University of Zurich[UZH]

Department of Geography

Visualizing the Effect of Border Policies on Migration Flows on the Balkan Route

Master's Thesis – GEO 511

Matteo Riva
12-722-641

Supervisors
Dr. Arzu Çöltekin
Dr. Timothy Raeymaekers
Dr. Halldor Janetzko

Faculty representative
Prof. Dr. Sara Irina Fabrikant

Geographic Information Visualization & Analysis (GIVA)
Department of Geography, University of Zurich
Winterthurerstrasse 190, 8057 Zurich, Switzerland

Submitted 28.09.2017

Abstract

Nowadays, Europe is facing a migration crisis that will affect the future development of the region and its neighboring nations. This migration phenomenon has been classified as the largest mass movement Europe has experienced since World War II. Its high importance has made this topic a central focus for several researchers, politicians and journalists, both with quantitative and qualitative approaches. As a consequence, the number of maps produced to represent this phenomenon is relatively large covering various aspects of this issue. However, it appears that a research gap is still present. In fact, within the substantial number of interactive maps, none of them seems to consider both the quantity of migrants and the border regulations that influence their journey. The aim of this thesis is to contribute to filling this research gap by producing such an interactive map that provides border policies as static, intrinsic information. In a second stance, the goal of this thesis is to compare the produced map against a simulation of the current available data, that only offers the possibility to study interactive maps of migrants' arrivals while omitting to provide an intrinsic interactive visualization of the border policies. This between-subject study was designed to test three hypotheses regarding the integration of border policies in an interactive map. The results of the study are promising for the intrinsic visualization of border policies. However, there are several other steps that needs to be made in order to provide further evidences and confirm this auspicious trend.

Acknowledgment

First, I would like to thank my supervisors Dr. Arzu Çöltekin, Dr. Timothy Raeymaekers and Dr. Halldor Janetzko from the University of Zurich for guiding me throughout my thesis, for the interesting discussions and for always having a cooperative and helpful approach.

I wish to thank the experts Simon Sontowski, Dr. Sara Landolt, Sven Daniel Wolfe and Ephraim Pörtner, who accepted to be interviewed. The discussions we had were particularly useful for gaining a critical understanding of the visualization implemented for this thesis.

I would particularly like to thank my friend Pablo a Marca for reading and correcting the thesis. I also want to thank Omar Lenzi and Luca Lenzi for participating in the pilot study and giving their precious feedback. As well as my friend Andrea Sartori for helping me with the structuring of the online survey and the statistical analyses.

Finally, I would like to thank my family and friends for supporting me throughout my entire studies and more. Thank you very much.

Table of contents

List of Figures

List of Tables

1. Introduction

Migration is a broadly discussed topic both within and outside of academic research. Newspapers, television and online media are constantly reporting the situation and often propose in-depth analyses with interviews, videos, stories or investigation of the available data. In the last years, the focus laid on migration movements across the Mediterranean and along the Balkan states. This so-called migration crisis[1] extends to the whole European continent and beyond, and the possible routes stretch from eastern to western Europe (ACAPS 2016). One of these, namely, the Balkan route, is the main focus of this research. More specifically, the following countries will be included in the case study: Turkey, Greece, Macedonia, Serbia, Hungary, Croatia, Slovenia, Austria and Germany.

"The summer of 2015 could have been just another episode within this history [of European migration], but the pace and scale of migration escalated parallel to the intensification of wars from Libya to Syria and the Greater Middle East" (Bojadzijev and Mezzadra 2015, 1). For this and many other reasons, the term *migration* has been largely discussed in different research fields: from quantitative to qualitative analyses, from philosophical to practical questions. Given the large interest in the topic, newspapers and online media articles contain visualizations that supposedly help gather more information about this situation in an intuitive. In the case of migration patterns, these representations are often maps, which illustrate the Balkan route in its various forms and according to several factors. In an online environment, these maps are sometimes offered with an interactivity level that allows the user to explore the map and potentially learn more information. For instance, using time-aware maps it is possible to inquire into the migration changes through different time periods, whereas a map that allows filtering according to the country of origin might help in understanding how different people experience the migration process. Despite the great amount of such visualizations there are still several open questions and debates over the

[1] The term *crisis* is usually used in the literature about Balkan route migration, but it might already suggest a specific connotation to the situation and to the possible consequences and solutions applicable to it.

efficacy of these representations. Indeed, "the representation of the movements of refugees and migrants as linear, singular uninterrupted journeys or flows of people heading toward Europe is grossly misleading" (Crawley et al. 2016b, 20). In addition to these discussions about the visualization approach, another research gap is *surprisingly* still present. Namely, among the numerous maps none of them portrays an interactive environment which combines the information about migrants' arrivals with an intrinsic depiction of policies implemented at the states' borders. The mutual influence of these two factors is easily acknowledgeable: on the one hand, border policies influence the possibility to travel, and thus the number of migrants entering a specific state; on the other hand, according to the current migration magnitude a country might choose (not) to implement policies at its border (REACH 2004). Nonetheless, the attempts of bringing these two factors together in an animated cartographic environment are absent. Clearly, there are many other factors which influence the migration movement however, the one mentioned here is amongst those which could significantly increase the understanding of migration phenomena and the countermeasures that various states have applied.

The aim of this thesis is to fill this research gap by implementing a map that considers both the number of migrants' arrivals and the border policies, intrinsically in the same visualization. This map should encourage users to reflect on the interplay between these two factors, and to use them to mutually explain each other. In this process, no information is being newly collected or personally retrieved; the data is already available and only need some processing and adjustments. Therefore, currently there is already the possibility to analyze the numbers of arrivals while considering the border policies. However, these policies are only presented in the form of static tables or lists. The choice of not considering an interactive visualization of border policies and arrivals might thus be driven by a demonstrated preference and better performance of the static and extrinsic version. Pursuing this path, one should also evaluate the performance metrics and subjective metrics of the newly implemented map against the current interactive opportunities.

1.1. Personal Motivation

Beside the scientific reason that indicated a specific research gap and led to this topic, there is also a personal motivation behind the choosing of this specific focus. There are mainly three reasons behind this choice. First, I always appreciated the interdisciplinary nature of every geography-related topic. The fuzzy nature of the three geographic branches (i.e. human geography, physical geography and cartography/remote sensing) not only allows, but often requires an interdisciplinary approach to fully understand a situation or phenomenon. Since I am very interested in cartography, and this migration movement is strictly connected to political discourses, the combination of the two disciplines immediately shows its advantages. Moreover, the possibility to overcome rather theoretical questions in favor of a study with a direct relation to an existing phenomenon was a decisive factor in my decision.

The second reason is given by the importance of the so-called migration crisis today. As mentioned earlier, I was looking for a topic with a visible impact that could interest me as well as the people to whom I would show it. Moreover – back to the interdisciplinary nature – this topic has been discussed and analyzed at many different levels of society. Almost everyone has heard of this migration issue, either in direct or indirect terms. Indeed, this topic has been the central focus of various official, governmental media reports as well as being informally discussed either in social media platforms or at work, with friends or with family members. Furthermore, the migration issue is poignant in the political agendas of numerous European states. A large portion of the population is confronted with voting sessions that directly or indirectly influence the border policies and the future migration situation of the country.

The third reason for choosing this topic is a more private one. A couple of years ago, I heard the story of two friends of mine, who went to Serbia as volunteers in a refugees' camp. I was honestly impressed by the situation they described. Since then, I have repeatedly tried to organize my holiday sessions to reserve some time for such an experience. Unfortunately, up to now I could not satisfy this desire, but month after month I have been more interested in the Balkan route and its development. Therefore, the choice of

this topic has somehow also satisfied my wish to know more and – I hope – make at least a facet of the issue more understandable and visible through the implemented interactive map. I still intend to go either to a Balkan country or elsewhere to help as a volunteer in a refugee camp, but until then, I am glad to have had to possibility to write this thesis on such an interesting and important subject.

1.2. Structure of the Thesis

To address the above-mentioned objectives, this thesis is structured as follows. Chapter 2 introduces the three research questions that guided the work for this thesis. Chapter 3 offers an overview of the state-of-the-art research in geovisualization and, specifically, an explanation of theories and issues related to interactive visualization. Chapter 4 introduces the data used for the interactive visualization, while also describing the necessary manipulations. Chapter 5 describes the production process of the interactive visualization as well as discussing the theoretical ideas behind the most important decisions. Subsequently, there is a presentation of the user study and its overall design (chapter 6) and of the experts' interviews (chapter 7) followed by the results and their statistical analysis (chapter 8). Chapter 9 discusses the results in relation to the research questions and the existing literature. Finally, chapter 10 concludes with a summary of the main findings and offers an outlook for future studies.

2. Research Questions

In this chapter, there is a brief presentation and discussion of the research questions (RSQ). Each research question is linked to a specific part of either the map implementation or the user study. The proposed hypotheses are based both on existing literature (chapter 3) and on personal reasoning.

The first research question aims to evaluate whether the absence of an interactive map displaying both border policies and arrivals information is due to a lack of correlation between these two aspects.

> ***RSQ 1:*** *Do border policies influence migration trajectories?*
>
> ---
>
> ***Hypothesis:*** *The border policies have a considerable influence on migration trajectories and have also affected the Balkan principal route.*

As mentioned above, there appears to be a research gap given by the absent analysis of the interplay between migration arrivals and border policies in existing visualizations. Therefore, the performance metrics and the subjective metrics of the intrinsic visualization implemented for this thesis should be examined and compared against the current solutions.

> ***RSQ 2:*** *How does intrinsic border policies visualization compare to an information equivalent extrinsic visualization, regarding performance metrics and subjective metrics, in the context of data journalism?*
>
> ---
>
> ***Hypothesis:*** *The intrinsic border policies visualization shows better results at both performance metrics (accuracy + response time) and subjective metrics (evaluation, preferences) with respect to a visualization displaying border policies as extrinsic information.*

In a context of data journalism, the presented data not only deliver new information to the public, but might also influence people's opinion regarding a certain topic. Therefore, in this thesis, the impact of the visualizations is also analyzed. Questions concerning the opinion of participants toward migrants and migration were asked both before and after having worked with either the intrinsic or the extrinsic visualization. This allows observing if the visualizations have a particular impact on people's ideas.

