MASTERARBEIT

Constructing Parallel Narratives in Cartographic Storytelling

zur Erlangung des akademischen Grades

Master of Science

im Rahmen des Studiums

Cartography

eingereicht von

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ausgeführt am Institut für Geodäsie und Geoinformation der Fakultät für Mathematik und Geoinformation der Technischen Universität Wien

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Wien, 10.10.2021   _____   _____

                     Unterschrift (Verfasserin)   Unterschrift (Betreuer)

MASTER THESIS

Constructing Parallel Narratives in Cartographic Storytelling

For the Achievement of the Academic Title

Master of Science

Within the Degree Course

Cartography

Submitted By

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Completed at the Department of Geodesy and Geoinformation of the Faculty for Mathematics and Geoinformation at the Technical University Vienna

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Vienna, 10.10.2021   _____   _____

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Cartography M.Sc.

Master thesis

Constructing Parallel Narratives in Cartographic Storytelling

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UNIVERSITY OF TWENTE. — ITC

2021

Constructing Parallel Narratives in Cartographic Storytelling

submitted for the academic degree of Master of Science (M.Sc.)
conducted at the Department of Aerospace and Geodesy
Technical University of Munich

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Date of submission: 10.10.2020

Statement of Authorship

Herewith I declare that I am the sole author of the submitted Master's thesis entitled:

"Constructing Parallel Narratives in Cartographic Storytelling"

I have fully referenced the ideas and work of others, whether published or unpublished. Literal or analogous citations are clearly marked as such.

Munich, 10.10.2021   Stephanie, Fovenyessy

Acknowledgements

First I am immensely grateful for the opportunity to take part in this Cartography Master's program. My experiences over the past two years have positively contributed to my growth both academically and personally. I will always cherish these experiences.

Second I would sincerely like to thank both of my supervisors and my reviewer for always providing positive support.

Professor Gartner – thank you very much for supporting me from the beginning and for helping me to narrow down my ideas.

Franz-Benjamin Mocnik – thank you very much for continually supporting me and keeping me on track. Our discussions always helped to motivate me.

Edyta Bogucka – thank you for always providing me with new ideas.

Thirdly, I especially would like to thank the members of the research group BioInvasions – global change – Macroecology at the University of Wien, Franz Essl, Bernd Lenzner, Dr. Wolf-Christian Saul, and Dr. Jonathan Jeschke, for meeting with me on so many occasions and providing me with data on their Invasive Alien Species (IAS) Scenarios.

Finally, would like to thank everyone else involved in supporting the thesis process including, Barend Köbben, Juliane Cron, and Wangshu Wang.

Abstract

This thesis aims to provide an understanding on how parallel narratives can be applied in cartographic storytelling. An increase in research on cartographic storytelling has outlined techniques and structures used to convey stories. This thesis will expand upon this research and focus on the presentation of parallel narratives in cartographic stories. Parallel narratives are widely used in both literature and film and are defined as the presentation of multiple narratives in one story. The narratives are linked by a common theme and often present opposing views or sides to one story. Design elements and structures in both visual/cartographic storytelling and parallel narratives will be presented in order to understand what design elements and structures are important in cartographic parallel narrative stories. Through a qualitative content analysis of existing examples of parallel narratives in cartographic stories a typology of parallel narratives in cartographic stories is presented. The typology of parallel narratives helps to describe the various structure and presentation of parallel narratives in cartographic stories. A case study further examines how certain elements of a visual story contribute to the display of a parallel narrative in a cartographic storytelling.

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1. Introduction

1.1. Background and Motivation

Visual stories have become a predominant method for consuming information. Social media, news media, TV programs, and all sorts of advertisements are constantly bombarding us with visual information woven together to create a story. These visual stories range from graphics presented by major news organizations that visualize current events throughout the world to the album of photos your friend posted on their social media.

The importance of stories is not new. Stories, written, oral, and visual, are deeply rooted in human culture (Gershon & Page, 2001). Stories present information and facts in a memorable way allowing them to be conserved and passed on (Kosara & Mackinlay, 2013). Visual storytelling, like oral and written storytelling, has been around for hundreds of centuries. Technology has allowed for the presentation of visual stories to spread and has also provided new methods to convey information. Visual stories help us process information by both presenting information in a visual manner and by condensing important information into understandable graphics. Visual stories can also be presented in a spatial manner, illustrating the locations where events occurred.

Every story has some spatial component and therefore can be visualized in a spatial manner. For example most major news organizations including The New York Times and The Wall Street Journal have created spatial visualizations illustrating the spread of the corona virus throughout the world. In addition social media platforms have given the individual the ability to visualize their journeys through maps. For this reason cartographic stories are wildly used by digital news media to captivate readers and display spatial data. Cartographic storytelling enhances the map with additional text and media in order to convey a story.

Research in the field of cartography has begun to focus on how storytelling techniques can be applied in cartographic storytelling visualizations. In cartographic storytelling several papers have described how narrative structures can be applied to visual storytelling and cartographic storytelling, however an assessment of how parallel narratives can be applied to these structures or what structures and elements best support parallel narratives has not been outlined for visual storytelling or cartographic storytelling.

Defined by Bridget Baudinet, "a parallel narrative is a story structure where two or more separate narratives are linked by a common character, event, or theme" (Baudinet, n.d.). One famous example of a parallel narrative done in film is Pulp Fiction (1994), where several plot lines intersect. Other examples include the films Magnolia (1999) and The Hours (2002), in which several protagonists storylines are told, connected by a common theme. Parallel narratives have become more popular in recent years in both literature

and film. They present a complex and more realistic depiction of the world around us by often examining multiple sides of a story.

Online news and social media is rapidly expanding into everyday life and our ability to consume a wide variety of media and information is ever adapting. This allows for a rapid intake of all sorts of local, regional and international stories. With so many stories spreading and developing in real time it is always important to understand that there are two or more sides to every story. Current research on structuring stories in cartographic storytelling has focused on the presentation of one narrative.

This thesis will address how parallel narratives can be constructed in cartographic storytelling. Focus will be put on determining what design elements help to present and distinguish between multiple narratives as well as the creation of a typology for parallel narratives in cartographic storytelling.

1.2. Research Identification

1.2.1. Research Objectives

The overall objective of this thesis is to examine how parallel narratives are applied in cartographic storytelling and develop a typology that describes the presentation of parallel narratives in cartographic storytelling. In order to accomplish this objective four sub-objectives have been outlined. The four sub-objectives are as follows:

Objective 1:
The first objective is to examine the design elements and techniques used to enhance and structure a story in both visual and cartographic storytelling. In order to conceptualize methods for visualizing parallel narratives in cartographic storytelling, current research on visual methods used in visual stories and cartographic stories will be outlined. Focus will be on visualization techniques used to present the structure or flow of the story as well as devices included that highlight or emphasize important pieces of the story.

Objective 2:
The second objective is to examine parallel narrative structures present in literature and film in order to develop and apply these structures and methods to cartographic storytelling. Structures describe how the various storylines are organized in the narrative. Parallel narrative structures in both literature and film are well researched and summarizing these structures will help to apply them to cartographic storytelling.

Objective 3:
The third objective is to develop a typology categorizing the types of parallel narratives in cartographic stories. Based on information collected in objectives one and two, existing examples of parallel narratives in cartographic stories will be identified and examined in order to identify important structures and techniques used specifically in cartographic stories that present parallel narratives.

Objective 4:

The fourth objective is to test methods of presenting parallel narratives in cartographic storytelling discovered by objective three. This objective aims to gain a better understanding on how viewers understand the presentation of parallel narratives in cartographic storytelling. In order to achieve this objective cartographic parallel narrative stories will be created with data provided by the research group BioInvasions – global change – Macroecology at the University of Wien. Therefore, a sub-objective will be to create a cartographic parallel narrative story with methods outlined in object three.

1.2.2. Research Questions

To meet the above objectives, several research questions must be addressed.

Research Question 1: What are the important techniques used in cartographic storytelling to tell a story?
- How are visual and cartographic stories structured?
- What elements (devices) do visual and cartographic stories use to emphasize and enhance a story?

Research Question 2: How are parallel narratives presented in literature and film?
- What defines a parallel narrative?
- What typology is there for parallel narratives in literature and film?

Research Question 3: How can cartographic parallel narrative stories be classified?
- What techniques or characteristics do existing examples of parallel narratives in cartographic stories have?

Research Question 4: What design elements or techniques are most effective in distinguishing between as well as providing a comparison of parallel narratives in cartographic storytelling?
- How can the data from the research group BioInvasions – global change – Macroecology at the University of Wien be presented in a cartographic story.

1.2.3. Research Methodology

Several steps will be taken in order to answer the research questions. First a literature review will take place it order to meet objectives one and two. Current literature on visual and cartographic storytelling will be examined in order to discover and categorize design elements and techniques that aid in the presentation of visual stories and narratives. Current literature on parallel narratives will be examined in order understand the classifications of parallel narratives. In order to examine the presentation of parallel narratives in cartographic stories a qualitative content analysis will be conducted. The content of the existing examples of parallel narratives in cartographic stories will be analyzed based on both cartographic and parallel narrative techniques discovered through the literature reviews. The qualitative content analysis will include coding and card sorting.

In order to test certain design elements that were found to contribute to the presentation of parallel narratives in cartographic stories though the qualitative content analysis, a case study will be developed. The case study will be conducted with research from the project AlienScenarios developed by the research group BioInvasions – global change – Macroecology at the University of Wien. The case study will develop two cartographic parallel narrative stories. To test design elements in both stories a questionnaire will be developed and sent out to the general public.

1.3. Thesis Structure

This thesis is broken up into seven chapters. The first chapter provides the background and motivation for this thesis along with the research objectives. The following four chapters address each of the research objectives and questions outlined in chapter one. The second chapter discusses visual storytelling and cartographic storytelling. The third chapter discusses parallel narratives in literature and film. The fourth chapter outlines the methodology used to develop a typology of parallel narratives in cartographic storytelling as well as the results. The fifth chapter discusses the case study developed to test methods used to present parallel narratives in cartographic storytelling. The final two chapters present an assessment and conclusion on this thesis. The sixth chapter presents the discussion with limitations. The final chapter presents the answers to the research questions and future research along with the conclusion.

2. Visual and Cartographic Storytelling

This chapter presents an overview on the development and definition of stories and narratives, and how they are applied in visual storytelling, cartography and cartographic storytelling. The chapter begins by defining both story and narrative as important concepts and detailing how they fit together. Expanding on the two concepts of stories and narratives, the chapter focuses on visual storytelling and further cartographic storytelling. Both visual storytelling and cartographic storytelling are described by their design elements.

2.1. Stories and Narratives

Stories and storytelling have been around since humans first began to communicate (Rodríguez et al., 2015). Stories go back as far as the spoken language. Long before there were any written stories there were oral narratives that passed between generations and cultures. As time has passed, "technology and culture have constantly provided new and increasingly sophisticated means to tell stories" (Gershon & Page, 2001, p. 31). Now all types of media are used to convey stories: oral tradition, printed word, film, and digital media.

The terms story and narrative are often used interchangeably, however there is a distinct difference between the two. A story consists of events and characters, it is the content, while a narrative focuses on how the story is told (Chatman, 2007; Kim et al., 2018). The narrative presents the events in a discrete and ordered sequential manner (Chatman, 2007). Therefore a narrative can be considered as the structure behind the story. The structure of "a good storyline has a plot that develops over time in a tension curve, based on cause, intervention and effect" (Thöny et al., 2018, p. 4).

In any basic story the narrative is structured with a beginning, middle, and end. This structure is often referred to as the three act narrative arc (Figure 1). The story arc is the sequence of events (*What Is a Narrative Arc?*, 2017). The first act, or beginning, sets the plot and introduces the setting, characters, and conflict. At the end of the first act an event causes tension for the characters. In the second act, the middle, the plot develops, and the tension continues to build until the conflict reaches a climax. The climax is a turning point in the narrative. Events that lead to a resolution occur between act two and act three. In act three the conflict is resolved and the story ends (Figure 1) (Nussbaumer Knaflic, 2020; *What Is a Narrative Arc?*, 2017). This, of course, is a simplified description of a basic narrative structure. A story often presents multiple conflicts that help to hold the reader/viewers' attention and move the story along (Nussbaumer Knaflic, 2020).
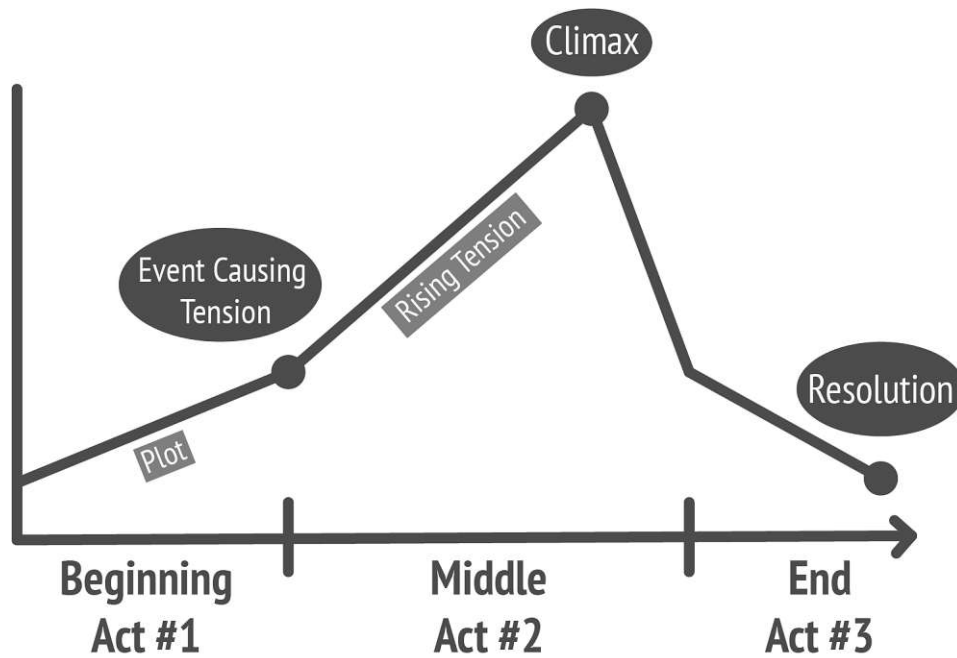
Figure 1. Three act narrative curve. Created based on figures by Nussbaumer Knaflic (2020).

While the narrative arc describes the order the narrative is presented to the viewer, the narrative can also be described by the temporal order in which the events occur (Kim et al., 2018). This is the relationship between the chronological sequence of the events of the story and the sequence within which the events are narrated to the audience (Kim et al., 2018). There are two main ways to describe the order in which events occur in a narrative: linear and non-linear. In a linear narrative, events are presented in chronological order. In a non-linear narrative the timeline of events is disjointed. This can include the use of flashbacks. Non-linearity in narratives often increases the suspense of the story (Kim et al., 2018).

A story can also include multiple narratives that can be structured both linearly and non-linearly. When a story has more than one narrative it is called a parallel narrative. In a parallel narrative structure, multiple narratives are woven or tied together through a common theme, event, location, character, and/or artefact (Learning Center, n.d.). The two or more narratives come together to tell a specific story. The way in which the narratives are structured, linearly or non-linearly, and interwoven determines how the reader/viewer perceives the story and its underlying messages (Kim et al., 2018).

Narrative structure, and its ability to guide the audience through a story, has become an important topic in not only written storytelling. Storytelling, the act of telling a story, is important in many different disciplines and fields including journalism, education, entertainment, politics, and scientific research (Tong et al., 2018). Several subfields of storytelling have been developing to describe how a story is presented. One such field is visual storytelling.

2.2 Visual Storytelling

Visual storytelling, like oral and written storytelling, has been around for hundreds of centuries, perhaps since early humans began to draw on cave walls. However the subject of visual storytelling as a concept discussed and used in academia and mainstream media

is relatively new (Tong et al., 2018). Traditionally, visualizations were used to support a narrative as supplementary information. Visual storytelling presents a story independently of traditional text or video (Figueiras, 2014).

Visual storytelling combines data and a story to present viewers with a visual display. Data is collected and processed before visual techniques are applied. Creating a visual narrative entails "using a tool, such as Tableau or Microsoft Excel to visually analyze data and to generate visualizations via vector graphics or images for presentation", and then deciding "how to thread the representations into a compelling yet understandable sequence" (Hullman et al., 2013, p. 2406). These visual representations are described by Tong et al. as: "a set of story pieces, visualized to support one or more intended messages" (Tong et al., 2018, p. 2). When the data and the "story pieces" are connected or presented in a meaningful way that the viewer can understand a story is told (Tong et al., 2018). Visual storytelling can be used to explain: "to understand what is present in the data" and to communicate: "to display and discuss visualizations with the public by telling stories based on the data and the facts" (Rodríguez et al., 2015, p. 3). Without the storytelling element of the visualization the audience would lack explanations about the plot and would have to rely on their own ability to interpret the data correctly (Figueiras, 2014).

Visual stories and narratives can be broken down just like written stories and narratives. The visual story is comprised of the events and characters. The characters in the visualization are "visual elements representing data points" (Kwan-Liu Ma et al., 2012, p. 1). The events are the "patterns in data sets represented in visualizations" (Hullman et al., 2013, p. 2406). Kwan -Liu Ma et al also describes what the setting and plot are comprised of in a visual story by noting that the setting of a visualization is "all of the background information a viewer needs to know in order to contextualize and comprehend the visualization" (Kwan-Liu Ma et al., 2012, p. 1). The plot of the "visualization arises from the from the juxtaposition of its visual elements, how they interact and compare with one other, and how they evolve over time" (Kwan-Liu Ma et al., 2012, p. 1). The visual narrative is the structure of the characters and transitions between events (Tong et al., 2018).

The narrative structure of visual stories differs from literature and film because the information that might have been presented in 100 pages of text or an hour of film is now condensed to a smaller graphical representation. Roth describes a characteristic of visual stories as partial stating that "visual stories privilege brevity over completeness" (R. E. Roth, 2020, p. 3). Visual narratives present a smaller set of characters and events that can be used to "exemplify broader patterns and trends" (R. E. Roth, 2020, p. 3).

The basic elements of a three act narrative arc can further be examined when looking at visual narratives (Figure 1). The first element that must be included in a visual narrative structure is a "navigational component" that indicates to the viewer where to start and how to progress through the visualization (Cohn, 2013, p. 414). This is important because static visualizations are two dimensional and therefore "lack a temporal sequence or relevant linear axis to inform a plotline" (R. E. Roth, 2020, p. 5). Each act must include specific visual elements to enforce the linearity and direction of the narrative (R. E. Roth, 2020). In the beginning the viewer should understand the subject and characters involved in the visualization. The conflict arises as the viewer understands the relationship between the various characters. Symbols, text, animation, and other graphics

can help highlight key relationships. The resolution of the visual story can be presented as the resources included, inviting the viewer to do their own research into the topics conclusion or the author can choose to exclude a resolution from the visualization leaving the viewer with a memorable cliff-hanger (R. E. Roth, 2020).

In addition to narrative structure the designer of the visual story can introduce other narrative elements to influence the way in which the story is told. These elements can be grouped into several categories including narrative design patterns, narrative visualization elements, and interactivity (Bach et al., 2018; Segel & Heer, 2010).

2.2.1 Narrative Design Patterns

Narrative Design Patterns are techniques used to effect flow and argumentation in data-driven visual narratives (*NAPA Cards*, 2016). Narrative design patterns are not exclusive and are often combined to further the designer's intent in creating the visualization. The use of narrative design patterns can be broken down into five intentions: argumentation, flow, framing, emotion, and engagement (Bach et al., 2018). Narrative design patterns that support argumentation with "different ways to present, support, reinforce, contradict or discuss a given message" (Bach et al., 2018, p. 6). These narrative design patterns include: compare, concertize, repetition, and rhetorical question. Flow patterns help structure the narrative and include: exploration, gradual reveal, repetition, and speed-up/slow-down (Bach et al., 2018). Framing patterns help to dictate the way in which the audience perceives the visualization. Framing patterns include: familiar setting, make-a-guess, defamiliarization, convention breaking, silent data, and physical metaphors (Bach et al., 2018). Emotion patterns help to spark emotions in the audience making the visualization more relatable and memorable. These narrative patterns include: familiar setting, gradual visual reveal, humans-behind-the-dots, rhetorical question, silent data, and user-finds-themselves (Bach et al., 2018). The final narrative pattern engagement, connects the viewer to the story and includes patterns such as: addressing the audience, breaking the 4th wall, call to action, exploration, make a guess, rhetorical question, and user finds themselves (Bach et al., 2018). All of these narrative patterns

2.2.2 Narrative Visualization Elements

Segel and Heer have outlined several key concepts related to narrative visual design elements. These include genre, visual narrative tactics, and narrative structure tactics (Segel & Heer, 2010).

Genre describes media that share similarities. Segel and Heer have outlined seven genres for visual narratives: magazine style, annotated chart, partitioned poster, flow chart, comic strip, slide show, and film/video/animation (Figure 2) (Segel & Heer, 2010). The categories are defined by the "number of frames" and "the order of the visual elements" in the visualization (Segel & Heer, 2010, p. 8).
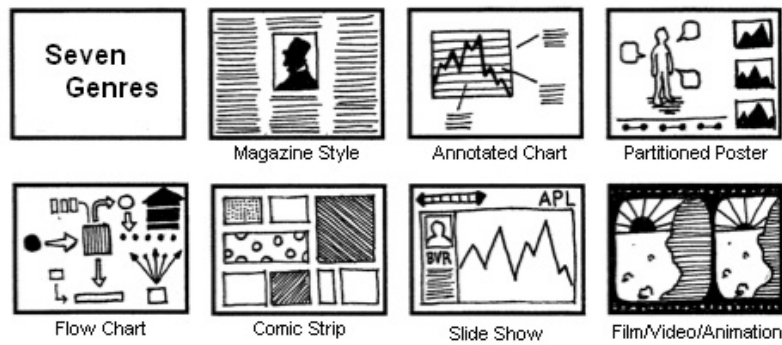
Figure 2. Seven Genres for visual storytelling presented by Segel and Heer (2010). The genres are magazine style, annotated chart, partitioned poster, flow chart, comic strip, slide show, and film/video/animation.

Visual Narrative Tactics are devices used to enhance and assist the story (Segel & Heer, 2010). One category of visual narrative tactics is highlighting. Highlighting helps emphasize certain features in the visualization and includes zooming, presenting close ups, and animations (Segel & Heer, 2010).

Narrative structure tactics are devices used in the visualization that help facilitate the order and structure of the narrative and include interactivity and messaging (Segel & Heer, 2010). Narrative structure tactics include interactivity and messaging. Interactivity will be discussed in the following section. Messaging is important in visual storytelling and is used to communicate elements of the story that cannot be visualized or need clarification. Annotations, captions, information texts, and summaries are a few of the ways messaging can be put into a visualization (Segel & Heer, 2010).

2.2.3 Interactivity

Interactivity is increasingly integrated into web-based visual storytelling. It can be a really important strategy in visual storytelling. Including an interactive element into the visualization can make the story more memorable and personable. Interactivity allows users to manipulate and explore the visualization as they choose (Segel & Heer, 2010). There are many techniques, detailed by Segel and Heer (2010) that provide an interactive display including hover highlighting, navigation buttons, details-on-demand, layer list, info panel, and info pop-up.

