journey to scientific enlightenment. Based on their previous roles in science television, they are trusted by the public as sources of scientific information. Sagan and Tyson are enthusiastic and charismatic and possess many of the characteristics said to typify those known as "science popularizers." Other oft-noted examples of science popularizers include Bill Nye the Science Guy and Stephen Hawking. This term generally describes someone who communicates science to the public in an engaging way, making science popular (Goodell, 1977, pp. 163-176; LaFollette, 2013, pp. 154-169). In fact, Sagan is often cited as the go-to example of a science popularizer, and Tyson clearly aims to follow in his footsteps (Brainard, 2013; Goodell, 1977, pp. 163-176).

Both Sagan and Tyson are scientists who later hosted several science television series, establishing their authority in the culture as science communicators. Sagan, an astronomer and cosmologist, was an active scientist before and after *Cosmos* aired. He

taught and did research at Harvard University and then at Cornell University, where he directed the Laboratory for Planetary Studies from 1972 to 1981 (Davidson, 1999, pp. 138, 209). He also frequently served as an advisor to NASA (Davidson, 1999, p. 91). Further, Sagan established himself as a visible source of scientific information through writing books such as *The Cosmic Connection* and by appearing on television shows such as Johnny Carson's *Tonight Show* (Davidson, 1999; pp. 161-165). In fact, *Time* magazine dubbed Sagan the "prince of popularizers" (Golden, 1980). Before hosting *Cosmos* (2014), Tyson followed a similar path, from scientist to science communicator. Tyson is an astrophysicist and director of the Hayden Planetarium at the American Museum of Natural History. He wrote several books on astrophysics including *Death by Black Hole* and continued in his role as science communicator by hosting science television shows such as *NOVA ScienceNow* on PBS. Like Sagan, Tyson has become somewhat of a pop culture icon in his role as a science communicator, making appearances on popular television shows such as *The Daily Show* and *The Colbert Report* (Hayden Planetarium, n.d.). Tyson also holds a number of pop culture awards and recognitions, such as being named one of "The Most Influential Nerds of 2014" by *GQ Magazine* (Tang, Sintumuang, & Campion, 2014).

***Cosmos* on Television**

During the 1980s, science was often represented on television through science fiction shows, such as *Battlestar Galactica*, *The Incredible Hulk*, and *The Six Million Dollar Man*. However, these shows were sometimes inaccurate and were not intended to teach science to the general public (LaFollette 2013, p. 155). On the other hand, the

series teaching science often emphasized the interface between science and other subjects, such as politics, and *Cosmos* (1980) fit right in. In addition to covering various scientific topics ranging from astronomy to mathematics to biology to earth sciences, *Cosmos* (1980) addressed the social and political context of the topics covered. The show was well received, winning 15 Emmys and a Peabody Award. Today, the series has remained popular, and reruns have been aired on the Discovery Channel (LaFollette, 2013, p. 158). *Cosmos* (1980) was also the most popular series on PBS during 1980 through 1990 (Spangenburg & Moser, 2009). The original *Cosmos* series is also thriving via the Internet, through which the show and Sagan have garnered a large fan base (Lachney, 2015).

The *Cosmos* update received acclaim similar to that of the original. *Cosmos* (2014) won four Emmys and was nominated for 12, and the series won a Peabody Award (Steinberg, 2015; Television Academy, n.d.). Because of his work on the series and other science communication efforts, Tyson was awarded the National Academy of Sciences' Public Welfare Medal, an award Sagan won after *Cosmos* (1980) in 1994 (National Academy of Sciences, 2014; National Academy of Sciences, 2015). The idea for the *Cosmos* remake originated at a meeting between Tyson and producer Seth MacFarlane, creator of comedies such as the cartoon sitcom *Family Guy*. For years, the idea of remaking *Cosmos* with Tyson as the host had been pitched by the co-creators of the original series: Ann Druyan and Steven Soter, an astrophysicist. Their pitch was turned down by television networks until MacFarlane expressed interest in producing the series (Itzkoff, 2011). MacFarlane's interest in the remake stemmed from his concern for

science literacy. He told the *New York Times*, “The older I got, I noticed a pattern in our culture of lethargy. We got to the Moon, and then we just stopped” (Itzkoff, 2011, para. 7). The reboot was supported by some of the makers of the original *Cosmos*, including writer/director Ann Druyan, who stated, “We weren’t interested in going to the audience that already knew that it loved science. We wanted to go to the largest possible audience and attract people who’d never even thought about it” (Itzkoff, 2011, para. 10).

***Cosmos* and the Environment**

Besides educating viewers, both *Cosmos* series delve into controversial scientific topics, such as evolution (Brainard, 2013). Tyson told *Parade* magazine, “*Cosmos* is not only about updating you on what science is but also conveying why it matters — especially in the 21st century, when issues related to science are fundamental to political issues. There are political hot potatoes that could be settled or informed if we became more scientifically literate” (Sherr, 2014, para. 16). Similarly, in *Cosmos* (1980), Sagan made political statements and promoted nuclear disarmament (Dörries, 2011). A controversial area covered in both series is the environment and environmental activism.

Sagan and Tyson have been outspoken about the environment within and outside of *Cosmos*. Although a cosmologist, Sagan was academically and personally involved in environmental risk. His first wife, microbiologist Lynn Margulis, co-hypothesized the Gaia Hypothesis, which states that life and inorganic matter on Earth create a system that sustains life. Before there was widespread public concern about climate change, Sagan studied the greenhouse effect on Venus for his dissertation (Davidson 1991, pp. 101-102). He became an authority on the greenhouse effect and testified before Congress in

1984 on the potential dangers of the greenhouse effect on Earth (Congress of the U.S., W. T. 1984). Additionally, Sagan was outspoken academically and politically about nuclear war and its consequences (Badash, 2009, pp. 47-109). Sagan, along with Richard P. Turco, Owen Toon, Thomas P. Ackerman, and James B. Pollack, developed a model demonstrating the potential devastating environmental consequences of nuclear winter, a hypothesized result of nuclear war (Turco et al., 1983). Sagan's academic interest in nuclear winter translated directly into political and social action. In 1983, he wrote an article in *Parade* magazine urging the public to consider the consequences of nuclear war, specifically nuclear winter (Badash, 2001).

Although Tyson does not possess the same academic background as Sagan on environmental risk, he has been outspoken about environmental issues and their relation to scientific literacy and policy (Sherr, 2014). In an interview with the *Milwaukee Journal Sentinel*, Tyson said, "You can treat your environment well because it's a good thing to do and the right thing to do. But let's say you don't even have those kinds of altruistic sensibilities, then science literacy allows you to understand the causes and effects of your actions" (Johnson, 2014, para. 5).

Study Goals

For this study, I used content analysis to compare how environmental issues in *Cosmos* are framed in the two series as well as the relative number of segments addressing such issues. I also examined whether the environmental risk communication strategies differed between the two series. Additionally, I determined whether such changes agree with what the literature currently identifies as best practices in

environmental risk communication to inform viewers and potentially incite action to mitigate or prevent environmental risk. Although, findings about *Cosmos* cannot be generalized to all science programming, they can contribute to a body of knowledge on how well such programs promote environmental literacy and whether their success has changed over the years.

Kairos, the Environment, and *Cosmos*

An influential rhetorical factor in *Cosmos* is the series' timeliness or kairos. Sorensen (2013) suggested that kairos, referring to a message being delivered at the "right time," played an important role in the first series' success. Kairos is considered to be one of the most important factors in rhetorical discourse, as it helps ensure that the audience is receptive to the message conveyed (Eskin, 2002; Sipiora, 2002). Although some members of the public may not have embraced *Cosmos*' messages, many tuned in and were exposed to pro-environmental ideas. Additionally, when kairos is combined with knowledge regarding practical applications, the audience can be inspired to take social action (Sipiora, 2002). In fact, action is often at the root of environmental messages. Like many other social movements, environmentalism values altering individual behavior for the greater good. This attempt to inspire behavioral change is often seen today when climate change is discussed in the media, and collective action is often cited as a way to prevent anthropogenic environmental disaster.

Cosmos (1980) aired at a turning point in the American public's view of environmental problems. The 1960s and early 1970s were characterized by increased government action and public interest in addressing environmental issues. This

environmental interest was also reflected in the media and popular culture during this time, from Rachel Carson's *Silent Spring* in 1962 to the creation of Earth Day in 1970. Not only did this reflect existing public concern for the environment, but it stimulated further interest as well. Beginning in the late 1970s and into the 1980s, however, the environmental movement faced political backlash, leading to reduced government action (Kline, 1997, pp. 117-8).

The scientific community began reaching a consensus in the mid-to-late 1980s that climate change is occurring and that it is anthropogenically caused (Hulme, 2009, p. 63). A particularly significant year in terms of climate change was 1988, when the Intergovernmental Panel on Climate Change (IPCC), a panel of scientists and other experts that assesses the current conditions related to climate change, was established. Further, the United States Congress began to pay more attention to climate change at this time, with an average of 10 hearings per year on climate change rather than the average of two seen in previous years (Hulme, 2009, pp. 64-65).

The increase in scientific knowledge and increased environmental attention from Congress also influenced changes in the media. In comparing attitudes of newspaper editors about the environment in 1977 and 1992, Bowman (1994) demonstrated that editors became more concerned with environmental issues, though this did not initially translate to increased environmental coverage. Similarly, Trumbo (1995) noted a steady decrease in environmental coverage from 1988 to the early 1990s. Then, environmental coverage began to increase in 1997 (Wilson, 2000), continued to increase into the 2000s

(Liu et al., 2011) and peaked in 2007, a year after *An Inconvenient Truth* was released (Nerlich, Forsyth & Clarke, 2012).

By the 1990s many Americans began to grow apathetic about environmental issues, and this apathy has persisted to this day (Kline, 1997, p. 136; McCright & Dunlap, 2003). Although there is a general trend toward increased apathy toward the environment, public concern for the environment cycles. In 2007, the same year that environmental coverage peaked, a Gallup poll found that 43 percent of Americans were worried about the environment. However, this number decreased to 31 percent in 2014 (Riffkin, 2014). Despite this lack of concern, Americans are becoming more aware of climate change. However, this also cycles with media influence. In 2007, 61 percent of Americans said that they believed that climate change had already begun. This number changed to 55 percent in 2015. Yet, both of these numbers are an increase from 48 percent in 1998 (Saad, 2015).

Barriers to Effective Environmental Risk Communication

Much of the knowledge that the public has gained about environmental risk, specifically climate change, has been through the media (Nisbet, 2009; O'Neill & Nicholson-Cole, 2009; Whitmarsh, 2008). When communicated effectively, media messages about the environment can influence audiences' opinion and the issues they prioritize (McCombs & Ghanem, 2001, pp. 67-81; McCombs, 2004). A study by Östman (2014) indicates that pro-environmental messages in the media can encourage pro-environmental behavior. Further, Howell (2012) suggests that by providing solutions, environmentally related films may produce long-term action among viewers. Despite

this potential, a number of barriers limit the success of environmental risk communication in terms of public engagement. Wibeck (2014) points to three main barriers preventing the public from acting on climate change: lack of understanding, sociocultural factors, and lack of sense of agency (discussed below). These same barriers were mentioned in previous research by Cantrill (1993), who said these concerns influence people's views on environmental communication and potential to engage in environmental advocacy. Although these factors are distinct, they are also interlinked, and each plays a role in how individuals understand environmental risk as well as potential actions taken to mitigate environmental risk.

Lack of Understanding

Many environmental hazards, such as pollution and climate change, occur at scales difficult for humans to perceive (Kollmuss, 2002; Moser & Dilling, 2004, p. 34). Environmental contaminants may be too small to detect with the naked eye, and the effects of climate change generally occur on a time scale that is too long for an individual to perceive. Often, the complexities associated with environmental risk can be difficult to understand and communicate (Seacrest, Kuzelka, & Leonard, 2000; Sterman & Sweeney, 2007). For example, Ungar (2000) demonstrated that the public frequently confuses climate change with other environmental issues, such as ozone depletion. Further contributing to confusion on environmental issues is the lack of accurate scientific information in the media. Typically, the media have focused on environmental risk events with easily identifiable causes rather than those that are ongoing and multifaceted (Allan, Adam, & Carter, 2000, pp. 46-50; Hansen, 1991). Studies have

shown that reporters often lack an adequate understanding of the science behind environmental risks and therefore may communicate inaccurate information, especially in reporting on complex risks such as climate change (Bell, 1994; Wilson, 2002).

Sociocultural Factors

Barriers to understanding environmental risk are not just intellectual. A number of psychological, emotional, and behavioral factors determine how an individual perceives information and whether he or she will accept and retain that information (Hulme, 2009, p. 215). Sociocultural factors, which include social and cultural attitudes and beliefs, can influence the public's perception of environmental issues (Wibeck, 2014). Sociocultural factors are distinct from demographics, which have been shown to be relatively poor predictors of environmental attitudes (Cantrill, 1993). Sociocultural factors play into public understanding of climate change and should not be neglected when developing messages to incite action (Moser & Dilling, 2004, pp. 10-14). Narratives, metaphors, and framing have been cited as methods of addressing sociocultural factors (Hertog & McLeod, 2001).