> ***RSQ 3:*** *Do participants' opinion change according to the visualization method, in the context of data journalism?*

> ***Hypothesis:*** *By changing visualizations type, the opinion of people regarding border policies change as well.*

3. Literature Review

This chapter centers on the state-of-the-art of current research on geovisualization. The structure of this chapter resembles in several ways the research method that led to the visualization presented in this thesis. First, after a brief introduction, the discourse focuses on temporal data and the animated visualization approaches for space-time information. The second part highlights the nature of symbolization and the meaning that each symbol conveys, specifically for migration patterns. In this context, the power of maps of influencing people's opinion or choice is also addressed. Third, the chapter focuses on the journalistic aspect of migration stories, since this thesis aims to discuss innovative solutions in the context of data journalism.

Andrienko at al. introduce visualization as an apparently simple process, arguing that "[it] is representation of data in a visual form" (2008a, 2). However, to achieve this task and correctly visualize a phenomenon, a more complex approach is required. In order to properly use the information available nowadays, one must find ways to explore and communicate this data evocatively (Heer, Bostock, and Ogievetsky 2010; Few 2013). Scientists have always been confronted with issues regarding the visual representation of data, and, in an analogous way, the geographic community has constantly been concerned with the visualization of geographic information. Here as well, map authors are called upon to implement geovisualizations that meet the goal of allowing exploration and analysis of patterns and spatial trends (Andrienko et al. 2008a; Crampton 2002; Kraak 2003). The importance of visual representation is also highlighted by Heer, Bostock, and Ogievetsky:

> Well-designed visual representations can replace cognitive calculations with simple perceptual inferences and improve comprehension, memory, and decision making. By making data more accessible and appealing, visual representations may also help engage more diverse audiences in exploration and analysis. The challenge is to create effective and engaging visualizations that are appropriate to the data (2010, 59).

The need to combine pieces of information with an appropriate visualization choice is even more imperative considering the current trend of what Jenny, Jenny, and Räber (2008) define as *instant maps*. This term refers to the

nowadays immense possibility of creating geovisualizations in an online environment. However, a larger number of publications does not necessarily lead to improved maps: the speed and relative ease of production shift the focus away from other central design aspects (Jenny, Jenny, and Räber 2008). Moreover, the vastness of possible analysis options delivers maps overcrowded with information, that finally do not convey even the simplest concept.

> The graphical design of a web map must be coarser and simpler than the design of a paper map so that it conveys the desired information under the less than ideal conditions of [possible] low screen resolution, increased viewing distance, shorter reading time (Jenny, Jenny, and Räber 2008, 47).

3.1. Visualizing Movement Data

Geovisualization methods are suitable for visualizing movement data, make this knowledge available for users and allow them to understand the meaning of these patterns (Fabrikant, Tuggener, and Coltekin 2012). Movement data is described by Andrienko et al. (2008b) as having five characteristics: trajectory, space, time, moving entities and related phenomena. Each one of these features contributes to a more comprehensive understanding of the core principles of movement data. The term *trajectory* defines the path of a moving object, and this already requires two other inseparable aspects: *space* and *time*. Space and time are both defined as a set of, respectively, locations and moments, which require some kind of reference system in order to be distinguished from one another (Andrienko et al. 2008b). The *moving entities* are the actual object – or objects – that moves or change in the given spatial and temporal system, and "like locations in space and moments in time, the entities that move have their own characteristics, which may influence the movement and, hence, need to be taken into account in the analysis" (Andrienko et al. 2008b, 11). Finally, the movement pattern might also be influenced by *related phenomena* taking place in the environment. For instance, if one is interested in the movement of workers from the periphery to the city center, it might be necessary to consider the daily traffic, the season, the presence of parades or other cultural events. Andrienko et al. (2008b) cite the famous example of Minard Napoleon's Russian campaign map, where a graph of winter temperatures – a factor that had a great influence on the movement of the army – is also included. For the case

considered in this thesis, one of the possible related phenomena are the policies implemented at the borders that allow or deny the possibility to travel along certain routes, which are visualized on the map. Given the high complexity of movement data and the additional link with other quantitative and qualitative factors, it is really difficult to adequately display all this information in one single map. Therefore, cartographers often resort to animated visualizations (Andrienko et al. 2008a; Muehlenhaus 2014). Humans can "understand and characterize the movement behavior of a population of entities with the help of interactive visual displays, which are properly combined with other kinds of tools for analysis" (Andrienko et al. 2008a, 10).

3.2. Animation

The use of animation in maps has been made possible by the shift of digital cartography. Before having the opportunity to implement animated maps with a computer software, the use of animation was very limited and time expensive (Muehlenhaus 2014). Animation are described as follows:

> The main goal of a temporal animation is to effectively highlight the distribution and movement of a process over time. Effectively designed temporal animation maps generally have a similar visual hierarchy to thematic maps except that they also must emphasize the movement and diffusion of an element. They should also prominently display an animation legend (Muehlenhaus 2014, 65).

DiBiase et al. (1992) identify three visual variables specifically related to animation: duration, rate of change, and order. *Duration* defines how long a single map frame is shown on the screen before the next frame takes its place. *Rate of change* is the measure of how quickly this change between frames happens. Lastly, the *order* of how things appear on the map can also be considered as a visual feature for animated maps. These visual variables are essential elements to be considered when implementing a temporal visualization (DiBiase et al. 1992). Indeed, "the dynamic variables can be used to emphasize the location of a phenomenon, highlight its attributes, or visualize change in its spatial, temporal, and attribute dimensions" (DiBiase et al. 1992, 201). In the visualization realized for this thesis the *order* of

things is clearly chronological, usually called a *time series*. The viewpoint stays constant, while the other attributes change with the proceeding of time.

Even though animations and interactive visualizations seem to be favored by the users, researches show that these visualizations are poorly efficient as opposed to static visualizations. Indeed, Poplin (2015) argues that there is a need to a more detailed and deeper understanding of the efficacy of interactive maps with respect to their static counterpart. Several studies (Hegarty 1992; Hegarty and Just 1993; Morrison and Tversky 2001; Tversky, Morrison, and Bétrancourt 2002) either indicate better performances for static visualizations or argue that the preference for animated version is caused by a non-symmetrical information content between the compared visualizations. For instance, Tversky, Morrison, and Bétrancourt (2002) claim that animations are ineffective even in delivering temporal data that appears to be best suited for interactive visualizations. They state that:

> The drawback of animation may not be the cognitive congruence between the conceptual material and the visual presentation but rather perceptual and cognitive limitations in the processing of a changing visual situation. Effective graphics should conform […] to the Apprehension Principle: the structure and content of the external representation should be readily and accurately perceived and comprehended (Tversky, Morrison, and Bétrancourt 2002, 255–56).

As mentioned above, the evidence of worse performance metrics of interactive visualization does not influence people's opinion about them. In fact, Hegarty et al. (2009) indicate that participants in their study strongly favor animated visualizations over static ones.

3.3. Intrinsic vs. Extrinsic Visualization

Several studies on uncertainty visualization provide interesting findings concerning the depiction of associated map information. This information can be represented either in an intrinsic or an extrinsic way (Gershon 1998; Slocum et al. 2003; Brügger, Fabrikant, and Çöltekin 2016; Štěrba et al. 2014). An intrinsic visualization is obtained by changing specific visual features of an already existing elements. For instance, one could change the transparency to show different degree of uncertainty. On the other hand, there is the possibility of displaying these pieces of information in an extrinsic way with additional geometries. This "representation might rely on

associated objects in the proximity of the real object, such as the icon of an airplane followed by a question mark, where the question mark conveys a doubt about the plane's existence" (Gershon 1998, 44).

Brügger, Fabrikant, and Çöltekin (2016) tested the difference between intrinsic and extrinsic information visualization by displaying elevation information. On the one hand, elevation is intrinsically visualized with colors and arrows, based on a categorization of elevation data. The extrinsic counterpart presents an elevation profile next to the visualization. In this case the users have to link the information displayed on the profile with the corresponding locations in the visualization (Brügger, Fabrikant, and Çöltekin 2016, 3). Based on the results of the experiment, Brügger, Fabrikant, and Çöltekin (2016) claim that participants show worse response accuracy with the extrinsic elevation profile compared to the intrinsic symbolization approaches. Furthermore, the response time analysis reveals that users with intrinsic colored and arrows visualizations are faster in solving the proposed questions as opposed to the extrinsic elevation profile symbolization. Brügger, Fabrikant, and Çöltekin (2016) hypothesize that this difference can be explained by a potential susceptibility to "split attention effects potentially increasing cognitive load, as participants switch between map and profile to integrate the elevation information with the locational reference" (Brügger, Fabrikant, and Çöltekin 2016, 6). This cognitive and visual effect has been studied by different authors such as Mousavi, Low, and Sweller (1995), Mayer and Moreno (1998) and Chandler and Sweller (1992), who conducted experiments with various visual variables.

> The split-attention effect occurs when learners are required to divide their attention among and mentally integrate multiple sources of information. Mentally integrating multiple sources of information results in less effective acquisition of information than if learners are presented the same material in a physically integrated form. A physically integrated format reduces the load on working memory (Mousavi, Low, and Sweller 1995, 319)

There are also limitations to both extrinsic and intrinsic symbolizations. Slocum et al. (2003) argue that intrinsic methods are not well suited for identifying specific information, while extrinsic approaches do not perform well on complex visualizations. Brügger, Fabrikant, and Çöltekin (2016) further illustrate that in their study, participants show a clear preference for extrinsic symbolization of the elevation profile.

3.4. Symbolization of Migration Data

There is general agreement on certain rules of symbols' visualization. For instance, in flow maps, the line width is usually correlated with a certain quantity measure, the lines are often curved, the number of intersections is minimized and arrows are used to indicate flows direction (Jenny et al. 2017). Nonetheless, in a more holistic view, maps should not only be tested and analyzed for the effectiveness of delivering certain information, but also for the intrinsic meaning of the visualization choices. Even more so if, as in this thesis, the map is specifically intended for an informative journalistic purpose. Moreover, migration requires a certain tact and the conveyed information should be as unbiased as possible. Thus, if one is interested in understanding how maps work, a significant focus should be given to the symbols design and connotation issues (MacEachren 1995; MacEachren and Kraak 2001). As Saussure (1999) claims, a sign is defined by the *signifier* (i.e. image) and the *signified* (i.e. interpretant). Therefore, one needs to consider the explicitness of the link between these two elements. Does what the map is intended to deliver correspond to what the sign conveys? What is interpreted?