Interactivity can also be examined by the role it plays in determining the sequencing of the narrative in the visualization. In an interactive visualization the linearity of the narrative is determined by both the user and the author (Segel & Heer, 2010). When the reader or user of the visualization makes the decisions that move the narrative along, it is called reader-driven, and when the author of the visualization determines the sequencing of the narrative, it is called author-driven. Segel and Heer (2010) outline three schemas that combine both reader-driven and author-driven approaches: the martini glass structure, the interactive slideshow, and the drill-down story (Figure 3). In the martini glass structure the visualization begins with an author driven approach in which the author portrays the information they consider to be important for the narrative. Then the visualization opens up and the viewer is able to explore the data how they choose (Segel & Heer, 2010). The interactive slideshow format allows viewers to interact

intermittently throughout the narrative, while the author controls the flow and structure of the narrative. The drill-down story format begins with a reader driven approach where the reader begins by selecting which part of the visualization they would like to learn more about. Then the individual narratives are told in the structure presented by the author (Segel & Heer, 2010).
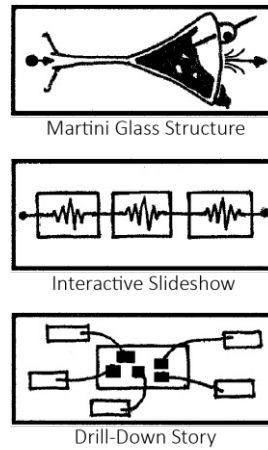
Figure 3. Visual representations of the three interactivity formats defined by Segel and Heer (2010). Images obtained from Narrative Visualization: Telling Stories with Data by Segel and Heer (2010).

There are many forms of visual storytelling that utilize the elements mentioned including, but not limited to comic books, video games, and infographics (Segel & Heer, 2010). The spread of visual stories has increased in news media with the transition from print news to digital news (Song, 2017). News stories are supplemented with infographics that help lead the viewer through the story (Song, 2017). Maps have become another important form of visual media incorporated into all types of visual stories to illustrate the spatial component of the narrative. Maps as independent visualizations can also be considered as a form of visual storytelling.

2.3. Traditional Cartography and Narratives

Similar to oral and written narratives, maps tell stories. Cartwright and Field write that maps are ppowerful tools for representing events that have challenged nations and peoples and stories of personal human endeavour, overcoming obstacles and tragedies" (Cartwright & Field, 2015, p. 2). Much like stories, maps have been around for tens of centuries. The earliest undisputed maps are on clay tablets dated back to around 2300BC in Mesopotamia (Riffenburgh, 2014). The narrative power of maps is also present in historical records. Mappae mundi, largely T-O maps, from the Medieval period in Europe (c.410-1000) did not just present geographical features but included Christian world views as well (Riffenburgh, 2014). In addition, the Chinese book, Classic of Mountains and Seas, with versions dating back to the 4th century, presents the geographic narrative of ancient mythic China, and in more recent history the 1675 Britannia Atlas "told the story of rising interconnectedness of British transport and trade" (Song, 2017, p. 1).

Historically, these maps and the stories they told, were used by rulers and religious leaders to advance their ideas about the places they lived in. In more recent history, leading up to today, maps and the narratives they present, have been used "by scholars,

journalists, activists, lobbyist and individuals to tell non-fictional stories, as support tools in their research and to assist in developing arguments about places" (Caquard & Cartwright, 2014, p. 101).

Caquard and Bryne describe that maps tell stories in both a figurative and literal sense (Caquard & Bryne, 2009). Maps tell stories in a figurative sense because maps "are not what they seem: they are not an objective and neutral representation of reality" (Caquard & Bryne, 2009, p. 374). There is an entire subcategory of cartography called "persuasive maps", "suggestive maps", or "propaganda maps" in which the presentation of accurate information is not a priority (Muehlenhaus, 2011, p. 29). Persuasive maps facilitate a specific interpretation from the map over others (Muehlenhaus, 2011). Maps tell stories in a literal sense because in relation to the places they represent they depict "how to get there, who lives there, and how the place has changed over time" (Caquard & Bryne, 2009, p. 374).

Maps also tell stories in the way that individual viewers perceive the information presented. In processing and synthesizing information presented in a map the viewer brings their own experience and background. Different viewers can each have a different outlook or understanding of a certain map, therefore creating their own narrative.

It can then be argued that a stand-alone map "propose[s] facts, relationships, correlations, and situations that suggest or support some story," but does not have the narrative power to tell a complete story (Denil, 2017, p. 19). To best present the narrative behind the map, the map "need[s] to be enhanced with rich media artefacts" that illustrate the tension, conflict, and resolution (Cartwright & Field, 2015, p. 2). This leads to cartographic storytelling, which combines the map and the story it presents with additional text and media elements to enhance and direct the narrative.

2.4 Cartographic Storytelling

Just about every story can be told through cartographic storytelling, "as all events occur in a spatial or geographic context" (Song, 2017, p. 5). While new focus has been put on cartographic storytelling as a result of advances in technology including but not limited to widespread internet, mobile and social media use, it actually has been a part of the practice of cartography since the beginning. For example maps from antiquity were popular because they presented a cultural narrative, not because they presented facts or were even accurate (R. E. Roth, 2020). In addition, in many indigenous communities spatial narratives were apart of performance and oral discourse (Caquard, 2013).

The recent increase in popularity of visual narratives including map-based visual narratives has produced a variety of new sub-topics. "Cartographic storytelling", "story map", "fictional cartography", "narrative atlas", "geospatial storytelling", "spatial narratives", and "map-based visual storytelling" are among some of the terms under the umbrella of cartography, emphasizing its relationship with narratives, that have increased in popularity (Caquard, 2013, p. 135; R. E. Roth, 2020, p. 1). Many different authors have put forth distinct definitions for specific terms but for the purpose of this research the term "cartographic storytelling" will be used to describe all "cartographic representations that exhibit narrative elements" (R. E. Roth, 2020, p. 3).

Cartographic storytelling is data driven and combines both art and science (R. E. Roth, 2020). It is a form of visual media that presents a map or series of maps along with information graphics or additional text to advance a spatial story (Song, 2017). Cartographic stories are "tools for providing an explicit, spatial, and visual complement to the implicit geographic components of a textual story or argument" (Song, 2017, p. 5).

Cartographic storytelling is more common and more wide spread today due to "digital and web-based mechanisms for authoring and sharing information" (Song, 2017, p. 2). The digital tools that are now available for incorporating spatial content into stories have allowed for maps to become more interactive, personalized, and accessible (Caquard & Bryne, 2009). Cartographic stories can be created by anyone online who wants to document and geotag their own journeys (Caquard, 2013). Additionally, professionals in numerous fields including journalism and computer science are creating cartographic stories for commercial and political purposes (R. E. Roth, 2015).

As cartographic stories are becoming a more popular form of storytelling, research has begun to focus on how narratives are presented in cartographic storytelling and what elements and techniques can be implemented to best present the narratives.

The concept of a three arc narrative in cartographic storytelling is very similar to the representation of the three arc narrative in visual storytelling [Figure 1]. The cartographic story should present an element that indicates to the viewer were to start and how to progress through the visualization (Cohn, 2013). Since maps are often "two-dimensional and thus often lack a temporal sequence or relevant linear axis to inform a plotline" it is important to introduce an element that enforces linearity through the cartographic story (R. E. Roth, 2020, p. 5). Just as in visual storytelling, in the beginning the viewer should understand the subject and characters involved in the visualization. The second part of the narrative arc represents a development in the plot leading up to a conflict. Roth comments that this makes the "visual storytelling approach best suited for explaining change rather than stability in geographic phenomena and processes" (R. E. Roth, 2020, p. 7). Following the climax, the resolution may be shaped by the persuasive rhetoric used by the author to present one interpretation of the story over others (R. E. Roth, 2020). As noted in visual storytelling, the resolution of the cartographic story can be presented as the resources included or the author can choose to exclude a resolution from the visualization inviting the viewer to do their own research into the topics conclusion and leaving the viewer with a memorable cliff-hanger (R. E. Roth, 2020).

As many cartographic researchers have pointed out, research into the design of map-based visual stories is new (Caquard, 2013; Cartwright & Field, 2015; R. E. Roth, 2015; Song, 2017). Therefore, outlined information on guidelines, structures and elements to employ when creating a cartographic story is still developing (Song, 2017). Researchers such as Roth have been instrumental in examining structures, methods and devices used to present cartographic stories. Roth outlines visual storytelling elements, genres and tropes adapted to cartographic storytelling (R. E. Roth, 2020). Cartographic storytelling genres categorize cartographic stories by the way in which they enforce linearity through the visualization (R. E. Roth, 2020). Additionally, it is important to examine how the map is presented in the cartographic story. This is considered the map layout. Cartographic storytelling tropes are rhetoric devices used to progress the story (R. E. Roth, 2020).

2.4.1 Genre

In general, a genre is a category describing media that share specific similarities. In their paper "Narrative Visualization: Telling Stories with Data", Segel and Heer described the seven genres for visual narratives (Segel & Heer, 2010). These genres as mentioned in section 2.2, describe the "number of frames and the order of the visual elements" in the visualization (Figure 2) (Segel & Heer, 2010, p. 1). Based on these genres Roth, in his paper "Cartographic Design as Visual Storytelling: Synthesis and Review of Map-Based Narratives, Genres, and Tropes", outlines seven genres for describing cartographic storytelling (R. E. Roth, 2020). Roth argues that for spatial narratives the number of frames is not important and therefore proposes seven genres for spatial narratives based on "the visual or interactive technique used to enforce linearity in the narrative sequence" (R. E. Roth, 2020, p. 10). Linearity in visual narratives refers to the ordering of elements that make up a narrative. The genres Roth proposes are: static visual stories, narrated animations, longform infographics, multimedia visual experiences, dynamic slideshows, personalized story maps, and compilations (Figure 4) (R. E. Roth, 2020). These genres are not exclusive and several might be present in the same cartographic story. Each of the genres are described below:
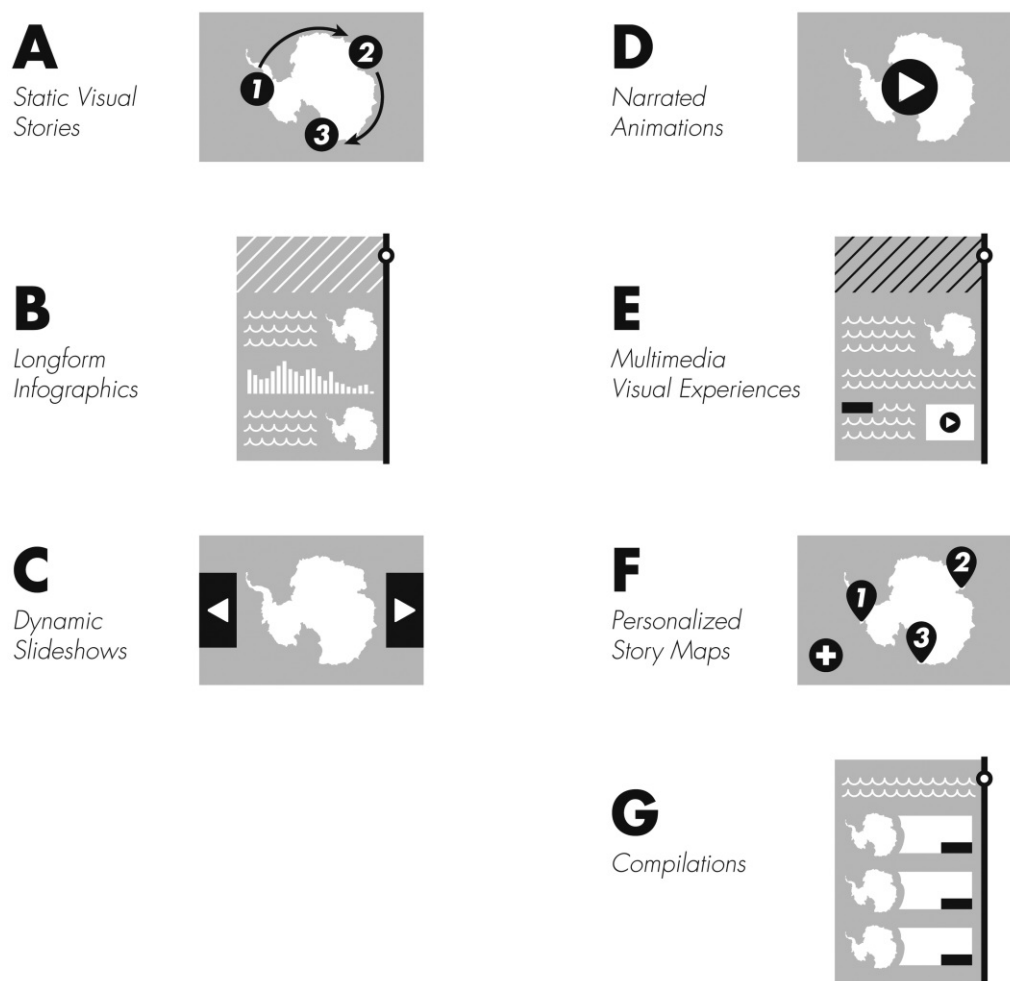
Figure 4. Cartographic story genres presented by Roth (2020). The seven genres are categorized by the technique used to enforce linearity through the narrative (R. E. Roth, 2020). The seven genres are static visual stories, narrated animation, longform infographics, multimedia visual experiences, dynamic slideshows, personalized story maps, and compilations. Image obtained from Cartographic Design as Visual Storytelling: Synthesis and Review of Map-Based Narratives, Genres, and Tropes by Robert E. Roth (2020).

Static Visual Stories:

As described by Roth a static visual story (Figure 4)"enforces linearity through partitioning of the layout into frames and use of annotation to clarify reading" (R. E. Roth, 2020, p. 10). All of the content is displayed in one view. Static visual stories are categorized by the incorporation either small multiple maps or one full map with annotations (R. E. Roth, 2020).

Narrated Animations:

In narrated animation (Figure 4) the narrative is presented with a spatial animation depicted along a temporal scale. Linearity is enforced as the animation plays out. Narrated animations allow for the presentation of dynamic spatial phenomena that change over time (R. E. Roth, 2020).

Longform Infographics:

In longform infographics (Figure 4) linearity is enforced as the viewer scrolls through the cartographic story. Textual information and visualizations are stacked in a web format, which forces the reader to scroll to reveal the narrative (R. E. Roth, 2020).

Multimedia Visual Experience:

A multimedia visual experience (Figure 4) uses anchor tags and hyperlinks to divide the visual narrative into sections. Hyperlinks can bring the viewer to a new map or section of the visualization and activate images and graphics (R. E. Roth, 2020).

Dynamic Slideshow:

In the dynamic slideshow (Figure 4) the narrative is presented through a series of slides often enforced through horizontal scrolling. The dynamic slideshow mimics an atlas as the viewer goes though slides like pages in an atlas. Linearity is enforced as the viewer clicks or swipes through the slides (R. E. Roth, 2020).

Personalized Story Maps:

The personalized story map genre (Figure 4) highlights the increase the general publics' ability to contribute and collaborate in online maps. Designer and audience become one and linearity is enforced by order of contributions to the cartographic story (R. E. Roth, 2020).

Compilations:

Compilations (Figure 4) are the final cartographic storytelling genre outlined by Roth (2020). Compilation present current information in near-real time. Linearity in the story occurs with time. The viewer gets to experience the narrative as it happens live (R. E. Roth, 2020).

2.4.2. Map Layout

In addition to examining the layout of the entire visualization it is important to examine the layout of the map within the visualization. On his webpage "MapUIPatterns", Michael Gaigg discusses user interface patterns related to map design. User interface patterns "describe solution[s] to observed and recurring problem[s]" (Gaigg, n.d.). One category explored by Gaigg are Map Layout Patterns (See Figure 5 for some examples). Layout

patterns describe how the map is presented in the visualization, including the structure of the map and visualization. There are many ways to describe the layout of a map especially as it is applied in different mediums such as web design and mobile design. For simplicity the more common and general layouts will be focused on here as follows:

Full Map Layout:

The full map layout (Figure 5) might be considered as the basic cartographic visualization. In the full map layout, the map is at the core of the visualization and may take up the entire visualization. Information can be added on top of or surrounding the map but remains secondary to the map itself. Therefore the full map layout maximizes the level of detail the viewer can observe in the map (Gaigg, n.d.).

Embedded Map Layout:

The embedded map layout (Figure 5) is most often used in websites and therefore lends itself well to be incorporated in web-based longform infographics. In the embedded map the layout the map is inserted into the webpage with map data from a third party provider (Gaigg, n.d.). Third party provider examples include ESRI, USGS, and MapBox. Media providers often use embedded maps when they don't have the technological capabilities to create their own maps. An embedded map often takes up the entire webpage or spans the full width of a web based infographic (Gaigg, n.d.).

Reference Map Layout:

The reference map layout (Figure 5) is generally smaller than the full map or embedded map layout. It presents the map as an additional view for context purposes (Gaigg, n.d.). In cartographic storytelling a reference map is added to another layout when additional spatial information would benefit the understanding of the cartographic story.

Partial Map Layout:

The partial map layout (Figure 5) presents the map and additional information side by side. It is used when the map and the additional content are of equal importance (Gaigg, n.d.). This allows the viewer to easily jump between the information and the map. The side by side map layout can be considered as a sub-category of the partial map layout. In the side by side map layout, two or more maps are presented side by side. The maps are of equal importance in the visualization and comparing the maps is the primary motivation for the visualization.
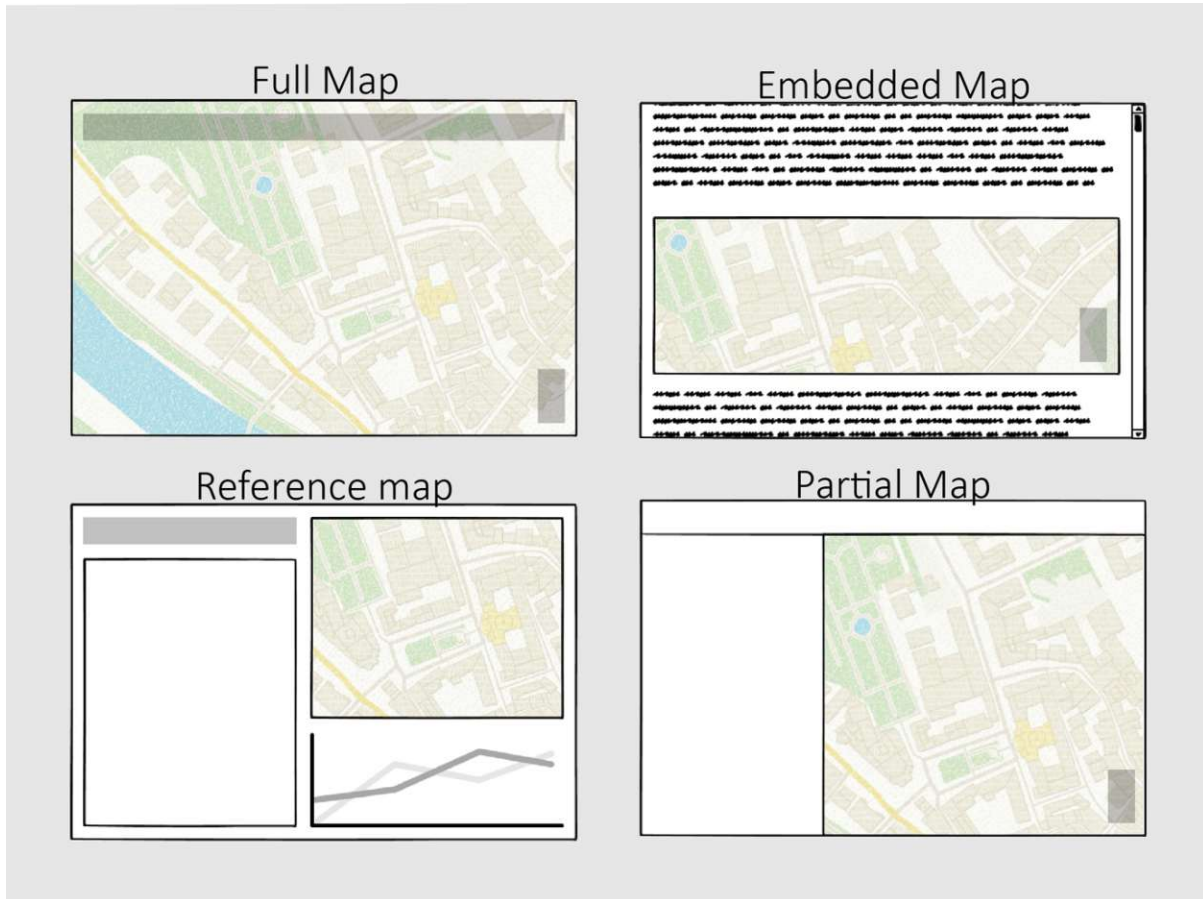
Figure 5. Four map layouts, full map, embedded map, reference map, and partial map, described by Michael Gaigg. Illustrations taken from the website MapUIPatterns (Gaigg, n.d.).

Side by Side Map Layout:
The side by side map layout also falls under the category of a map series (Figure 6). Another way to describe the map layout is in the number of maps presented. A map series presents multiple maps in a visualization. In a single map layout one map presents all of the information (Muehlenhaus, 2011).

Small Multiples Map Layout:
The small multiples map layout is also a type of map series (Figure 6). The small multiples map layout gets its origins from comics as visual stories. Comics present a series of visual frames that come together to tell a story. The small multiples map layout presents multiple small maps with a limited amount of additional information. Small multiple work well for cartographic storytelling since they can present the temporal dimension over the sequence of maps (R. E. Roth, 2020).