Frequently, environmental risks provoke a sense of outrage or fear, which is directly related to cultural beliefs and values. Specifically, cultural, political, and psychological factors influence how people perceive risk and determine which risks are more threatening (Douglas & Wildavsky, 1982). As Hulme (2009) stated, “[H]uman cultures have always been capable of constructing narratives of fear around their direct or vicarious experience of ‘strange’ unknown or portended climates. Yet these discourses of fear... are not imposed by Nature; they are imposed by culture” (pp. 67-

68). Sandman (1987) notes the following as factors that contribute to public outrage: lack of voluntariness, lack of control, unfairness, unfavorable processes (with regard to how those communicating the message respond), immorality (seeing environmental degradation as evil), unfamiliarity (exotic risks provoke more outrage), memorability, dread (related to long latency), and danger to many people in at a single place and time.

Lack of a Sense of Agency

In addition to intellectual and sociocultural factors, a lack of a sense of agency can contribute to inaction on environmental risk. Although this barrier is distinct from the other two barriers, it is interconnected with them, as lack of understanding and sociocultural barriers can lead to individuals feeling powerless to act against environmental risk. For example, research indicates that environmental films that address climate change often use emotional appeals that communicate this lack of power, specifically, messages emphasizing loss, nostalgia, and sometimes mass extinction (Hammond & Breton, 2014). Likewise, television coverage of environmental risk often focuses on disaster narratives (Greenberg, Sandman, Sachsman, & Salomone, 1989; McComas & Shanahan, 1999). The overuse of such messages has, in some instances, caused viewers to see the issues as overly sensationalized, and viewers have begun to experience “issue fatigue” (Hulme, 2009, p. 212-214; Maibach, Nisbet, Baldwin, Akerlof, & Diao, 2010). In studying the fictional climate change disaster movie *The Day After Tomorrow*, Leiserowitz (2004) demonstrated that the film increased anxiety among viewers about climate change. Additionally, viewers had trouble distinguishing which parts of the film were scientifically based and which were

dramatized. Thus, viewers were less likely to believe that extreme weather events could result from climate change. Lastly, while some viewers indicated they felt motivated to take action against climate change, they also mentioned that they felt they did not have information on how to act.

Framing Environmental Risk

In each episode of *Cosmos*, Sagan or Tyson creates narratives to illustrate scientific concepts and engage viewers. These narratives frequently recount scientists' journeys to their discoveries and the challenges and adversities they faced. To create such narratives, choices are made about what content to include, influencing how the content is framed. Such frames can be constructed through use of literary devices, such as metaphors, or through visuals (Brossard, 2010, pp. 310-313). How the media frames environmental issues has been demonstrated to influence some members of the public on solutions to environmental problems (Nisbet, 2009), connections between various environmental events and disasters (Boykoff, 2007; Koteyko, Thelwall, & Nerlich, 2010), and the source of responsibility for such events (Gameson & Mondigliani, 1989).

Framing has been defined as assembling a narrative or message in such a way that supports a particular view. This could include, for example, focusing on health effects of an environmental disaster and not mentioning the economic impacts. Further, framing shapes the way that the audience thinks and feels about the content presented (Entman, 2007). Specifically, Entman (1993) notes, "To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral

evaluation, and/or treatment recommended for the item described” (p. 52). Further, the purpose of framing generally falls into the following categories: defining, diagnosing, making moral judgments, and suggesting remedies (Entman, 1993). In studying the framing of climate change in major U.S. newspapers, Trumbo (1996) found that the frames that appeared coincided with Entman’s purposes and developed the following framing scheme:

Defining problems: impacts of climate change

Diagnosing causes: evidence as to the reality of climate change

Making moral judgements: action statements

Suggesting remedies: provide specific information about how solutions should be implemented

In studying newspaper, television, and Twitter coverage of the Intergovernmental Panel on Climate Change’s Fifth Assessment Report (IPCC AR5) in the United States and the United Kingdom, O’Neill, Williams, Kurz, Wiersma, & Boykoff (2015) identified ten climate change frames: settled science, political/ideological struggle, role of science, uncertain science, disaster, security, morality and ethics, opportunity, economics, and health. Of these frames, the only ones found in U.S. television coverage of IPCC AR5 were political/ideological struggles, disaster, and uncertain science.

Environmental Risk Communication Strategies that Inspire Action

As has been the trend in science communication as a whole, recent environmental risk communication literature emphasizes public engagement in addition to public understanding (Besley, Kramer, Yao, & Toumey, 2008; Einsiedel, 2008, pp.

173-184; Irwin & Michael, 2003; Nerlich, Koteyko, & Brown, 2010; Powell & Kleinman 2008). According to Wibeck (2014) the ultimate goal of climate change communication is “to identify communication strategies that efficiently support sustainable development and reduce climate impact” (p. 14). Likewise, the goal of environmental risk communication is generally for the target audience to alter their behavior to avoid or mitigate the risk. In recent years, climate change specifically has been a major focus within the environmental risk literature (Wibeck, 2014). There are generally three ways for the public to respond to climate change: lifestyle change, political influence, and participation in citizen climate science and political dialogue (Wibeck, 2014). Other research echoes this assertion. Moser and Dilling (2006, p. 19) identify individual influence through consumption, or buying environmentally conscious products, and politics, or supporting environmentally conscious policies. Further, Maibach, Roser-Renouf, and Leiserowitz (2008) note four ways that individuals can take action against climate change: reducing household energy use, recycling, altering mode of transportation, and choosing to consume environmentally responsible products.

To address common barriers to effective climate change communication, Wibeck (2014) suggests making content clear, applicable, and engaging to the viewer; using visual or figurative language, such as metaphors and images; using health, security, economic, and moral frames; and being mindful of the intended audience. Prior literature has recommended providing specific, tangible solutions rather than focusing on problems (Cooney, 2010; Maibach et al., 2010; Nicolson-Cole, 2005; O’Neill & Nicholson-Cole 2009). Likewise, Cantrill (1993) recommends “demonstrating how the

proposed solution supports the progress of human-centered needs and is compatible with a technological orientation” and “providing directions for easily adopted actions which support the advocated policy” (p. 88). Additionally, visual or figurative language and images have been shown to effectively communicate the potential effects of environmental risks (Bronnimann, 2002; Hamblyn, 2009; Manzo, 2010; Nicolson-Cole, 2005; O’Neill & Hulme, 2009; O’Neill & Nicholson-Cole, 2009). According to Allan et al. (2000, p. 3), environmental risks “operate outside of the capacity of (unaided) human perception... Without visual presences, the hazards associated with these technologies are difficult to represent as risks.” Similarly, narratives have also been cited as a means of promoting understanding and inspiring action (Graesser, Olde, & Klettke, 2002; Oatley, 1991; Slater & Rouner, 2002; Wibeck, 2014). By nature, narratives provide context, which can improve comprehension (Felman, 1989; Graesser, Singer, & Trabasso, 1994). Further, narratives are often relatable and enhance engagement and interest in the topic (Green & Brock, 2000; Green, 2004; Green, 2006; Schank & Abelson, 1995).

Research Objectives

Because effective environmental communication has the potential to not only inform but mobilize the audience, it is important to consider the environmental communication strategies in popular science television, such as *Cosmos*. Additionally, because *Cosmos* was remade more than 30 years later, it offers the opportunity to compare how such communication strategies have changed. Therefore, a purpose of this study was to determine whether, and if so how, environmental risk communication

strategies have changed between the *Cosmos* series. Further, the study was intended to determine whether those changes are in accordance with what the current literature recommends for effective environmental communication that incites behavioral change. In short, did the *Cosmos* remake differ from the original in its communication strategy, and if so, did that change result in increased potential to inspire environmentally responsible action among its viewers?

Research Question 1: Do the topics and themes related to environmental risk differ between the two *Cosmos* series? If so, in what way(s)?

Research Question 2: How do the environmental risk communication strategies used in the two *Cosmos* series compare to best practices for inspiring appropriate action among viewers?

Although *Cosmos* (1980) is generally considered successful in communicating science, the audience that Sagan addressed differed from Tyson's audience. Additionally, since the first *Cosmos* series aired in 1980, much knowledge has been gained about environmental risk and communicating environmental risk. Thus, this study asked to what extent each of the two *Cosmos* series followed recommended environmental communications strategies. Although this study did not look into the potential impacts of such differences or similarities, it serves as a first step in understanding the differences that exist not only between the two series but also between messages about environmental risk in science television 34 years apart. More broadly stated, this study examined whether *Cosmos*, an example of science on television,

differed in its communication strategies to effectively inform and incite action from viewers.

CHAPTER II

METHOD

Content analysis was the method selected for this study because of its suitability to answer the posed research questions. Content analysis studies let researchers isolate and examine certain concepts independently, specifically those represented by key words and phrases (Carley 1992). Not only can these concepts be quantified, but they can be compared, which is what this study aimed to do. Furthermore, content analysis is ideal for describing media that have not been extensively studied and can lay the foundation for additional studies (Wimmer & Dominick 2010, p. 159).

For this study, both *Cosmos* series were viewed on DVD. The two series are comparable in length; each contains 13 episodes. *Cosmos* (1980) episodes are approximately 60 minutes long, whereas *Cosmos* (2014) episodes are approximately 40 minutes long to accommodate commercial breaks. Episodes in each series were divided into 11 segments per episode, which were based on the chapter breaks on the DVD. These segments were the unit of analysis. Although *Cosmos* (1980) has been re-released with updates from Carl Sagan, this version was not analyzed, as this study examined the changes in content between the original 1980 version and the 2014 remake.

I developed categories through emergent coding by viewing each episode and reading the transcripts, which were obtained from the online transcript database ‘Springfield! Springfield!’ (www.springfieldspringfield.co.uk). I checked the accuracy of

these transcripts as I viewed all the episodes in the series. Recurring words or phrases related to the research questions were considered as categories, and I created coding sheets containing these emergent categories. The content was coded by two coders, each with knowledge of content analysis and science communication but with different backgrounds. I was the first coder and have a background in biomedical and wildlife sciences, and the second coder was a master's student in science and technology journalism, with a background in astronomy.

First, the second coder was trained to understand how to appropriately assign codes and evaluate the content using the code book as a guide. The coders conducted a pilot test on an episode of *NOVA*, a PBS educational series that focuses on various scientific topics, to help ensure that categories were exhaustive and mutually exclusive (Krippendorff, 1980; 75). The episode selected for the pilot test, titled “Energy’s Big Gamble,” aired in 2009 and focused on Governor Arnold Schwarzenegger’s plan, AB 32, to reduce carbon dioxide emissions in California. However, *Cosmos* and *NOVA* are structured differently. *Cosmos* was hosted by a single narrator whereas the narrator in the *NOVA* was much less prominent and the episode focused more on interviews. Despite this difference in structure, the episode covered topics related to anthropogenic environmental risk that are also covered in *Cosmos*. Conducting a pilot test also allowed the coders to practice using the code sheet and code book, since the pilot test used the same coding criteria as the *Cosmos* analysis. From the pilot test a preliminary measurement of intercoder reliability was obtained using Krippendorff’s alpha and

percent agreement. These measurements demonstrated whether the two coders independently agreed on the presence of items in the studied categories.

Coding

Although both *Cosmos* series discuss environmental risks throughout the universe, the primary focus of this study was anthropogenic environmental risks on Earth. Coders marked content using a coding sheet (Appendix A), following the rules detailed in a code book (Appendix B). The two coders independently identified content falling into categories associated with environmental risk. Because segments were the unit of analysis, coders completed the coding sheet immediately after viewing each segment. Then, the two coders discussed their coding decisions and filled out a third coding sheet, which included their mutually agreed upon codes. Complete definitions for all coding categories appear in the code book (Appendix B).

In each coding sheet, coders identified the topics, frames, approaches, and visuals that appeared in a given segment. The topic categories were the following:

Climate change/global warming

Deforestation

Energy (fossil fuels, solar, wind, etc.)

Erosion

Extreme anthropogenic caused weather events

Greenhouse gases/CO₂

Loss of biodiversity

Nuclear (war or winter)

Pollution

Sea level rising/melting glacier

Coders also could select “Other” and list additional topics related to environmental risk; thus, the coding scheme was exhaustive. Additionally, which topics appeared together in a segment was examined. This was done to illustrate how concepts are interrelated, identifying the potential for viewers to confuse environmental concepts as well as the potential for viewer to grasp relationships between topics. Also, to determine how frequently environmental risk was discussed in each series, the number of segments in which codes appeared was recorded.

Framing was assessed based on coding schemes developed by Wibeck (2014) and O’Neill et al. (2015). The framing categories were as follows:

Disaster

Economics

Health

Morality/Ethics

Opportunity

Role of science

Security

Settled science

Uncertain science

Coders could select “None” when none of the listed frames appeared in the segment. Although these coding schemes were established by Wibeck (2014) and

O'Neill et al. (2015) to assess climate change specifically, we used them to address environmental risks in general.