This discourse is seminal for the choice of visualization symbols. For instance, one could argue in favor or against red colored flow lines, since they could suggest danger. Indeed, studies suggest that red color and its association with failure and negativity might be linked to poor performance (Elliot et al. 2007) or even diminish the persuasiveness of a message (Gerend and Sias 2009). In the case of migration patterns, particular attention is necessary when dealing with the visualization migration flow as arrows. Like the red color example, arrows have a generally understood, conventional meaning: they indicate directions. Even NASA uses this symbol to depict direction in a message prepared for potential encountering of extraterrestrial life (Sagan 1975). Nevertheless, while arrows are a commonly used symbol for representing movement and direction, this sign is closely associated with hunting, protection and aggression (Frutiger 1989; Follett 2009). As a matter of fact, "few map symbols are as forceful and suggestive as the arrow [which] can dramatize an attack across the border, exaggerate a concentration of troops, and perhaps even justify a preemptive strike" (Monmonier 1991, 107). Therefore, there might be a substantial difference between what the sign is intended to convey (in this case, movement direction) and what it really

delivers (correspondingly, dangerous and assailant movement direction). Therefore, one needs to carefully assess whether the use of arrow symbols for representing migrants might be unconsciously interpreted as threatening movement patterns. Considering these aspects contributes to a more informed decision for the visualization product of this thesis.

In general, the power of maps to effectively influence people's idea or at least to deliver meaningful messages is broadly discussed by Monmonier (1991). In his opinion, citizens do not usually question the authority of maps or analyze the possible alternative or untold information. In terms of political decisions – that perfectly match the case of migration movements – knowledge is power and conveying specific, selected information is a form of ideology transmission. Monmonier (1991) argues that in the past, government maps have been politically loaded and poorly objective. For instance, "crude explorers' maps made possible treaties between nations with conflicting claims. [...] maps drawn up by diplomats and generals became a political reality lends an unintended irony to the aphorism that the pen is mightier than the sword" (Monmonier 1991, 90). Similar to the link between political agenda and maps, advertising has also a series of resemblances with cartographic visualizations. According to Monmonier (1991), both cartography and advertising usually communicate only a partial version of the truth. Maps and advertisement must be equally understandable and simple, but neither of them can achieve this objective by showing the whole truth. Therefore, beside the more technical designing focus, peculiar attention must be given to the possible interpretation of the produced maps. In fact, Pandey et al. (2014), McGhee (2016) and Wood, Fels, and Krygier (2010) also suggest that different designs can lead to changes in understanding of a particular phenomenon, thus stating that visualization indeed affects the decision-making process.

> The easiest way to unleash the power of the map would be to get real about the fact that maps are propositions. As long as we conceive of maps as representations, our imagination will be fettered by the received picture of the world that it is claimed maps no more than mirror. Invariably this received picture is inadequate, inaccurate, often false; and always it is in thrall to dominant interests. Of course, this is why it's the received picture. All that making maps of this picture does is confirm its authority (Wood, Fels, and Krygier 2010, 39).

3.5. Geovisualization and Journalism

In recent years the public has increasingly been allowed to interact with the contents of journalistic articles, to the point that people became almost journalists themselves (Singer 2011). On the other hand, the internet also favors journalism by making new technologies available. In fact, in recent years, there has been an increase in the quantity of computer designed maps used for journalistic purposes (Segel and Heer 2010). Moreover, the amount of data at disposal is also increasing enormously. Nonetheless, as Clark (2014), Börner (2012) and Zambrano and Engelhardt (2008) argue, the immense quantity of data available on the web is powerful but requires the correct framework to be analyzed and ultimately comprehended. Often, it is precisely the visualization of information that allows big data to be understood (Clark 2014). The journalistic landscape has developed guidelines for geovisualization (Bounegru, Chambers, and Gray 2012) but despite this extended interest in geovisualization for the online media, systematic scientific research is still insufficient.

Given the vastness of possible visualizations in online story-telling landscape, a taxonomy or some form of categorization can be useful to identify and understand which media type to use for each goal. Segel and Heer (2010) categorize seven visualization genres: magazine style, annotated chart, partitioned poster, flow chart, comic strip, slide show, and film/video/animation (FIGURE 1).

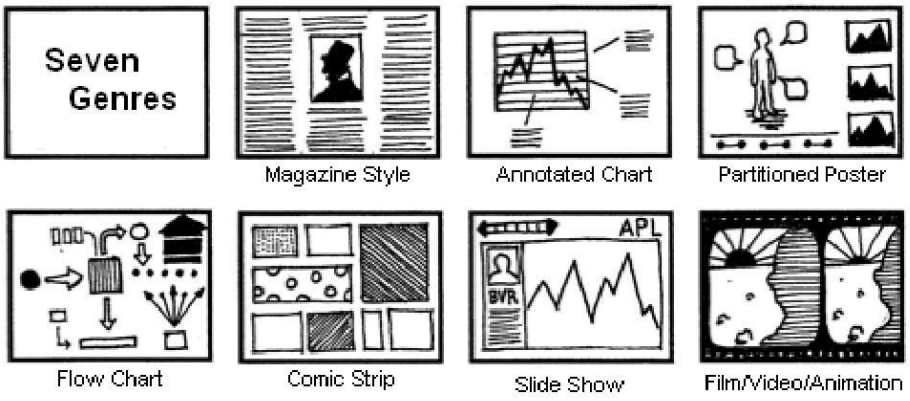


FIGURE 1: Genres of Narrative Visualization (Segel and Heer 2010)

However, this categorization does not exclude the possibility of combining these genres into more complex visualizations. Even if each genre – or a combination of them – can be used to visualize a particular story, there are genres that are more appropriate than others (Segel and Heer 2010). Therefore, one needs to carefully assess which visualization is best suited for displaying and explaining the data. Furthermore, these genres might be expanded with messaging and/or interactivity. Messaging defines the use of text to provide clarifications and descriptions for the visualization. Interactivity is defined by the possibility to actively manipulate the visualization. The features allowing an interaction between the user and the map are numerous, and the level of possible interaction can be very different. Ranging from *author-driven* visualizations, where to interactivity level is reduced, to *reader-driven* approaches that allows a vast interaction and has no predefined displaying order (Segel and Heer 2010).

> The appropriate use of messaging and interactivity will depend on a variety of factors. Messaging might clarify visual elements but produce clutter. Interactivity might engage the user but detract from the author's intended message. Again, these tradeoffs require context-specific consideration and judgment (Segel and Heer 2010, 1145–46).

3.6. Visualization of Migration Movement

After briefly introducing a couple of examples of visualization of migration patterns, this section presents the results obtained from a systematic research of visualizations of the Balkan route migration found on the internet, in research papers, in reports and in similar documents. There exist already several migration maps displaying origins and destinations and the magnitude of migrants involved. However, most of these examples tend to display only an end-to-end line or single aspect of the migration process (Crawley et al. 2016a; Crawley et al. 2016b). Particularly, an absence of concomitant consideration of border policies and arrivals in an interactive setting can be observed, as the following paragraphs illustrate.

3.6.1. Gallery of Migration Visualizations

Minard's Napoleon Campaign

The visualization of the march of Napoleon's army on Moscow (FIGURE 2) is the most famous map of Charles Joseph Minard. The visualizations depict the march and retreat of Napoleon's army with flow lines. The number of soldiers is showed with varying line width. Moreover, pieces of information about the weather are also provided.

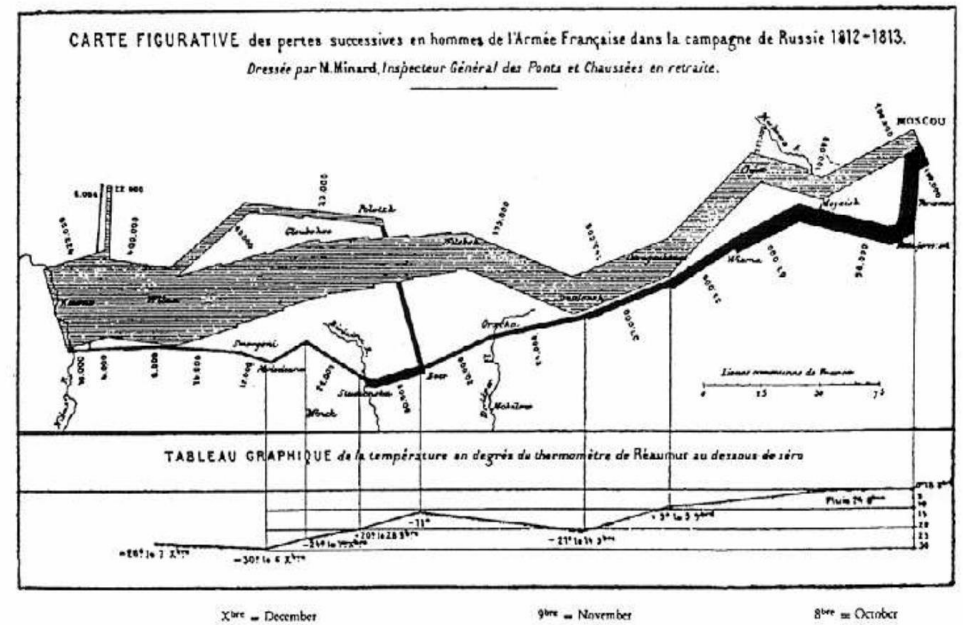


FIGURE 2: The Napoleon's Russian campaign of 1812 (Andrienko et al. 2008b)

Refugee Movements

A group of researchers of the University of Zurich (Capstone Course Mapping Global Refugee Movements 2017) designed a website environment where migration movements from 1990 until 2013 are visualized (FIGURE 3). The world is divided in regions that can be selected in order to visualize the migration movements from and directed to the specified geographic area. Textual and other visual variables indicate further information on asylum countries and percentage values of migration within the selected region as opposed to migration across regions. Here, migratory movements are displayed as flow lines with varying size. Pop-ups indicate the absolute values

of each line, but a legend that recapitulate this piece of information is absent. The time-aware animation that shows the situation throughout the years is a common example of how this information is presented in online visualizations.