Map layout patterns that are concerned with the layout within the map itself include dynamic vs stable map layouts and fragmented or fluid map layouts (Figure 6). In a dynamic map layout elements added to the map indicate motion, change, and/or movement (Muehlenhaus, 2011). These could be arrows or a time animation. Stable maps do not include any elements which imply movement or change. In a fragmented map layout, the map includes elements that "stand out as independent entities" (Muehlenhaus, 2011, p. 32). This can include images or large chunks of text. In a fluid map layout,

additional elements blend well with the map. For example, text that is added in the map is shaped by the geographical features.
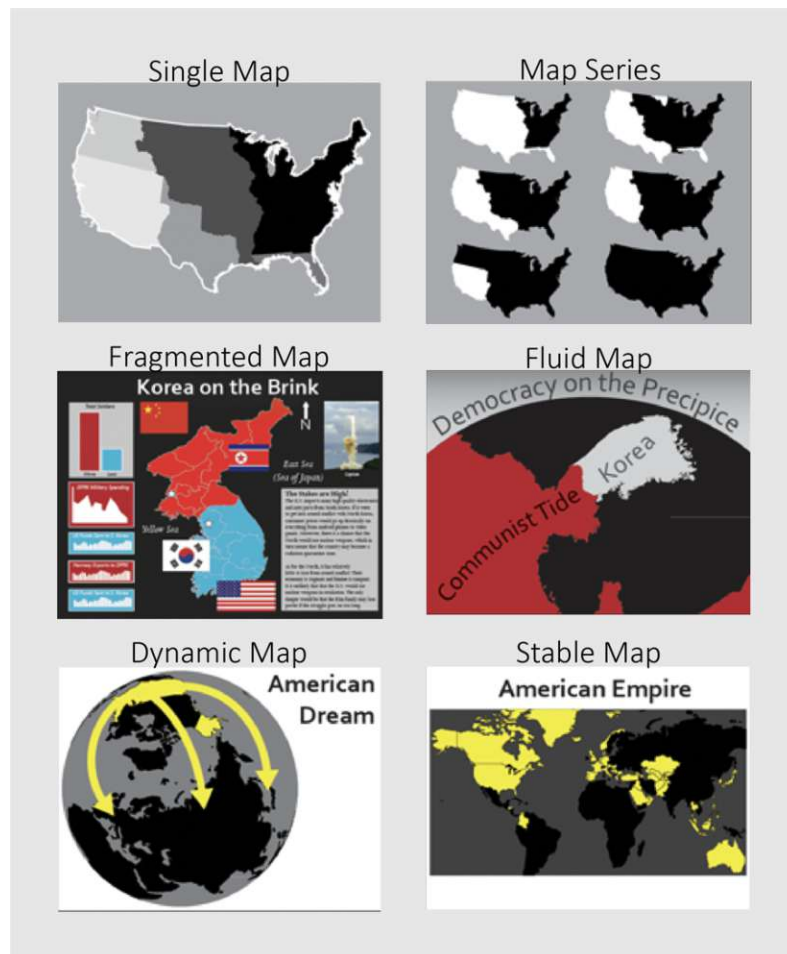
Figure 6. Visual representations of three groupings of map layout styles. Map layout styles are Single map vs Map series, Fragmented map vs fluid map, and dynamic map vs stable map (Muehlenhaus, 2011). Images obtained from Genealogy That Counts: Using Content Analysis to Explore the Evolution of Persuasive Cartography by Ian Muehlenhaus (2011).

2.4.3. Trope

In general a trope describes recurring rhetoric devices that advance the plotline (R. E. Roth, 2020; Song, 2017). Tropes are techniques used to enhance the narrative (Gershon & Page, 2001). Based on Smith's (1996) concept of tropes for non-visual spatial narratives and Gershon and Page's (2001) tropes proposed for information visualization, Roth presents seven tropes specific to cartographic storytelling: mood, continuity, dosing, metaphor, redundancy, attention, and voice (Gershon & Page, 2001; R. E. Roth, 2020; Smith, 1996). The description of each trope are as follows:

Mood:
The setting the mood (mood) trope sets the visual tone of the narrative through design elements. The mood indicates to the audience how they should react to certain parts of the narrative (R. E. Roth, 2020). Design elements that can influence the mood include color, base map design, typography, symbolization, and images (Song, 2017). Mood is essentially the visual style and should be cohesive through the visualization.

Continuity:

Enforcing linearity, or continuity, establishes a specific order for processing the visualization. This does not mean that the cartographic narrative has to be linear and can also be non-linear. Continuity brings the elements of the visual narrative into an organized structure (R. E. Roth, 2020). Continuity can include the use of scrolling, swiping, arrows, titles, numbered sections, a selection bar, and timelines to structure the cartographic story.

Dosing:

Information dosing (dosing) involves grouping of information to reduce the overall complexity of the visualization. Dosing divides the visualization up into individual story frames sequenced together. Dosing also includes separating the visualization into sections and determining the speed at which an animated visualization is viewed (R. E. Roth, 2020).

Metaphor:

The visual simile, or metaphor, trope presents a visual analogy to facilitate a better understanding of complex information. A map symbol that's design is associated with the concept it is representing on the map is a common metaphor used in cartography (R. E. Roth, 2020). The metaphor trope often includes visual juxtaposition techniques to compare related or unrelated concepts. Other techniques include benchmarking, cartooning, and hyperrealism (Song, 2017).

Redundancy:

The effective redundancy (redundancy) trope introduces repetition of important information to enforce story themes. Repeated elements may include colors, symbols, or graphics to "develop visual motifs" throughout the narrative (Song, 2017, p. 14). As Roth describes, "redundancy teaches the audience a single visual syntax for acquiring critical information in the opening scene and then consistently applies this syntax throughout the story" (R. E. Roth, 2020, p. 20).

Attention:

Focus attention (attention) draws the viewers' attention to key information in the visualization (R. E. Roth, 2020; Song, 2017). There are many techniques for focusing the viewers' attention. Roth outlines nine techniques: highlighting through outlines, highlighting though shading, leader lines with label, arrows with label, frame, opacity mask, numbering, zooming, and text labeling (R. E. Roth, 2020).

Voice:

Voice, the final trope outlined by Roth (2020), allows for the audience to feel included or reflected in the cartographic story (R. E. Roth, 2020). The voice presented can be the designers, characters, or the audiences (R. E. Roth, 2020). Voice makes the story more personable "allowing both designers and the audience to draw from their experiences, opinions, and values when interpreting the story" (Song, 2017, p. 16). Personal commentary and quotations are a key technique used to include voice in the cartographic story (R. E. Roth, 2020).

Cartographic storytelling guidelines, structures and elements can also be taken from visual storytelling methods as discussed in section 2.2. Visual Storytelling can also apply to cartographic storytelling. For example, narrative design patterns, visual narrative tactics, messaging, and interactivity can all be applied to cartographic storytelling as well.

Genre, map layout, and trope are three important design elements that are specific to cartographic storytelling, however additional elements that are not specific to cartographic storytelling are also used. These include elements used in visual storytelling such as narrative design pattern, visual narrative elements, and interactivity.

Design elements used in both visual and cartographic storytelling are important to understand when examining design elements in cartographic parallel narrative stories. In addition it also important to understand elements and structures specific to parallel narratives.

3. Parallel Narratives

In this chapter parallel narratives will be presented and defined by current presentation forms in both literature and film. Parallel narratives are an important narrative structure used in both literature and film. So much so that research on different forms of parallel narratives has been done with both mediums. Examining how media, such as literature and film, present and structure the parallel narratives will provide insight for applying parallel narratives to cartographic storytelling.

3.1. Definition and Use

Parallel narratives, also referred to as multiple narratives or duel narratives, are present in many narrative media such as books, TV shows and movies. Parallel narratives present multiple storylines, and follow multiple protagonists' distinct stories. No character is focused on as the only main character, and no storyline is privileged over the others. These stories are interwoven together with a common theme, event, or character (Learning Center, n.d.). This structure often highlights a larger macro story/theme that connects all of the storylines (Camboni, 2012).

Combining multiple storylines allows for the presentation of multiple perspectives and experiences across generations or cultures (Wright, 2017). As stated by Roth in her thesis, *Life is Messy: An exploration of parallel narratives*, "parallel narratives are the most effective storytelling mode in realistically depicting the chaos and randomness of life" (J. Roth, 2010, p. 15). Parallel narratives provide the readers or viewers with multiple perspectives, which is more realistic and relatable to their everyday lives. The relatability and complexity has led to an increase in the usage of parallel narratives.

In both books and film, parallel narratives have become increasingly popular. When examining the increased use of parallel narratives in Young Adult novels, Koss makes the argument that textual and technological changes in society as a whole are driving the increase in demand for parallel narratives in media (Koss, 2009). Koss argues that society as a whole is becoming more accepting of diversity and differing viewpoints. Technology has also changed and developed rapidly in recent decades. Most of society is accustomed to using multiple digital media platforms to gain information and communicate (Koss, 2009). As technology and society are changing, becoming more complex and accepting of differences, so too is the presentation of information and the format of narratives.

The complexity in parallel narratives forces the reader to "sort through, analyze, and organize" information while "occasionally juggling conflicting information from unreliable narrators" (Koss, 2009, p. 77). While this can be more complicated, it is also more rewarding when pieces of the narrative puzzle are put together. Voice and structure are therefore important in assisting the reader/audience to understand and separate the various narratives.

Even though less conventional than the single protagonist, single storyline narrative, every character is still the "main character" or "hero" in their own narrative. Each main

character or protagonist needs their own story arc complete with conflict and resolution (*How to Write a Novel with Multiple Points of View*, n.d.). Structuring parallel narratives in order to prevent confusion for the reader/audience when distinguishing the narratives is important. In books, chapters help to break up the various points of view presented. Additionally if each chapter is titled as the character, location, or time frame of a specific narrative the reader is able to understand which narrative is about to be presented (*How to Write a Novel with Multiple Points of View*, n.d.). Films often use the presence of certain character or locations to separate narratives. Visual elements such as lighting can also be used.

Categories of parallel narratives are described in both literature and film. The categories each define a generalized method for the presentation of parallel narratives. The structure as well as the interaction between the multiple narratives is important in separating the categories of parallel narratives. Parallel narrative stories may not always explicitly fall into one category.

Current literature on parallel narratives in literature and films does not present a unified taxonomy. There the different modes of presenting parallel narratives classified in both. While the various categories in both literature and film could be compared and grouped into larger categories to represent parallel narratives in general, distinctions between the two classifications are important. Text and film media use different methods to illustrate multiple narratives and this can come across in the taxonomy of parallel narratives in each classification.

3.2. Parallel Narratives in Literature

In a study done to examine the increase in multiple narratives in Young Adult Novels, Koss, analyzed a list of 205 books published between 1999 and 2007. As a result, five distinct categories emerged for novels written using multiple narrative perspectives. These categories were: One event - Multiple Perspectives, One story - Multiple Perspectives, Multiple stories - Multiple Perspectives - Intertwined, Then and Now, and Parallel Stories (Table 1) (Koss, 2009). The categories are classified by the link that connects the narratives. The links are event, story, time, and artifact. The story link is broken down further by the number of stories told. Do the narratives build on each as time progresses or does each narrative have a sub-story that is somehow interwoven with the other sub-stories.. These five categories are detailed below:

Table 1. Parallel narratives categories in literature defined by Koss (2009). Table recreated based on table in Young Adult Novels with Multiple Narrative Perspectives: The Changing Nature of YA Literature by Melanie D. Koss (2009).

Category	Definition
One Event, Multiple Perspectives	Novels that tell a story that focuses on one major event, which is told from the point of view of a number of different participants involved with the event.
One Story, Multiple Perspectives	Novels that tell one story, but the tale is told via alternating narrators or perspectives.
Multiple Stories, Multiple Perspectives, Intertwined	Novels that tell multiple stories told by multiple characters, whose lives become somehow intertwined.
Then and Now	Novels in which the main character or a number of characters tell their individual stories at different points in time through the use of flashbacks and flash forwards.
Parallel Stories	Novels in which two parallel stories are told, each of which typically takes place in a different time period, often through the use of a journal or as an older character telling a younger character stories of his or her youth.

One Event - Multiple Perspective:

Most of the novels analyzed fell under categories that included multiple perspectives. In the One Event – Multiple Perspectives category, novels revolve around one event, which is then told from different characters' points of view (Koss, 2009). One example of One Event – Multiple Perspectives is from the novel *Real Time* by Pnina Moed Kass. In the novel, all of the narratives revolve around a tragic event in Israel. The narratives each tell a different perspective on the event (Kass, 2006).

One Story – Multiple Perspectives:

In the category One Story – Multiple Perspectives, a story is told through the various narratives and characters presented (Koss, 2009). Each character presents their own perspective that builds upon others to create a storyline. One example of One Story – Multiple Perspectives is the novel *Not the End of the World* by Geraldine McCaughrean. In the novel, the story of Noah's Arc is told from various characters involved, including some of the animals and Noah's daughter, son's and wife (McCaughrean, 2004).

Multiple Stories – Multiple Perspectives – Intertwined:

In the category Multiple Stories – Multiple Perspectives – Intertwined, multiple stories are told from the perspectives of the various characters. These stories and the narratives that contribute to them are somehow intertwined together. One example of Multiple Stories – Multiple Perspectives – Intertwined is the novel *Sisterhood of the Traveling Pants* by Ann Brashares. In the novel four best friends narrate the journey's they each go on during their summer vacations. The narratives are intertwined through their friendship and a pair of pants they share (Brashares, 2014).

Then and Now:

The remaining two categories that do not fall under the grouping of multiple perspectives are Then and Now and Parallel Stories. In Then and Now novels, one story with multiple narratives is told during different time periods. This includes the narratives of a single character as they present different perspectives at different times in their life. One example of Then and Now narratives is the novel *Turnabout* by Margaret Peterson Haddix. In the novel two older women participate in an experiment that makes them gradually reverse in age and grow younger and younger (Haddix, 2012). The multiple stories are told at different times in their lives as they grow younger.

Parallel Stories:

In Parallel Stories novels, more than one story is told, often during different time periods (Koss, 2009). The stories are often connected though an artifact like a journal or book. One example of Parallel Stories is the novel *Endymion Spring* by Matthew Skelton. In the novel, the book *Endymion Spring* connects two narratives. The first is presented from the point of view of the children who find the book in a library in the 21st century and the second is written from the point of view of the man who wrote the book in 1453 (Skelton, 2008).

3.3. Parallel Narratives in Film

In the comprehensive guide to writing films, *The 21st Century Screenplay*, Aronson (2010) outlines six modes for presenting parallel narratives in film. These modes are: tandem, multiple protagonist, double journey, flashback, consecutive-stories and fractured tandem (Figure 7). Aronson breaks these into two groups: ensemble films (linear narratives) and non-linear films. Linearity refers to the temporal structure of the narrative. Linear narratives tell the story in chronological order (Learning Center, n.d.). Ensemble films are linear narratives and include tandem, multiple protagonist and double journey narratives (Aronson, 2010). Nonlinear/fractured narratives are presented out of chronological order. The story jumps around in the timeline, often with flashbacks. Nonlinear films include flashback, consecutive stories and fractured tandem. The two categories along with their respective modes are detailed below:
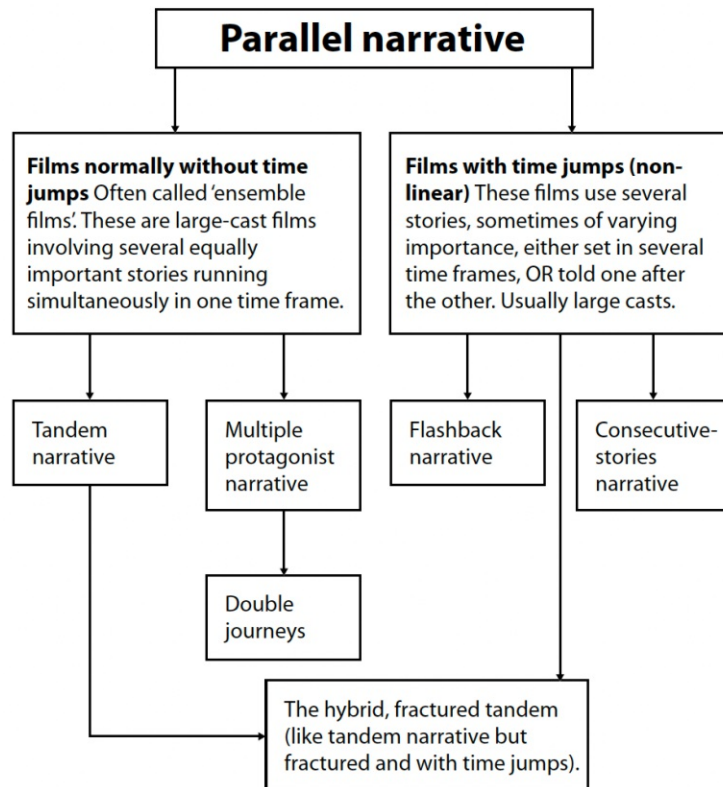
Figure 7. Figure presents the breakdown of the categories of parallel narratives in film. Figure obtained from The 21st Century Screenplay by Linda Aronson (2010).

3.3.1 Ensemble films (linear narratives)

Tandem narratives:

Aronson has coined the motto "same theme, different adventures," to describe tandem narratives (Aronson, 2010, p. 173). Tandem narratives often include several stories of equal importance that run simultaneously through the film. These stories occur in the same time frame and geographical area (Aronson, 2010). Connecting the characters or storylines within a tandem narrative is very important. Arguably the most import device used to connect the storylines is the overlying theme. Often this theme or overlying message calls for change, either within society or the characters. One example of tandem narrative is the film: "*Traffic,*" (2001), which weaves together three separate storylines connected by the drug trade in the United States. Each storyline introduces another side of the drug trade and how it effects the lives of the people involved (Soderbergh et al., 2001).

Multiple protagonist narratives:

For multiple protagonist narratives, the motto given by Aronson is "same team, same adventure" (Aronson, 2010, p. 173). They focus on the interactions between the characters and storylines. The characters are often apart of a team or group that goes on some type of journey or adventure. The narrative jumps between the different characters/storylines showing each characters' response to the same event and the interactions between various characters. No one character can be the single hero/protagonist but rather the group should be looked at as being different "versions of

the same protagonist" (Aronson, 2010, p. 174). For example in the book and subsequent film, "*The Jane Austen Book Club,*" (2007), a group of six characters change and react to events in their lives as they come together to read Austen's six major novels (Swicord et al., 2007). Not one character stands out as the protagonist and each character changes in response to their common experience in the book club.

Double journey narratives:

The double journey narrative is a version of the multiple protagonist narrative. In this version two specific characters' journeys interact as they either come towards each other, run in parallel with each other, or journey apart. Both characters are protagonists with their own storyline and have their own sub-characters. Often these two characters represent different sides of an issue or different responses to a social convention (Aronson, 2010). In the animated film "Finding Nemo," (2003), father and son clown fish go on separate journeys to find each other after getting separated. Whileon their journey to find each other physically, they both also go on an emotional journey to reconnect as Marlin, the father, learns to accept that his son Nemo is getting older and Nemo learns to listen to his father's concerns (Stanton et al., 2003).

3.3.2 Non-linear films

Flashback narratives:

Flashback narratives present viewers with a glimpse into the past. They allow the audience to get a better understanding of past events in the storyline. They also break up the traditional sequence of a three part narrative by taking the viewer to another time or place in the past in an effort to help them better understand the current situation. There are various different types of flashbacks used in film and literature – illustration/memory flashbacks, regret flashbacks, bookend flashbacks, preview flashbacks and life-changing incident flashbacks (Aronson, 2010). For example, in the movie "*The Usual Suspects,*" (1995), memory flashbacks are used to add suspense as Roger Kint explains to Agent Dave Kujan the series of events that led him and the other suspects to the ship that had set fire (Singer et al., 1995).

Consecutive-stories:

The narratives of consecutive stories present two or more separate stories one after the other. Storylines are connected in the narrative though the content in each story and the structure of the stories. Consecutive stories can be broken down into three main groups based on message and structure, which are as follows: stories walking into the picture, different perspectives of the same event and different consequences triggered by the same event. For example, in the film "Lola Rennt" (1998) time restarts twice to reveal different scenarios triggered by the same event. The main character Lola relives the 20 minutes she has to find and deliver 100,000 Deutsche Mark's to her boyfriend before he gets killed for the money (Tykwer et al., 1999). The three storylines share the same content but reveal different consequence's based on Lola's actions.

Fractured tandem:

The fractured tandem narrative is a non-linear tandem narrative. In these narratives the multiple storylines still have equal importance but are told non-linearly. As described by Aronson, the storylines are either, "from different time frames" or all of the storylines are not told in chronological order (Aronson, 2010, p. 376). The film "*The Hours*" (2002) is

one example of a fractured tandem narrative. The film examines a day the lives of three women from different generations who are all connected by the novel "Mrs. Dalloway" (Daldry et al., 2003). The film switches between the three storylines, which are from different time frames but each is equally important and bound together resulting in a fractured tandem narrative.

Parallel narrative modes in both literature and film both highlight the importance of the narratives connect both through the overall theme and how the narratives are physically or visually connected or interwoven together in the story. The techniques used to tell a story in both literature and film are both very different from cartographic storytelling however, just as the three-act narrative structure is still applied when developing cartographic stories, so to can parallel narrative structures.

4. Parallel Narratives in Cartographic Storytelling

This chapter will describe the methodology used to develop a typology for the presentation of parallel narratives in cartographic storytelling and the resulting categorization. A qualitative content analysis of existing examples of parallel narratives in cartographic stories will be conducted based on design elements presented in visual narratives, cartographic stories, and parallel narratives. A qualitative content analysis will allow for a better understanding on how parallel narratives are presented in cartographic stories. Based on the existing examples and the qualitative content analysis, card sorting will take place in order to find groupings of cartographic stories that will lead to the development of a typology for the presentation of parallel narratives in cartographic storytelling. Results of the qualitative content analysis will be presented along with the resulting typology of parallel narratives in cartographic storytelling.

4.1 Quantitative Content Analysis

Content analysis describes a range of analytical approaches from interpretive analyses to textual analyses (Hsieh & Shannon, 2005). Content analysis is used to quantify qualitative data by coding data into specific categories and then analyzing the results using statistics (Hsieh & Shannon, 2005). There are three main approaches to qualitative content analysis: conventional, directed, and summative content analysis (Hsieh & Shannon, 2005). With conventional content analysis qualitative categories are determined during the process of coding based on the data. With directed content analysis qualitative categories are determined before coding based on prior research and existing theories (Hsieh & Shannon, 2005). With summative content analysis keywords or content from previous literature are used as categories for coding. The aim of summative content analysis is to explore and interpret the usage of the keywords or content (Hsieh & Shannon, 2005).

For this study, examples of cartographic stories with parallel narratives were collected as the data to analyze. A combination of conventional, directed, and summative content analysis was then used to examine the examples of parallel narratives found in cartographic stories. Initially, variables to code by were taken from existing research and theory. Upon examining several parallel narrative cartographic stories, additional codes were included to better address and understand the presentation of parallel narratives in the cartographic stories. Once coding was complete, results were interpreted to provide a better understanding on what role the codes played in the presentation of parallel narratives within the cartographic stories. Then card sorting provided a platform for categorizing types of cartographic parallel narratives and led to the creation of the taxonomy of parallel narratives in cartographic storytelling.

4.1.1 Existing Examples

Research into the distinction on what it means to have parallel narratives in cartographic stories is not yet present. Certain questions arise when trying to determine what it looks

like to have parallel narratives in cartographic stories. Does there need to be one map with parallel narratives or multiple maps each displaying a different narrative? Does any map that displays two variables count as an example of a parallel narrative? For example, does a map of the United States' presidential election results by state, with blue denoting democrat and red denoting republican count as a parallel narrative?

To present a definition for parallel narratives in cartographic stories that can be applied when examining maps, the definition of both parallel narratives in literature and film, and the definition of cartographic stories will be examined and combined. Parallel narratives are stories that interweave two or more narratives, which are connected by a common theme. Each narrative is equal in importance and has its own story arc. Cartographic stories present maps with additional text and media that both enhances the viewer's understanding of the story and provides a specific interpretation of the data being visualized. Therefore, parallel narratives in cartographic storytelling can be defined as a map or combination of maps that with additional text and media present two or more narratives interwoven by a common theme. In conclusion there can be one or more than one map used to present parallel narratives in cartographic stories. However, not just any map displaying multiple variables can count as a parallel narrative in cartographic storytelling since additional text or media is needed for it to be a cartographic story.