Further, coders also identified the themes present in each segment, which were generated through initial viewing of both *Cosmos* series. These themes included the following:

Calling for action without a specific solution

Educating

Defining a term

Dispelling a myth

Explaining a process

Storytelling

References to human mass extinction and loss

Providing historical, social, or political context

Providing solutions

Presenting a negative alternative reality/Warning

Presenting a positive alternative reality/Hope

When coders selected "Providing solutions," they were also asked to list the solutions that were provided.

Lastly, coders were asked to identify visual images and visual or figurative language, such as metaphors, that appeared. The coders noted the appearance of visuals related to environmental risk, stating whether they appeared (Y or N) and describing each in a sentence or phrase. Additionally, the coders noted the hosts' use of metaphors,

analogies, and similes related to environmental risk. In this case, coders also marked Y or N and quoted the metaphors, analogies, and similes used by the host.

Reliability

I watched all segments in the series to determine whether references to environmental risk were present. Then, I filled out a code sheet for each segment that referenced anthropogenic environmental risk. I also double-checked for completeness by searching the transcripts for the specified words using the “find” tool in Microsoft Word. The second coder coded the segments once again. Any coding disagreements were resolved through discussion between the two coders. Having a second coder was intended to reduce subjectivity and bias (Wimmer & Dominick, 2010, p. 163).

Krippendorff’s alpha was selected to measure intercoder reliability because it accounts for intercoder agreement due to chance. Krippendorff’s alpha was calculated for each series and for each segment. Also, Krippendorff’s alpha was calculated between my answers and the agreed upon answers. This showed whether and, if so, when answers were adjusted based on the input from the second coder. According to Krippendorff (1980, p. 147), an acceptable alpha is greater than 0.67. As an additional measurement of reliability, percent agreement was computed. According to Wimmer and Dominick (2010, p. 175) and Neuendorf (2002, p. 145), most content analysis studies have at least 80 to 90 percent agreement between coders.

CHAPTER III

RESULTS

This study used content analysis to better understand environmental risk content in *Cosmos* (1980) and *Cosmos* (2014). Each series had 13 episodes, each of which was divided into 11 segments; I used the segments as the unit of analysis. This totaled 143 segments in each series. For this study, I watched all episodes from both *Cosmos* series. However, this study focused on the episode segments with content related to anthropogenic environmental risk. I found that nine segments from three episodes in *Cosmos* (1980) and 26 segments from five episodes in *Cosmos* (2014) referred to anthropogenic environmental risk and addressed at least one of the specified environmental risk topics. Thus, the number of segments featuring environmental risk almost tripled from the 1980 series to the 2014 series. It should be noted that the amount of environmental content varied among the segments. Some segments only had a sentence or two related to environmental risk, whereas others were devoted entirely to anthropogenic environmental risk.

Reliability

Intercoder reliability was measured using Krippendorff's alpha and percent agreement. For the pilot test, in which a *NOVA* episode was analyzed, Krippendorff's alpha was 0.74 and percent agreement was 86 percent. For *Cosmos* (1980), Krippendorff's alpha was 0.62 and percent agreement was 90 percent, and for *Cosmos*

(2014), Krippendorff's alpha was 0.73 and percent agreement was 88 percent. Each of these numbers except for Krippendorff's alpha for *Cosmos* (1980) was over 0.67 and had a percent agreement over 80 percent. Thus, these values were acceptable. There are several possible explanations for the low Krippendorff's alpha for *Cosmos* (1980), including a small sample size of content. Because there was much less environmental risk content in *Cosmos* (1980) than in the other series, disagreements between the coders could have affected Krippendorff's alpha for *Cosmos* (1980) more notably. Additionally, Krippendorff's alpha corrects for agreement due to chance, whereas percent agreement does not. This may be what led to the discrepancy between the high percent agreement and low Krippendorff's alpha for *Cosmos* (1980).

The final coding responses used in this analysis were based on codes agreed upon from the discussion between the two coders. In comparing my original responses to the agreed-upon responses, the Krippendorff's alphas equaled 0.89, 0.86, and 0.94 for *NOVA*, *Cosmos* (1980), and *Cosmos* (2014), respectively. This shows that some of the original responses I gave changed because of discussion with the second coder. However, all the alphas were acceptable (over 0.67), which supports the conclusion that the coding scheme was consistently followed.

Topics Covered

In *Cosmos* (1980), there were 18 instances in which an environmental risk topic was noted, and in *Cosmos* (2014) there were 56 instances. *Cosmos* (1980) at least touched on all of the topics examined except "Sea Levels Rising/Glaciers Melting" and had one "Other" topic, which concerned environmental "catastrophe" in general.

Cosmos (2014) covered all examined topics, and there were no “Other” topics. The number of segments in which each topic appeared is listed in Appendix D and graphed in Figure 1.

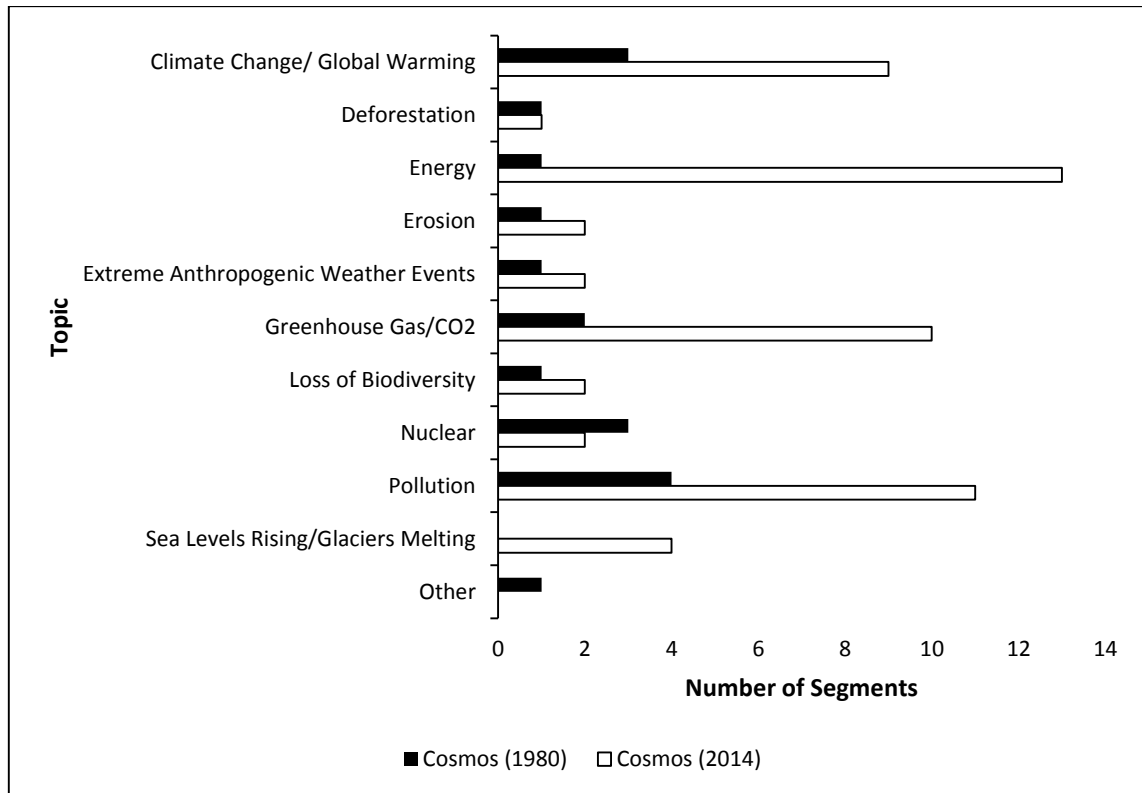


Figure 1. Frequency of Appearance for Each Environmental Topic in *Cosmos* (1980) and *Cosmos* (2014).

The most mentioned topics in *Cosmos* (1980), in descending order, were “Pollution,” “Nuclear,” “Climate Change,” and “Greenhouse Gas/CO₂.” Similarly, the most mentioned topics in *Cosmos* (2014) were “Energy,” “Pollution,” “Greenhouse Gas/CO₂,” and “Climate Change.” Many of the topics ranked similarly in terms of the

amount of coverage received in each series. The exceptions were “Nuclear” and “Energy.” There was only one segment mentioning “Energy” in *Cosmos* (1980), and there were 13 segments mentioning “Energy” in *Cosmos* (2014). In *Cosmos* (1980) a higher proportion of segments (3 of the 18 environmental risk segments) were devoted to nuclear war and nuclear winter than in *Cosmos* (2014) (2 of the 56 environmental risk segments).

“Nuclear”

In addition to differing frequency of appearance of “Nuclear,” a difference in tone exists between the two series when discussing “Nuclear.” Sagan tended to emphasize the destruction a nuclear exchange could bring. In “Who Speaks for the Earth,” he said of nuclear war, “There would be other agonies: loss of loved ones; the legions of the burned, blinded, and mutilated; the absence of medical care; disease; plague; long-lived radiation poisoning of the soil and water.” Later in the episode, he simply stated, “Nuclear arms threaten every person on Earth.”

In contrast, *Cosmos* (2014) generally discussed “Nuclear” in retrospect. In the episode “The World Set Free,” Tyson reflected on the Cold War struggle between the United States and Soviet Union and the potential for nuclear war. “That terror has subsided, to be replaced by a few new fears,” he said. “The danger that the 2,000 largest cities on Earth would be reduced to rubble in the span of an afternoon is no longer one of them.” Tyson continued by stating that the Cold War helped America become more scientifically literate and ultimately helped put a man on the moon through the Apollo

missions, which he said were “conceived as a demonstration of the superior power and precision of our strategic missiles” (“The World Set Free”).

“Pollution”

In *Cosmos* (1980), pollution was discussed broadly, without many specific examples. In “Heaven and Hell,” Sagan said, “The Earth has mechanisms to cleanse itself, to neutralize the toxic substances in its system, but these mechanisms work only up to a point. Beyond some critical threshold, they break down. The damage becomes irreversible.” In contrast, *Cosmos* (2014) described the causes and health effects of pollution in detail through the story of scientist Clair Patterson, who discovered the high concentration of lead in the environment and determined that leaded gasoline was the source.

Topic Associations: “Climate Change/Global Warming,” “Greenhouse Gas/CO₂,” and “Energy”

In terms of which topics appeared together, the two series differed greatly. In *Cosmos* (1980), “Nuclear” and “Pollution” appeared together twice, as did “Climate Change/Global Warming” and “Pollution.” In *Cosmos* (2014), the top association was between “Greenhouse gas/CO₂” and “Climate Change/Global Warming,” which were mentioned in the same segment eight times. The second most prominent association in *Cosmos* (2014) was between “Greenhouse Gas/CO₂” and “Energy,” which appeared together six times. Table 1 lists the most frequently occurring pairs of topics that most frequently appeared together. (See Appendix E for all associations.)

Table 1. Associations between Environmental Topics in *Cosmos* (1980) and *Cosmos* (2014).

<i>Cosmos</i> (1980)	<i>Cosmos</i> (2014)
Climate Change—Pollution (2)	Greenhouse Gas/CO ₂ —Climate Change (8)
Pollution—Nuclear (2)	Greenhouse gas/CO ₂ —Energy (6)
	Energy—Climate Change (5)
	Sea Levels Rising/Melting Glaciers—Climate Change (4)
	Sea Levels Rising/Melting Glaciers—Greenhouse Gas/CO ₂ (3)
	Climate Change—Extreme Anthropogenic Weather Events (2)
	Climate Change—Pollution (2)
	Extreme Anthropogenic Weather Events—Greenhouse Gas/CO ₂ (2)
	Extreme Anthropogenic Weather Events—Sea Levels (2)
	Greenhouse gas/CO ₂ —Nuclear (2)
	Greenhouse gas/CO ₂ —Pollution (2)

Note. The number of times each of these topics appeared together is noted in parentheses.

The association between “Climate Change/Global Warming,” “Greenhouse Gas/CO₂,” and “Energy” helped Tyson explain the cause of climate change. In “The World Set Free,” he said, “By burning coal, oil, and gas, our civilization is exhaling

carbon dioxide much faster than Earth can absorb it. So, CO₂ is building up in the atmosphere. The planet is heating up.”

Framing

To better understand the context in which these topics were discussed, I also analyzed the framing of environmental risks within segments related to environmental risk. Framing refers to assembling a narrative or message in such a way that supports a particular view. In addition to having similar a number of topics per segment, *Cosmos* (1980) and *Cosmos* (2014) had the same average number of frames per segment. *Cosmos* (1980) averaged 2.8 frames per segment, and so did *Cosmos* (2014). However, because more episodes in *Cosmos* (2014) contained references to environmental risk, there were more total instances of framing associated with environmental risk. There were 26 instances in which the frames studied appeared in *Cosmos* (1980) and 74 in *Cosmos* (2014). In *Cosmos* (1980), seven of the 10 frames examined appeared, and in *Cosmos* (2014) all frames appeared. The number of segments each frame appears in is graphed in Figure 2.