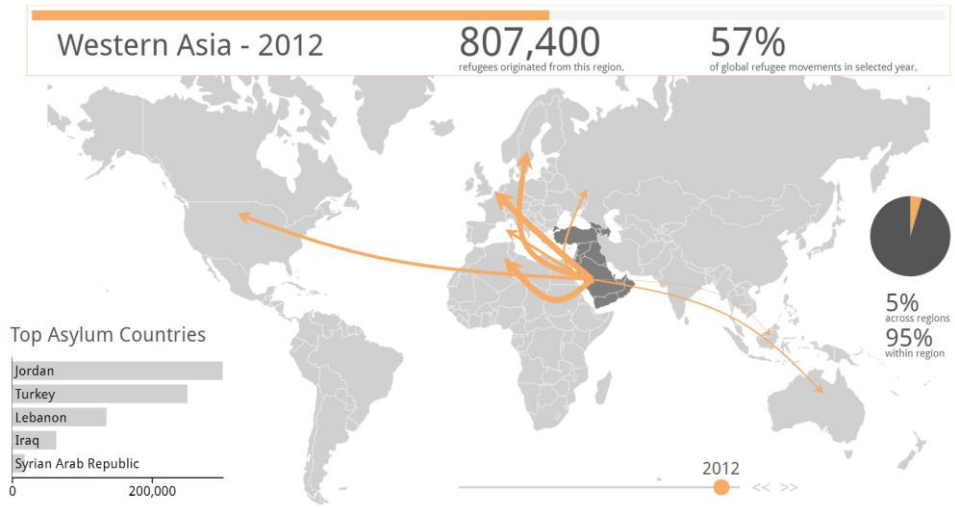


FIGURE 3: Snapshot of the Refugee Movements map
(Capstone Course Mapping Global Refugee Movements 2017)

ESRI Story Map

The ESRI story map *The Uprooted* [2] present a story-like scrolling design that alternates images, text boxes and interactive maps. The visualization of the Balkan route (FIGURE 4) allows zooming and panning and the map further changes while scrolling, following the different states' borders of the along the route. Migration routes are displayed as arrows, with no additional numerical information. The choice of following the migrants path with the animation is a feature that distinguishes this visualization from all the other presented in this chapter.

[2] Available at http://storymaps.esri.com/stories/2016/the-uprooted/index.html (last access: 19.09.2017)

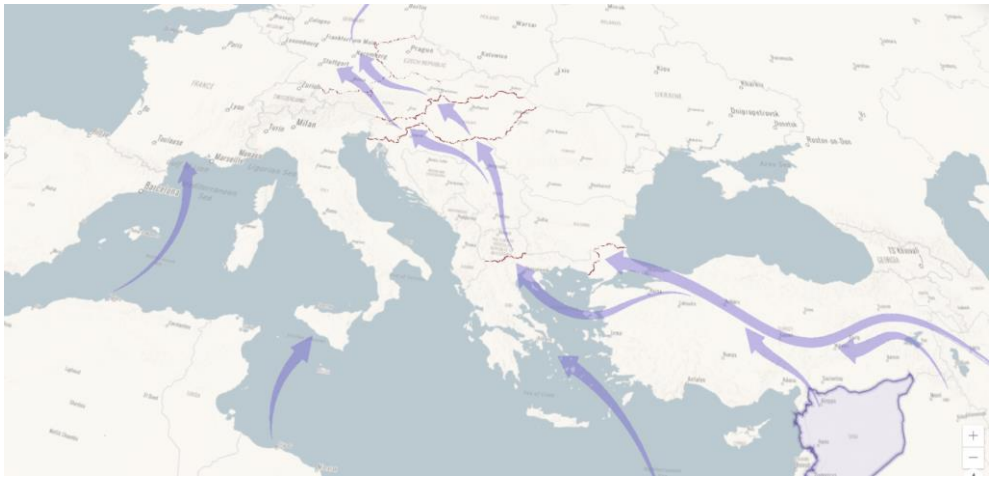


FIGURE 4: Snapshot of ESRI story map *The Uprooted* (ESRI 2016)

Open Migration Dashboard

The Dashboard designed by the organization Open Migration summarizes several different visualization methods to display migration movements. The example most linked to the visualization implemented for this thesis, is an interactive map with time aware data that illustrates migrants' arrivals in Greek islands and Italy as proportional circles (FIGURE 5).

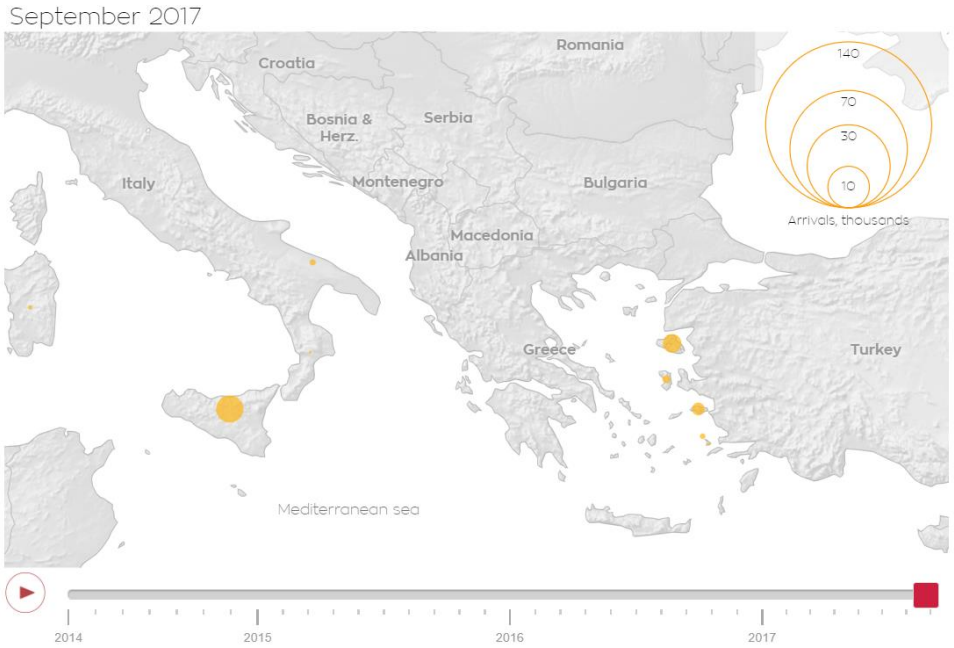


FIGURE 5: Snapshot of Dashboard interactive visualization (Open Migration 2017)

The Washington Post

This Washington Post three-episodes story *A New Age of Walls* [3] describe the development of the borders across the world in recent years. Similar to the ESRI story described above, this website alternates textual data, videos, images, and geographic visualizations. The designed visualizations are static and do not allow any interaction between the users and the map. Interestingly, both border policies and number of arrivals are cited, but each of these feature is displayed in a separate visualization. Arrivals are visualized with proportional circles associated with each Balkan state. The temporal information is not considered in these static visualizations.

Figure 6: Border fences on the Balkan route (The Washington Post 2017)

[3] Accessible at https://www.washingtonpost.com/graphics/world/border-barriers/global-illegal-immigration-prevention/ (last access: 19.09.2017)

Figure 7: Average daily arrivals in the Balkan states (The Washington Post 2017)

Animal Migration

Maps and geographic information have been instrumental in studying migration in non-human domains as well. Geographic visualizations are often employed when studying animal migration. For instance, Krisp (2006, 2004) depicts ecological barriers using 3D visualization (Figure 8) where the height-axis represents the difficulty to overstep a specific barrier, revealing the severity of obstacles and demonstrating habitat fragmentation. Another example is brought by Pinto and Keitt (2009) who extend the least-cost path approach in order to define corridors for animal movement in their habitat. In this case, the barriers are addressed indirectly since the least-cost approach tries to avoid inefficient paths, e.g., obstacles. Pirnat (2000) looked at the relevant problem of habitat fragmentation and analyzed it with the help of cartographic visualizations. In these ecological researches, geographic visualizations beside being communication devices, are analyses tools.

FIGURE 8: Ecological barriers visualized as 3D walls (Krisp 2006)

3.6.2. Analysis of Available Balkan Route Visualizations

A table summarizing the features of the Balkan route visualizations found on specifically designed websites or displayed in reports, journals and documents was produced (see Appendix A). In order to analyze these maps, the following criteria were identified: map type, interactivity, number of migrants, and factors influencing migration. Alongside the factors influencing the movement of migrants through the Balkan route one can find: causes, border policies, citizenship and associated rights, demography, environment (terrain, weather, season, etc.), and consequences (Grossi 2016; Cataldi 2016; Dustmann et al. 2016; Genova 2013; Piesse 2014; Stanojoska 2016; DRC 2016; Frontex 2016b; PeaceGeeks 2015; Curzi 2016a, 2016b; Kasparek 2016; Kuschminder, Bresser, and Siegel 2015; Smale 2016). The causes are the possible push- and pull-factors that induce migrants to decide to start the journey to Europe. As for the consequences, the topic is still undergoing constant changes, but a geovisualization has the ability to present the current situation for the hosting states, and even display some kind of estimates of future scenarios. The demographics and the citizenship status and associated rights are, on the one hand, embedded in the border regulations, while, on the other hand, they influence the travel possibilities of migrants (e.g. older people or children might require longer travel time). Moreover, different

legislations offer diverse travel possibilities depending on the nationality of the migrants; for instance, SIA migrants (Syria, Iraq, Afghanistan) are generally favored compared to the others (REACH 2004). Nonetheless, in this thesis the focus lies on the border policies, as a shaping factor of migration patterns.

As mentioned earlier, the research gap consists precisely in displaying the correlation between border policies and the number of arrivals in an interactive, animated visualization. TABLE 1 depicts this situation. Interestingly, none of the proposed maps possess all of these three features. Thus, one of the goals of this thesis is to implement a geovisualization that contemplates all the three features: border policies, arrivals and interaction.

TABLE 1: Availability of interactivity, number of migrants and border policies

ID	INTERACTIVITY	MIGRANTS NUMBER	BORDER POLICIES
1	✓	✓	×
2	×	×	×
3	✓	×	✓
4	✓	✓	×
5	×	×	×
6	×	✓	×
7	×	×	✓
8	✓	×	×
9	×	×	×
10	✓	✓	×
11	✓	✓	×
12	✓	×	×
13	×	✓	×
14	×	×	✓
15	✓	×	×
16	✓	×	✓
17	×	×	✓
18	✓	✓	×
19	×	×	×
20	×	×	✓
21	×	×	✓
22	×	×	×
23	✓	✓	×
24	✓	✓	×
25	×	×	×
26	✓	×	×
27	×	✓	✓
28	✓	×	✓
29	×	×	×
30	×	×	✓

4. Data

This chapter describes the data used for the implementation of the visualization. These are basically divided into two categories: data about migrants' arrivals and information on the border policies. The following paragraphs illustrate the datasets as well as the various steps that led to the final manipulated version of the data.