While parallel narratives in cartographic storytelling have not previously been defined, many cartographic stories, published by news organizations, cartographers, and other scientific researchers, present parallel narratives. Through researching various news platforms, visual narrative publishing sites, creative networking sites, and cartographic visualization platforms, 64 cartographic stories were collected. Upon further examination 11 were removed because they either did not present two narratives or could not be classified as cartographic story. This left 53 examples of cartographic stories that visualized parallel narratives (Appendix I – Complete coding table of existing examples).

The examples of parallel narrative cartographic stories have a wide range of topics, from climate change and animal migrations to history and human development. Each story is designed in its own way with different visualization techniques, narrative structure tactics and map layout. While each cartographic parallel narrative is different there are similarities in structure and design that can be found.

Both cartographic stories and parallel narratives have distinct taxonomies that group cartographic stories and parallel narratives by similar design elements and structures.
Since the presentation of parallel narratives in cartographic stories has not been thoroughly researched, no such taxonomies exist to group cartographic parallel narratives. While an attempt could be made to fit cartographic parallel narratives into either the categories of cartographic storytelling or the categories of parallel narratives, neither would properly describe the relationship between the cartographic story and the parallel narratives it presents. The main goal of this quantitative content analysis is to create a taxonomy for cartographic parallel narratives.

4.1.2 Codes

Coding helps to examine trends in cartographic stories that contain parallel narratives. Coding is a two-step process which involves (1) defining variables of interest (the codes) and (2) labeling these variables when they are present in the examined map (Muehlenhaus, 2011). This section will outline and define the codes used in this qualitative content analysis.

The variables of interest selected to code were identified from current literature on cartographic storytelling techniques, and the presentation of parallel narratives in text and film. A list of 56 variable codes were compiled and explicitly defined. The list of variable codes was refined as the maps were coded. Variables were added when new techniques that played a role in visualizing parallel narratives in cartographic storytelling were noted. In addition variable codes that were not present in any coded map were removed. The final list of 51 variable codes was subdivided into seven broader categories: genre, map layout, interactivity, trope, narrative pattern, visual narrative tactics, and parallel narrative tactics as described in chapter 2, sections 2.2 and 2.4 (Appendix II).

Genre:
Genre explicitly comprises of the taxonomy of visual storytelling genres proposed by Roth (Figure 4) (R. E. Roth, 2020). Roth defines the visual storytelling genres by "the visual or interactive technique used to enforce linearity in the narrative" (R. E. Roth, 2020, pg. 25). This helps to define what elements of the visualization move the narrative along. Genre categorization for coding was broken down into static visual stories, longform infographic, dynamic slideshow, narrated animation, multimedia visual experience, personalized storymap, and compilation.

Map Layout:
Map Layout describes how the map(s) is presented in the visualization and the layout of elements in the map. Map layout categories were derived from Michael Gaigg's Map Layout Patterns (Figure 5) and Ian Muehlenhaus' Layout/Rhetoric codes (Figure 6) (Gaigg, n.d.; Muehlenhaus, 2011). Map layout categorization was broken down into embedded map, reference map, side by side, full map, partitioned map, small multiples, single map vs map series, fragmented vs fluid layout, and dynamic vs. stable.

Interactivity Format:
Interactivity Format refers to the three common schemas for interactivity in visual narratives proposed by Segel and Heer (2010). All three interactivity schemas combine author-driven and reader-driven approaches. Interactivity format classification was broken down into categorizing the cartographic story as interactive or not, and if so categorizing the type of interactive structure as either martini glass structure, interactive slideshow, and/or drill down story.

Trope:
Trope is defined by Roth (2020) as visual storytelling techniques that enhance the narrative and advance the plotline. Song (2017) and Roth (2020) both detail a list of seven tropes used in cartographic storytelling that will be used here as codes. The codes

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used under the category trope include setting the mood (mood), enforcing linearity (continuity), information dosing (dosing), visual simile (metaphor), effective redundancy (redundancy), voice, and focus attention (attention).

Narrative Patterns:

Narrative Patterns are techniques used to effect flow and argumentation in data-driven visual narratives (*NAPA Cards*, 2016). Narrative patterns help support argumentation, flow, framing, emotion, and engagement in the visualization (Bach et al., 2018). Codes categorized under the narrative pattern's classification were broken down into incorporating the audience, repetition, juxtaposition, human behind the dot, rhetorical question, familiar setting, call to action, gradual visual reveal, defamiliarization, and concretize.

Visual Narrative Tactics:

Visual Narrative Tactics are devices used to enhance and assist the story (Segel & Heer, 2010). For this study, coding visual narrative tactics are comprised of several techniques discussed by Segel and Heer (2010) as both visual narrative and narrative structure tactics. Here they are subdivided into three categories: highlighting, interactivity, and messaging. Highlighting refers to visual devices used to enhance and draw the reader's attention to certain aspects of the visual narrative. Highlighting codes include close ups, feature distinction, audio, time animation, and zooming. Interactivity refers to the devices included in the visualization that allow specific user interaction (Segel & Heer, 2010). Interactivity codes are divided into layer list, visited marker, marker list, info panel, and info pop up. Messaging refers to the format in which text media is added to the visualization in order to enhance and/or structure the narrative. Messaging codes are divided into: annotation, info text, captions, and summary. In addition, image and video codes were added to visual narrative tactics.

Parallel Narrative Tactics:

There is no research available on the presentation of parallel narratives in either visual or cartographic storytelling. Therefore, codes used to analyze parallel narrative tactics in cartographic stories were derived from elements of parallel narratives that had been defined within literature and film. Codes for parallel narrative tactics include color separating narratives, number of narratives, link, contrasting or complementary narratives, and sequence.

Color separating narratives distinguishes if color plays a role in separating the narratives. As discussed with parallel narratives in literature and film, structuring parallel narratives in order to prevent confusion for the reader/audience when distinguishing the narratives is important. It was noted that color often plays a role in distinguishing stories in cartographic stories.

The distinction in the number of stories can be made between two stories and many stories in research done on parallel stories in literature and film. The more narratives in a story the less information an author can provide for each. Therefore, it is important to determine how the number of narratives plays a role in creating a cartographic story.

Link denotes the element of a story that connects the various narratives. What makes a combination of multiple narratives one story vs multiple stories is the connection

between the narratives that illustrate a larger theme. Narratives share a common theme but are often connected further by a common character, event, location, or subject – this is the link.

Contrasting or complementary narratives denotes whether the narratives work together and build upon each other to present a story or whether they provide different and distinct information that is connected by a larger theme. Narratives that are complementary add information to the story that builds upon previous narratives. Contrasting narratives could be viewed separately but the combination of the narratives is what tells the full story and presentation of a larger theme.

Sequence refers to the ordering of the narratives in the story. In cartographic stories the ordering of narratives is not always as clear as in literature or film since both narratives can be presented at the same time in the visual frame. Linear narratives present the order of events in a chronological order. Therefore, in a cartographic story the narratives are chronologically ordered, and design elements indicate to the viewer where to begin the visualization. Non-linear narratives present events out of chronological order. For example, in cartographic stories the events of each narrative map may occur at the same time, but each map is viewed one after the other. Simultaneous narratives present events that occur at the same time. One example in cartographic stories is when the events of the narratives take place at the same time and are also presented to the viewer at the same time with no distinction of which narrative should be read first.

4.1.3 Coding Analysis

As part of the analysis, each map was investigated in the same manner for all of the variable codes. When a code was added or adjusted all maps were reevaluated. Coding produced four different types of data measurements, depending on the code. (1) Measurements were given by an "X" if the cartographic story presented a code. Nothing was added if the cartographic story did not present a code. (2) Binary or trinary measurements (e.g. single map or map series) were taken to distinguish between two or three opposing concepts. (3) Measurements were descriptive. When an 'X' was given denoting that a cartographic story presented a code, additional information was included to distinguish certain characteristics of the code in the cartographic story. (4) Measurements were quantitative and produced a number (Appendix II).

Two coding sessions took place in order to make sure that every cartographic story was coded in the exact same manner. Upon examination of the 56 codes and coding results, five codes were removed because they either were not represented in any map or overlapped with other codes. The codes removed were: genre – personalized storymap, genre – compilation, trope – voice, trope – effective redundancy, and visual narrative tactics – feature distinction. This resulted in 51 final codes. The coding analysis results for each of the seven categories are as follows:

Genre:
In coding each cartographic story for genre, it was found that the category was not exclusive. Some cartographic stories presented more than one genre. Measurements for each genre were given with an X if the cartographic story presented that genre.

Map Layout:

In coding for each cartographic story for map layout it was found that the category was not exclusive. Depending on the number of maps presented, the format of the cartographic story and the platform used, different combinations of map layouts were presented. The first six map layout codes: embedded map, reference map, side by side, full map, partial map, and small multiples were measured by an X if the cartographic story included that map layout. The remaining three map layouts: single map vs map series, fragmented layout vs fluid layout, and dynamic vs stable were all measured by binary measurements. Each map either presented one or the other.

Interactivity Format:

In coding each cartographic story for interactivity format, the first code labeled as Interactivity, was measured with an X if the cartographic story was interactive. If the cartographic story was interactive then it was investigated to see if the interactivity format was a martini glass structure, an interactive slideshow, or a drill down story. Each interactive cartographic story was classified as at least one of the formats.

Trope:

In coding each cartographic story the trope category was not exclusive. Several of the cartographic parallel narratives' stories presented five of the six tropes. The four trope codes: setting the mood, enforcing linearity, information dosing, and focus attention were found to be the most prevalent tropes. In coding for these four tropes it was noted that a distinction could be made in the way that each cartographic parallel narrative story presented the trope. Coding for the setting the mood code presented four methods that were frequently used: images, color, basemap, and font. In coding for the enforcing linearity code, seven methods were frequently used to enforce linearity. These methods were the use of a timeline, titles, scrolling, selection bar, numbers, animations, and pages. Each of these methods helped to distinguish between narratives. Coding for the information dosing code presented three methods that were frequently used: selected stories, infographics, and images. Selected stories are a general term used to indicate when additional text was included on a specific piece of the narrative. The descriptions of infographics or images was noted when the cartographic parallel narrative story included infographics or images that provided additional information to the narratives. Coding for the focus attention code presented four methods that were frequently used: color, symbols, text, and infographics. All of these methods were included in the measurement of the specific trope as descriptive measurements. The remaining trope, visual simile was measured with an X if presented in the cartographic parallel narrative story.

Narrative Pattern:

In coding each cartographic story, the narrative pattern category was not exclusive. Many of the cartographic stories presented two or more narrative patterns. Measurements for each narrative pattern were given with an X if the cartographic story presented that narrative pattern.

Visual Narrative Tactics:

In coding each cartographic story, the visual narrative tactic category was not exclusive. Many of the cartographic stories presented two or more visual narrative tactics.

Measurements for each visual narrative tactic were given with an X if the cartographic story presented that visual narrative tactic.

Parallel Narrative Tactics:
The codes for parallel narrative tactics were measured in several different ways. The first code, color separating narratives, was measured with an X if color was used to separate the narratives. The second code, number of narratives, was measured quantitatively. Each cartographic story was given a number based on the number of parallel narratives it presented. The third code, link, was measured by four descriptive methods. While all of the parallel narratives in each story shared a common theme, additional methods were used to further link the narratives. These methods used characters, event, location, and subject. The fifth code, contrasting or complimentary, was measured binarily with the parallel narratives either being contrasting or complimentary. The final code, sequence, was measured with three descriptive methods: linear, non-linear, and simultaneous. Each cartographic parallel narrative story was exclusively one type of sequence.

Once every map was coded for and reviewed a second time card sorting of each map took place in order to conceptualize the typology of parallel narratives in cartographic stories.

4.2.3 Card Sorting

Card sorting is a qualitative research method often utilized in user experience (UX) design. UX design refers to the implementation of design elements that support usability in products. In card sorting, research participants sort specific topics written on cards into groupings that they feel make sense to them. This type of research helps to create a better user interface that matches the users understanding of the information (Groß, 2016; Sherwin, 2018).

There are various types of card sorting: open vs. closed card sorting, moderated vs. unmoderated card sorting, and paper vs. digital card sorting. In open card sorting categories are not predefined, while in closed card sorting category names are predetermined by the researcher. Moderated card sorting involves interactions between the participants and the facilitator or researcher. The facilitator can gain valuable insight into the participants' decisions by asking them specific questions or asking them to think aloud. Unmoderated card sorting on the other hand, involves no interaction between the facilitator and the participant. In paper card sorting the topics are written or illustrated on physical cards. This allows the participant to interact directly with the material. In digital card sorting, a software or web based tool is used to create online cards for participants to sort (Sherwin, 2018).

For the purpose of this study open, partially moderated, paper card sorting was performed. After drawing out each cartographic narrative design onto pieces of paper a partially moderated sorting session took place with no predefined categories. A facilitator, whose background includes research done with card sorting but was unfamiliar with the previously researched maps, assisted in asking questions about the map variables and structures indicated on the cards. This lead to groupings of certain cartographic stories together.

Cartographic stories were grouped together based on how the narratives within the story were presented and how they interacted. Cartographic stories are categories, into genres, by the way it enforces the direction of the narrative to the viewer. Parallel narratives in literature and film are categorized by the elements that connect the narratives and how they are positioned together in the story. Both of these categorizations were taken into consideration when categorizing parallel narratives in cartographic stories.

Based on the groupings of cards a second card sorting took place to refine the categories based on specific definitions (Figure 8). These groupings became the foundation for the creation of the taxonomy of parallel narratives in cartographic storytelling.
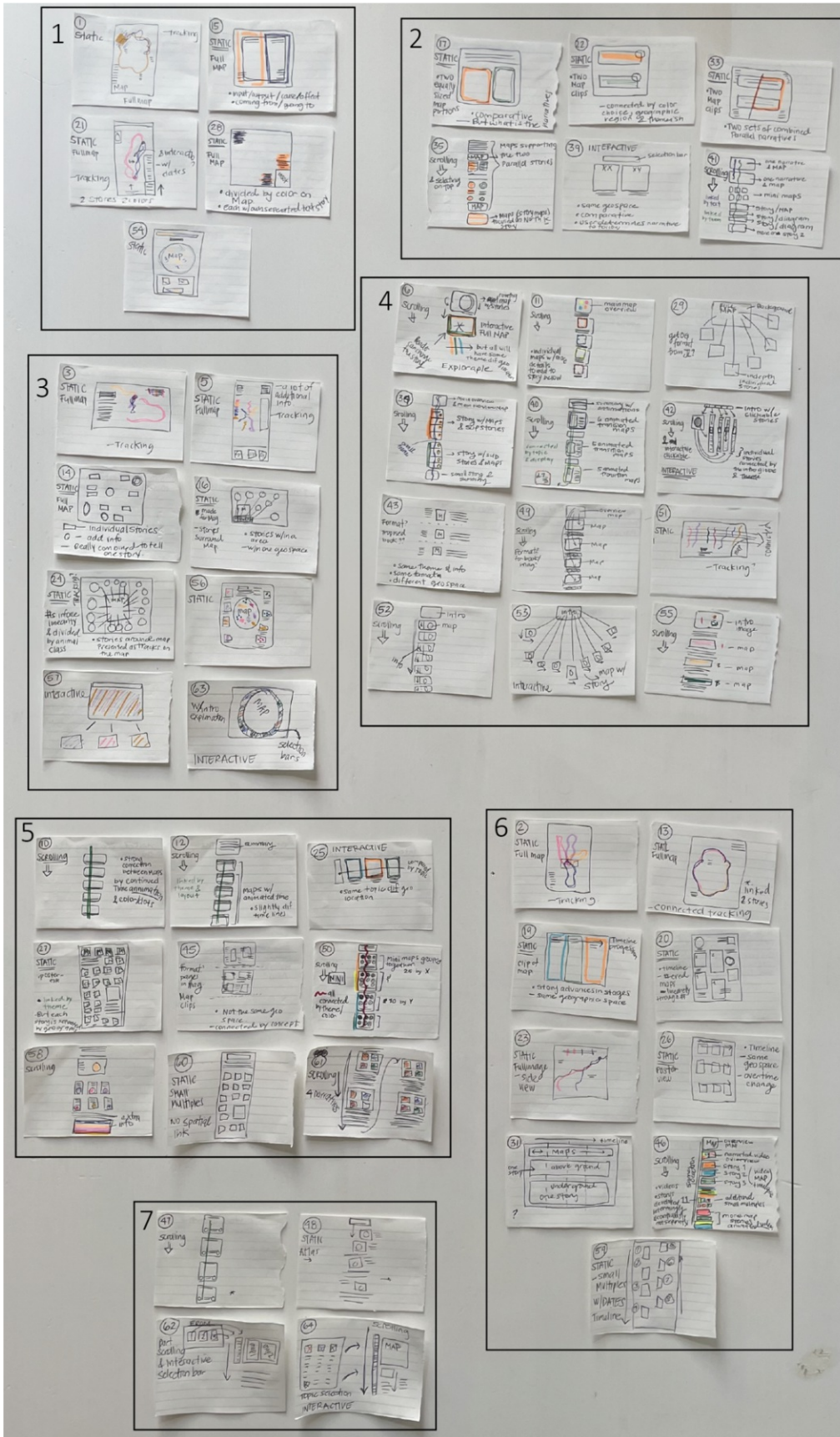
Figure 8. Image of the 53 cards used in card sorting grouped into the finalized categories. The groupings are labeled 1-7 which corresponds to the categories discussed in the results section (4.2.2) (see also Figure 9; Table 9). The circled numbers on each card correspond to the numbers given to each cartographic story collected for qualitative content analysis (Appendix I).

4.2 Results

Results from the qualitative content analysis provide insights into the techniques used in presenting parallel narratives in cartographic stories. The qualitative content analysis has also led to the development of a typology of cartographic parallel narrative stories. The results section will discuss both.

4.2.1 Coding Results

After the 53 maps were coded, the coding results were analyzed for key insights. The number of maps that presented each code were counted, and the percentage of the total was calculated (Appendix III). Several insights were drawn from each category of codes.

Genre:
The genre present in a cartographic parallel story was not exclusive and some stories presented more than one genre. For example, cartographic parallel stories that presented either narrated animations or dynamic slideshows were always paired with either the genre longform infographic or the genre multimedia visual experience. Over 91% of the maps fell into either the genre static visual stories (49%) or the genre longform infographic (42%) (Table 2). Only 4 maps were classified as neither static visual stories nor longform infographic.

Table 2. Results of code category – Genre. This table show the number of cartographic parallel narrative stories that presented each genre as well as the percentage of the total.

Code	Total Count (53)	Percentage of total
Genre : Static Visual Stories	26	49%
Genre : Longform Infographic	22	42%
Genre : Dynamic Slideshow	1	2%
Genre : Narrated Animations	3	6%
Genre : Multimedia Visual Experience	9	17%

Map Layout:
The map layout was also not an exclusive category. For the six, singular not comparative, map layouts more than half of the cartographic parallel stories presented more than one map layout. 50% of the cartographic parallel stories were classified as using a partial map layout (Table 3). The comparative map layouts such as single map vs map series were exclusive categories and every map was either a single map or a map series. It was found that 66% of the cartographic parallel stories were map series and 34% were single maps.

Table 3. Results of code category – Map Layout. This table show the number of cartographic parallel narrative stories that presented each map layout as well as the percentage of the total.

Code	Total Count (53)	Percentage of total
Map Layout : Embedded Map	14	26%
Map Layout : Reference Map	11	21%
Map Layout : Side by Side	11	21%
Map Layout : Full Map	14	26%
Map Layout : Partial Map	25	47%
Map Layout : Small multiples	14	26%
Map Layout : single map vs map series - single map	18	34%
Map Layout : single map vs map series - map series	35	66%
Map Layout : Fragmented layout vs fluid layout - fragmented	40	75%
Map Layout : Fragmented layout vs fluid layout - fluid	13	25%
Map Layout : Dynamic vs stable - dynamic	16	30%
Map Layout : Dynamic vs stable - stable	37	70%

Interactivity Format:

Only 19% of the cartographic parallel stories were interactive. The interactive format used in each interactive story was not exclusive but 70% of the cartographic stories that were interactive had a drill down interactive format.

Table 4. Results of code category – Interactivity Format. This table show the number of cartographic parallel narrative stories that were interactive and how many presented each interactivity format.

Code	Total Count (53)	Percentage of total
Interactivity Format : Interactive	10	19%
Interactivity Format : Martini glass structure	3	6%
Interactivity Format : Interactive slide show	4	8%
Interactivity Format : Drill down story	7	13%

Trope:

The inclusion of tropes in the cartographic parallel stories was a very widely used technique. The trope enforcing linearity was used in 96% of the stories, and the tropes setting the mood and information dosing were both used in 70% of the stories. The two most important devices used in enforcing linearity were titles and scrolling. 68% of the cartographic parallel stories presented either titles (32%) or scrolling (36%). The two most prominent devices used to set the mood were images and colors. 68% of the cartographic parallel stories used either images (38%) or colors (30%). Selected stories were the most frequently used method of information dosing found in 62% of the cartographic parallel stories.

Table 5. Results of code category – Trope. This table show the number of cartographic parallel narrative stories that presented each trope as well as each method used.

Code	Total Count (53)	Percentage of total
Trope : *Setting the MOOD*	37	70%
images	20	38%
color	16	30%
basemap	10	19%
font	3	6%
Trope : *Enforcing Linearity (CONTINUITY)*	51	96%
timeline	10	19%
titles	17	32%
scrolling	19	36%
selection bar	6	11%
numbered	5	9%
animation	3	6%
pages	4	8%
Trope : *Information DOSING*	37	70%
selected stories	33	62%
infographics	11	21%
images	5	9%
Trope : *Visual Simile (METAPHOR)*	3	6%
Trope : *Focus ATTENTION*	18	34%
color	7	13%
symbols	4	8%
text	5	9%
infographics	2	4%

Narrative Patterns:

On average narrative patterns were used in 17% of the cartographic parallel stories and therefore less frequently used than tropes. However, the narrative patterns juxtaposition and repetition were used significantly more frequently. The narrative pattern juxtaposition was used in 57% of the stories and the narrative pattern repetition was used in 42% of the stories.

Table 6. Results of code category – Narrative Pattern. This table show the number of cartographic parallel narrative stories that presented each narrative pattern as well as the percentage of the total.

Code	Total Count (53)	Percentage of total
Narrative Patterns : *Incorporating the audience*	3	6%
Narrative Patterns : *Repition*	22	42%
Narrative Patterns : *Juxtaposition*	30	57%
Narrative Patterns : *Human behind the dot*	7	13%
Narrative Patterns : *Rhetorical question*	3	6%
Narrative Patterns : *Familiar setting*	3	6%
Narrative Patterns : *Call to action*	3	6%
Narrative Patterns : *Gradual Visual Reveal*	8	15%
Narrative Patterns : *Defamilarization*	2	4%
Narrative Patterns : *Maningful use of space*	4	8%
Narrative Patterns : *Concretize*	15	28%

Visual Narrative Tactics:

Messaging is an extremely important aspect of the cartographic parallel stories. Every single story had some form of messaging. Only 5 had just one form of messaging, while 15 had all 4 types: annotation, info text, captions, and summary.