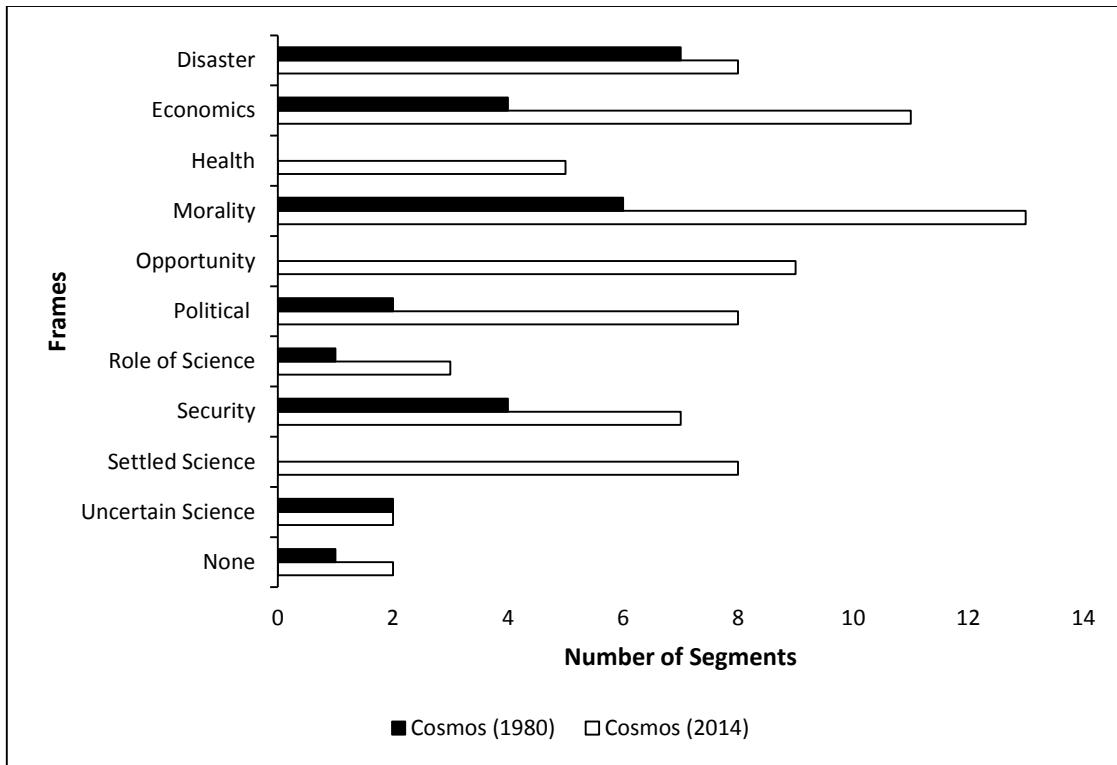


Figure 2. Frequency in which Frames Appear in *Cosmos* (1980) and *Cosmos* (2014).

The frames most frequently appearing in *Cosmos* (1980), in descending order, were “Disaster,” “Morality,” “Economics,” and “Security,” and those in *Cosmos* (2014), in descending order, were “Morality,” “Economics,” and “Opportunity.” Although “Opportunity” was one of the most prevalent frames in *Cosmos* (2014), it did not appear in *Cosmos* (1980). Another considerable difference was the frequency of the “Disaster” frame in relation to the number of environmental risk-related segments, from 7 of the 18 segments in *Cosmos* (1980) to 8 of the 56 segments in *Cosmos* (2014). The two series also differed considerably in the number of “Settled Science” frames. In *Cosmos* (1980), there were no “Settled Science” frames, but the number rose to eight segments, in

Cosmos (2014). Each *Cosmos* series had two segments with an “Uncertain Science” frame.

Disaster

Disaster framing was more frequent in *Cosmos* (1980) than in *Cosmos* (2014). However, both series applied the disaster frame to a variety of topics, which are not the same but similar between the series. In *Cosmos* (1980), Sagan frequently used the disaster frame when discussing nuclear war. For example, in “Who Speaks for the Earth,” he described the aftereffects of a nuclear exchange by saying, “In such an exchange not everyone would be killed by the blast and firestorm and the immediate radiation. There would be other agonies: loss of loved ones; the legions of the burned, blinded, and mutilated; the absence of medical care; disease; plague; long-lived radiation poisoning of the soil and water.”

In *Cosmos* (2014), Tyson used disaster framing largely when discussing climate change, pollution, and greenhouse gas. In “The Clean Room,” he used the disaster frame in discussing pollution. He explained how the ubiquitous use of lead contributed to the fall of the Roman Empire and described the public health crisis that occurred in America when tetra-ethyl lead was used in gasoline. Additionally, he used the disaster frame in discussing climate change and emissions. He said, “[W]e’re dumping carbon dioxide into the atmosphere at a rate the Earth hasn’t seen since great climate catastrophes of the past, the ones that led to mass extinctions” (“The Lost Worlds of Planet Earth”).

Economics

“Economics” was a dominant frame in both *Cosmos* series, and “Morality” and “Economics” often appeared together. In *Cosmos* (1980), Sagan asked, “Which do we value more: short-term profits or the long-term habitability of our planetary home?” (“Heaven and Hell”). As in this quote, environmental interests were generally portrayed as at odds with economic development. By mentioning the habitability of the Earth, Sagan made the question a moral one.

Similarly, in *Cosmos* (2014), Tyson told the story of Clair Patterson, emphasizing the economic as well as political and ideological struggle between Patterson and the oil companies (“The Clean Room”). In the episode, Patterson’s research is defunded by the oil companies because he linked the widespread presence of lead in the environment to leaded gasoline and opposed use of leaded gasoline. Much of the episode centers on this tug-of-war between scientific and public health interests versus the financial interests of large oil companies. However, Tyson showed that the battle is more than science versus industry by discussing Robert Kehoe, a doctor hired by General Motors to demonstrate the supposed safety of leaded gasoline. He said, “This was one of the first times that the authority of science was used to cloak a threat to public health and the environment.” Additionally, Tyson told stories in which environmentally conscious inventions were passed over in favor of cheaper and less environmental alternatives. Specifically, in “The World Set Free” Tyson referred to Augustin Mouchot, who invented a solar power concentrator, and Frank Shuman, who led a team that built solar energy concentrators. Although functional, Mouchot’s and

Shuman's inventions were never implemented on a large scale because coal and petroleum were more economical.

Health

The "Health" frame appears only in *Cosmos* (2014). Most notably, this frame appears when Tyson discusses Clair Patterson's discovery of lead in the environment resulting from its widespread use in gasoline. Tyson called this "one of the greatest public health victories of the 20th century" ("The Clean Room"). He also discussed the health effects on lead in individuals, saying, "[S]ome of the workers who processed the stuff in factories in Delaware and New Jersey were going insane, hallucinating, jumping out of windows. They died screaming." The episode ended with Tyson showing a graph of the 75 percent drop in the lead levels in the average child's blood within a few years of removing lead from gasoline.

Morality

Sagan and Tyson emphasized stewardship, and the Earth was said to be the responsibility of humans. In "Heaven and Hell," Sagan said, "And today, forests and grasslands are being destroyed frivolously, carelessly by humans who are heedless of the beauty of our cousins, the trees, and ignorant of the possible climatic catastrophes which large-scale burning of forests can bring." He then concluded the episode by asking, "If a visitor arrived from another world, what account would we give of our stewardship of the planet?"

Both series considered morality globally and across generations. Sagan noted that the politics of Earth are small in comparison to the universe. "The world is divided

politically, but ecologically it is tightly interwoven. There are no useless threads in the fabric of the ecosystem,” Sagan said (“Heaven and Hell”). Both series mentioned the quality of life of future generations. In “The World Set Free,” Tyson said, “If we don’t change our ways, what will the planet be like in our children’s future? Based on scientific projections, if we just keep on doing business as usual, our kids will be in for a rough ride.” Similarly, Sagan said, “And, yet we ravage Earth at an accelerated pace, as if it belonged to this one generation, as if it were ours to do with as we please” (“Heaven and Hell”).

Sagan and Tyson referred to science and critical thinking as a source of morality. When Sagan imagined human extinction due to nuclear war in “Who Speaks for the Earth?” he noted that humans evolved compassion, foresight, and reason and then said, “But instead we listened to that reptilian voice within us, counseling fear, territoriality, aggression.” Similarly, Tyson argued that science is what will save us from the risks of climate change. He said humans must use their intelligence “as cats use stealth before pouncing, as walking sticks use camouflage, to make it the tool of our survival” (“The Immortals”).

Opportunity

The opportunity frame was present only in *Cosmos* (2014). Mentions of opportunity generally occurred when the potential for mitigating or overcoming environmental risk was discussed. In “The World Set Free,” in telling the story of Augustin Mouchot, inventor of the first solar-powered engine, Tyson simply stated, “The sun isn’t the problem, but it is the solution, and we’ve known this for a long

time...” In this episode, Tyson also told the story of Frank Shuman’s unsuccessful plan to build a solar power plant in the Sahara Desert, which failed because fossil fuels were widely and cheaply available at the time. This episode also suggested using wind power alongside solar power, stating, “If we could harness a tiny fraction of the available solar and wind power, we could supply all our energy needs forever and without adding any carbon to the atmosphere.”

Settled Science and Uncertain Science

Sagan frequently discussed climate change and the lack of scientific knowledge at the time, while Tyson presented climate change as a scientific fact. In the episode “Heaven and Hell,” Sagan reflected this scientific uncertainty when he said, “The indiscriminant destruction of vegetation may alter the global climate in ways that no scientist can yet predict.” At the end of the episode, he went on to say that the study of Earth’s climate is in its “earliest stages of development” and that such studies are “funded poorly and grudgingly.” In these statements, Sagan noted the limitations of the climate science at the time and emphasized the importance of increased funding and exploration of this area of research.

On the other hand, Tyson presented climate change as a fact, in keeping with the increased understanding of climate change. In the episode “The Immortals,” Tyson said, “...[W]e’re pumping greenhouse gases into our atmosphere at a rate not seen on Earth for a million years, and the scientific consensus is that we’re destabilizing our climate.” Similarly, in ‘The World Set Free’ Tyson said, “It’s now clear beyond a reasonable doubt that we are changing the climate.”

Approaches

For a more comprehensive understanding of how environmental risk topics were discussed in both *Cosmos* series, the coders identified the approaches used. In terms of average number of approaches per segment, *Cosmos* (1980) and *Cosmos* (2014) were similar, with 1.7 approaches per segment and 1.6 approaches per segment, respectively. The examined approaches appeared 25 times in *Cosmos* (1980) and 69 times in *Cosmos* (2014). The number of segments each approach appears in is graphed in Figure 3.

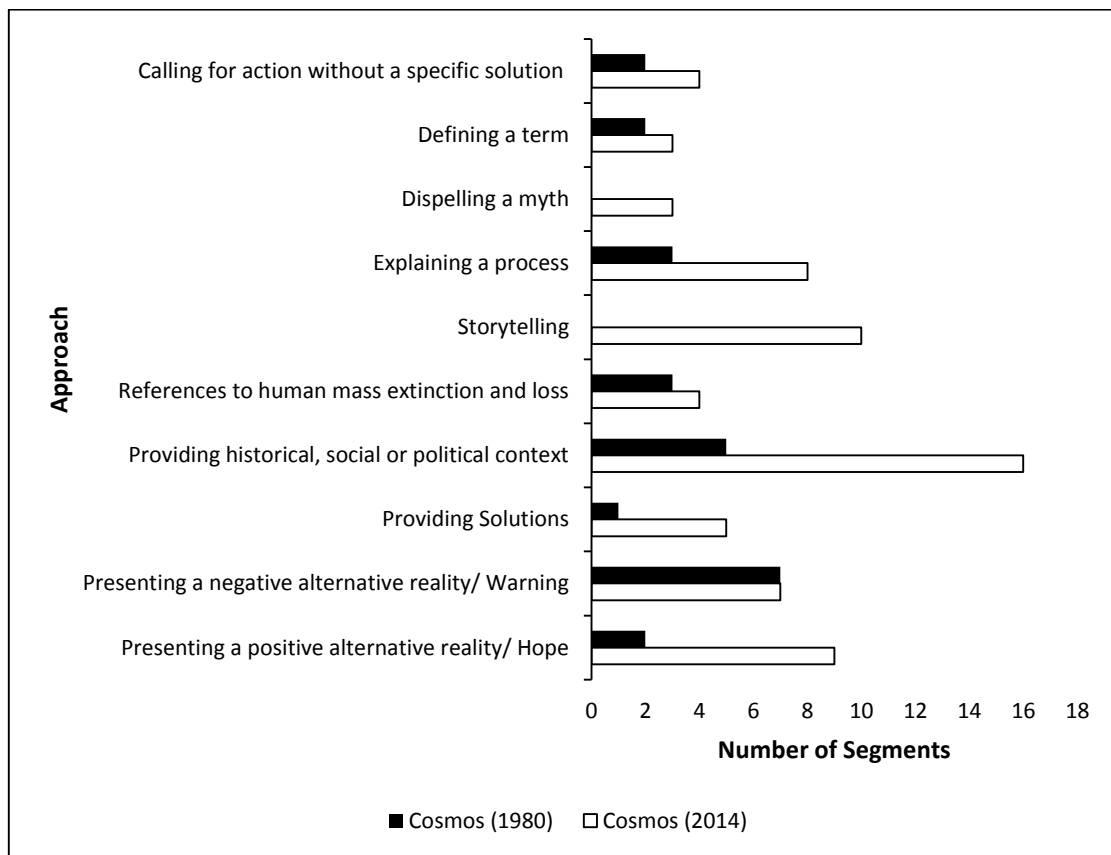


Figure 3. Frequency in which the Studied Approaches Appeared in *Cosmos* (1980) and *Cosmos* (2014).