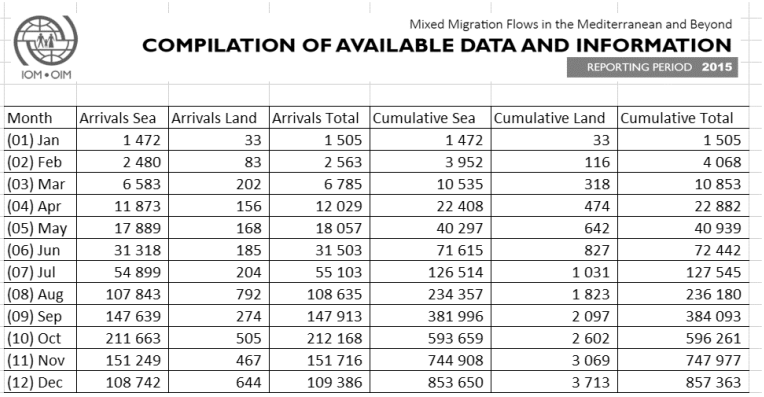
4.1. Arrivals Information

The data about the migrants' arrivals are provided by two sources: UNHCR (United Nations High Commissioner for Refugees) and IOM (International Organization for Migration). Both datasets contain daily as well as monthly and yearly numbers of arrivals in various Balkan states and other European nations. In general, the retrieved values are estimations of the actual number of migrants, but in some cases specific states were able to collect each legal crossing in a precise manner. In the followings paragraphs, both IOM and UNHCR datasets are described examples of the stored information are shown.

The "IOM Migration Flow – Europe" website[4] provides material of various kind. Recent trends, transit routes, stranded people, missing migrants and deaths information are each displayed in specific map environments. The datasets retrieved for this study are the "Summary of Arrivals to Europe - 2015 Overview" (IOM 2015) and the "2016 Flows to Europe Overview Dataset" (IOM 2016). This data is available to the public via the IOM online documents database. Depending on the year of retrieval and production, the data has been kept and saved in a different way, which clearly complicates the comparability of the findings. For 2015 complete yearly and monthly data (FIGURE 9) for Greece and Italy are available, whereas the information for other states are reduced to yearly or partially complete monthly numbers about migrants' arrivals (IOM 2015). The other dataset (IOM 2016) is almost

[4] Available at *https://iom.maps.arcgis.com/apps/MapSeries/index.html?appid=446a1fd87f3c4f5baf943eacdd02a215* [last access 23.09.2017]

identical, but it further provides daily cumulative arrivals information for each Balkan state and Italy (FIGURE 10).



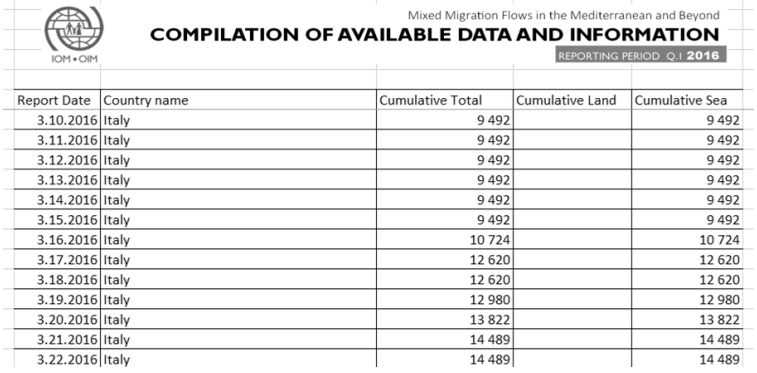
Mixed Migration Flows in the Mediterranean and Beyond

COMPILATION OF AVAILABLE DATA AND INFORMATION

REPORTING PERIOD 2015

Month	Arrivals Sea	Arrivals Land	Arrivals Total	Cumulative Sea	Cumulative Land	Cumulative Total
(01) Jan	1 472	33	1 505	1 472	33	1 505
(02) Feb	2 480	83	2 563	3 952	116	4 068
(03) Mar	6 583	202	6 785	10 535	318	10 853
(04) Apr	11 873	156	12 029	22 408	474	22 882
(05) May	17 889	168	18 057	40 297	642	40 939
(06) Jun	31 318	185	31 503	71 615	827	72 442
(07) Jul	54 899	204	55 103	126 514	1 031	127 545
(08) Aug	107 843	792	108 635	234 357	1 823	236 180
(09) Sep	147 639	274	147 913	381 996	2 097	384 093
(10) Oct	211 663	505	212 168	593 659	2 602	596 261
(11) Nov	151 249	467	151 716	744 908	3 069	747 977
(12) Dec	108 742	644	109 386	853 650	3 713	857 363

FIGURE 9: Monthly arrivals information (IOM 2015)



Mixed Migration Flows in the Mediterranean and Beyond

COMPILATION OF AVAILABLE DATA AND INFORMATION

REPORTING PERIOD Q.I 2016

Report Date	Country name	Cumulative Total	Cumulative Land	Cumulative Sea
3.10.2016	Italy	9 492		9 492
3.11.2016	Italy	9 492		9 492
3.12.2016	Italy	9 492		9 492
3.13.2016	Italy	9 492		9 492
3.14.2016	Italy	9 492		9 492
3.15.2016	Italy	9 492		9 492
3.16.2016	Italy	10 724		10 724
3.17.2016	Italy	12 620		12 620
3.18.2016	Italy	12 620		12 620
3.19.2016	Italy	12 980		12 980
3.20.2016	Italy	13 822		13 822
3.21.2016	Italy	14 489		14 489
3.22.2016	Italy	14 489		14 489

FIGURE 10: Daily arrivals information (IOM 2016)

The "Operational Portal – Refugee Situations" website[5] hosted by UNHCR presents a map view with some data about the arrivals and the demography of migrants. Like the IOM website, a sort of online catalogue of documents and datasets is provided in the form of a public access platform. The dataset retrieved for this study is the "Daily Estimated Arrivals per Country - Flows through Western Balkans Route and Italy" (UNHCR 2016). The available pieces of information are the daily numbers of arrivals, expressed for each country of the Balkan route and Italy (FIGURE 11). In addition to this dataset, some data had to be manually input for the month of September

[5] Available at *http://data2.unhcr.org/en/situations/* [last access 23.09.2017]

2015, which was displayed on the website and made available in other written reports but not included in the UNCHR dataset file.

Europe Refugees and Migrants Emergency Response
Daily Estimated Arrivals per Country - Flows through Western Balkans Route
1 October 2015 - 10 May 2016

Date	Arrivals to Greek Islands	Departures to mainland Greece	Arrivals to fYRoM	Arrivals to Serbia	Arrivals to Croatia	Arrivals to Hungary	Arrivals to Slovenia	Arrivals to Austria
01.10.2015	2 631	2 409	4 370	5 900	4 344	3 667	0	4 550
02.10.2015	4 055	1 215	5 853	3 700	5 546	4 897	0	2 700
03.10.2015	6 097	4 480	4 202	3 700	6 086	6 056	N/A	7 100
04.10.2015	4 763	1 513	5 181	4 250	5 065	5 925	0	5 800
05.10.2015	5 909	7 833	4 282	3 250	6 338	5 952	0	6 100
06.10.2015	6 496	6 707	4 156	2 650	6 370	6 000	N/A	5 800
07.10.2015	3 734	4 886	7 816	4 350	4 446	6 103	0	5 861
08.10.2015	4 295	5 349	7 663	4 650	7 798	4 583	6	4 229
09.10.2015	5 695	2 631	6 107	6 550	8 201	7 215	0	6 700
10.10.2015	4 045	2 214	4 922	4 850	7 896	7 907	N/A	5 050
11.10.2015	4 034	4 950	5 448	5 950	5 732	7 897	N/A	8 540
12.10.2015	4 671	5 879	5 645	6 556	7 317	8 702	0	8 240
13.10.2015	6 079	4 052	4 551	5 330	5 286	7 081	0	5 280
14.10.2015	6 380	4 564	5 073	5 280	4 814	5 157	0	7 000
15.10.2015	6 830	3 660	5 373	5 850	5 138	4 808	0	5 235
16.10.2015	8 564	6 743	6 181	5 700	5 260	6 353	0	6 500
17.10.2015	9 063	4 239	4 988	5 250	6 415	870	3 000	5 155
18.10.2015	8 900	5 457	10 005	10 150	4 390	41	2 700	1 822
19.10.2015	8 337	4 119	4 299	4 850	4 388	22	7 677	4 300

FIGURE 11: Daily arrivals information (UNHCR 2016)

As opposed to the IOM datasets (2015, 2016), the UNHCR (2016) file contains directly the needed information and there is no need to restructure the data and derive the daily quantities from cumulative information. However, the UNHCR dataset has some missing data, which could be completed with IOM information or vice-versa. Therefore, the IOM (2015, 2016) and the UNHCR (2016) datasets were combined into one metadata file concerning migrants' arrivals. Since both sources state that the available numbers are estimations of the real situation and both are reliable references in this context, simple mathematical mean values were computed for each day and each state with multiples entries. Generally, the data only differs in small quantities. However, even with this strategy, at the end of this linking process between UNHCR and IOM information there were still some days with unknown numbers of arrivals. Moreover, the structure of the information about the border policies (see below) favored an analysis on daily information, instead of simplified weekly numbers of arrivals. On the one hand, this simplification could have facilitated the understanding of the general trend. Nevertheless, on the other hand, the link between border

policies and migrants' arrivals is better visible and more comprehensible with a daily granularity. In the FIGURE 12, two additional columns for longitude and latitude are displayed; these are necessary to display each state's information in the correct location on the map.