Table 7. Results of code category – Visual Narrative Tactics. This table show the number of cartographic narrative stories that presented each visual narrative tactic as well as the percentage of the total.

Code	Total Count (53)	Percentage of total
Visual Narrative Tactics : Close ups	6	11%
Visual Narrative Tactics : time annimation	3	6%
Visual Narrative Tactics : zooming	7	13%
Visual Narrative Tactics : Layer list	5	9%
Visual Narrative Tactics : Info Panel	4	8%
Visual Narrative Tactics : Info Pop up	3	6%
Visual Narrative Tactics : Annotation	34	64%
Visual Narrative Tactics : Info text	42	79%
Visual Narrative Tactics : captions	28	53%
Visual Narrative Tactics : summary	37	70%
Visual Narrative Tactics : Image	25	47%
Visual Narrative Tactics : Video	2	4%

Parallel Narrative Tactics:

In parallel narrative tactics link, contrasting or complementary, and sequence were filled in for every story. The most used link was subject (60%), followed by location (23%). Most cartographic parallel stories presented contrasting narratives (77%) vs complementary narratives (23%). For sequence, simultaneous narratives (42%) were most common followed by non-linear narratives (38%) and then linear narratives (21%).

Table 8. Results of code category – Parallel Narrative Tactics. This table show the number of cartographic parallel narrative stories that presented each parallel narrative tactic as well as the percentage of the total.

Code	Total Count (53)	Percentage of total
Parallel Narrative Tactics : Color seperating narratives	22	42%
Parallel Narrative Tactics : Number of narratives (mean, median)	(8, 4)	
Parallel Narrative Tactics : link		
characters	3	6%
event	6	11%
location	12	23%
subject	32	60%
Parallel Narrative Tactics : Contrasting or Complimentary - Contrasting	41	77%
Parallel Narrative Tactics : Contrasting or Complimentary - Complimentary	12	23%
Parallel Narrative Tactics : Sequence		
Linear	11	21%
Non-Linear	20	38%
Simultaneous	22	42%

Analysis of the coding results provided a better understanding of important features in cartographic parallel narratives. Visual cards were created of each map in order to perform card sorting and classify a taxonomy for parallel narratives in cartographic storytelling.

4.2.2 Typology of Parallel Narratives in Cartographic Storytelling

Quantitative content analysis, which included coding and card sorting, led to the grouping of existing examples into categories. Categorization was based on several concepts including: what linked the two narratives, how the two narratives interacted in the visualization, and what visual elements guided the viewer between the narratives. As a result seven categories were defined. The typology of cartographic parallel narrative stories is: (1) Two Narratives – One Map, (2) Two Narratives – Multiple Maps, (3) Many Narratives – One Map, (4) Many Narratives – Multiple Maps – Spatial Connection, (5) Many Narratives – Multiple Maps – No Spatial Connection, (6) Same Space – Temporal Progression, and (7) Same Space – Different Points of View (Figure 9).

The following section outlines each category and a table with the definitions is provided at the end of.

Two Narratives – One Map
In *Two Narratives – One Map* (see Figure 9), two narratives are told through one map in the cartographic story. The visualization focuses on two characters that are both of equal importance in the narrative. These narratives often present opposing views on the same event or theme. With one map the two narratives interact in the same map. This allows the viewer to inspect how the narratives interact spatially. Because only one map is used to present two narratives, color becomes an important technique used to structurally separate the two narratives. Each narrative is represented on the map with a different colored cartographic feature. This is usually red and blue.

Analysis of the coding results for the five cartographic parallel narratives categorized as *Two Narrative – One Map* highlighted several characteristics that they all shared: all were classified as genre – static visual stories, all were map layout – single map, all used the parallel narrative tactic – color separating stories, each story had exactly two narratives, and all of them were parallel narrative tactic – contrasting narratives. Additionally, 80% of the *Two Narrative – One Map* cartographic parallel narratives presented simultaneous sequence narratives.
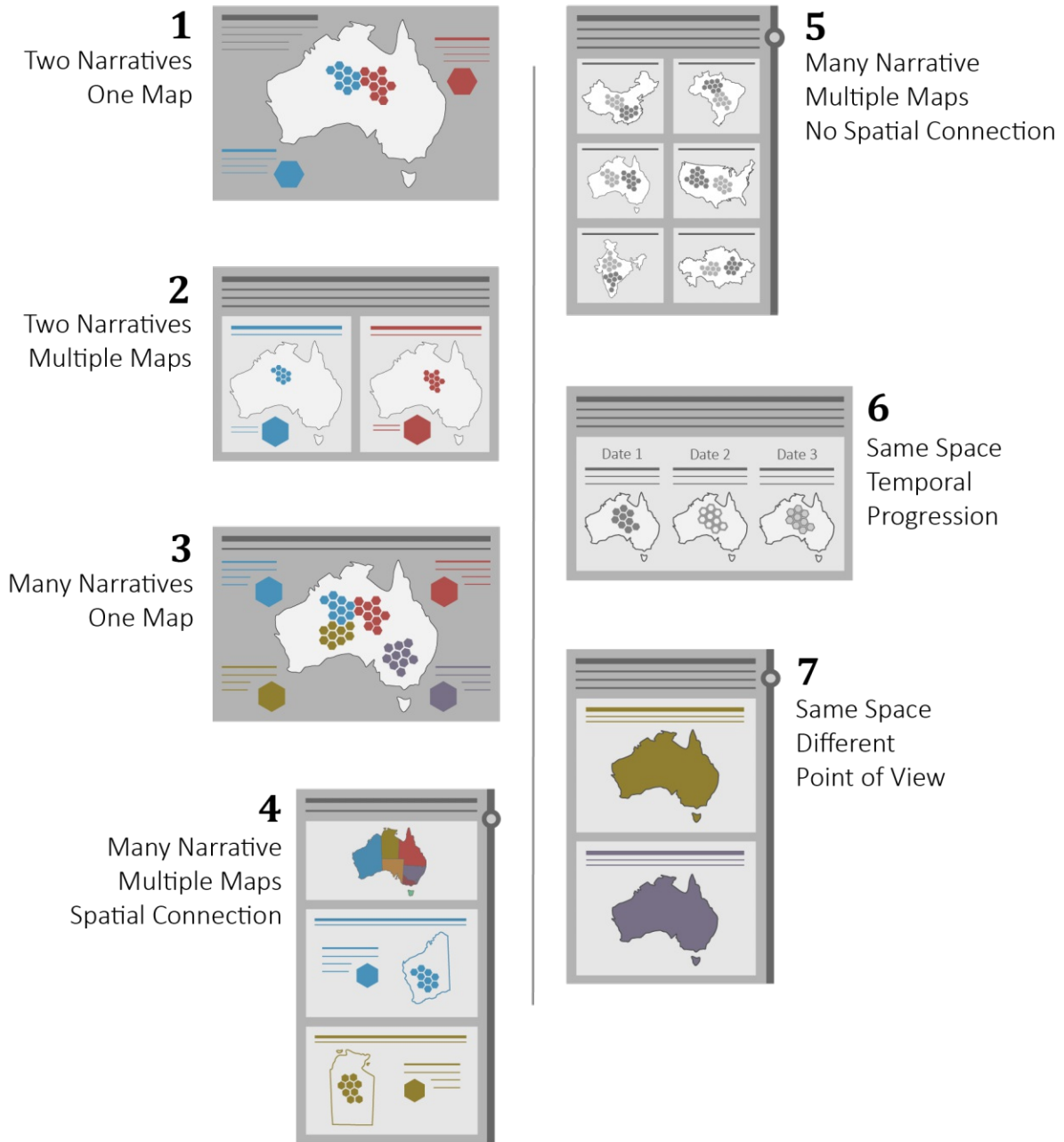
Figure 9. Visual example of each Cartographic Parallel Narrative Story category. Lines in each visualization represent text elements and the hexagons represent images, infographics, symbols, and other map features.

One example of *Two Narratives – One Map* comes from the cartographic story, *Radio Rivalry - Red Sox and Yankees Radio Networks,* by Tim Wallace (Figure 10) (Wallace, 2011). The cartographic parallel narrative uses the parallel narrative tactic – color separating stories with the two colors, red and blue, to highlight the regions in New England that listen to radio coverage of either the Red Sox or Yankees baseball teams. The two characters on the map (the red and blue) interact and overlap portraying listener trends. The map is annotated with city and state names and info texts are included throughout the map providing important information to the narratives.
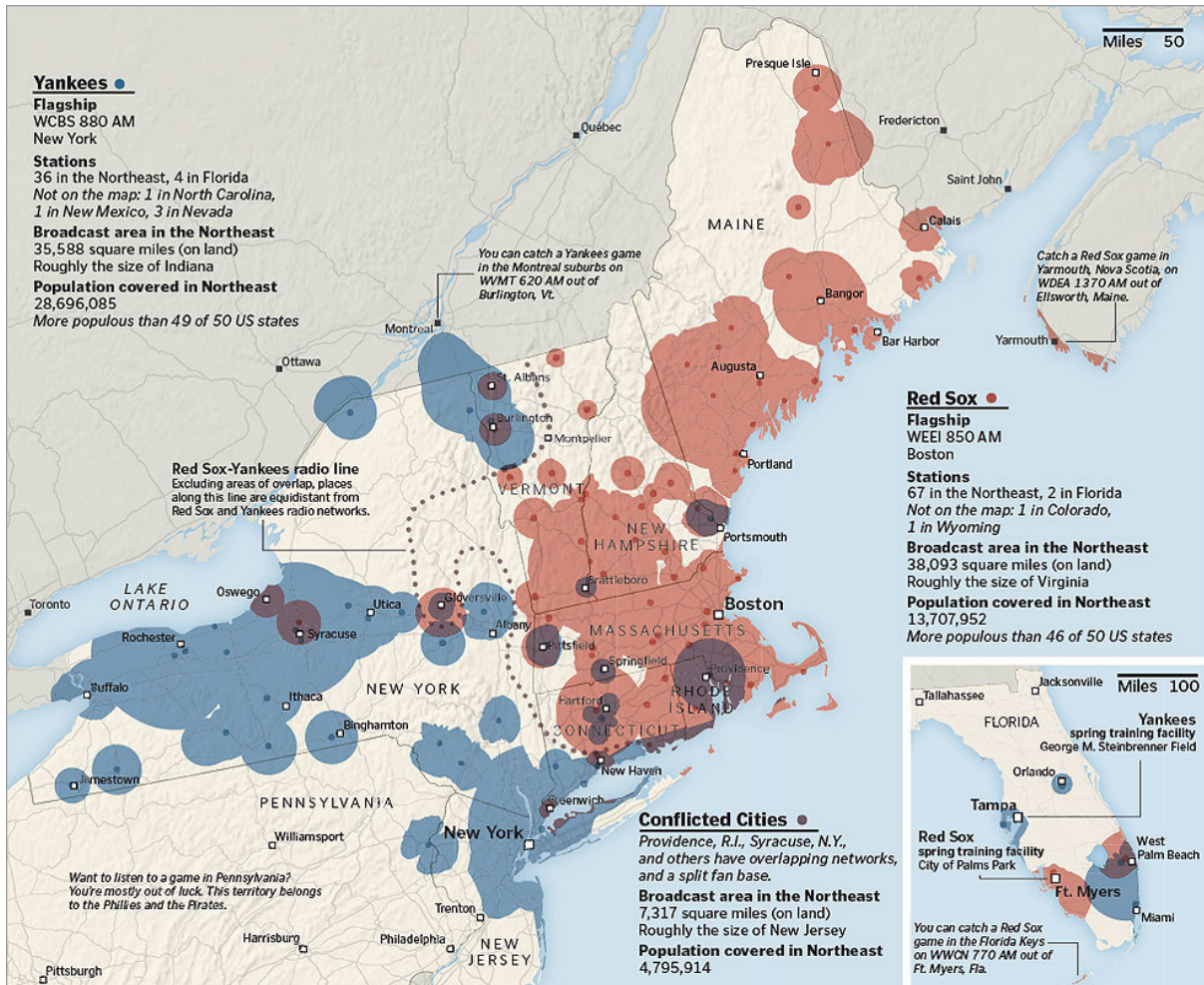
Figure 10. Radio Rivalry - Red Sox and Yankees Radio Networks by Tim Wallace (2011).

Two Narratives – Multiple Maps

In *Two Narratives – Multiple Maps* (see Figure 9), two narratives are told through a series of maps. Just as in *Two Narratives – One Map,* the visualization focuses on two characters that are both of equal importance in the narrative. These narratives often present opposing views on the same event or theme. With two maps, either both narratives have their own map, or more than one map depicts the two narratives together. With narratives that each have their own map, visual order plays some importance in linearity. The reader will view one map first and then the other. Therefore, it is non-linear if both maps portray events that occur at the same time. If there are multiple maps depicting both narratives together then this can allow for a linear portrayal of the narratives as they interact.

Analysis of the coding results for the six cartographic parallel narratives categorized as *Two Narrative – Multiple Maps* highlighted several characteristics. All of the stories were map layout - map series. Half the stories were categorized as genre – static visual stories and half were categorized as either longform infographic or multimedia visual experience. The narrative pattern – juxtaposition was present in 83% of the stories while the narrative pattern – repetition was not present in any of the stories. This shows that comparing narratives was very important while presenting similarities was not

important. Unlike *Two Narratives – One Map*, only one story used the parallel narrative tactic – color separating stories.

One example of *Two Narratives – Multiple Maps* comes from the cartographic story, *Earthquake Risk/Volcano Risk*, published by National Geographic (Figure 11) (Prueitt & Mellett, 1985). The cartographic story is a static visual map series that uses one map to portray the risks of earthquakes in the United States and another map to portray the risks of volcanoes in the United States. Both maps use the same colors to highlight the level of risk, connecting the narratives. The maps are juxtaposed on top of each other in the visualization in order to provoke a comparison.
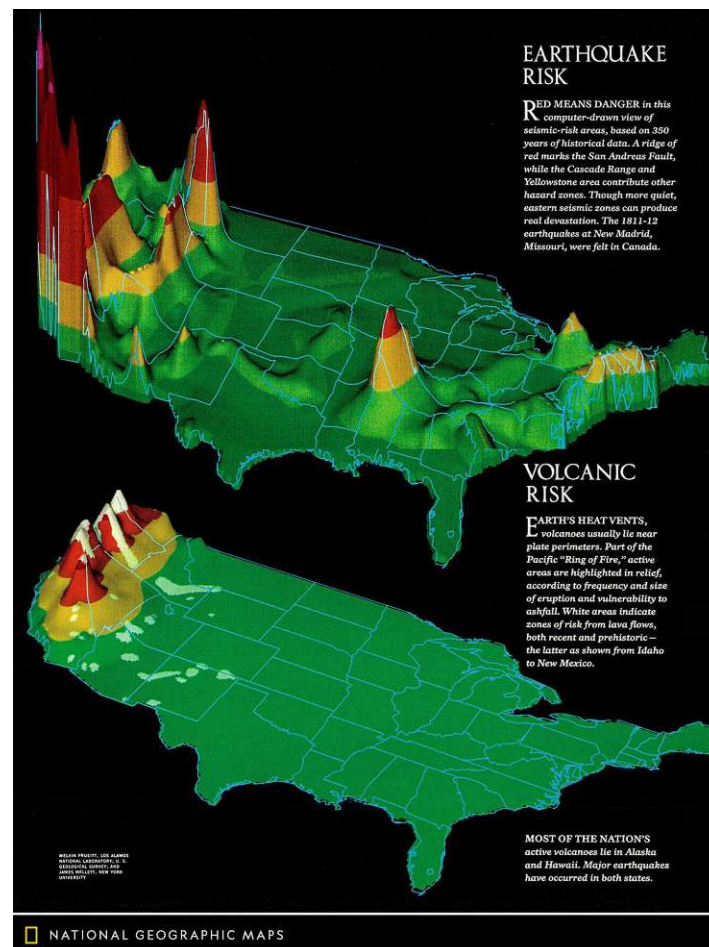
Figure 11. Earthquake Risk/Volcano Risk published in National Geographic (Prueitt & Mellett, 1985).

Many Narratives – One Map

In *Many Narratives – One Map* (see Figure 9), more than two narratives are visualized in one map. Like *Two Narratives – One Map*, in *Many Narratives – One Map* the multiple narratives interact in one map visualization. The visualization focuses on more than two characters. Each narrative can be examined independently but when put together it tells a bigger story. Colors and titles structure and separate the narratives. Narratives are often distinguished by different colors that accompany the different characters. Narratives can also be distinguished by titles given to each character and their corresponding narrative.

Analysis of the coding results for the eight cartographic parallel narratives categorized as *Many Narratives – One Maps* highlighted several characteristics. 75 % of the stories were genre – static visual stories and 25% were multimedia visual experience. All of them were map layout – single map and all of them presented the tropes setting the mood and enforcing linearity. The narrative pattern – repetition is significantly more important in *Multiple Narratives – One Map* than with both two narrative categories. Narrative pattern – repetition is present in 63% of the stories. In *Multiple Narratives – One Map*, repetition helps to connect elements of each narrative together.

One example of *Many Narratives – One Map* comes from the cartographic story, *Great Migrations*, published in the November 2010 issue of National Geographic Magazine (Figure 12) (Pepple, 2010). The map in the center of the cartographic story provides an overview of each specific species (each narrative) migration route and how they each interact on a global scale. The map and additional elements, which provide text and images for each species, are of equal importance making this a partial map layout. The images of each species help to set the mood and the numbered descriptions of each species migration patterns help to enforce linearity.
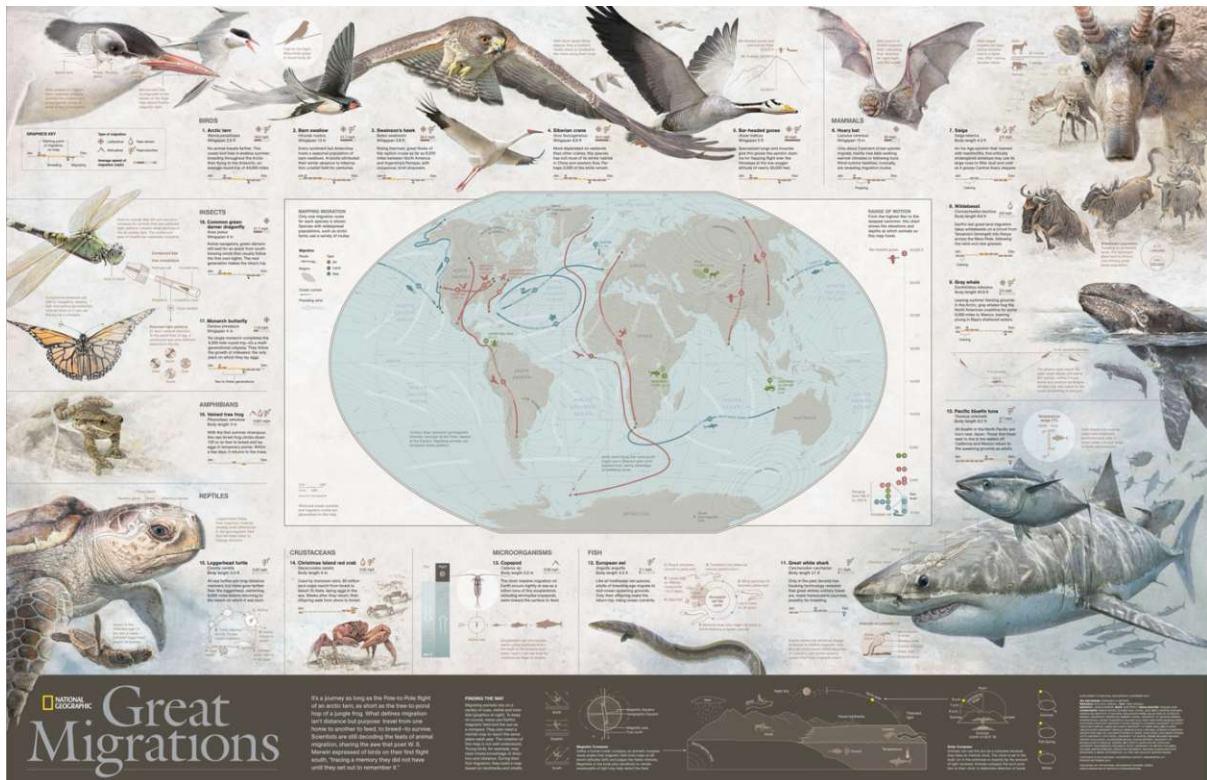
Figure 12. Great Migrations, published in the November 2010 issue of National Geographic Magazine (Pepple, 2010).

Many Narratives – Multiple Maps – Spatial Connection

In *Many Narratives – Multiple Maps – Spatial Connection* (see Figure 9), multiple narratives that share a common or adjacent location are presented in a series of maps. The narratives are linked by theme and spatial proximity. The cartographic story begins with an overview map that introduces all of the characters. In other words, the overview map includes all of the regions that are presented in the story. Following the overview map, each narrative (the region) is visualized in a separate map. Therefore, the individual

maps separate and structure the narratives. Color can be a tool used to highlight the differences between the maps. Scrolling or flipping between maps moves the story along

Analysis of the coding results for the twelve cartographic parallel narratives categorized as *Many Narratives – Multiple Maps - Spatial Connection* highlights several characteristics. 83% of the stories are genre - longform infographic with the most common method of enforcing linearity being the use of scrolling. 83% of the stories were map series. The two stories that were not map series were interactive and therefore, provided the viewer the ability to change map regions in one map window. The use of narrative pattern – repletion (67%) was much higher than the use of juxtaposition (17%). 92% of the stories were nonlinear sequence. This is because each narrative takes place at the same time but is viewed one after the other.

One example of *Many Narratives – Multiple Maps – Spatial Connection* comes from the cartographic story, *Time to Choose*, published by the Conservation Lands Foundation (Figure 13) (Van City Studios, n.d.). The cartographic visualization begins with a summary of the intent in creating the cartographic narrative and an overview map that illustrates all of the places that will be discussed further. As the viewer scrolls down a map view appears with scrolling information about the location in the left panel. As the viewer continues to scroll the map view changes to the second location and its corresponding information. The information given for each map and the style of the maps is consistent.

Figure 13. Screenshots from the cartographic story, Time to Choose, published by the Conservation Lands Foundation (Van City Studios, n.d.). The cartographic story is a scrolling story that could not be fully presented here due to length. The first picture is from the introduction to the cartographic story and presents an overview map. The following two pictures are two of the narratives presented as you scroll down. As you scroll the map on the left zooms to new the location.

Many Narratives – Multiple Maps – No Spatial Connection

In *Many Narratives – Multiple Maps – No Spatial Connection* (see Figure 9), multiple narratives that are not geographically related are presented over a series of maps. The narratives depict different locations all with the same scale and thematic elements. The narratives are linked by theme, not by location. Therefore, no overview map is provided that connects the narratives. Each narrative (map) in the cartographic story is connected

by the variables and elements displayed. Color often connected the narratives instead of separating them. Instead of color separating the narratives, each map separates the narratives and structures the overall story. The order in which the viewer receives the story is depicted by the order of the maps are presented.