The most frequently appearing approaches in *Cosmos* (1980), were “Presenting a negative alternative reality/Warning” and “Providing Historical, Social, or Political Context.” In *Cosmos* (2014) the most frequently appearing approaches, in descending order, were “Providing Historical, Social, or Political Context” and “Narrative Storytelling.” An approach that did not appear in *Cosmos* (1980) is “Dispelling a Myth.” However, this approach appeared in three segments in *Cosmos* (2014). The total number of segments that provided specific solutions increased between *Cosmos* (1980) and *Cosmos* (2014), from one segment to five segments.

Providing Context

Both *Cosmos* series provide historical, political, and social context regarding environmental issues. In particular, Sagan noted that, at the time, studies of climate change were “funded poorly and grudgingly” and that this limited the understanding of climate change (“Heaven and Hell”). In the episode “The World Set Free” of *Cosmos* (2014), Tyson provided the audience with historical context on the discovery of climate change and greenhouse gases. He mentioned the work of Svante Arrhenius, who determined the amount of CO₂ in the atmosphere that would melt arctic ice; E.O. Hulburt, who confirmed this hypothesis; and Guy Callendar, who discovered the link between CO₂ and climate change.

Storytelling

The increase in narrative storytelling in *Cosmos* from no segments in *Cosmos* (1980) to ten in *Cosmos* (2014) was due mainly to the inclusion of the narrative on Clair Patterson. In the episode “The Clean Room,” Tyson described how Patterson started his

scientific career attempting to discover the age of Earth, but, in learning that most of his samples were contaminated with lead, turned instead to focusing on finding the source of lead in the environment.

Alternative Realities and the Future, Hope, and Warning

Alternative realities are present in both series, but sometimes the message is a warning and sometimes hope. In the episode “Who Speaks for the Earth?” in *Cosmos* (1980), Sagan told of a dream he has in which he looks into the “Book of Worlds,” which allows him to read about the fate of the Earth. In this dream, he learns that humanity has become extinct because of nuclear war. “So, it was nuclear war — a full nuclear exchange. No more big questions. No more answers. Never again a love of a child. No descendants to remember us and be proud.” Additionally, he refers to nuclear weapons as “genies of death patiently awaiting the rubbing of the lamps.” However, the message is not without hope. Sagan said that worldwide reduction in slavery, decreased nationalism, and increased equality between the sexes are reason for hope. “A new consciousness is developing which sees the Earth as a single organism and recognizes that an organism at war with itself is doomed,” he said.

Alternative realities in *Cosmos* (2014) more frequently communicate hope. After discussing humanity’s potential for mitigating the effects of climate change, the episode “The World Set Free” ends with images of a civilization living in harmony with the environment. While this image is shown, the struggle to combat climate change is compared to the moon landing, as a quote by John F. Kennedy is played: “But why, some say, the moon? Why choose this as our goal? ...We chose to go to the moon and do

other things, not because it is easy, but because it is hard.” In “The Lost Worlds of Planet Earth,” Tyson made it clear that humanity must decide its own fate. After suggesting that humanity use its intelligence to combat climate change, he walked through the “Halls of Extinction,” through which there is a door for each major extinction event, and noted the last door was unmarked. He said, “What happens here, in countless ways, both large and small, is being written by us.”

Solutions

When noting that solutions were provided, the coders also listed the solutions. The only solution suggested by Sagan in *Cosmos* (1980) was solar power. In the episode “Encyclopedia Galactica,” he presented an alternative reality of an alien civilization, much like the civilizations on Earth, depletes other fuel sources and now depends on the sun for energy. The civilization builds a shell around their sun to “harvest every photon of sunlight.” Using solar energy is a frequently proposed solution in *Cosmos* (2014) as well; it is brought up in three of the five segments that offer solutions. In “The Lost Worlds of Planet Earth,” Tyson contrasted solar energy with environmentally damaging fossil fuels, saying, “...the glorious sun pours immaculate, free energy down upon us — more than we will ever need. Why can’t we summon the ingenuity and courage of the generations that came before us?” In addition to recommending solar and wind energy, Tyson made some unconventional suggestions. In “Deeper and Deeper Still,” he proposed using artificial photosynthesis to generate energy, saying that it would make every other energy source obsolete. And in “The Immortals,” Tyson said he could

imagine that our descendants could “siphon off the energy of a threatening supervolcano before it explodes.”

Images and Comparative Language

Both *Cosmos* series rely heavily on visual images and visual or figurative language, such as analogies, similes, and metaphors. In *Cosmos* (1980), eight segments related to environmental risk contained images, and in *Cosmos* (2014) all segments related to environmental risk contained images. Also, seven segments in *Cosmos* (1980) contained comparisons related to environmental risk, along with 15 segments in *Cosmos* (2014). See Appendix E for the list of quotes indicated by the coders as using comparative language.

A recurring metaphor in both series was the comparison of Earth to Heaven and the potential for the greenhouse effect to turn it into Hell. In discussing the greenhouse effect, both series compared Earth and Venus, saying Venus is a “Hell” or “inferno” in relation to Earth because of the heat trapped by the greenhouse effect. *Cosmos* (1980) makes this comparison six times, *Cosmos* (2014) three times. Of the Heaven and Hell comparisons, one statement by Sagan appears in both series: “It may not take much to destabilize the climate, to convert this Heaven, our only home in the cosmos, into a kind of Hell.” In the first series, Sagan states this and in the second a voice-over of Sagan is used.

Both *Cosmos* series employ visuals in some form, either in visually descriptive language or images, such as charts or animations. These visualizations were often used to explain complex scientific processes. For example, in “The Clean Room” the reason

that lead is poisonous was explained through an animation of the molecules. At the same time, Tyson described the process, saying, “Enzymes in the cell are fooled by the lead’s masquerade, and they begin to dance, but it’s a dance of death because the lead is an imposter that can’t fulfill the cell’s vital needs.”

CHAPTER IV

DISCUSSION

Although the two *Cosmos* series were alike in many ways and shared the same goals of bringing science to the public (Keveney, 2014), the series often differed in communicating environmental risk. Specifically, the number of segments spent on environmental risk as well as some of the frames and approaches used to discuss environmental risk differed between the two series. To answer this study's first research question, ("Do the topics and themes related to environmental risk differ between the two *Cosmos* series? If so, in what way(s)?"), notable differences between the two series are discussed in this section.

In considering the differences in how environmental risk is talked about in each series, this discussion also addresses the second research question: "How do the environmental risk communication strategies used in the two *Cosmos* series compare to best practices for inspiring appropriate action among viewers?" Clearly each series has strengths and weaknesses in communicating environmental risk and potentially inspiring action. This discussion outlines such strengths and weaknesses as compared to what science communication and risk communication scholars recommend.

Increase in Environmental Risk Coverage

The number of environmental risk segments increased nearly three-fold (2.78 times) between *Cosmos* (1980) and *Cosmos* (2014). Both series refer to environmental risk throughout the series. However, these occurrences were sometimes brief mentions but other times were substantial proportions of segments or episodes. Factors that could have contributed to this overall increase include kairos, settled science, and the change in topics covered.

Kairos

Kairos or the appropriateness of a message for a specific time is a key factor in the success of the message's reception and the potential for inspiring action (Eskin, 2002; Sipiora, 2002). Although the success of *Cosmos* (1980) has been attributed in part to kairos (Sorensen, 2013), perhaps kairos contributed to the success of both series. In addition to influencing the popularity of each series, kairos could have played a role in the overall increase in environmental messages and audiences' receptiveness to environmental messages.

Environmental coverage is often event-driven and frequently cycles in the amount of coverage received, with higher amounts when an event related to environmental risk occurs (Allan et al., 2000; Hansen, 1991). Both *Cosmos* (1980) and *Cosmos* (2014) aired within a period of the news cycle in which there was decreased coverage and public concern about environmental issues. Specifically, *Cosmos* (1980) aired after the environmental progress of the 1960s and 1970s and during the beginning of a political backlash against environmentalism (Kline, 1997, pp. 117-8). Similarly,

Cosmos (2014) aired after a significant increase in environmental coverage, which began after the release of *An Inconvenient Truth* in 2006 (Cox & Pezzullo, 2016, pp. 93-96).

However, this coverage peaked in 2007 and has since declined (Nerlich et al., 2012).

Despite these cycles, environmental coverage has increased substantially overall in the United States, as well as other countries (Hansen, 2015; Schmidt, Ivanova, & Schaefer, 2013). This increase in environmental content in the media in general began in 1997, the year the Kyoto Protocol was first adopted (Wilson, 2002), and coverage increased further in the 2000s (Liu, Lindquist, & Vedlitz, 2011). Therefore, the increase in coverage in *Cosmos* (2014) reflects a larger media trend toward greater environmental coverage. This increase in coverage also parallels the increase in understanding of environmental issues, especially climate change, in the scientific community (Oreskes, 2004). Further, there has also been an increase in public concern between these two time periods. In 1982, 43 percent of Americans were “very concerned” or “somewhat concerned” about climate change (Dunlap & Scarce 1991). This number rose to 65 percent of Americans in 2013 (Leiserowitz et al., 2014). Considering these factors, it is reasonable that there would be such an increase in environmental content from *Cosmos* (1980) to *Cosmos* (2014).

“Settled Science,” “Uncertain Science,” and “Climate Change”

The overall increase in scientific knowledge regarding environmental risk is also apparent in the increased use of the “Settled Science” frame and decreased use of the “Uncertain Science” frame. In both series, these frames were generally used in reference to climate change, which was supported by more scientific evidence by the time *Cosmos*

(2014) aired (Oreskes, 2004). For example, in *Cosmos* (1980), Sagan said studies on climate change are in the “earliest stages of development.” In contrast, Tyson stated, “It’s now clear beyond a reasonable doubt that we are changing the climate.” These two statements demonstrate how the message on climate change evolved between the series, from uncertain to certain. It is also possible that “Settled Science” frames may have been more necessary to effectively communicate the effects of climate change to the audience of *Cosmos* (2014). Perhaps the audience of *Cosmos* (1980) was more trusting of Sagan and his message. However, further studies could help fully understand this dynamic and the differences between the two audiences.

Although the “Uncertain Science” frame has been used less frequently in mass media in recent years with regard to climate change, it was widely used in the past to diminish credibility of climate change scientists (Boykoff, 2007; Nisbet & Scheufele, 2009; Zhao, Leiserowitz, Maibach, & Roser-Renouf, 2011). In *Cosmos* (2014), Tyson stated that there is scientific consensus on climate change. In stating climate change as a scientific fact, Tyson helped address audience barriers to understanding of environmental risk (Wibeck, 2014).

Rather than emphasizing controversy, both series focused on context, such as informing viewers of the history related to scientific concepts. This is a strategy recommended by Corbett and Durfree (2014) to improve public understanding of environmental issues. Although Sagan used the “Uncertain Science” frame, he generally did so to provide context and inform the audience that the scientific studies have yet to be done. By providing context, both series promoted audience understanding of climate

change and the science behind it. Because the media play a large role in shaping public perceptions of climate change, the fact that both Tyson and Sagan emphasized context is important particularly for promoting education and action (Nisbet, 2009; O'Neill & Nicholson-Cole, 2009).

Change in Complexity of Topics

Another factor potentially affecting the frequency of environmental risk topic appearance in *Cosmos* was the change in the topics discussed. Specifically, *Cosmos* (1980) tended to focus on risks that are less complex and have a single source. This is related primarily to the amount of time spent on the “Nuclear” topic. In terms of nuclear risks, there is little need to explain the cause for concern, because the risk has a clear source and the negative effects are wide reaching and immediate. Although “Climate Change/Global Warming” and “Greenhouse gas/CO₂” are top-occurring topics in both series, *Cosmos* (2014) spent more time explaining the connection between these topics and “Energy.” This association is more complex and multifactorial and requires more time to explain thoroughly—another factor in the increased time spent discussing environmental risk (Kollmuss, 2002; Moser & Dilling, 2004, p. 34).

Previous research indicates that audiences can confuse unrelated environmental topics if they appear together (Ungar, 2000). However, the top co-occurring topics (“Climate change/Global warming,” “Energy,” and “Greenhouse gas/CO₂”) in *Cosmos* (2014) are intricately related, and repeatedly mentioning the topics together solidifies the association. In particular, the causal relationship between greenhouse gases and climate change was the most frequently appearing association. Tyson not only explained directly

that greenhouse gases contribute to climate change; he also reinforced this association by mentioning the two in segments together. By taking the time to explain the relationship between these topics, Tyson addressed barriers to understanding (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Wibeck, 2014). Wibeck (2014) stated that barriers to understanding are a key factor in limiting public engagement and action. Therefore, a more thorough explanation can give the public a better opportunity to understand environmental risk and become engaged.