Date	Country	Longitude	Latitude	Arrivals UNHCR	Arrivals IOM	Arrivals
01.25.16	Serbia	21,005859	44,016521	2 827	2829	2828
01.26.16	Serbia	21,005859	44,016521	3 091	2967	3029
01.27.16	Serbia	21,005859	44,016521	1 695	1517	1606
01.28.16	Serbia	21,005859	44,016521	1 940	1835	1888
01.29.16	Serbia	21,005859	44,016521	2 167	2034	2101
01.30.16	Serbia	21,005859	44,016521	1 540	1510	1525
01.31.16	Serbia	21,005859	44,016521	103	3129	1616
02.01.16	Serbia	21,005859	44,016521	660	616	638
02.02.16	Serbia	21,005859	44,016521	966	903	935
02.03.16	Serbia	21,005859	44,016521	2 825	2780	2803
02.04.16	Serbia	21,005859	44,016521	2 653	2522	2588
02.05.16	Serbia	21,005859	44,016521	2 694	2585	2640
02.06.16	Serbia	21,005859	44,016521	1 901	1839	1870
02.07.16	Serbia	21,005859	44,016521	2 739	2924	2832
02.08.16	Serbia	21,005859	44,016521	2 563	2268	2416
02.09.16	Serbia	21,005859	44,016521	2 379	2313	2346
02.10.16	Serbia	21,005859	44,016521	1 758	1975	1867
02.11.16	Serbia	21,005859	44,016521	2 636	2481	2559
02.12.16	Serbia	21,005859	44,016521	1 923	1627	1775

FIGURE 12: Final dataset with arrivals information

4.2. Border Policies

Unlike what happens with the migrants' arrivals information, the border policies are not available in already structured datasets. Therefore, it was necessary to search for different kinds of documents, reports and news articles (Borić and Sabic 2016; DRC 2016; Frontex 2016a, 2016b; REACH 2004; European Council 2016; FTReporters 2016; Pluim and Bilger 2016; Wolf 2016). After gathering enough information, the data was compounded in a specific way. First, the relevant borders for the Balkan route were identified. The original country geometries, provided by Natural Earth[6], were then divided into subsections according to the border adjacencies. The example of Hungary is provided to explain this procedure. The first stage is to recognize the unwanted borders, which in this case are the Hungary-Romania and the Hungary-Slovakia sections. Thereafter, the remaining relevant border is divided into subsectors: Hungary-Slovenia, Hungary-Croatia, Hungary-Serbia and Hungary-Austria. Indeed, a policy might apply to the whole state's

[6] Available at *http://www.naturalearthdata.com* [last access 19.09.2017]

border as well as being implemented only to regulate the migrants' travel between two countries. For instance, Hungary may choose to regulate the whole border without distinction, otherwise maybe the government could implement different policies according to the border needs. For computing reasons and compatibility with ArcGIS, two separate files were created. As FIGURE 13 shows, one of the file comprises the borders coordinates and a "borderID" that defines the border's sector name (e.g. HUNSRB stands for the border between Hungary and Serbia), while the other dataset contains the daily information about each border policies for each "borderID" (FIGURE 14). These two sources were linked in a stage of the map implementation.

OBJECTID *	Shape*	BorderID	ORIG_FID	Longitude	Latitude
233	Point	HUNSRB	7	18,905371	45,931738
234	Point	HUNSRB	7	18,927832	45,931396
235	Point	HUNSRB	7	19,015723	45,959717
236	Point	HUNSRB	7	19,047656	45,982666
237	Point	HUNSRB	7	19,066211	46,009521
238	Point	HUNSRB	7	19,087305	46,016162
239	Point	HUNSRB	7	19,146289	45,987012
240	Point	HUNSRB	7	19,208398	45,984424
241	Point	HUNSRB	7	19,278125	46,002881
242	Point	HUNSRB	7	19,330273	46,028516
243	Point	HUNSRB	7	19,392871	46,049805
244	Point	HUNSRB	7	19,421289	46,064453
245	Point	HUNSRB	7	19,45752	46,087354
246	Point	HUNSRB	7	19,530762	46,155176
247	Point	HUNSRB	7	19,613477	46,169189
248	Point	HUNSRB	7	19,724512	46,151904
249	Point	HUNSRB	7	19,844434	46,145898
250	Point	HUNSRB	7	19,934082	46,161475
251	Point	HUNSRB	7	20,161426	46,141895
252	Point	HUNSRB	7	20,210156	46,126025
253	Point	HUNSRB	7	20,241797	46,108594

FIGURE 13: Final dataset with BorderID and coordinates

DateFie	BorderID	Policy	PolicyType	Country
09.10.15	HUNSRB			
09.11.15	HUNSRB			
09.12.15	HUNSRB			
09.13.15	HUNSRB			
09.14.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.15.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.16.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.17.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.18.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.19.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.20.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.21.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.22.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.23.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.24.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.25.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary
09.26.15	HUNSRB	Hungary erects fence at Serbian border	1	Hungary

FIGURE 14: Final dataset with daily border policies information

4.2.1. A Taxonomy for Border Policies

The retrieved policies where mostly provided in the form of unstructured textual descriptions with mentions of the border where the policies were implemented. Yet, through classification, one can impose order and coherence to this unstructured policies data. Therefore, after having analyzed the existing policies, four classes have been identified, each representing a policy type, plus a single category that displays the EU-Turkey agreement. The other classes have been named as follows: militarization, intake quota, fence/wall and demography. TABLE 2 describes this taxonomy.

TABLE 2: Implemented border policies taxonomy

POLICY	DESCRIPTION	EXAMPLE
Demography	Policies that allow or prohibit passage according to the migrants' country of origin or according to other biographic information.	*[19.11.2015] Macedonia stops allowing economic migrants to enter the country.*
Intake quota	Policies that set a maximum number of migrants' intake per day for a specific nation or a single border sector.	*[18.10.2015] Slovenia restricts intake to 2500 arrivals per day.*
Wall / Fence	Policies that describe the partial or total closure of the border due to the construction of a wall and/or a fence alongside sensible parts or the entire state's border.	*[14.09.2015] Hungary seals Serbian border with wire fence.*
Militarization	Militaries or police forces are deployed at the border to enhance controls and surveillance.	*[14.09.2015] Austria puts soldiers at border and enhances passport checks.*
EU-Turkey Agreement	This class includes all the events related to the conclusion of the agreement between Turkey and the European Union.	*[20.03.2016] Agreement between Turkey and EU comes into effect.*

Another decision regarding the classification of the policies could have been possible. Nevertheless, this taxonomy provides a relatively simple but comprehensive division. The indirect states' attitude changes caused by events such as a terrorist attack perpetrated in Europe or the publication of the well-known picture of a Syrian boy found dead on a Turkish beach, were deliberately omitted.

5. Visualization Design

The visualization[7] was implemented using ArcGIS online[8] and the ArcGIS Desktop version (v.10.4.1.). In general, the visualization has been implemented following Muehlenhaus (2014) suggestions contained in his book *Web cartography*. According to him, there are three key principles to be considered while producing a web map.

> First, find and design map elements that facilitate your communication goals rather than simply using default map elements. Second, not all maps need every map element. In fact, sometimes map elements clutter a map and its message. Be selective. Third, [...] respect the established rules of map elements in the visual hierarchy [...] emphasizing data and map elements that are crucial for message communication, remains important (Muehlenhaus 2014, 24).

Muehlenhaus's perspective has been then compared with other studies in order to gain a broader understanding of the situation and to widen the spectrum of opinion in terms of design and visualization choices. In this thesis, a large portion of the resources was specifically addressed to the design and implementation of the visualization, thus the aim is to portray a captivating visualization that could be further improved beyond this work.

5.1. Background

The background map consists of two features: land masses with political borders and sea. This background was rendered as neutral (Muehlenhaus 2014). The base map was implemented with the online software Mapbox[9]. This website provides a series of editable base styles (i.e. backgrounds) and allows to import data and perform simple analyses. The resulting map can be integrated in websites, smartphone applications or online and offline mapping softwares (in this case ArcGIS online).

---

[7] Available at *https://uzh.maps.arcgis.com/apps/TimeAware/index.html?appid=aafd41aa83304952a0a5c90f1b35f7dc* [last access: 28.09.2017]

[8] Available at *https://www.arcgis.com* [last access: 19.09.2017]

[9] Available at *http://www.mapbox.com* [last access: 19.09.2017]

5.2. Visualizing Border Policies

Two very similar maps (vis1, vis2) were implemented with the sole difference of the displaying approach used for the border policies. Indeed, one of the research questions precisely focus on the difference between the current extrinsic approach and the proposed intrinsic visualization of border policies. For the sake of comparison, the number of differences between the two maps is reduced exclusively to the border policies conception. This way, the differences observed in the user study are more easily attributed to changes in the policies' visualization approach. Nevertheless, other confounding factors might still influence the results, but the intended differences between the two users' groups are reduced to a single change. This difference is discussed in further details in this subchapter, whereas, in the following subchapters, the visualizations (vis1, vis2) are referred to as a singular object.

5.2.1. Extrinsic Border Policies: Table

This extrinsic visualization is intended to simulate the current situation, where one does not have the possibility to visualize both the migrants' arrivals and the border policies in an animated map, but instead, the animation of the arrivals is supported by an extrinsic static tables, articles, or timelines of implemented border policies. This visualization (FIGURE 15) type was realized only to have an operational visualization for the user study. Indeed, it is favorable to have fewer differences as possible while comparing visualizations in a user study. Therefore, the simulation with a self-implemented visualization is advantageous, even if this map does not stem from a real example. In this case, the visualization contains a table where the policies are listed chronologically. The date written next to each policy represents the implementation date of these regulations. Furthermore, two columns illustrate which state implemented the policy and at which border. It is important to highlight that it does not exist a complete version of this map (only shorter videos). In fact, this visualization was produced only to have a comparable element for the user study, therefore, the implementation of this map was directly done during the video editing procedure. A possible problem worth mentioning is that an extrinsic policies representation is confronted with a limited screen space, namely, it is difficult to write all the

policies into a table that fits in the visualization window without making it unreadable and filled with visual elements. For instance, FIGURE 16 shows an example where the time window is reduced only to two months, and the policies list already counts numerous entries.