Analysis of the coding results for the nine cartographic parallel narratives categorized as *Many Narratives – Multiple maps – No Spatial Connection* highlights several characteristics. The genre of cartographic story was less important in categorizing stories with no spatial connection. Map layout was more important with 56% of the stories presenting the map layout - small multiples, and 100% of the stories being map series. Color played an important role in setting the mood (44%).

One example of *Many Narratives – Multiple Maps – No Spatial Connection* come from the cartographic story, *What if it was your city*, by Alberto Lucas López (Figure 14) (López, 2015). The cartographic story includes twenty small maps visualizing what the impact zone of an atomic bomb would look like in various cities around the world. Each map has the same color theme and a legend describes the meaning of the colors used in the visualization.
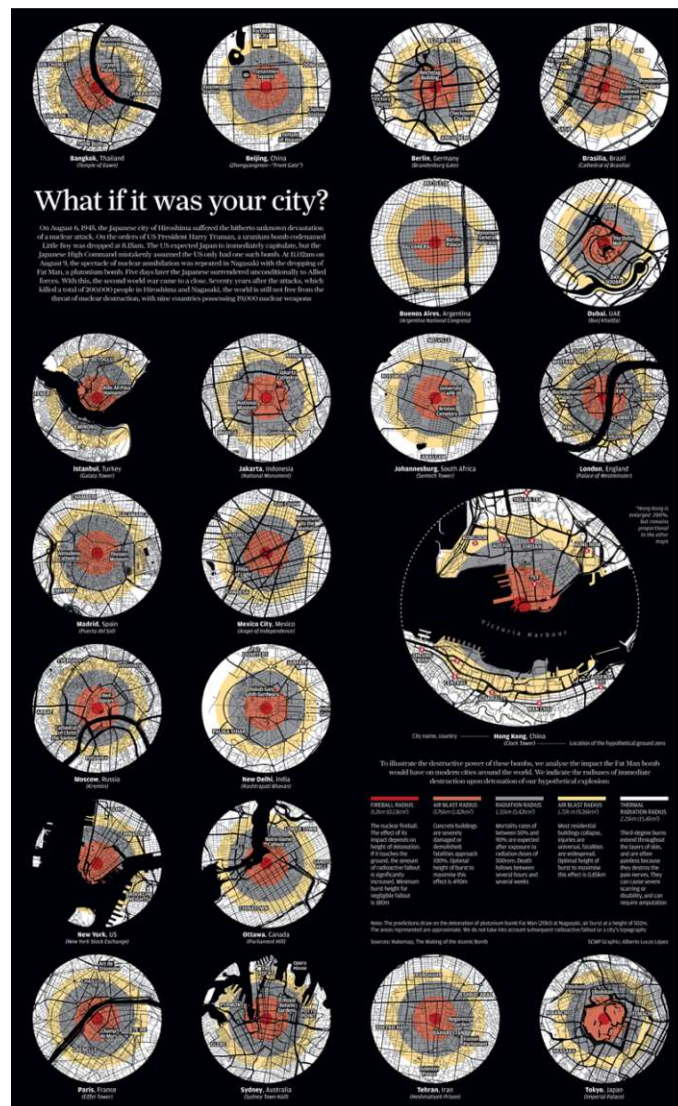
Figure 14. What if it was your city by Alberto Lucas López (López, 2015).

Same Space – Temporal Progression

In *Same Space – Temporal Progression* (see Figure 9), two or more narratives are told about the same location over a series of time. Each narrative presents the same location at a different point or span of time. The inclusion of dates or a timeline separate the narratives and structures the story. A timeline can be either animated or text.

Analysis of the coding results for the nine cartographic parallel narratives categorized as *Same Space – Temporal Progression* highlights several characteristics. 89% of the stories were static visual stories and 67% were map series. Most significantly, in comparison to other categories, timelines played an important role in enforcing linearity and were present in 78% of the stories. Also, in contrast to all other categories most (89%) of the stories were complimentary narratives with linear sequencing.

One example of S*ame Space – Temporal Progression* comes from the cartographic story, *American Slavery*, by Bill Rankin (Figure 15) (Rankin, 2016). The cartographic story features nine maps depicting every ten years from 1790 – 1870. Dates placed above each map make up a timeline. Each map uses the same colors and dots to indicate the percentage of slaves and number of people within a region of 250sqmi. The maps are juxtaposed side by side so that the viewer can observe the changes over time.
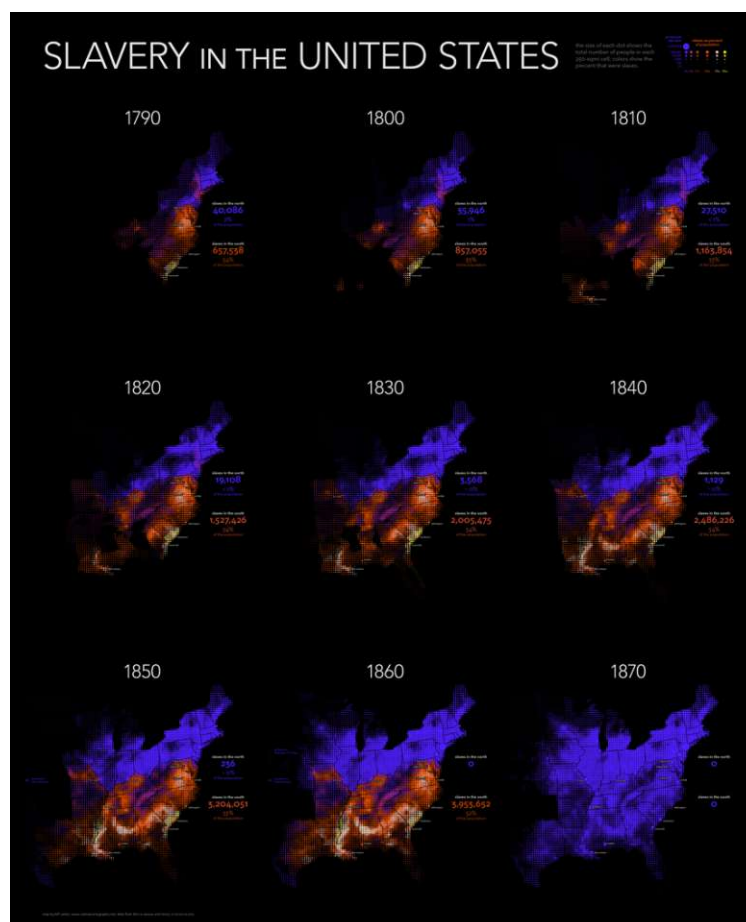
Figure 15. Slavery in the United States, by Bill Rankin (Rankin, 2016).

Same Space – Point of View

In *Same Space – Different Point of View* (see Figure 9), two or more narratives are told about the same location over a series of maps. The narratives present different points of view on specific characteristics or variables associated with the location. The narratives are not ordered temporally but are usually occurring at the same time. Scrolling or swiping control the progression of the story and each map separates the narratives.

Analysis of the coding results for the four cartographic parallel narratives categorized as S*ame Space – Different Point of View* highlights several characteristics. Since only four cartographic stories were found to analyze, the results are not as comprehensive, but several characteristics can still be pointed out. 100% of S*ame Space – Different Points of View* stories were layout maps series and genre - longform infographic, with 50% also genre - multimedia and interactive.

One example of S*ame Space – Different Point of View* comes from the cartographic story, *Maps*, depicting the differences in map projections (Figure 16) (Alb a Gon, 2020). Four maps show how Mercader cylindrical, Robinson pseudo-cylindrical, Ptolemy conic equidistant, and Lambert planar azimuthal projections compare when projecting the world. A single red line from Newfoundland, Canada to the south of Ireland is included in each map to further highlight the difference in map projections. To indicate that each map presents its own narrative, each map has its own color.
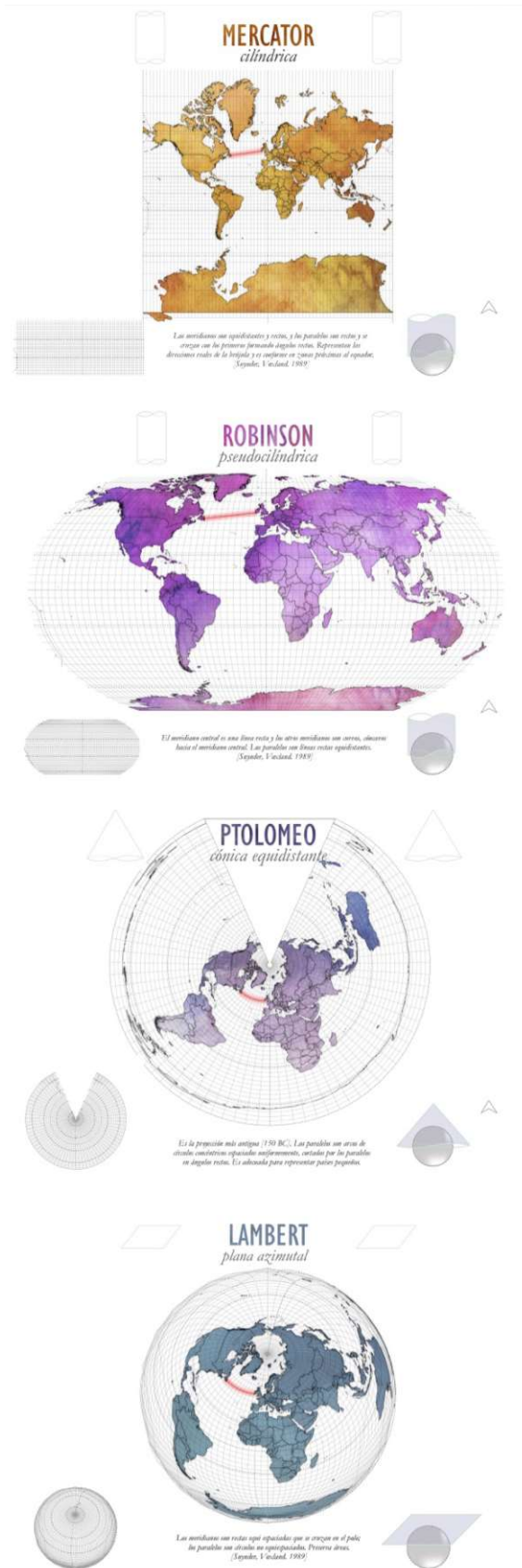
Figure 16. Maps depicting the differences in map projections (Alb a Gon, 2020). This figure has been reduced in size to fit on one page. Normal viewing of this figure would use scrolling to move through the story from one map to the next.

In concluding, the typology of cartographic parallel narrative stories is: (1) Two Narratives – One Map, (2) Two Narratives – Multiple Maps, (3) Many Narratives – One Map, (4) Many Narratives – Multiple Maps – Spatial Connection, (5) Many Narratives – Multiple Maps – No Spatial Connection, (6) Same Space – Temporal Progression, and (7) Same Space – Different Points of View (Table 9). Specific techniques are prominent in each category. Discovered through qualitative content analysis of existing examples, several techniques are prominent in all of the categories as well. Further investigation will aim to address how these techniques aid in a viewer's understanding and compare the parallel narratives in cartographic stories.

Table 9. This table presents the definition of each category. The example column is in reference to numbers given to existing examples of cartographic parallel narratives stories used in the qualitative content analysis. Information corresponding to each number can be found in Appendix I.

		Category		Definition	Examples
1	Two Narratives	One Map		The visualization focuses on two characters that are both of equal importance in the narrative. These narratives often present opposing views on the same event or theme. With *one map* the two narratives interact in the same map.	1, 15, 21, 28, 54
2		Multiple Maps		The visualization focuses on two characters that are both of equal importance in the narrative. These narratives often present opposing views on the same event or theme. With *two maps* either both narratives have their own map or more then one map depicts the two narratives together.	17, 22, 23, 35, 39, 41
3	Many Narratives	One Map		The visualization presents more than two narratives. Like *Two Narratives-One Map* , in *Many Narratives-One Map* the multiple narratives interact in one map visualization.	3, 5, 14, 16, 24, 56, 57
4		Multiple Maps	Spatial connection	The visualization presents more than two narratives. These narratives are presented through multiple maps. The narratives are linked by theme and spatial proximity. An overview map is included that introduces all of the characters and then each seperate narrative follows.	6, 11, 29, 34, 40, 42, 43, 49, 51, 52, 53, 55
5			No spatial connection	The visualization presents more than two narratives. These narratives are presented through multiple maps. The narratives are linked by theme but not location. No overview map is provided that connects the narratives. Each narrative (map) in the cartographic story is connected by variables and characteristics displayed.	10, 12, 25, 27, 45, 50, 58, 60, 61
6	Same Space	Temporal Progression		Two or more narratives are told about the same location and in a linear fashion. Each narrative progresses along a temporal scale. Each narrative presnets the same location at a different point or span of time.	2, 13, 19, 20, 23, 26, 31, 46, 59
7		Different Points of View		Two or more narratives are told about the same location. The narratives present different points of view on specific characteristics or variables associated with the location.	47, 48, 62, 64

5. Case Study: Cartographic Parallel Narrative Storytelling with Invasive Alien Species Scenarios

In order to test some of the design elements perceived to be important in cartographic parallel narrative stories, a case study and pre-study questionnaire were developed. This case study is a pre-study and only presents the first step in understanding how design elements can be utilized to present parallel narratives in cartographic storytelling.

The case study is in partnership with the research group BioInvasions – global change – Macroecology at the University of Wien. The group has five core missions concerning biological invasive alien species: understanding patterns, assessing consequences, developing innovative ideas and concepts, engaging in science-policy communication, and communicating and interacting with the public (Essl et al., n.d.). The group is working on several projects focused on research and outreach that present parallel narratives. The parallel narratives have not yet been spatially visualized, but the development of a cartographic visualization would aid in communicating important issues regarding invasive alien species to the stakeholders and the general public.

5.1 Data Acquisition

The research group BioInvasions – global change – Macroecology is currently working on the project AlienScenarios – researching and outlining a range of possible future biological invasion trajectories and their impacts (Essl et al., n.d.). In order to develop the possible future scenarios, research focuses on drivers that impacted the spread of invasive alien species (IAS). Twenty-four drivers were identified from five groups – politics & demography [6], economy & trade [3], lifestyle & values [4], technology [2], and environment & natural resources [9] – as suitable for building the scenarios. Based on these drivers, four groups of narratives were developed with a total of 16 plausible biological invasion scenarios. Each set of four scenarios is developed based on two main drivers, while also considering all other relevant drivers (Roura-Pascual et al., 2021).

There are many narratives that are told by the research and data on future alien species invasion scenarios. Each of the 16 scenarios is a narrative that can be examined on a global scale. Due to time constraints for this thesis visualizing all 16 scenarios on a global scale was not possible. Therefore, focus turned to four invasive alien species future scenarios developed for Europe.

InvasiBES is a BIODIVERSA funded project that aims to "better understand and anticipate the multi-faceted impacts of invasive alien species on biodiversity and ecosystem services" (*InvasiBES*, n.d.). InvasiBES, in partnership with the project AlienScenarios, has developed four scenarios that each outline a possible future societal structure and its impact on, and management of, IAS. A paper outlining the development of the four European scenarios has not yet been published but two members of InvasiBES, Dr. Wolf-Christian Saul and Prof. Dr. Jonathan M. Jeschke were able to provide descriptions and additional information on the scenarios.

The four specific scenarios developed for Europe are called *Lost in Europe*, *Big Tech rules Europe*, *Back to nature*, and *Technological (pseudo-)panacea* (Saul & Jeschke, n.d.). Important characteristics that separate these four scenarios include the increase or decrease of international trade and trade regulations, the focus on scientific technological advancement, the ability of a government to cooperate with other governments, and the level of environmental awareness.

In the *Lost (in) Europe* scenario, international trade is reduced and there is a disintegration of the EU. There is a lack of scientific literacy and increased land use contributes to environmental degradation. For IAS this means that there is a decrease in regulations and introduction of IAS goes largely uncontrolled and expands due to increased land use (Saul & Jeschke, n.d.).

In the *Big Tech Rules Europe* scenario, there is an increase in trade and technology. Urban population grows, while rural population decrease's and people become increasingly disconnected from nature. For IAS, this means an it has the ability to expand due to increased trade and a general lack of concern for the effect of IAS on the local environment (Saul & Jeschke, n.d.).

In the *Back to Nature* scenario, rural areas grow in population as people return to rural areas from urban areas. Trade decreases and there is low technological innovation. There is a high environmental awareness but lack of common environmental regulations. For IAS, this means an overall decrease in the introduction of IAS but already established IAS are able to continue to spread (Saul & Jeschke, n.d.).

In the *Technological (pseudo-)panacea* scenario, there is an increase in trade and technology, but also an increase in trade regulations. There is also a high but stabilized ecological footprint due to a high environmental awareness. The general societal belief is that society can solve all environmental problems. For IAS, this means an increase in introduced IAS due to trade but also an increase in management and regulations (Saul & Jeschke, n.d.).

As the narratives are comparative scenarios for the future, presenting the narratives in parallel would give viewers a better understanding of the relationship between certain drivers and their effects in each scenarios. In order to understand how to visualize the four parallel scenarios in a way that is beneficial for the AlienScenarios project, several meetings were held with two members of the research group BioInvasions – global change – Macroecology, Franz Essl and Bernd Lenzner, and two members of InvasiBES, Dr. Wolf-Christian Saul and Dr. Jonathan Jeschke. In meetings with Franz Essl, Bernd Lenzner, Dr. Wolf-Christian Saul, and Dr. Jonathan Jeschke, the objective for creating cartographic parallel narratives for the IAS scenarios was discussed and the data and information to be included was outlined.

While the four scenarios are developed for Europe, the data is not quantitative or spatially referenced and therefore can't simply be visualized using a geospatial analysis software. In meetings with Franz Essl, Bernd Lenzner, Dr. Wolf-Christian Saul, and Dr. Jonathan Jeschke it was suggested that creating visualizations of stylized landscapes based off three regions, northern, central, and southern Europe, would help to communicate the

impact that invasive species might have on each region. A stylized landscape depicts a region (landscape) that is not a real place but rather a representation of many places. When creating a stylized geographical landscape specific spatially referenced data would not be needed. It was then was proposed that including a species for each region would help viewers better understand the concept of IAS.

Originally it was proposed to create cartographic parallel narratives for each region in Europe as well as for a variety of different invasive species; however, due to time constraints only one cartographic parallel narrative could be created. Central Europe was chosen to be the landscape location as that is where the research group is located and therefor would be most beneficial for outreach. It was also proposed to include three species, one plant, one animal, and one aquatic; however, due to time constraints only one was selected. Following further discussions with Franz Essl, Bernd Lenzner, Dr. Wolf-Christian Saul, and Dr. Jonathan Jeschke, it was decided that the group could provide the most information on the species Ambrosia artemisiifolia (annual ragweed). Ambrosia (ragweed) is an invasive plant species in Europe. It is currently spreading in most of central Europe and is spreading north due to climate change. Ambrosia thrives in summer crop fields, road verges, railway stations, and open ruderal sites. Spread of Ambrosia is concerning because of its highly allergic pollen and yield losses in infested fields (Essl et al., 2015).

The spread and management of Ambrosia would occur differently in each of the four outlined scenarios. An outline of Ambrosia's response to each of the four scenarios was created based on the implication for IAS in each scenario, characteristics of the Ambrosia species, as well as ratings on important drivers for Ambrosia in each scenario outlined by Franz Essl (F. Essl, personal communication, September 28, 2021).

5.2 Design Goals and Opportunities

There are many different ways to create a cartographic parallel narrative, as shown in chapter 4. Many design decisions depend on both the data and the audience. Who you want to be able to understand the cartographic story is just as important as what you want to show. The aim for the research group BioInvasions – global change – Macroecology was to present a cartographic visualization for outreach purposes that the general public can understand. This means the messaging should be clear and understandable and the design should be engaging.

The type of data is also important in deciding what visualization techniques should be included. One goal of this case study is to test design elements perceived to be important in cartographic parallel narratives as well as examine how the IAS cartographic parallel narrative fits into the typology outlined in chapter 4. Each of the European IAS scenarios presents a different possible future for one landscape region. Therefore, each narrative is about the same location and time but presents different perspectives. This means that it is not considered as a *Same Space – Temporal Progression* or a *Multiple Maps – No Spatial Connection* cartographic parallel narrative. Furthermore, the narratives do not interact and cannot be displayed on one map without overlapping because they display data at the exact same location. This means that it cannot be a *Many Narratives – One Map* cartographic parallel narrative. It is also not a *Multiple Narratives – Spatial Connection*

cartographic parallel narratives either because there is no overview map that is then broken down into smaller regions. Therefore, the type of cartographic parallel narrative that the European IAS scenarios present is a *Same Space – Different Point of View*.

Based on the content analysis of existing examples of parallel narratives in cartographic stories presented in section 4.2.2, only four examples present *Same Space – Different Point of View* narratives. This is a very small sample size and therefor there is not enough samples to conclude what cartographic and parallel narrative elements and techniques are most prevalent in *Same Space – Different Point of View* stories. It would be beneficial to create several cartographic parallel narratives that utilize different techniques to further examine the typology of *Same Space – Different Point of View*.

There are several important design choices to choose from when creating a *Same Space – Different Point of View* cartographic parallel narrative. Design choices discussed here will be narrowed down by the design elements (codes) discussed in section 4.1.2, which include genre, map layout, interactivity, tropes, narrative patterns, visual narrative tactics, and parallel narrative tactics:

- All four of the *Same Space – Different Point of View* cartographic parallel stories examined in chapter 4 were longform infographics with two of them also including multimedia visual experiences. However, with only four examples it should further be explored if creating a static visual story could also present the narratives in a visually pleasing and understandable way.

- Should the cartographic story present a single map or a map series? The European IAS Scenarios story has four narratives that each depict information about the same area and would need to overlap if presented on the same map. If a single map was to be used to visualize the narratives, it would have to be divided equally into four sections with equal characteristics. The distinction between each narrative would have to be obvious. This could be done with color coded narratives. Another option would be to have a map series in which each narrative is presented on a different map. If visualized in a map series, options for map layout include embedded, side by side, and small multiples.

- Should the cartographic parallel narratives be interactive? Interactivity is useful in user engagement. Users could select what drivers of IAS they would like to add to the map display and use a selection bar to switch between the narratives. Users could also hover over or click on certain features to retrieve extra information.

- What tropes should be included or emphasized to enhance the narratives? Enforcing linearity is especially important in visualizing parallel cartographic narratives. Linearity helps to direct the viewer through the story. The cartographic parallel narrative could use titles, numbers, scrolling or a selection bar to enforce linearity.

- What narrative patterns would aid in supporting the intended message. How could these narrative patterns be applied in the cartographic story. Juxtaposing might be an important narrative pattern to include to aid in the comparison between scenarios.

- The IAS scenarios presents a story that might require a lot of text to guide the general public through the storyline. How should messaging be used throughout the cartographic story and what information should be highlighted.

- In deciding how to display the parallelism of the narratives formatting is important. The narratives can be viewed separately or together. When viewed together it is important to be able to distinguish between the narratives and various design elements can be included to help separate the narratives.