Approaches and How *Cosmos* Explains Environmental Risk

The creators of both *Cosmos* series have said they want to educate viewers in science, and the approaches used in both shows reflect this desire in terms of environmental risk communication (Brainard, 2013; Itzkoff, 2011; Keveney, 2014). The approaches used help further combat barriers to understanding of environmental risk and can contribute to the audience's ability to take action (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Wibeck, 2014).

Storytelling

A notable difference between *Cosmos* (1980) and *Cosmos* (2014) is the increased use of storytelling in explaining environmental risks, from none in *Cosmos* (1980) to ten segments containing narratives in *Cosmos* (2014), due mainly to the lengthy coverage of Clair Paterson's story. Unlike simply stating scientific information, narratives require context, and to tell a story about science is also to provide context in which the science occurred (Dahlstorm, 2010; Dahlstorm, 2012; Trabasso & Sperry, 1985).

Narratives can help overcome sociocultural barriers because they help address scientific topics within the cultural context in which the science occurs in (Wibeck, 2014). Corbett and Durfee (2004) and Wibeck (2014) have stated that providing context also helps the audience better understand the concept presented, and better understanding helps overcome barriers to scientific literacy.

Further, narratives are widely cited as a way to enhance understanding of complex topics (Avraamidou & Osborne, 2009; Norris, Guilbert, Smith, Hakimelahi, & Phillips, 2005), and they are particularly good at communicating cause and effect (Kreuter et al., 2007). Narratives by definition provide an example of an abstract concept, making it easier to understand (Dahlstrom, 2010). Because narratives can play such a powerful role in explaining concepts and engaging the public, the approach for communicating environmental risk in *Cosmos* (2014) was more in accordance with what scholars recommend than that of *Cosmos* (1980).

Images and Visual Language

The amounts of comparative language, such as metaphors and analogies, are roughly the same in the environmental risk segments in both *Cosmos* series. Both Sagan and Tyson used these rhetorical tools to enhance audience understanding of concepts. Some of these comparisons remained the same between the two series, specifically the comparison of Earth to Heaven and Venus to Hell in describing greenhouse gases. Using comparative language helps the audience conceptualize difficult scientific concepts (Graesser et al., 2002; Oatley, 1991; Slater & Rouner 2002) and thus addresses audience barriers to understanding (Wibeck, 2014).

Although the amount of visual or figurative language (e.g. metaphors) remained the same, the frequency of images increased. *Cosmos* (2014) used graphs and illustrated concepts by using animations. This increase in images, specifically animations, probably was enabled by the technological advances in animation technology available to the creators of *Cosmos* (2014). It is also possible that the advances in graphics technology made it possible to include more narratives, which were absent in *Cosmos* (1980), because animations may allow creators to illustrate aspects of the story that cannot be easily filmed. The technology available when *Cosmos* (2014) was created is another example of *kairos*, as the digital animation technology allowed the message to be conveyed in a way not possible when the original series was created in 1980.

Nuclear War: From Disaster and Warning to Opportunity and Hope

Cosmos (1980) and *Cosmos* (2014) differed dramatically in tone when discussing nuclear war and nuclear winter. *Cosmos* (1980) frequently used the disaster frame and discussed negative alternative realities and warned the audience. However, *Cosmos* (2014) discussed the possibility of nuclear war in hindsight and emphasized the scientific knowledge gained during that time. This shift in tone is likely due to the time in which the shows aired. The most notable difference between these two time periods is the fact that *Cosmos* (1980) aired during the Cold War, when the threat of nuclear war was still looming, and *Cosmos* (2014) aired 23 years after the end of the Cold War (Badash, 2001). Therefore, the audience of *Cosmos* (2014) did not experience the looming possibility of nuclear war that the audience of *Cosmos* (1980) did.

Disaster, Warning, and Mass Extinction in Cosmos (1980)

In discussing nuclear war and related topics, *Cosmos* (1980) generally approached the subject using disaster frames, warnings, and messages of mass extinction. Although these messages are not unwarranted and are widely used in the media when discussing environmental devastation, they are not ideal for inciting action (Greenberg et al., 1989; Hammond & Breton, 2014; McComas & Shanahan 1999). Disaster framing and messages of warning and mass extinction tend to cause the audience to feel they have no control (Wibeck, 2014).

These approaches and the disaster frame may provoke many of the feelings that Sandman (1987) noted would promote outrage (lack of voluntariness, lack of control, unfairness, unfavorable processes, immorality, unfamiliarity, memorability, dread, and danger to many people at a single place and time). Further, viewers are more likely to feel “issue fatigue” than if disaster frames are not used (Hulme, 2009; Maibach et al., 2010) or feel powerless and anxious (Leiserowitz, 2004).

Positive Alternative Realities and Hope in Cosmos (2014)

In *Cosmos* (2014), Tyson used positive alternative realities to compare the nuclear challenges of the past to the climate change challenges of today and offer hope for overcoming the latter. Although presenting positive alternative realities and hope is generally a better way of inspiring audiences (Spence & Pidgeon, 2010) and inciting action than the disaster frame (Bain, Hornsey, Bongiorno, & Jeffries, 2012; Wibeck, 2014), scholars have criticized the belief that major scientific development increase as a

result of the Cold War (Goldston, 2008; Irwin & Wayne, 1996, pp. 1-17; Nisbet & Scheufele, 2009).

The myth of the Space Race as the golden age for scientific innovation and science literacy has been perpetuated by various science communicators (Goldston, 2008; Nisbet & Scheufele, 2009). Although scientific advancements certainly occurred during this time, public trust in science and science literacy during that time were comparable to those in recent years (Kohut, 2009; Michael, 1960; National Science Board, 2008; Swinehart & McLeod, 1960; Withey, 1959). In fact, at the time, Americans tended to see the Space Race as a political rather than scientific victory (Michael, 1960; Swinehart & McLeod, 1960). Nisbet and Scheufele (2009) argue that using this “fall from grace narrative” and exaggerating today’s lack of science literacy is in line with a deficit model strategy, enforcing the need to fill the void in the public’s science knowledge. They have stated that this approach “only likely fans the flames of science conflicts,” (p. 1768) because these remarks generally are interpreted as condescending. This can cause the audience to become disengaged and less likely to act.

Framing

Framing describes the selection of certain information to include in a medium to promote or enhance a certain message (Entman, 1993). Ultimately, framing can influence how an audience perceives the topic being discussed (Entman, 2007) and understands the linkage between concepts (Scheufele & Tewksbury, 2007). In environmental communication, recommended frames include security, health, economic, and morality frames because these frames illustrate the importance of environmental

issues to people within their everyday lives (Maibach et al., 2010; Wibeck, 2014; Zia & Todd, 2010). Thus, by being more relevant to the viewer, these frames promote better understanding of environmental issues (Wibeck, 2014). Further, framing can connect the topic to what the public values and make it culturally relevant, helping to overcome sociocultural barriers (Nisbet & Scheufele 2009; Wibeck, 2014). Most of the recommended frames appear in both *Cosmos* series, although the “Health” frame appears only in *Cosmos* (2014). By using these frames, both series communicate environmental issues in ways that tend to be interesting and relevant to the public.

Security

Security frames were more prominent in *Cosmos* (1980) and were often discussed alongside nuclear disaster, specifically national security and defense. This is evident in Sagan’s statements such as, “Nuclear arms threaten every person on Earth.” *Cosmos* (2014) discussed national security with regard to nuclear disaster but in retrospect. The close association of “Security” and “Nuclear” in both series and the decrease in “Nuclear” coverage in *Cosmos* (2014) likely account for the decrease in “Security” frames in *Cosmos* (2014). Further, the shift toward a more optimistic tone in *Cosmos* (2014), as evidenced by the increase in segments that refer to hope and positive alternative realities, likely also contributed to the decrease in “Security” frames.

According to O'Brien, Eriksen, Nygaard, and Schjolden (2007) “Security” frames are rarely seen within scientific discussions of environmental risk, but they can complement other approaches and should be used within scientific discourse. Similarly, Wibeck (2014) and Zia and Todd (2010) recommend using “Security” frames to

promote public interest and engagement. However, Myers, Nisbet, Maibach, and Leiserowitz (2012) note that “Security” frames angered audience members who researchers determined to be “dismissive,” “alarmed,” or “doubtful” regarding climate change. Participants who were considered “cautious” or “disengaged” did not experience anger. Therefore, the success of the “Security” frame is also likely influenced by the viewers’ existing ideas and feelings about environmental risks. Thus, the “Security” frame has the potential to heighten the interest of some, but not all members of the audience. By emphasizing security, Sagan and Tyson tapped into a concern shared by most—safety, which has the potential to engender action in some but inaction in others.

Health

Of the frames examined in this study, the health frame showed the greatest change between the *Cosmos* series, from no “Health” frames in *Cosmos* (1980) to appearing in 5 out of 56 environmental segments in *Cosmos* (2014). The “Health” frame appeared mainly in the narrative about Clair Patterson’s advocacy to remove lead from gasoline.

Like the “Security” frame, the “Health” frame reaches viewers who may not necessarily be interested in environmental issues, because this frame emphasizes a threat to personal safety or wellness. Of the recommended frames, “Health” has been demonstrated to be one of the most likely to garner public engagement and action (Myers et al., 2012; Wibeck, 2014). Further, “Health” frames have been shown to make audiences more hopeful that a solution to mitigating environmental issues can be achieved (Myers et al., 2012). Therefore, “Health” frames have the potential to empower

the audience and address the lack of agency barrier (Wibeck, 2014). Further, in *Cosmos* (2014) “Health” frames were used alongside “Morality” frames, a narrative, and visuals, thus combining several recommended strategies for enhancing understanding and promoting action (Wibeck, 2014).

Morality

The use of the “Morality” frame was similar in *Cosmos* (1980) and *Cosmos* (2014). Future generations, responsibility, and stewardship were frequent themes within the “Morality” frame in both series. Both series also addressed the inherent value of the Earth and the need to preserve it. Additionally, Sagan and Tyson emphasized that science can be a source of morality and urged viewers to ignore “the reptilian voice within us” and make intelligence “the tool of our survival.”

The morality frame is recommended because of its potential to help overcome sociocultural barriers (Wibeck, 2014). Further, using the “Morality” frame can be effective in reaching religious audience members and others who may not otherwise be concerned about environmental risk (Bingham, 2006; Nisbet & Scheufele, 2009). Further, people are more likely to act if they believe the issue is a moral one (Nisbet & Scheufele 2009).

Both series also referenced the need to address environmental issues for the sake of future generations. This has been a growing concern in the public. In 2013, 65 percent of Americans surveyed said they believe climate change would harm future generations (Leiserowitz et al., 2014), an increase from 37 percent in 1982 (Dunlap & Scarce, 1991). Because of this increase, mentioning the welfare of future generations might have been a

more successful appeal in *Cosmos* (2014), though not necessarily unsuccessful in *Cosmos* (1980).

Economics

The “Economics” frame appears in is roughly the same proportion of environmentally related segments in both *Cosmos* series. Although “Economics” is a recommended frame (Wibeck, 2014), it was sometimes combined with strategies that are not recommended. In both *Cosmos* series, the economic frame often occurred alongside political or ideological struggle, creating a narrative of economics versus the environment. For example, Sagan said, “Which do we value more: short-term profits or the long-term habitability of our planetary home?” Similarly, Tyson juxtaposed the financial interest of large oil companies with the public health interests of Clair Patterson.

By combining the “Economics” frame with references to political or ideological struggles, Sagan and Tyson run counter to the strategy recommended by Cantrill (1993), who suggested “providing opportunities for people to consider the actual similarities between themselves and their adversaries” (p. 88) Instead, emphasizing these ideological disagreements can alienate members of the audience, making them less receptive to understanding and acting on environmental risk (Corbett & Dufree, 2004).

Solutions Proposed in *Cosmos*

Both *Cosmos* series proposed solutions, some vague and some specific. *Cosmos* (2014) more often proposed concrete solutions, but some of these were somewhat unrealistic. Therefore, not all the solutions proposed were ideal for inciting action.

Specific Solutions: Solar and Wind Energy

Although both Sagan and Tyson proposed solutions to environmental risks, only one segment in *Cosmos* (1980) provides a specific such solution. However, both series mention solar power, and *Cosmos* (2014) mentions wind power. The increase in suggesting wind and solar power in *Cosmos* reflects a larger trend toward these suggestions both by experts and in the media (Gallagher, Holdren, & Sagar, 2006; Holdren, 2006; Pacala & Socolow, 2004; Speth, 2008). With increased awareness of climate change, wind power is being increasingly suggested as a way to mitigate such climate change, and the media are being used to shape the public's understanding of the technology (Leiserowitz, 2005; Stephens et al., 2009; Thompson, 2005). Additionally, use of solar and wind energy is expanding in the United States (Wiser & Bolinger, 2008).