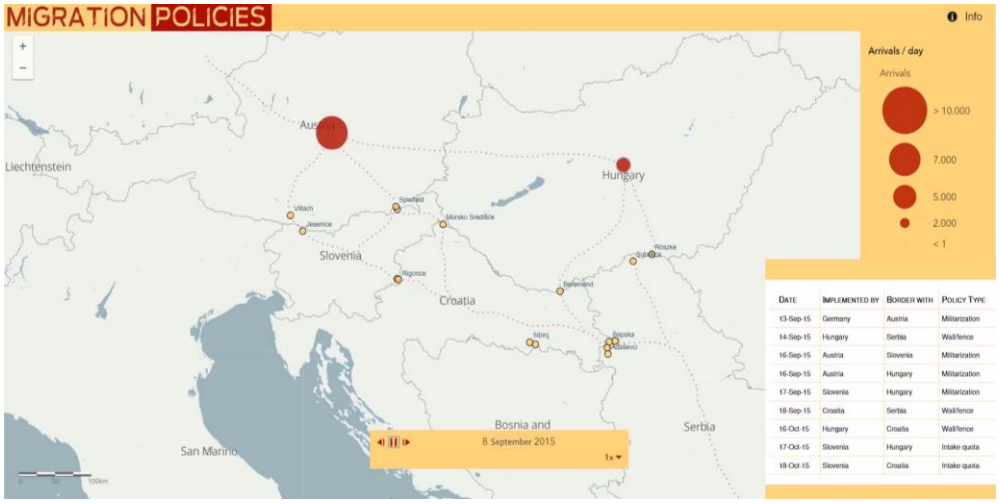


FIGURE 15: Extrinsic policies visualization (vis1)

DATE	IMPLEMENTED BY	BORDER WITH	POLICY TYPE
13-Sep-15	Germany	Austria	Militarization
14-Sep-15	Hungary	Serbia	Wall/fence
16-Sep-15	Austria	Slovenia	Militarization
16-Sep-15	Austria	Hungary	Militarization
17-Sep-15	Slovenia	Hungary	Militarization
18-Sep-15	Croatia	Serbia	Wall/fence
16-Oct-15	Hungary	Croatia	Wall/fence
17-Oct-15	Slovenia	Hungary	Intake quota
18-Oct-15	Slovenia	Croatia	Intake quota

FIGURE 16: Border policies table (vis1)

5.2.2. Intrinsic Border Policies: Colored Lines

In this case, border policies are displayed as colored lines (FIGURE 17). As previously expressed, many different policies have been implemented in the Balkan route, thus for clarity purposes these regulations are grouped into four categories. The geometries for the states' border lines were obtained from Natural Earth as a shapefile. To reduce the size of the file and the possible loading time for the layer, only the relevant borders were selected and maintained. The following geometries were preserved: Turkey, Greece, Serbia, Hungary, Croatia, Slovenia, Austria, Germany. It is important to mention that these geometries are not used to display the background borders of each state, but only for the implementation and depiction of border policies along the Balkan route. The geometry of these borders is fixed; therefore, it matches the background geometry only on certain zoom levels. On closer zoom levels, the two borders do not perfectly overlap. However, since the zoom level required to notice the difference is not relevant for the map, it was not necessary to ameliorate and refine the Natural Earth shapefile. Moreover, a more complex geometry would have required a higher computational capacity with the risk of slowing down the animation.

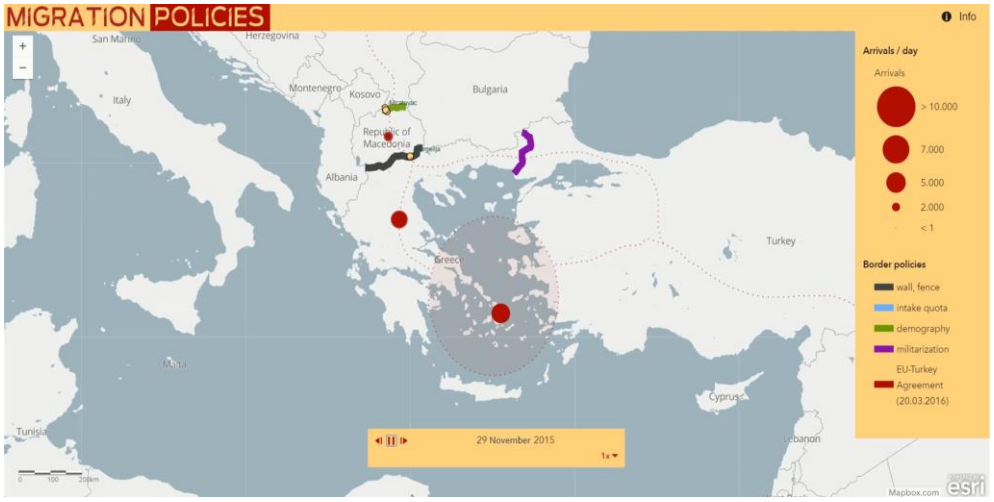


FIGURE 17: Intrinsic policies visualization (vis2)

As soon as a border policy is implemented, the corresponding border line is colored according to the policy type. In the real world, the implementation date does not always correspond to the actual implementation of the policy.

For instance, a border wall or a fence requires some time to be built and fully functioning. Similarly, the official announcement of military patrol at the border might require some more days until the military establish an efficient patrol system. Nevertheless, the official date mostly corresponds to the switch period, i.e. the time when one could observe the largest changes caused by that policy. The borders stay colored as long as the policy is in place. If another policy is implemented at the same border, the line is colored according to the newest policy. This clearly causes a loss of information but, if not so, the visualization would be overcomplicated (e.g. the combination of colors would decrease readability).

5.3. Visualizing the Number of Arrivals

In order to display arrivals information three possibilities were taken into consideration. Similar to other maps presented in chapter 3, it is possible to use lines to display flows. This common option was however discarded for the following reasons. First "the representation of the movements of refugees and migrants as linear, singular uninterrupted journeys or flows of people heading toward Europe is grossly misleading" (Crawley et al. 2016b, 7). This critique might yet be resolved by implementing a more complex flow map with multiple routes, stops, detours and even intrinsic information of the flow itself. As proposed by Guo (2009), using what he calls *multivariate flow mapping*, it could be possible to cluster the flow into different categories and identify these with a diversified colors. In fact, traditional flow maps are ineffective since "they cannot display multivariate information, such as age compositions or income levels of migrants in each flow" (Guo 2009, 1042). Nevertheless, while these considerations would perhaps favor a flow map, another important remark needs to be made. The data available from UNHCR (2016) and IOM (2015, 2016) describe the daily arrivals in each country. Thus, a representation of flow lines between states could be misleading and give the false impression that the number of migrants represent the number of people travelling in that segment, while in realty it only displays the number of migrants that entered a specific state. Furthermore, as explained by Frutiger (1989), the arrows might assign a threatening character to the migrants' movement.

Thus, once the option of working with flows and lines is discarded, choropleth or symbols maps were considered. There are advantages and disadvantages that could support the use of either of these methods. The combination of arrivals information with border policies should also be considered. Indeed, border policies are displayed as colored thick lines, and the readability of both this data and a choropleth migrants' arrivals layer would have been more complicated than the combination of lines with symbols. Therefore, the final decision was to depict the arrivals of migrants as proportional symbols; one circle for each state.

As any other proportional symbols map, the size of the circles varies according to the number of migrants' arrivals for each day. According to Muehlenhaus (2014), size is a good criteria for highlighting differences in objects, since the understanding of the relationship between size and count is conventional to humans. "Size difference is one of the most intuitive visual variables for humans to comprehend. Therefore, these maps are extremely intuitive and easy to read" (Muehlenhaus 2014, 159). The choice of a proportional symbol map is also consistent with the available data. Indeed, proportional symbols maps are excellent for displaying raw values that are distributed in some sort of entities, as for instance different states (Muehlenhaus 2014). In addition to this, the preference was given to proportional symbols instead of graduated symbols, because the user should be able to observe as many significant changes as possible. Using a categorization of arrivals into classes could hide some information and an appropriate classification would be difficult to find. A possible drawback of symbols maps is the danger of visualizing overlapping symbols, which however in this case is not an issue since the circles are few and well distributed (Muehlenhaus 2014).

5.4. Visualizing Migration Routes

It is quite controversial to state that in a map representing migration, the routes are one of the least important features displayed. Nevertheless, the representation of migration routes as a singular flow is misleading and does not deliver an accurate understanding of the situation (Crawley et al. 2016a). Therefore, instead of identifying all the possible different routes and

displaying unique lines according to the actual routes, a general estimated route visualization was preferred. The routes are visualized as red dotted lines that stretch from border to border while intersecting the proportional symbols and the border crossing points. Indeed, a reliable information about the routes is that at some point the registered migrants travel through one of the official crossing points. In between, i.e. inside each state, the routes are only sketched as lines that cross the countries. In this visualization, the route might also be assigned to the background map, since the red dotted lines are not modified according to the route pattern of the current timeframe in the interactive visualization. Notwithstanding the issues listed above, the final choice was to display the routes. By doing so, one can have a quick overview of migration patterns.

5.5. Colors

Particular attention needs to be addressed to the color selection since this is one of the most important design elements and, at the same time, one of the most prone to readability issues. In fact, colors are displayed differently according to the screen, the room light and many other factors, and people themselves perceive colors differently (Muehlenhaus 2014). To increase readability and understandability, the number of colors is reduced as much as possible (Jenny, Jenny, and Räber 2008). The background has a neutral gray color, opposed to a more intense blue tint for the sea, while states borders are drawn with a darker gray hue. This should enhance the contrast with other map layers, and help these important elements to pop out and be more visible (Muehlenhaus 2014).

For the rest of the map, and for the online environment container as well, two colors are used: a dark red (RGB 168/0/0) and a dark yellow (RGB 255/211/128). These colors are used for the proportional circles symbols as well as for the dotted-routes. Furthermore, the logo and the overall design recall this color combination. Another colored feature of the map concerns the border policies (only for vis2). Without repeating much about the idea of this visualization strategy, one can observe that the colors are sufficiently different, but the colors choice might appear peculiar. These colors were selected after an analysis of the visualization with the software Color Oracle

14[10], which was used to account for deuteranopia. As FIGURE 18 shows, the chosen colors are different both for normal vision and deuteranopia simulated screen setting. While the hue changes completely, it is still possible to discern between the lines. Since numerous people are colorblind it is imperative to consider this aspect while designing a visualization (Muehlenhaus 2014).

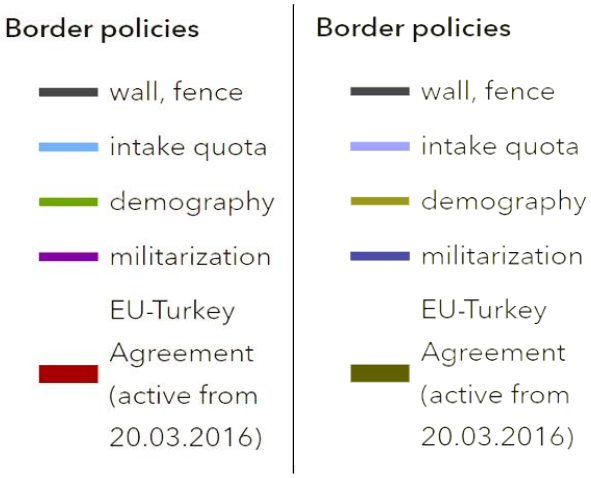


FIGURE 18: Border policies with normal vision (left) and deuteranopia (right)

5.6. Animation

The central feature of the visualization is the temporal animation, a quality of computer designed maps which is crucial for effectively visualizing changes over time (Muehlenhaus 2014). The map displays data from a timespan of multiple months, from 1. September 2015 to 31. March 2016. The duration of each frame (i.e. each day) and the rate of change between elements has been decided according to the quantity of information shown on each day and the time needed to retrieve all these data for the users. According to Muehlenhaus (2014), since the animation is one of the fundamental features of the map, the temporal legend is supposed to be always visible, allowing also some level of interaction with it. In fact, this particular type of legend is both a map element and part of the animation, making it indispensable to understand the visualization.