All of these design opportunities would accomplish the design goals however not all of them could be tested. The design outcomes are discussed in the following section.

5.3 Design Outcome

The final design outcome produced two cartographic parallel narrative stories for the invasive alien species (IAS) scenarios in Europe: one static story and one scrolling story. Both stories included the same maps, text, titles, colors, symbols, and images. The stories differed in the way that each map, text, title, symbol, and image was presented.

Both of the cartographic parallel stories separated the narratives into four maps. Since the concept of IAS scenarios is quite complex already, it was decided that separating the narratives by maps would help in the understanding of the separate scenarios. Each map portrays the landscape of a city in Central Europe. Each map has the same roads and river to indicate that the four maps depict the same city. Each map uses the same colors to indicate urban areas and rural areas and the same symbols to indicate where Ambrosia is spreading and where it has been managed.

Both of the cartographic parallel stories include the same text. A summary/introduction text was added to both stories to explain the background behind the IAS scenarios and summarized the four scenarios visualized. In addition, information text was included to both to introduce the species Ambrosia artemisiifolia and also to inform the general public who might not be aware of the species before viewing the story. An information text describing each of the four scenarios in more detail was also included and each map was annotated with explanatory information.

Both of the cartographic parallel stories used titles to identify each narrative. Each map was titled with the scenario it portrayed. Titles were also used to introduce the story and to highlight the selected species. In addition to titles, symbols were included to highlight important drivers in each scenario.

Both of the cartographic parallel stories have the same color scheme to set the mood. Earth tones were chosen since the topic centers around environmental awareness. Color was not used to separate the narratives since color was already being used to present information in each narrative and too many colors might have overwhelmed the visualization. In addition, colors can be associated with emotions such as good (green) or bad (red) and happy (yellow) or sad (grey). Assigning a color to each narrative might have influenced and biased the viewers' understanding of each narrative. In addition, one

image of Ambrosia was included to provide viewers with a better understanding of what Ambrosia looks like. The style of the image also contributes to setting the mood.

The two representations of cartographic parallel narratives presenting the IAS scenarios share many characteristics in order to highlight the characteristics that they do not share. The separate, static and scrolling, cartographic parallel narratives are presented below.

The *Static* Cartographic Parallel Narrative Story

The static cartographic parallel narrative story (Figure 17) juxtaposes the four narratives side by side and stacked in a square. Titles were bolded and placed above and to the outside of each map. Titles included the scenario number (#) and name. Below each scenario title are symbols indicating the relevant drivers and a short text description of that scenario.

Each narrative was separated using bold break lines. One legend was included in the center of the four narratives aiding in separating the four narratives. The description of Ambrosia and the image of Ambrosia is included at the top of the four narratives, separating the top two.

Above the narratives and information on Ambrosia is the introduction/summary text. The text was included at the top of the cartographic story to provide viewers with background information before viewing each scenario. The introductory text included information on important drivers that impacted the spread and management of Ambrosia in each of the different scenarios. The symbol that represents each driver was included in the text to indicate to the reader what each symbol meant.

Figure 17. Static IAS scenarios cartographic parallel narrative story. This figure has been scaled to fit on the page, but was originally slightly larger.

The *Scrolling* Cartographic Parallel Narrative Story

The scrolling cartographic parallel narrative story (Figure 18) was created using ESRI StoryMaps. ESRI StoryMaps allows you to add images, text and videos to your existing maps to "create an interactive narrative that is easy to publish and share" (*Digital Storytelling with Maps | ArcGIS StoryMaps*, n.d.). Due to time restrictions it was not feasible to develop a scrolling cartographic story without the use of a software program. ESRI StoryMaps was chosen to create the scrolling cartographic parallel narrative story due to its user-friendly story builder and potential to display parallel narratives.

When examining cartographic storytelling software such as ESRI StoryMaps, there was almost no functionality's available that specifically had been tailored to telling parallel narratives. Only one function was found in ESRI StoryMaps – the swipe media function.

The function allows the viewer to interactively swipe between two maps or images. Initially, the map scenarios as images were displayed using the swipe function; however, since only two images/maps could be presented in one swipe display, two separate swipe displays would be needed to present all four scenarios. This would only allow comparison between each set of images/maps and not between all four. Therefore, it was concluded that the swipe function was only suited for presenting two parallel narratives.

After examination of all other display functions, the four narratives were displayed using the immersive sidecar function. This function allowed for scrolling to initiate the change between each narrative. The sidecar function presents the image/map on one side of the screen with an information panel on the other. The viewer scrolls through the information associated with the first image/map until the next image/map appears with its associated information. Each of the scenario maps included in the static cartographic parallel narrative story were used with a white background and placed with the river and roads in the same location to present smooth transitions between the maps. The information included to the left of the maps presented in the same format for each narrative. The scrolling information panel began with the legend that described the symbols on the map. Underneath of the legend is the scenario number (#) and title in bold text. Beneath each scenario title is the symbol(s) that represents each driver associated with that scenario. Underneath the symbol(s) is the short informational text about the scenario.

Above the sidecar function displaying all of the narratives is the introductory information. The story title was presented in bold text with the introduction/summary text below it. Because a text function was used to include text in the StoryMap no images or figures could be included with the text. Therefore, the symbols associated with each important driver needed to be defined separately. An image of all four symbols is included below the introduction text and next to a text box defining each symbol. Inserted below the icons is the image of Ambrosia paired with the short informational text on what Ambrosia is.
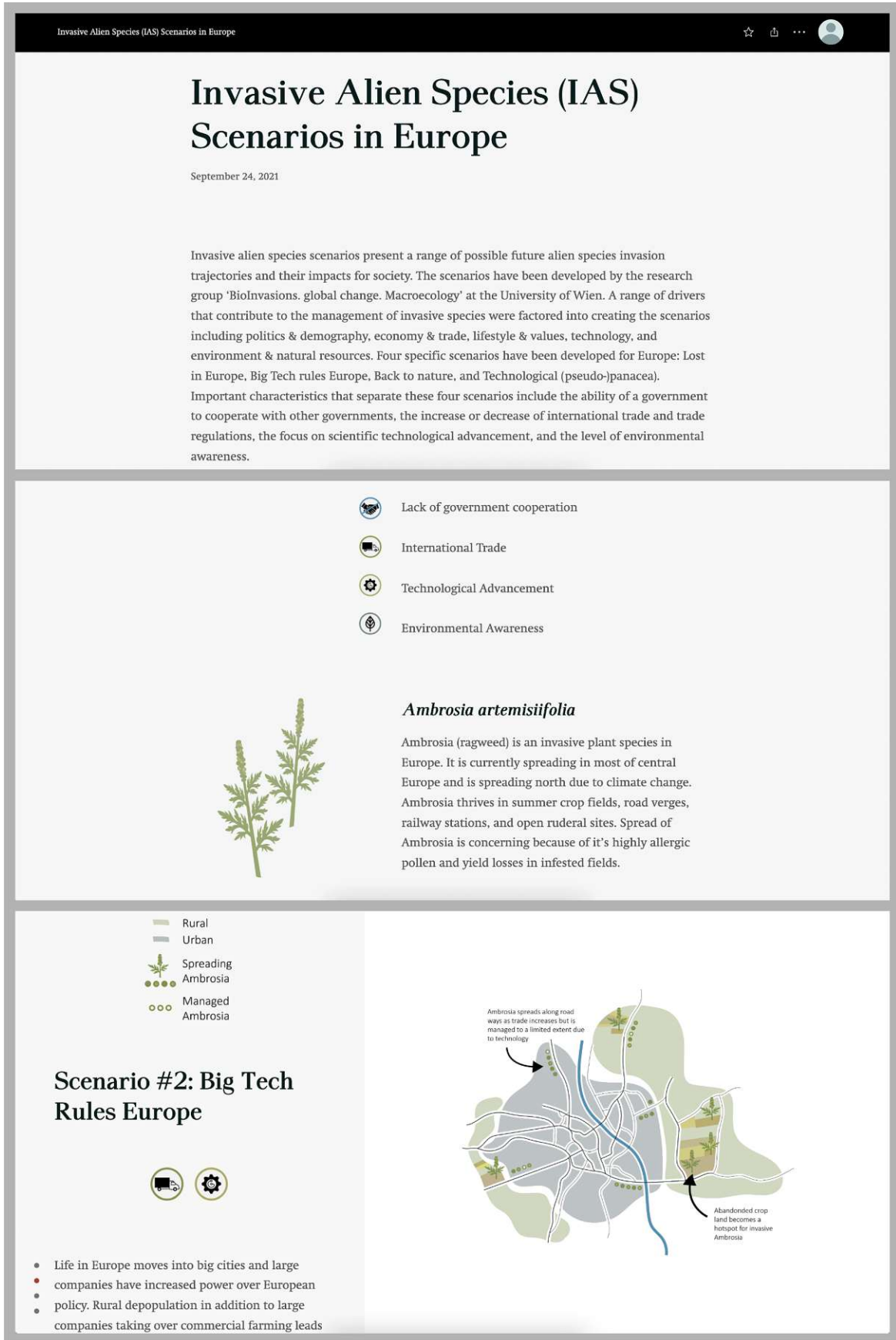
Figure 18. Scrolling IAS scenarios cartographic parallel narrative story (Appendix IV). This figure presents three screenshots from the ESRI StoryMap. The first screenshot shows the introduction text. Scrolling down would bring up the second screenshot with the symbols and Ambrosia species description and the Ambrosia image. The third image shows the second scenario.

5.4 Pre-Study Questionnaire

In order to test the usability of both the static and scrolling European IAS scenario cartographic parallel narrative stories, a pre-study questionnaire was developed. This is a pre-study questionnaire because it will only examine a smaller subset of concepts related to cartographic parallel narrative stories. The case study and resulting cartographic parallel narrative stories only presents one type of typology of cartographic parallel narratives. Therefore, only the *Same Space – Different Point of View* will be examined with this questionnaire, as well as a small subset of techniques used to present parallel narratives in cartography.

5.4.1 Methodology

Study questions were developed to address the viewers perception of parallel narratives in both the static and scrolling cartographic stories. The questions were divided into four sections. The first set of questions addressed the static story. The second set of questions addressed the scrolling story. The third set of questions asked users to compare the static and scrolling stories. The fourth set of questions asked the users about their background information on the subject.

Question answers were presented in three formats: as a slider Likert scale, fill in the blank, or multiple choice. Answers were formatted as fill in the blank when the question was either optional and asked for any further details or when the question asked for the participant to state a number. Answers were formatted as multiple choice for two select either or questions. Most answers were formatted as a Likert slider scale from 0 to 10 (Appendix V).

Several free survey sites were examined including google forms, SurveyMonkey, Survio, FreeOnlineSurvey, and Typeform. FreeOnlineSurveys.com was chosen to build the survey because it allowed images to be displayed at various scales and links to be included in questions and additional text. Using FreeOnlineSurvey.com the format and questions were divided into six pages.

The first page of the questionnaire informed the users that no personal data would be collected and provided a definition of both cartographic stories and parallel narratives.

The second page was titled: "Static Parallel Cartographic Story" and presented the static European IAS scenarios cartographic parallel narrative story followed by six questions. The questions asked users to identify how many narratives they thought the story presented, rate the use of titles, break lines, and symbols in separating the narratives, and rate if it would be more beneficial to view the narratives separately.

The third page was titled: "Scrolling (ESRI) Parallel Cartographic Story" and presented a link to the European IAS scenarios cartographic parallel narrative ESRI StoryMap. Users were asked to open the link and then answer six questions. The questions asked users to identify how many narratives they thought the story presented, rate the use of titles, scrolling, and symbols in separating the narratives, and rate if it would be more beneficial to view the narratives separately.

The fourth page of the questionnaire was titled: "Comparing the Parallel Cartographic Stories" and had four questions. The questions asked users to identify how effective each story was at presenting a comparison between the narratives and which story they preferred.

The fifth page of the questionnaire asked the users to rate usage of maps as well as previous knowledge on the topics of cartographic stories and parallel narrative.

The final page concluded the questionnaire and informed users where the data used to create the cartographic narratives came from as well as stated that the visualizations are based on assumptions and are predictions, not facts.

The survey was posted on social media platforms such as LinkedIn and Facebook and sent out to professional and social contacts using WhatsApp and Email. The survey was open for 10 days. The questionnaire got 37 responses with 29 of those being complete responses. Only the 29 complete responses were analyzed in the results.

5.4.2 Results

The questionnaire results provided interesting insights into understanding how parallel narratives and parallel narrative techniques are received and understood (Appendix VI).

Static cartographic parallel narrative story question results:
On average, users considered the static story to have 4 narratives. Only one person guessed 2 narratives and one person guessed 6. Of the three devices used to separate the four narratives, users found break lines to be most effective giving an average rating of 8,86. Second was the use of titles with an average rating of 8,55. Symbols were perceived as the least effective devices used to separate the narratives in the static story with an average rating of 6,59. When asked how beneficial it would be to separate the narratives, with 0 being not beneficial at all and 10 being very beneficial, on average users rated it a 4,21. 62% of users scored it below a 5, indicating that most viewed it as not beneficial.

Scrolling cartographic parallel narrative story question results:
On average, users considered the static story to have 4,03 narratives with all users saying 4 and only one saying 5. Of the three devices used to separate the four narratives (titles, scrolling, and symbols), users found titles to be most effective giving an average rating of 8,17. A close second was the use of scrolling with an average rating of 8,07. Symbols were perceived as the least effective devices used to separate the narratives in the scrolling story with an average rating of 7. When asked how beneficial it would be to separate the narratives, with 0 being not beneficial at all and 10 being very beneficial, on average users rated it a 3,86. 69% of users scored it below a 5, indicating that most viewed it as not beneficial.

In comparing the question results from the static cartographic story and the scrolling cartographic story, several differences can be noted. On average, devices used in the static story were rated higher than devices used in the scrolling story, although symbols were

rated higher in the scrolling story. In addition, on average users rated the benefit of separating the narratives lower for the scrolling story.

Comparing the parallel cartographic stories question results:
The first two questions in this section asked users how effective (0 being not effective at all and 10 being very effective) they thought each story was at presenting a comparison between the narratives. On average, users rated the static as a 7,83 in effectiveness and the scrolling story as a 7,03 in effectiveness. However, for both stories 55% of the users rated the effectiveness as an 8 or above. The third question in this section asked users which cartographic story they liked best. 48% of the users said they liked the static story best and 52% of users said they like the scrolling story best.

Background knowledge questions:
Three final questions were asked in order to understand the background knowledge users bring to the questionnaire. When asked how often they use maps (0 being very rarely and 10 being very frequently), users on average rated it at 8,59 with 83% of users rating it an 8 or above. When asked how familiar they are with cartographic stories (0 being never heard of the term before and 10 as having a very good understanding of the term), users on average rated it at 5,10. When asked how familiar they are with parallel narratives (0 being never heard of the term before and 10 as having a very good understanding of the term), users on average rated it at 4,59.

In conclusion these results show that felt that viewer the narratives together aided in their understanding of the story and that certain design elements were more effective in distinguishing between the narratives and therefore enforcing the viewers understanding that there were multiple narratives.

6. Discussion

The results of this thesis present the first step in understanding how to present parallel narratives in cartographic stories. Through qualitative content analysis seven categories of parallel narratives were developed: (1) Two Narratives – One Map, (2) Two Narratives – Multiple Maps, (3) Many Narratives – One Map, (4) Many Narratives – Multiple Maps – Spatial Connection, (5) Many Narratives – Multiple Maps – No Spatial Connection, (6) Same Space – Temporal Progression, and (7) Same Space – Different Points of View. These categories were investigated further and defined. These categories help to understand the various ways that parallel narratives can be presented in cartographic storytelling. Understanding how to visualize two or more narratives is important in order to provide viewers with complex, yet understandable, visualizations that can present multiple perspectives.

6.1 Limitations

Several limitations that may have impacted the results of this study should be noted. Further research (discussed in chapter 7.2) should be conducted to address these limitations. Points of limitation can be divided into cartographic storytelling techniques, quantitative content analysis, and case study.

Cartographic Storytelling Techniques:
Research into cartographic storytelling is still developing and therefore not all methods techniques may be outlined in research yet. This is why techniques for presenting visual stories were also presented and used for qualitative content analysis. In addition not all of the techniques that are discussed when it comes to visual storytelling could be presented. Therefore, it is likely that not all design techniques that could be important in presenting and structuring a cartographic parallel narrative stories were analyzed in this study.

Qualitative Content Analysis:
The qualitative content analysis was limited by several factors that may have affected the results. The first limitation is the number of examples that were collected. Cartographic stories were collected from various media, design, and cartographic sites, however not every platform could be exhaustively searched therefor not every cartographic story that presents parallel narratives was collected. Collected cartographic stories could present a bias based on the platforms and websites that they were collected from. This might have also have a effected on the percentage for each coding category. Specifically, only 17% of the cartographic parallel narrative stories were considered interactive. This could be because software, such as ESRI StoryMaps, that supports interactivity is not designed to present multiple cartographic narratives. It could also be because in general there are less interactive cartographic stories or it could be that non-interactive cartographic stories were more prevalent on the sites used in collecting examples.

Case Study:
The case study presented one type of cartographic parallel narrative story and therefore only this category could be examined. In addition the development of the European IAS

scenario cartographic parallel narrative stories was limited by time constraints and technical abilities. Certain design elements, such as interactivity, were not able to be explored for this reason. Another limitation in the case study was the presentation and distribution of the pre-study questionnaire. The questionnaire itself limited the size of the static parallel narrative story, which could have impacted the participants perception of the narratives. The scrolling parallel narrative story presented with a link in the questionnaire. While participants were advised to view the questionnaire on a computer, confirmation that they did this was not required. Therefore, if the scrolling story was viewed on a smart phone or other smaller screen the presentation and layout would have been altered and impacted the participants perception of the narratives. In addition to the presentation of the stories in the questionnaire, the distribution and number of participants is also a limitation to the results. The questionnaire was primarily distributed using Facebook, LinkedIn and WhatsApp therefore, participants were not completely random and could have presented a bias.

7. Conclusion

In conclusion, this thesis presents the first step in the examination of parallel narratives in cartographic storytelling.

Research on visual storytelling and cartographic storytelling led to the collection of design elements and structures used to present a story in visualizations such as a cartographic story. Research on parallel narratives resulted in understanding what defines a parallel narrative and how parallel narratives are categorized.

A qualitative content analysis was conducted in which 53 examples of cartographic parallel narrative stories were examined based on the design elements presented in the research on both visual/cartographic storytelling and parallel narratives.

Based on the qualitative content analysis of existing examples of cartographic parallel narrative stories seven categories were outlined to describe cartographic parallel narrative stories. These categories are *Two Narratives – One Map*, *Two Narratives – Multiple Maps*, *Many Narratives – One Map*, *Many Narratives – Multiple Maps – Spatial Connection*, *Many Narratives – Multiple Maps – No Spatial Connection*, *Same Space – Temporal Progression*, and *Same Space – Different Points of View.*

A pre-study case study using data from the research group BioInvasions – global change – Macroecology and the project AlienScenarios was conducted to test the design elements that were found to be important in presenting parallel narratives in cartographic storytelling. The case study and questionnaire revealed that the presentation of parallel narratives was useful for in understanding the story. The case study also revealed that certain design elements did better support the presentation and comparison of the parallel narratives in the cartographic parallel narrative stories.

Presented in this conclusion are the answers to the research questions outlined in chapter 1.2.2 as well as suggestions for future research.

7.1 Addressing the Research Questions

The answers to the research questions set in chapter 1.2.2 are summarized below.

Research Question 1: What are the important techniques used in cartographic storytelling to tell a story?
- How are visual and cartographic stories structured?
- What elements (devices) do visual and cartographic use to emphasize and enhance a story?

In order to answer the first research question both visual and cartographic storytelling were researched and presented. Examining visual storytelling, in addition to cartographic storytelling, is important because cartographic storytelling is a form of visual storytelling and utilizes many visual storytelling techniques. Visual and cartographic stories used a

wide variety of techniques, devices and structures to present a story. In summary they can be broken down into several categories: genre, map layout, interactivity, messaging, trope, narrative patterns, visual narrative tactics, and visual structure tactics.

Genres in both visual and cartographic stories describe how the narrative is structured. In visual narratives, Segel and Heer (2010, p. 8) categorizes genres by the "number of frames" and "order of the visual elements". In cartographic narratives, Roth (2020, p. 10) categorizes genres by the "technique used to enforce linearity". Map layouts are also used to structure the cartographic story as well as the information presented in the map. Many layouts help to determine how much information is presented inside as well as outside of the map display.

Interactivity is an important devices used in visual and cartographic storytelling. Interactivity provides the user with a little bit to total control over the narrative progression. Interactivity gives users the ability to decide how they read the story.

Narrative design patterns are techniques that help present the flow and argumentation behind a story (Bach et al., 2018).

Visual design elements (discussed in chapter 4 and 5 as visual narrative tactics) are devices used to enhance and assist in presenting the story. They are broken down into genre, visual narrative tactics, and narrative structure tactics (Segel & Heer, 2010). Visual narrative tactics include highlighting and narrative structure tactics include interactivity and messaging. Interactivity was discussed separately because of the role it played in the sequence of narratives.

There are many visual design elements that can be used in both visual and cartographic storytelling. Visual design elements that aid in structuring and progressing the storyline were focused on in this study.

Research Question 2: How are parallel narratives presented in literature and film?
- What defines a parallel narrative?
- What typology is there for parallel narratives in literature and film?

A parallel narrative is defined by the presentation of two or more narratives in one story. Parallel narratives interweave multiple narratives together based on a common theme and additionally are connected by an event, character, or artifact. All of the narratives are equally focused on so that the reader or viewer has an equal understanding of each. Because the reader or viewer is forced to understand multiple plotlines, multiple narratives tend to be more complex than singular narratives. This is why the structure and devices used to distinguish between the narratives is important.

Literature and film present two separate modes for classifying parallel narratives. In literature, parallel narratives are classified by the link that connects the narratives. The links are event, story, time, and artifact. The story link is broken down further by the number of stories told. Do the narratives build on each as time progresses or does each narrative have a sub-story that is somehow interwoven with the other sub-stories. The categories are: One event - Multiple Perspectives, One story - Multiple Perspectives, Multiple stories - Multiple Perspectives - Intertwined, Then and Now, and Parallel Stories

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(Koss, 2009). In film, parallel narratives are first classified by the linearity of the story and second by the interaction between the narratives. The categories are: : tandem, multiple protagonist, double journey, flashback, consecutive-stories and fractured tandem (Aronson, 2010).

Research Question 3: How can cartographic parallel narrative stories be classified?
- What techniques or characteristics do existing examples of parallel narratives in cartographic stories have?