This shift to providing more concrete solutions empowers viewers and addresses the barrier of not knowing how to deal with environmental risk. With this information viewers can know exactly what solutions address environmental risk. However, the solutions presented are more collective than individual, such as recycling or buying products that reduce pollution, and may be harder for individuals to implement. A mix of individual and collective solutions would be best for inciting action (Wibeck, 2014).

Vague Solutions: Human Intelligence

Although *Cosmos* (2014) offered several specific solutions to environmental issues (mainly solar and wind power), it also offered a vague solution: to use human intelligence to solve climate change. Although this is a solution, it is not the kind of

concrete solution that can produce action. Additionally, focusing on using human intelligence as a solution might not be ideal for inciting action, because it implies that humans are not currently using their intelligence. Scholars have warned that emphasizing public ignorance tends to alienate rather than engage members of the audience (Nisbet, 2009). Goldston (2008) suggested that this problem is exacerbated when science communicators pin science illiteracy solely on the public.

Strengths and Limitations

This study possessed a number of strengths, some of which are characteristic of a well-designed content analysis. The use of more than one coder in this study reduced the potential for bias. As in most content analysis studies, bias also was assessed through intercoder reliability. Further, using the transcript while viewing the show allowed the coders to better identify categories and understand those categories within context. Another strength of this study was the combination of qualitative and quantitative data collection. Simply employing one type of method or the other would provide narrow insight into communication strategies used. Therefore, both qualitative and quantitative measures were used.

In addition to its strengths, this study had some limitations. Oversimplifying codes is a common concern regarding content analysis studies, because reducing content to specific words or phrases can take the code out of context, thereby losing some meaning (Carley, 1992). This study attempted to mitigate this issue by having the coders view the entire episode and assess the use of rhetorical devices rather than using computer software to identify categories. Additionally, content analysis studies have

generally faced criticism over subjectivity. Although subjectivity was reduced by using two coders, the use of additional coders would further reduce this concern. Also, in this study the second coder coded only a subset of the data. Although this subset was considered by the author of this study to be representative enough to establish intercoder reliability, having both coders coding all of the data would have been ideal.

Future Research Directions

Content analysis studies, such as this one, can describe certain phenomena, such as the use of best practices, but they cannot determine the effects of the media. Surveys and intensive interviews could provide insight on whether *Cosmos* has affected its viewers' attitudes toward the environment and, if so, how. Specifically, interviews and surveys could be conducted before and after *Cosmos* was viewed to determine whether attitudes changed. Additionally, individuals' likelihood to adopt environmentally friendly behaviors could be assessed in future studies. Participants could be asked about various environmentally conscious actions and if these behaviors changed as a result of watching *Cosmos*.

Social media could provide a way for viewers to engage in the show and participate more actively in environmental conversations, and it is possible that such conversations were taking place. Therefore, additional studies could assess the effect of the social media use in association with *Cosmos* (2014). Studying social media is also significant in that more people are turning to social media for news (Matsa & Mitchell, 2014). Some viewers may have viewed segments from *Cosmos* (2014) only on social media; thus the show may have reached an even wider audience.

Other Considerations

Several other factors also might have contributed to what topics were covered, how they were presented, and how successful the messages might have been in both *Cosmos* series. For example, differences in the personalities between the shows' creators or hosts might have contributed to differences in the series. It is possible that *Cosmos* (2014) is more optimistic because it was produced by comedian Seth MacFarlane. However, such possibilities were out of the scope of this study and might be difficult to accurately assess. An additional factor to consider is the audience both shows reached. This might be more feasible to examine in a later study.

Channel and Audience

A major difference between the two series is the audience. In addition to airing in two different time periods, *Cosmos* (1980) aired on PBS and *Cosmos* (2014) aired on Fox, National Geographic, and Hulu. When it aired, *Cosmos* (2014) probably captured a larger and much more diverse audience because it aired on a basic and a premium cable channel and streamed on the Internet. According to the Pew Internet and American Life Project (Kohut, 2009), National Geographic is more widely viewed than PBS and its audience is more diverse audience in terms of gender, education level, age, religious background, and ideological orientation.

There are advantages and disadvantages to this probable increase in audience diversity. A wider audience could increase the chance that someone will be receptive to the message. However, this makes it difficult to target and tailor the message for the audience. Many science communication scholars emphasize the importance of knowing

the audience (Maibach et al., 2008; Moser & Dilling, 2006; O'Neill & Hulme, 2009; Wibeck, 2014). To better tailor environmental messages, Wibeck (2014) and Rootes (2007) recommend local communication. Although it may be the most effective form of communication, many local news outlets have cut or downsized their science and environmental coverage to save money, making local communication unfeasible (Brumfiel, 2009). Additionally, a nationally syndicated show such as *Cosmos* cannot practically tailor its message to various local audiences. Thus, nationally syndicated coverage may not be ideal, but it at least enables exposure to environmental issues. However, using social media, the Internet, and local forms of traditional media to supplement the show and tailor it in a more local way may have been possible for *Cosmos* (2014).

It is difficult to know whether the environmental communication strategies recommended by scholars reached the creators of *Cosmos*. However, it is apparent that *Cosmos* (2014) implemented more of the recommended strategies than did *Cosmos* (1980) with regard to environmental risk communication, possibly due to kairos. Even if the series creators had used the recommended strategies in creating the show, many of today's recommended strategies were not yet available to Sagan and the creators of *Cosmos* (1980). Additionally, *Cosmos* (2014) was able to employ modern graphics and air on several channels (including the Internet). These capabilities simply weren't available at the time of Sagan and *Cosmos* (1980). Given these limitations, Sagan was still able to employ many strategies that could inspire environmental action.

CHAPTER V

CONCLUSION

As a widely viewed popular science show, *Cosmos* has the ability to educate a diverse audience. As it ages, *Cosmos* (1980) remains popular, and *Cosmos* (2014) has followed in its predecessor's footsteps in receiving various awards, including a number of Emmys, and overall high acclaim (LaFollette, 2013; Steinberg, 2015; Television Academy, n.d.). In having a national and international audience, both *Cosmos* series could spread science literacy and contribute to nationwide discussions about science. Further, these series could focus attention on certain scientific topics and issues. This study specifically focused on how both *Cosmos* series addressed environmental issues and looked at how the strategies in the two series compared to those that are recommended to inspire action to mitigate environmental risk.

The most noticeable difference between the two series is the amount of time spent addressing environmental risk. This increase not only reflects a larger media trend toward increased environmental coverage (Liu, Lindquist, & Vedlitz, 2011; Nerlich et al., 2012; Wilson, 2000), but it is also likely results from increased scientific knowledge of environmental issues, particularly climate change (Oreskes, 2004). The increased environmental content in *Cosmos* (2014) also meant a wider variety of subjects covered and more detailed explanations of environmental processes. As scientists learned more

about the complexities of environmental issues, more airtime was needed to explain these complexities.

Not only did the amount of time spent discussing the environment change between *Cosmos* (1980) and *Cosmos* (2014), but the topics discussed changed as well. Several of the top-mentioned topics remained the same, including climate change and pollution, but some top-mentioned topics changed. *Cosmos* (1980) spent more time discussing nuclear disaster, whereas *Cosmos* (2014) spent more time discussing energy. In looking at topic associations, “Climate Change,” “Energy,” and “Greenhouse Gases” most frequently appeared together in *Cosmos* (2014). To the viewer, this solidifies the connection between these three factors.

Framing and approaches in the two series differed as well. More of the frames recommended by Wibeck (2014) and others (Maibach et al., 2010; Zia & Todd, 2010) were frequently used in *Cosmos* (2014) than in *Cosmos* (1980). In terms of approaches, both series provided context. Additionally, Sagan often used visual or figurative language, illustrating concepts in an engaging and charismatic way (LaFollette, 2013, pp. 156-159). In contrast, Tyson more often used storytelling to discuss environmental risk.

The overall tone of the two *Cosmos* series also differed. *Cosmos* (1980) more often uses a negative tone alongside mentions of mass extinction, warning, and destruction. In contrast, *Cosmos* (2014) more often focused on messages of hope and positive alternative realities. Communications scholars generally recommend focusing on more positive messages regarding environmental risk to empower the audience and

make them feel as though their action matters (Hammond & Breton, 2014; Greenberg et al., 1989; McComas & Shanahan, 1999).

It is unclear whether the creators of *Cosmos* knew of the recommended communication strategies. However, it is apparent that *Cosmos* (2014) implemented more of the recommended strategies than did *Cosmos* (1980). Even if the series creators had based the show on the recommended strategies, many of today's recommended strategies were yet published when *Cosmos* (1980) aired.

Overall, the two *Cosmos* series have been significant not only to science communication, but to the culture as a whole. The noted differences between the two series help illustrate the evolution of science on television. Although these findings cannot be generalized to all science programming, this study shows that changes are occurring in how environmental risk is presented on television and in the potential of this presentation to inspire action among viewers.

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APPENDIX A

CODE SHEET

Series: Number:	Episode Title:	Segment
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What topics are covered in this segment? (Circle all that apply):

Climate change/global warming	Loss of biodiversity
Deforestation	Nuclear (war or winter)
Energy (fossil fuels, solar, wind, etc.)	Pollution
Erosion	Sea levels rising/melting glaciers
Extreme anthropogenic weather events	Other (List):
Greenhouse gas/CO ₂	

What frames appear in this segment? (Circle all that apply):

Disaster	Role of science
Economics	Security
Health	Settled science
Morality/ethics	Uncertain science
Opportunity	None
Political/ideological struggle	

What approaches appear in this segment? (Circle all that apply):

Calling for action without a specific solution

Providing historical, social or political context

Educating

Providing Solutions

Defining a term

List:

Dispelling a myth

Presenting a negative alternative reality/
Warning

Explaining a process

Presenting a positive alternative reality/
Hope

Storytelling

References to human mass extinction and loss

Are visuals that relate to the dialogue included? Y N

Describe each in one sentence or phrase:

Does the host use analogies, metaphors, or similes related to environmental risk?

Y N

Quote:

APPENDIX B

CODE BOOK

Series: List year
Number:

Episode Title:

Segment

Remember that the purpose of this study is to identify anthropogenically caused environmental risks on Earth. Do not note natural disasters if not mentioned alongside climate change or another anthropogenic environmental risk. Do not note instances of risks that are naturally occurring or occurring on other planets unless they are being compared directly to anthropogenic environmental risk on Earth. Only note mentions of environmental risks that affect alien civilizations if they are being directly compared to humans on Earth.

What topics are covered in this segment? (Circle all that apply):

Climate change/global warming: Specifically note anthropogenic climate change. Do not consider the natural warming of the Earth, such as warming after the ice age. Only consider mentions of climate change on other planets if being compared with Earth.

Deforestation: This refers to the loss of trees and forests. Only note anthropogenic deforestation. Wildfires that are attributed to climate change can be noted in this category.

Energy (fossil fuels, solar, wind, etc.): Energy used for human consumption. Consider nuclear power in this category rather than the 'nuclear' category.

Erosion: This refers to the degradation and loss of land surface. This can also include soil degradation as a result of agricultural practices.

Extreme anthropogenic weather events/disasters: For example, floods, droughts, earthquakes. Only

consider those mentioned in the context of anthropogenic causes.

Greenhouse gas/CO₂: This refers to when gases, such as water vapor, carbon dioxide, methane, and ozone, become trapped in Earth's atmosphere. This causes radiation from the sun's rays to become unable to escape and must be absorbed by Earth's surface, causing the planet to warm. Only consider CO₂ or any of the other greenhouse gasses when mentioned as part of the greenhouse effect or climate change. References to CO₂

emissions belong in this category rather than the pollution category. Only note the greenhouse effect on other planets if it is directly compared to conditions on Earth. Do not note greenhouse gases of the past.

Loss of biodiversity: Only consider in the context of anthropogenic causes, for example loss of habitat or poaching of a species key to an ecosystem.

Nuclear (war or winter): This does not nuclear power or nuclear forces. Nuclear power belongs in the 'energy' category.

Ozone depletion/hole: This refers to the degradation or thinning of the Earth's ozone layer. Do not mention the ozone layer or ozone gas (O₃) that do not discuss degradation.

Pollution: This refers to contaminants that adversely affect the environment and/or overall health of the environment or the people or other life in it. This can be natural or synthetic.

Sea levels rising/melting glaciers: Note only when this is specifically related to climate change/global warming.

Other (Please describe):

What frames appear in this segment (Circle all that apply)? Framing is selecting certain content to include while not including other content. This ultimately influences the way that the viewer perceives the topic being discussed.

Disaster: The loss or destruction of people and/or their property.

Economics: The potential for people, corporations, nations, or others to make or lose money because of environmental risk.

Health: This can be public health or individual health. Specifically, note human health.

Morality/ethics: May include references to responsibility, or a duty. May discuss how certain actions impact other people or non-human animals, including future generations.

Opportunity: A chance for positive outcomes as a result of environmental risk. This may include mentions of the potential for innovation or conflict resolution.

Political/ideological struggle: This refers to science being challenged by something unscientific political or personal beliefs. This may occur at the individual or societal level.

Role of science: Consider references to science as a piece in understanding how to combat environmental risk. May compare the knowledge gained from science to other bodies of knowledge, such as politics.