Qualitative content analysis was used to determine how cartographic parallel narrative stories could be classified. They were classified into seven categories: (1) Two Narratives – One Map, (2) Two Narratives – Multiple Maps, (3) Many Narratives – One Map, (4) Many Narratives – Multiple Maps – Spatial Connection, (5) Many Narratives – Multiple Maps – No Spatial Connection, (6) Same Space – Temporal Progression, and (7) Same Space – Different Points of View. Categorization was based on several concepts including: what linked the two narratives, how the two narratives interacted in the visualization, and what visual elements guided the viewer between the narratives

The qualitative content analysis presented a better understanding of what techniques are used in cartographic parallel narrative stories. For genres of cartographic stories, static visual stories and longform infographics were both used more frequently than other genres. The partial map layout was the most frequently used map layout. More of the examples presented multiple maps with most of the single map examples falling under the two categories containing *One Map*. The tropes, setting the mood, enforcing linearity and information dosing, were all heavily used in creating cartographic parallel narrative stories. These tropes were important in presenting multiple narratives. Important visual narrative tactics were the use of repetition and juxtaposition. Color was a common method used to separate the narratives. More narratives were classified as contrasting with a majority of the narratives that were classified as complimentary falling under the category *Same Space – Temporal Progression*.

Research Question 4: What design elements or techniques are most effective in distinguishing between as well as providing a comparison of parallel narratives in cartographic storytelling?
- How can the data from the research group BioInvasions – global change – Macroecology at the University of Wien be presented in a cartographic story.

The data from the research group BioInvasions – global change – Macroecology at the University of Wien presented as a *Same Space – Different Point of View* cartographic parallel narrative story. Design elements are not exclusive to one category of cartographic parallel narrative story and therefor decisions still needed to be decided upon based on the specific data. Although there are many different ways to display the narratives it was decided to create two cartographic stories, one static and one scrolling, based on several factors.

A questionnaire was designed to test what design elements or techniques are most effective in distinguishing between as well as providing a comparison of parallel narratives in both the static and scrolling cartographic parallel narrative story. As a result it was discovered that the devices used in both stories did provide participants with the

general understanding that there was four narratives in each story. For the static story break lines were rated the highest in their effectiveness in separating the narratives. For the scrolling story titles were rated the highest in their effectiveness in separating the narratives.

7.2 Outlook

This thesis only presents the first step into research on the presentation of parallel narratives in cartographic storytelling. There are many avenues for continued research.

Future research on parallel narratives in cartographic storytelling should focus on developing a better understanding of how techniques, structures, and design elements are used in displaying parallel narratives. This includes further research on techniques, structures, and design elements that are used in cartographic storytelling, which would result in more codes to be used in analysis of existing examples. In addition, this includes the collection and analysis of more examples of cartographic parallel narratives stories. This could add to the development of the categories of parallel narratives in cartographic storytelling outlined in this thesis or it could present contradictions that modify the categories.

While the case study used one software platform, ESRI StoryMaps, to create the scrolling IAS scenarios cartographic parallel narrative story, current platforms that help users create their own cartographic story were not examined. Platforms and software, such as ESRI, that help users create cartographic stories could be examined based on their ability to provide devices that support the presentation of parallel narratives. These programs continually develop new feature that make the cartographic storytelling process more intuitive and user friendly. If currently they do not contain features that allow users to present parallel narratives, will features be added as the discussion on parallel narratives in cartographic storytelling continues?

Future research could also present a more in depth case study on each category of parallel narratives in cartographic storytelling. Each category should be researched further to better understand what techniques and structures can be used in each.

Finally future research should examine how parallel narratives can be used to enhance users understanding of complex concepts. The presentations of parallel narratives in literature and film have increased because they present a complex and more realistic depiction of the world around us. Online news and social media is rapidly expanding into everyday life. This allows for a rapid intake of all sorts of local, regional and international stories. With so many stories spreading and developing in real time it is always important to understand that there are two or more side to each every story. Cartographic stories have long been used to present and advance one narrative and it is time to better understand how cartographic storytelling can display parallel narratives that can better represent the complex reality behind most stories.

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Appendix

Appendix I – Complete coding table of existing examples

See attached file "QCA Data.xlsx"

Appendix II – Table of code definitions

Category	Code	Definition	Measurment
Genre	Static visual stories	All of the content is displayed in one view. The flow of the narrative is through particioning of the layout into frames and the use of annotations.	X
Genre	Narrated animations	The narrative is presented with a spatial animation depicted along a temporal scale.	X
Genre	longform infographics	Textual information and visualizations are stacked in a web format which forces the reader to sroll to reveal the narrative. Scrolling.	X
Genre	Multimedia Visual Experiences	Anchor tags and hyperlinks divide the visual narrative into sections.	X
Genre	Dynamic Slideshow	The narrative is presented through a series of slides often enforced through horizontal scrolling.	X
Map Layout	Side by Side	Presents two or more maps stacked or next to each other in the visualization for purposes of comparison.	X
Map Layout	Embedded Map	The map is inserted in a webpage with map data from a third party provider.	X
Map Layout	Reference Map	Presents the maps as an additional view for context purposes.	X
Map Layout	Partial Map	The map and other visual content are of equal importance and are presented side by side.	X
Map Layout	Full Map	The extent of the map takes up the entire visualization. Additionally information is added on top of the map.	X
Map Layout	Small Multiples	Multiple small maps with a limited amout of additional information are presented together to form a narrative.	X
Map Layout	Fragmented layout vs fluid	Is the layout of the map and additional information fragmented or fluid.	Binary: Fragmented, Fluid
Map Layout	Dynamic/active vs stable/static	In the map is the depiction of events dynamic, indicating movement or static.	Binary: Dynamic, Static
Map Layout	Single Map vs. Map Series	Is the cartographic story comprised of a single map or a series of maps.	Binary: Single map, Map series
Interactivity Format	Interactive	Coding whether or not the map is interactive.	X
Interactivity Format	Martini glass structure	The visualization begins with an author driven approach in which the author portrays the information they consider to important for the narrative. Then the visualization opens up and the viewer is able to explore the data how they choose.	X

Interactivity Format	Interactive slide show	This format allows viewers to interact intermittently throughout the narrative while the author controls the flow and structure of the narrative.	X
Interactivity Format	Drill down story	This format begins with a reader driven approach where the reader begins by selecting which part of the visualization they would like to learn more about. Then the individual narratives are told in the structure presented by the author.	X
Trope	Setting the mood, MOOD	Sets the visual tone of the narrative though design elements.	Descriptive: Basemap, Images, Colors, Font
Trope	Enforcing Linearity, CONTINUITY	Establishes a specific order for reading the visualization.	Descriptive: Numbered, Scrolling, Titles, Timeline, Selection bar, Pages, Animation
Trope	Information Dosing, DOSING	Grouping of information to reduce the overal complexity of the visualization.	Descriptive: Selected stories (annotations), Infographics, images
Trope	Visual simile, METAPHOR	Presents a visual analgy to facilitate a better understanding of complex information.	Descriptive: Maps
Trope	Effective Redundancy, REDUNDANCY	Repetition of important information to enforce story themes.	X
Trope	Focus Attention, ATTENTION	Attention emphasizes important or unusual information that cannot be missed in the story.	Descriptive: Color, Infographics, Symbols, Text
Narrative Patterns	Incorporating the audience	This allows the viewer to see themselves in the visualization. The indormation becaomes more personally relevant.	X
Narrative Patterns	Repition	A re-presentation of data multiple times with changes to one variable while other elements of the data/story don't change. This helps to emphasize changes and differences.	X
Narrative Patterns	Juxtaposition	Places two or more visualizations side by side in order to present a comparison. This highlights contrast and differences.	Descriptive: maps
Narrative Patterns	Humans behind the dot	Provides more information for individual data entities. This allows the data to be more relateable and concrete.	X
Narrative Patterns	Rhetorical question	Frames the main arguemnt as a question. Provokes the viewer to explore the information.	X

Narrative Patterns	Familiar Setting	Introduces an environment/location into the narrative which the viewer is familiar with. This makes the information conveyed personally relatable.	X
Narrative Patterns	Call to action	Outlines a problem that needs solving and then provides the viewer with an instruction to begin to solve the problem.	X
Narrative Patterns	Gradual visual reveal	Uses visual hierarchy to present a sequence of unfolding events in the narrative.	Descriptive: scrolling
Narrative Patterns	Defamiliarization	Presents something known in an unfamiliar way in order to force the viewer to think differently about the given topic.	X
Narrative Patterns	Meaningful use of Space	Uses space and direction to convey concepts. For example the directions up and right are potrayed as good and down and left are potrayed as bad.	X
Narrative Patterns	Concretize	Provides a frame of reference when data is large and hard to grasp.	Descriptive: graphics
Visual Narrative Tactics: Highlighting	close ups	A series of zoomed in snap shots.	X
Visual Narrative Tactics: Highlighting	Time animation	Change in the temporal dimention is animated.	X
Visual Narrative Tactics: Highlighting	Zooming	Either author or reader driven change from long shot to close up view.	X
Visual Narrative Tactics: Interactivity	Layer List	A selectable list of layers that can be included or excluded from the map display.	X
Visual Narrative Tactics: Interactivity	Info Panel	An information panel triggered by a click on the map that includes additional information without overlapping the map.	X
Visual Narrative Tactics: Interactivity	Info Pop-up	A pop-up triggered by hovering or clicking on a map marker.	X
Visual Narrative Tactics: Messaging	Annotations	Additional text throughout the visualization that help move the narrative along.	X

Visual Narrative Tactics: Messaging	Introductory text	Brief description providing the purpose of the cartographic narrative and any relevent background.	X
Visual Narrative Tactics: Messaging	Captions	Relevent information provided below a image, graphic, or map.	X
Visual Narrative Tactics: Messaging	summary	A description toward the end of the visualization that may provide insight into what the viewer should have taken from the visualization.	X
Visual Narrative Tactics	Image	Images are included in the visualization.	X
Visual Narrative Tactics	Video	Videos are included in the visualization	X
Parallel Narrative Tactics	Color Seperating narratives	Different colors are used to separate or distinguish the narratives	X
Parallel Narrative Tactics	Number of narratives	Number of separate narratives in the visualization.	Quantitative (#)
Parallel Narrative Tactics	Contrasting or Complimentary	Do the narratives present separate stories that are apart of the a theme or do the narratives present stories that build up each other.	Binary: Contrasting, Complimentary
Parallel Narrative Tactics	Sequence	Are the narratives linear, non-linear or simultaneously potrayed.	Tinary: Simultaneous, Linear, Non-linear

Appendix III – Coding Results Table

Codes	1. Two Narratives - One Map (5)	2. Two Narratives - Multiple Maps (6)	3. Many Narratives - One Map (8)	4. Spatial Connection (12)	5. No Spatial Connection (9)	6. Same space - Different times (9)	7. Same space - Different points of view (4)	Total count (53)
Genre : Static Visual Stories	100% (5)	50% (3)	75% (6)	8% (1)	33% (3)	89% (8)	–	26
Genre : Longform Infographic	–	33% (2)	–	83% (10)	56% (5)	11% (1)	100% (4)	22
Genre : Dynamic Slideshow	–	–	–	8% (1)	–	–	–	1
Genre : Narrated Animations	–	–	–	–	22% (2)	11% (1)	–	3
Genre : Multimedia Visual Experience	–	17% (1)	25% (2)	17% (2)	11% (1)	11% (1)	50% (2)	9
Map Layout : Embedded Map	–	50% (3)	13% (1)	50% (6)	11% (1)	11% (1)	50% (2)	14
Map Layout : Reference Map	–	17% (1)	25% (2)	50% (6)	–	22% (2)	–	11
Map Layout : Side by Side	20% (1)	67% (4)	–	–	22% (2)	22% (2)	50% (2)	11
Map Layout : Full Map	80% (4)	–	50% (4)	17% (2)	–	33% (3)	25% (1)	14
Map Layout : Partial Map	20% (1)	50% (3)	50% (4)	75% (9)	56% (5)	11% (1)	50% (2)	25
Map Layout : Small multiples	–	17% (1)	13% (1)	17% (2)	56% (5)	56% (5)	–	14
Map Layout : single map vs map series - single map	100% (5)	–	100% (8)	–	–	33% (3)	–	18
Map Layout : single map vs map series - map series	–	100% (6)	–	83% (10)	100% (9)	67% (6)	100% (4)	35
Map Layout : Fragmented layout vs fluid layout - fragmented	20% (1)	100% (6)	50% (4)	92% (11)	100% (9)	67% (6)	75% (3)	40
Map Layout : Fragmented layout vs fluid layout - fluid	80% (4)	–	50% (4)	8% (1)	–	33% (3)	25% (1)	13
Map Layout : Dynamic vs stable - dynamic	40% (2)	17% (1)	50% (4)	17% (2)	22% (2)	56% (5)	–	16
Map Layout : Dynamic vs stable - stable	60% (3)	83% (5)	50% (4)	83% (10)	78% (7)	44% (4)	100% (4)	37
Interactivity Format : Interactive?	–	17% (1)	25% (2)	33% (4)	11% (1)	–	50% (2)	10
Interactivity Format : Martini glass structure	–	–	13% (1)	17% (2)	–	–	–	3
Interactivity Format : Interactive slide show	–	–	–	25% (3)	–	–	25% (1)	4
Interactivity F ormat : Drill down story	–	17% (1)	13% (1)	17% (2)	11% (1)	–	50% (2)	7
Trope : Setting the MOOD	40% (3)	50% (3)	100% (8)	67% (8)	67% (6)	67% (6)	75% (3)	37
images	40% (2)	33% (2)	38% (3)	50% (6)	22% (2)	33% (3)	50% (2)	20
color	40% (2)	50% (3)	38% (3)	25% (3)	44% (4)	11% (1)	–	16
basemap	40% (2)	–	50% (4)	8% (1)	–	33% (3)	–	10
font	–	–	13% (1)	8% (1)	–	–	25% (1)	3
Trope : Enforcing Linearity (CONTINUITY)	80% (4)	83% (5)	100% (8)	100% (12)	100% (9)	100% (9)	100% (4)	51
timeline	40% (2)	–	13% (1)	–	–	78% (7)	–	10
titles	40% (2)	33% (2)	63% (5)	8% (1)	56% (5)	–	50% (2)	17
scrolling	–	33% (2)	–	75% (9)	56% (5)	11% (1)	50% (2)	19
selection bar	–	17% (1)	13% (1)	17% (2)	–	–	50% (2)	6
numbered	–	–	25% (2)	17% (2)	–	11% (1)	–	5
animation	–	–	–	–	22% (2)	11% (1)	–	3
pages	–	–	–	25% (3)	–	–	25% (1)	4
Trope : Information DOSING	80% (4)	50% (3)	75% (6)	100% (12)	44% (4)	56% (5)	75% (3)	37
selected stories	80% (4)	33% (2)	75% (6)	75% (9)	44% (4)	56% (5)	75% (3)	33
infographics	40% (2)	33% (2)	38% (3)	17% (2)	11% (1)	–	25% (1)	11
images	–	17% (1)	–	25% (3)	–	11% (1)	–	5
Trope : Visual Simile (METAPHOR)	–	17% (1)	–	8% (1)	11% (1)	–	–	3
Trope : Focus ATTENTION	80% (4)	17% (1)	25% (2)	50% (6)	22% (2)	22% (2)	25% (1)	18
color	20% (1)	–	13% (1)	8% (1)	22% (2)	11% (1)	25% (1)	7
symbols	40% (2)	–	–	17% (2)	–	–	–	4
text	20% (1)	17% (1)	–	17% (2)	–	11% (1)	–	5
infographics	–	–	13% (1)	8% (1)	–	–	–	2
Narrative Patterns : Incorporating the audience	–	–	–	17% (2)	–	–	–	3
Narrative Patterns : Repition	20% (1)	–	63% (5)	67% (8)	33% (3)	44% (4)	25% (1)	22
Narrative Patterns : Juxtaposition	80% (4)	83% (5)	75% (6)	17% (2)	44% (4)	78% (7)	50% (2)	30
Narrative Patterns : Human behind the dot	–	–	13% (1)	42% (5)	–	11% (1)	–	7
Narrative Patterns : Rhetorical question	–	–	13% (1)	–	22% (2)	–	–	3
Narrative Patterns : Familiar setting	–	17% (1)	–	8% (1)	11% (1)	–	–	3
Narrative Patterns : Call to action	–	–	13% (1)	17% (2)	–	–	–	3
Narrative Patterns : Gradual Visual Reveal	–	17% (1)	–	33% (4)	22% (2)	11% (1)	–	8
Narrative Patterns : Defamilarization	–	–	–	8% (1)	–	11% (1)	–	2
Narrative Patterns : Maningful use of space	20% (1)	–	38% (3)	–	–	–	–	4
Narrative Patterns : Concretize	40% (2)	50% (3)	50% (4)	25% (3)	22% (2)	11% (1)	–	15
Visual Narrative Tactics : Close ups	–	–	–	33% (4)	22% (2)	–	25% (1)	6
Visual Narrative Tactics : time animation	–	–	–	–	22% (2)	11% (1)	–	3
Visual Narrative Tactics : zooming	–	17% (1)	13% (1)	17% (2)	11% (1)	–	50% (2)	7
Visual Narrative Tactics : Layer list	–	–	25% (2)	–	11% (1)	–	–	5
Visual Narrative Tactics : Info Panel	–	–	–	8% (1)	11% (1)	–	50% (2)	4
Visual Narrative Tactics : Info Pop up	–	17% (1)	13% (1)	8% (1)	–	–	–	3
Visual Narrative Tactics : Annotation	100% (5)	50% (3)	88% (7)	67% (8)	33% (3)	78% (7)	25% (1)	34
Visual Narrative Tactics : Info text	100% (5)	50% (3)	75% (6)	92% (11)	67% (6)	89% (8)	75% (3)	42
Visual Narrative Tactics : captions	60% (3)	50% (3)	50% (4)	33% (4)	56% (5)	56% (5)	100% (4)	28
Visual Narrative Tactics : summary	60% (3)	50% (3)	100% (8)	83% (10)	78% (7)	33% (3)	75% (3)	37
Visual Narrative Tactics : Image	40% (2)	33% (2)	50% (4)	67% (8)	22% (2)	44% (4)	75% (3)	25
Visual Narrative Tactics : Video	–	–	–	8% (1)	–	11% (1)	–	2
Parallel Narrative Tactics : Color seperating narratives	100% (5)	17% (1)	50% (4)	50% (6)	22% (2)	33% (3)	25% (1)	22
Parallel Narrative Tactics : Number of narratives (mean, median)	(2, 2)	(2, 2)	(13, 8,5)	(9, 4)	(11, 7)	(5, 4)	(11,5, 9)	(8, 4)
Parallel Narrative Tactics : link								
characters	20% (1)	–	–	–	11% (1)	11% (1)	–	3
event	20% (1)	17% (1)	–	8% (1)	11% (1)	22% (2)	–	6
location	–	33% (2)	25% (2)	33% (4)	–	33% (3)	25% (1)	12
subject	60% (3)	50% (3)	75% (6)	58% (7)	78% (7)	33% (3)	75% (3)	32
Parallel Narrative Tactics : Contrasting or Complimentary - Contrasting	100% (5)	100% (6)	88% (7)	83% (10)	100% (9)	11% (1)	75% (3)	41
Parallel Narrative Tactics : Contrasting or Complimentary - Complimentary	–	–	13% (1)	17% (2)	–	89% (8)	25% (1)	12
Parallel Narrative Tactics : Sequence								
Linear	20% (1)	17% (1)	13% (1)	–	–	89% (8)	–	11
Non-Linear	–	–	38% (3)	92% (11)	44% (4)	11% (1)	25% (1)	20
Simultaneous	80% (4)	83% (5)	50% (4)	8% (1)	56% (5)	–	75% (3)	22

Appendix IV – ESRI Scrolling IAS Scenarios Story

See under https://arcg.is/1OWSjv

Appendix V – Questionnaire questions

Section #1
Parallel narratives in cartographic storytelling - Pre-study Questionnaire

This questionnaire is for a Cartography Masters thesis case study. No personal information will be collected or used.

Cartographic stories combine maps and storytelling. The map includes additional text and media elements that help to tell the story.

A parallel narrative is a story with multiple narratives. In a parallel narrative structure, multiple narratives are woven or tied together through a common theme, event, location, character, and/or artifact.

Section #2
Static parallel cartographic story

Please take a look at the cartographic story below. Familiarize yourself with the cartographic story for a few minutes before proceeding to the questions below.

1) *Based on your understanding of the cartographic story, how many narratives do you think it presents?
   a) Fill in the answer.
2) *How effective was the use of titles in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
3) *How effective was the use of break lines in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
4) *How effective was the use of symbols in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
5) Was there any other element you found to be effective in separating the narratives? If so, please detail it below.
   a) Fill in the answer.
6) *How beneficial would it be, for your understanding of the scenarios, to have the scenarios separated into individual cartographic stories? In comparison to having the narratives combined in this parallel narrative.
   a) Likert scale: (0, Not beneficial at all- 10, Extremely beneficial)

Section #3
Scrolling (ESRI) parallel cartographic story

Please take a look at the cartographic story linked here:
https://storymaps.arcgis.com/stories/038489c3091543a4aedc5005159366b5
Please copy and paste the link in a new tab and familiarize yourself with the cartographic story for a few minutes before returning to the questionnaire to answer the questions below.

1) *Based on your understanding of the cartographic story, how many narratives do you think it presents?
   a) Fill in the answer
2) *How effective was the use of titles in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
3) *How effective was the use of scrolling (e.g. scrolling initiated image switches) in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
4) *How effective was the use of symbols in separating the narratives?
   a) Likert scale: (0, Not effective at all - 10, Extremely effective)
5) Was there any other element you found to be effective in separating the narratives? If so, please detail it below.

        a) Fill in the answer.
6) *How beneficial would it be, for your understanding of the scenarios, to have the scenarios separated into individual cartographic stories? In comparison to having the narratives combined in this parallel narrative.
        a) Likert scale: (0, Not beneficial at all- 10, Extremely beneficial)

Section #4
Comparing the parallel cartographic stories

1) *How effective was the static cartographic story (the first) at presenting a comparison between the different narratives?
        a) Likert scale: (0, Not effective at all - 10, Extremely effective)
2) *How effective was the scrolling (ESRI) cartographic story (the second) at presenting a comparison between the different narratives?
        a) Likert scale: (0, Not effective at all - 10, Extremely effective)
3) *Which of the two cartographic stories did you like better?
        a) Multiple choice - (1) The static cartographic story (the first), (2) The scrolling cartographic story (the second).
4) Please provide a brief explanation as to why you preferred one over the other.
        a) Fill in the answer.

Section #5
Pre-Study Questionnaire

1) How often do you use maps?
        a) Likert scale: (0, very rarely - 10, very frequently)
2) How familiar are you with cartographic stories and cartographic storytelling?
        a) Likert scale: (0, I had not heard of cartographic stories until this survey - 10, I have a very good understanding of what a cartographic story is)
3) How familiar are you with parallel narratives?
        a) Likert scale: (0, I had not heard of parallel narratives until today - 10, I have a very good understanding of what parallel narratives are)

Section #6
Concluding
The previous cartographic stories are based on research done by the group 'BioInvasions. global change. Macroecology' at the University of Wien. The maps depict predictions of possible future scenarios and do not intend to conclusively state that such scenarios will actually occur.
a.   Please check the box if you understand. Multiple choice A) yes, B) no

Appendix VI – Questionnaire Answers

See attached file "Report Parallel narratives in cartographic storytelling - Pre-study Questionnaire.pdf"