Security: This often relates to national security and military defense. This may also mean security of resources or way of life, such as crops or housing.

Settled science: The topic is discussed in a way that gives the impression of scientific credibility or consensus. This may include citing specific studies or statistics. It may also include referring to well-known and well-respected scientists or scientific entities (i.e. the EPA, NASA, or NOAA).

Uncertain science: The science presented is communicated to be still up for debate among scientists. Do not consider debates between science and other fields. Do not note past instances of scientific uncertainty.

None: Circle if none of the above segments appear.

What approaches are used in this segment (Circle all that apply)?

Calling for action without proposing a specific solution: The host says something should be done without mentioning specifically what action should be taken.

Educating: Select if the host is educating in a way that does not fit the following categories

Defining a term: The term may or may not have been used before it is defined.

Dispelling a myth: The host mentions a misconception associated with environmental risk and counters with the scientific perspective.

Explaining of a process: The host describes in detail how an environmental process occurs. Visuals may or may not accompany the explanation.

Storytelling: This consists of a story with a main character or characters and a central conflict to be overcome. This may also include some biographical elements and scientific discoveries. The story may be factual or not. If the story is factual, it may have occurred in the past or present. It may be futuristic as well.

References to mass extinction and loss: This generally refers to loss of lives and/or property. Only consider past extinction when mentioned in conjunction with or compared with present conditions.

Providing historical, social or political context: This does not refer to biographical context or background of an individual.

Providing Solutions: A specific solution is given. Contrast this with the 'Calling for action without a specific solution' category.

Presenting a negative alternative reality/Warning: Note instances in which the host warns of the consequences of human activities that degrade the environment and/or presents potential consequences of such activities. The host may mention future

scenarios or alternative realities with negative impacts on humans due to anthropogenic environmental risk.

Presenting a positive alternative reality/ Hope: Note instances in which the host presents scenarios in the future or an alternative reality in which humans activities mitigate or do not lead to environmental risk. This may include scientific or technological advances and/or a cultural shift to valuing the environment.

Are visuals that relate to the dialogue included? These may be animated or not. This may include charts or graphs or other representations of data. If the host is in the in the shot, he may be using models or illustrating what is being said in another way.

Describe each in one sentence or phrase:

Does the host use analogies, metaphors or similes related to environmental risk? A related image may or may not be shown on screen.

Quote:

APPENDIX C

LIST OF SEGMENTS ANALYZED

Table C-1. Segments Analyzed in Cosmos (1980).

Episode Name	Segment Numbers
“Heaven and Hell” (Episode 4)	2, 4, 8, 9, 10 , and 11
“Encyclopedia Galactica” (Episode 12)	11
“Who Speaks for the Earth” (Episode 13)	3 and 4

Table C-2. Segments Analyzed in Cosmos (2014).

Episode Name	Segment Numbers
“Deeper and Deeper Still” (Episode 6)	3 and 4
“The Clean Room” (Episode 7)	1, 4, 5, 6, 7, 8, 9, 10, 11, and 12
“The Lost Worlds of Planet Earth” (Episode 9)	10
“The Immortals” (Episode 11)	8, 9, 10, and 11
“The World Set Free” (Episode 12)	3, 4, 5, 6, 7, 8, 9, 10, and 11

APPENDIX D

NUMBER OF SEGMENTS OF ENVIRONMENTAL RISK TOPICS, FRAMES AND APPROACHES

Table D-1. Number of Segments in which Environmental Risk Topics Appear in Cosmos (1980) and Cosmos (2014).

Topic	<i>Cosmos</i> (1980)	<i>Cosmos</i> (2014)
	Number of Segments	Number of Segments
Climate Change/ Global Warming	3	9
Deforestation	1	1
Energy	1	13
Erosion	1	2
Extreme Anthropogenic Weather Events	1	2
Greenhouse Gas/CO2	2	10
Loss of Biodiversity	1	2
Nuclear	3	2
Pollution	4	11
Sea Levels Rising/Glaciers Melting	0	4
Other	1	0

Table D-2. Number of Segments in which Environmental Risk Frames Appear in Cosmos (1980) and Cosmos (2014).

Frame	<i>Cosmos</i> (1980)	<i>Cosmos</i> (2014)
	Number of Segments	Number of Segments
Disaster	7	8
Economics	4	11
Health	0	5
Morality	6	13
Opportunity	0	9
Political	2	8
Role of Science	1	3
Security	4	7
Settled Science	0	8
Uncertain Science	2	2
None	1	2

Table D-3. Number of Segments in which Environmental Risk Approaches Appear in *Cosmos* (1980) and *Cosmos* (2014).

Approaches	<i>Cosmos</i> (1980)	<i>Cosmos</i> (2014)
	Number of Segments	Number of Segments
Calling for action without a specific solution	2	4
Defining a term	2	3
Dispelling a myth	0	3
Explaining a process	3	8
Narrative story telling	0	10
References to human mass extinction and loss	3	4
Providing historical, social, or political context	5	16
Providing solutions	1	5
Presenting a negative alternative reality/ Warning	7	7
Presenting a positive alternative reality/Hope	2	9

APPENDIX E

TOPIC ASSOCIATIONS

Table E-1. Topic Associations in Cosmos (1980).

1980	Climate Change/Global Warming	Deforestation	Energy	Erosion	Extreme Weather Events	Greenhouse Gas	Loss of Biodiversity	Nuclear	Pollution	Sea Levels Rising	Other
Climate Change/Global Warming	X	1	0	1	1	1	1	1	2	0	0
Deforestation	1	X	0	1	1	0	1	0	1	0	0
Energy	0	0	X	0	0	0	0	0	0	0	0
Erosion	1	1	1	X	1	1	1	0	1	0	0
Extreme Weather Events	1	1	0	1	X	0	1	0	1	0	0
Greenhouse Gas	1	0	0	0	0	X	0	0	0	0	0
Loss of Biodiversity	1	1	0	1	1	0	X	0	1	0	0
Nuclear	1	0	0	0	0	0	0	X	2	0	0
Pollution	2	1	0	1	1	0	1	2	X	0	0
Sea Levels Rising	0	0	0	0	0	0	0	0	0	X	0
Other	0	0	0	0	0	0	0	0	0	0	X

Table E-2. Topic Associations in Cosmos (2014).

2014	Climate Change/Global Warming	Deforestation	Energy	Erosion	Extreme Weather	Greenhouse Gas	Loss of Biodiversity	Nuclear	Pollution	Sea Levels Rising	Other
Climate Change/Global Warming	X	0	5	1	2	8	1	0	2	4	0
Deforestation	0	X	0	0	0	0	1	0	0	0	0
Energy	5	0	X	0	0	6	0	1	4	1	0
Erosion	1	0	0	X	1	1	0	0	0	1	0
Extreme Weather Events	2	0	0	1	X	2	1	0	0	2	0
Greenhouse Gas	8	0	6	1	2	X	1	2	2	3	0
Loss of Biodiversity	1	1	0	0	1	1	X	0	0	1	0
Nuclear	0	0	1	0	0	0	0	X	0	0	0
Pollution	2	0	4	0	0	2	0	0	X	0	0
Sea Levels Rising	4	0	1	1	2	3	1	0	0	X	0
Other	0	0	0	0	0	0	0	0	0	0	X

APPENDIX F

LIST OF VISUAL OR FIGURATIVE LANGUAGE USED

Cosmos (1980)

Episode 4 Segment 2

“In those Heavens, there are some worlds much like hell. Our planet is, in comparison, much like a Heaven.” [In the context of “catastrophes both intentional and inadvertent.”]

Episode 4 Segment 8

“Venus is the one place in the solar system most like Hell.” [In the context of Venus’s greenhouse gases]

“The greenhouse effect can make an Earth-like world into a planetary inferno.”

“The Hell of Venus is in stark contrast with the comparative Heaven of its neighboring world, our little planetary home, the Earth.” [In the context of Venus’s greenhouse gases]

Episode 4 Segment 9

“In only a little more than a century, in New York’s Central Park, the inscriptions on that obelisk have been almost totally obliterated—not by sand and water but by smog and industrial pollution—a bit like the atmosphere of Venus.”

“The indiscriminate destruction of vegetation may alter the global climate in ways that no scientist can predict. It has already deadened large patches of the Earth’s life-supporting skin.”

“The Earth has mechanisms to cleanse itself to neutralize the toxic substances in the system.”

“There are no useless threads in the fabric of the ecosystem. If you cut any one of them, you will unravel many others.” [In the context of loss of biodiversity]

“We have uncovered other worlds with cocking atmospheres and deadly surfaces. Shall we then recreate these Hells on Earth?”

“We need not force the hand of nature.” [In the context of creating more greenhouse gases]

Episode 4 Segment 10

“It may not take much to destabilize the Earth’s climate Earth’s climate, to convert this Heaven, our only home in the cosmos, into a kind of Hell.”

“Knowing that worlds can die alerts us to our own danger.” [In the context of climate change.]

Episode 13 Segment 3

“But instead, we listen to that reptilian voice within us, counselling fear, territoriality, aggression.” [In the context of nuclear war]

Episode 13 Segment 4

“Nuclear weapons have almost become a home handicraft industry.”

“The energy contained in these weapons—genies of death, patiently awaiting the rubbing of the lamps—totals far more than 10,000 Megatons.”

“The global balance of terror pioneered by the U.S. and Soviet Union holds hostage all the citizens of the Earth.”

“The hostile military establishments are locked in some ghastly mutual embrace.”

Cosmos (2014)

Episode 6 Segment 3

“This assembly line is the heart of the molecular industrial complex.” [In the context of photosynthesis as a ‘green’ power source]

Episode 6 Segment 4

“In the years since Darwin’s famous prediction, this moth species could have easily become extinct with all of the others—every one of them a unique phrase in life’s poetry, written in the atoms by eons of evolution.”

Episode 7 Segment 7

“Enzymes in the cell are fooled by the lead’s masquerade, and they begin to dance. But, it’s a dance of death, because the lead is an imposter that can’t fulfill the cell’s vital needs.”

Episode 7 Segment 9

“It was a form of time travel, to recover snow that had fallen three centuries ago, before the start of the Industrial Revolution.” [In the context of Claire Paterson’s research on lead content in the environment]

Episode 10 Segment 9

“This so-called ‘volcanic winter’ resembled a ‘nuclear winter’, but without the radiation.”

Episode 10 Segment 10

“But if our intelligence is the only edge, we must learn to use it better, to sharpen it, to understand its limitations and deficiencies—to use it as cats use stealth before pouncing, as walking sticks use camouflage, to make it the tool of our survival.” [In the context of finding a solution to climate change]

“But what about us? What is our own future? What would the Cosmic Calendar of the next 14 billion years look like?” [In the context of climate change]

Episode 10 Segment 11

“If the original Cosmic Calendar includes all of time from the birth of the universe until this very moment what would the Cosmic Calendar look like for the next 14 billion years? Just as with the Cosmic Calendar of the past, every month the future calendar equals about a billion years; every day, some 40 million.” [Later talks about a hopeful future for climate change]

Episode 12 Segment 3

“That's why Venus is such a ferocious inferno so hostile to life. The Earth, in stunning contrast, is alive. It breathes but very slowly. A single breath takes a whole year.” [In the context of Venus's greenhouse gases]

Episode 12 Segment 4

“The Earth keeps a detailed diary written in the snows of yesteryear. Climate scientists have drilled ice cores from the depths of glaciers in Greenland and Antarctica.”

“You're seeing the planet's own body heat.” [In the context of measuring infrared light off Earth and climate change]

“It's basic physics, just bookkeeping of the energy flow.” [In the context of the greenhouse effect]

“[Carbon dioxide] happens to be the chief climate-regulating gas of our global thermostat, year in, year out.”

Episode 12 Segment 5

“It may not take much to destabilize the Earth's climate, to convert this Heaven, our only home in the cosmos, into a kind of Hell.” [Quoting Sagan]

Episode 12 Segment 6

“My friend's [dog] meandering represents the short-term fluctuations—that's weather. It's almost impossible to predict what'll attract his interest next, but not hard to know what the range of his meandering will be, because I'm holding him on a leash. We can't observe climate directly-- all we see is the weather-- but the average weather, over the course of years, reveals a pattern.

I represent that long-term trend, which is climate.

Keep your eye on the man, not the dog.” [Talking about weather versus climate]

Episode 12 Segment 7

“Because the Arctic regions are warming faster than anywhere else on Earth, the permafrost is thawing and its contents are rotting, just like when you unplug the freezer.”

Episode 12 Segment 10

“Once there was a world rigged with 60,000 hair-triggered nuclear weapons. The combatants were the two most powerful countries on Earth, and they were locked in a deadly embrace, each vowing that they would rather see everything we love destroyed than submit to the will of the other.”

Episode 12 Segment 11

“Once there was a world if life ever existed on Venus, it would have had no chance to avert the hellish destiny of this world.”

“But why, some say, the Moon? Why choose this as our goal? And they may well ask, why climb the highest mountain? We choose to go to the Moon we choose to go to the Moon (applause, cheering) we choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard.” [Quoting Kennedy and comparing to averting climate change]