[10] Available at *http://colororacle.org/* [last access 19.09.2017]

5.7. Interactivity

The interactivity of the map is composed of several different aspects. According to Muehlenhaus (2014), people want to have the ability to interact with the visualization with the possibility to play, pause and stop, to scroll through time, or also to increase or reduce the speed of the animation itself. The implemented visualization (vis2) allows these interactive features. Second, the interactivity of the visualization is also defined by the ability of zooming in/out the given map scale. The possibility of zooming is also a very appreciated feature in computer maps, but the possibility of zooming should be set according to the goal of the visualization (Muehlenhaus 2014). In this case, however, it was not possible to adapt the zoom settings on ArcGIS online. Therefore, this could surely be an improvement for further development of this visualization. The zoom process is accessible either through mouse or touchpad scrolling or with plus and minus symbols that increase the usability of this feature (Muehlenhaus 2014). A third interaction possibility is given by the presence of pop-ups that appear when the user clicks either on circles displaying migrants' arrivals, or on the border in order to see which border policy is being currently implemented. In vis2, pop-ups are designed as simple as possible in order to avoid an overcrowded map with more elements than needed (Jenny et al. 2017).

5.8. Legend

The legend is always visible to the user. The choice of displaying the legend at all times at the expense of more screen place for the map is justified by the characteristics of the data and the animation of the map. In fact, the rate of change of the elements in the map requires the user to be certain about the information visualized (Muehlenhaus 2014).

5.9. Textual Information

There are two layers with pieces of textual information. The background map provides states' names, whose visibility is automatically set according to the current zoom level. The same visibility filter is used for border crossing points

and for their textual information (i.e. place names), which are all visible depending on the visualized zoom level. This adjustment allows to have a clean and not overcrowded base map (Cecconi and Galanda 2002). These texts and all the other written features of the visualization are designed according to visualization rules and principles regarding text font (for instance the use of a sans serif font to increase readability, or the use of a small number of different fonts), size, anti-aliasing and other options (Jenny, Jenny, and Räber 2008; Cecconi and Galanda 2002; Muehlenhaus 2014).

6. User Study

An online user study was conducted on the survey portal LamaPoll[11]. The overall structure of the questionnaire is summarized in FIGURE 19.

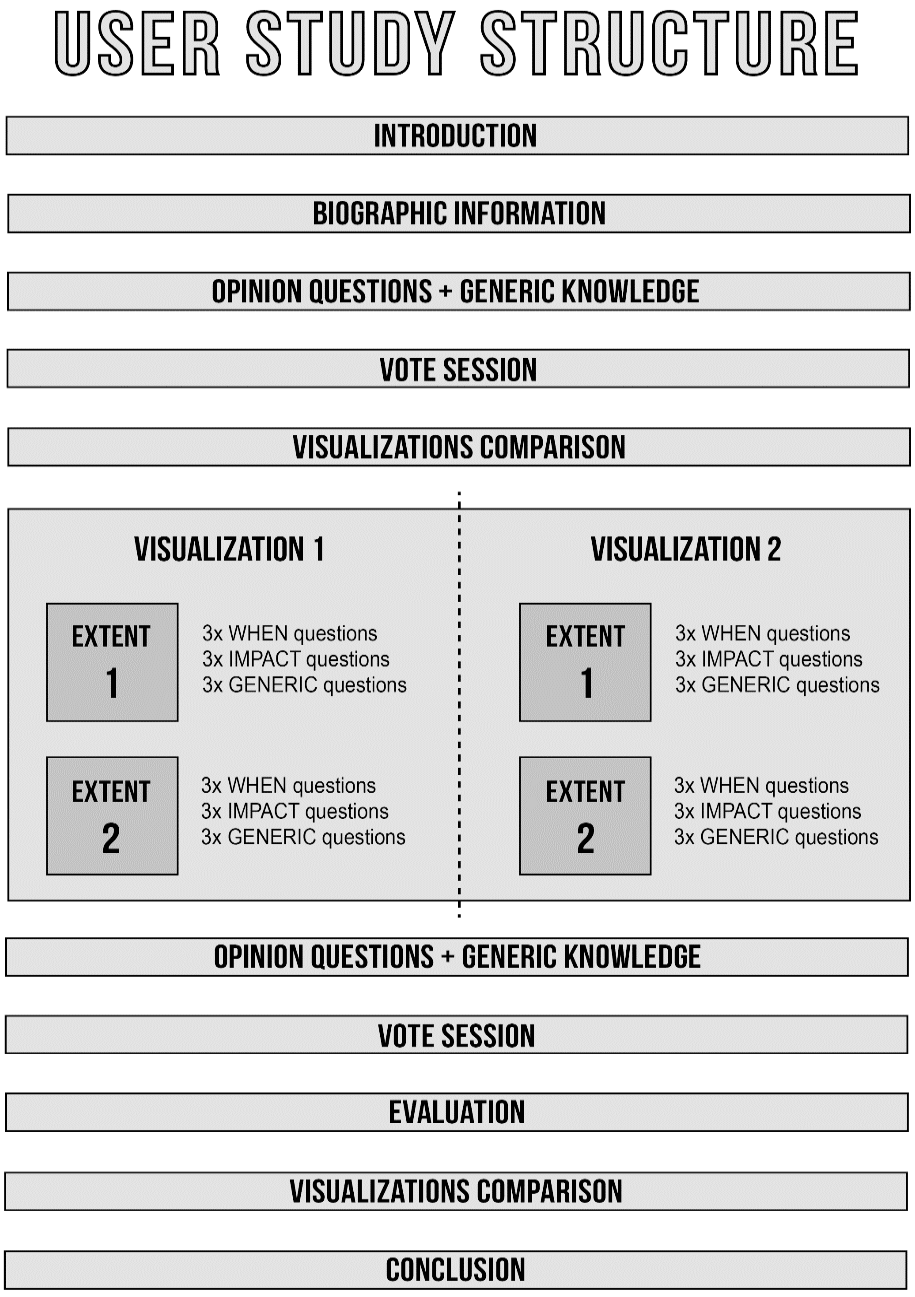


FIGURE 19: Structure of the online survey

[11] Available at *https://www.lamapoll.de/* [last access 19.09.2017]

As the above figure shows, this study is structured in a mirrored way. After the introduction and the usual biographic questions, some opinion questions on migration and the Balkan route are asked. Afterward, the participant must decide whether to accept or refuse the implementation of specific policies for some migration issues in a simulation of a national vote session. Before starting the main part of the survey, a comparison between the two map types (vis1 and vis2) is presented and the participants must select the preferred visualization between them. The next step, which is not shown in the above figure, is a randomly division of the participants in two evenly sized groups: group1 (vis1) and group2 (vis2). In the main part of the study, the participants from both groups are asked to complete the exact same tasks, but using either the map type with static, extrinsic policies representation in the form of a table (vis1) or the type with interactive, intrinsic policies displayed as colored lines (vis2). After the central part, the study structure is repeated with, again, "opinion questions + generic knowledge", a "vote sessions" and a "visualization comparison". This reiteration allows analyzing the behavior of the participants and their answers before and after having worked with either one or the other visualization type. Towards the end of the survey, the participants are also asked to evaluate the questionnaire and the displayed map video. The complete survey is available as Appendix.

The questionnaire ran from June 7^{th,} 2017 to July 4th, 2017. In this period, 77 participants completed the survey, by answering each of the proposed questions. In the following sections, each part of this user study is described in further detail.

6.1. Biographic Information

The biographic questions are mostly addressed to have filters that could be used in the analysis. Beside age, gender, highest educational degree, and occupation, both the country of origin and of residence are requested. These geographic evidences might be related to issues of migration and border policies. Due to the high percentage of potential Swiss residents that conducted the survey, in case one of them entered "Switzerland" as their country of origin, a subsequent question regarding their canton of origin and residence was asked.

Another part is focused on personal information such as the level of background knowledge and experience in certain fields (e.g. maps, politics or migration) and the disposition to the topic of the thesis and to migration discourses in general (e.g. inclination to read migration news). Here, participants are also asked if they or their parents are immigrants – questions that suggest their level of contextual knowledge.

6.2. Opinion Questions and Generic Knowledge

These questions are formulated both with the intention of assessing the level of knowledge before and after the survey, and with the purpose of investigating the participants' idea concerning migration and states policies. A broad variety of question types is used: open questions, single choice, multiple choice and Likert scale questions. Some of these questions are intentionally controversial or lead to doubtful and sometimes problematic decisions. This uncertainty should enforce comparison of the results between the opinion pre-study and the opinion post-study. In fact, all the questions are repeated after the participants had the possibility to work with either vis1 or vis2 and inform themselves about the Balkan route, migration movements and border policies.

6.3. Vote Session

The vote session presents four vote subjects with a similar formulation. In all cases the vote starts with the following sentence: "In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries" (see Appendix B). For each vote a consequence, policy or measure is then proposed. Differently from an actual vote session, here a broader answer spectrum is allowed. The participants do not only face yes/no decisions, but instead they are presented with a Likert scale with four possible answers: YES, YES>NO, NO>YES, NO. This slight change should prevent forcing the participants to choose an answer which does not fit their authentic opinion. Moreover, this should ease the participants' ability to deal with the mandatory nature of these questions that deliberately do not have a "no answer" option. As mentioned before, the vote session is repeated after

the participant has worked with either one of the proposed visualizations. This should allow to assess the influence that the map has on vote-like decisions that precisely concerns policies and migration. The only difference between the first and the second vote session is given by the introductory text that starts the two voting pages. On the one hand, the participant is prompted in the following way: "Your country has an upcoming popular vote about migration, hospitality and policies implementation. You will be asked to express an opinion on the following 4 decisions" (see Appendix B). On the other hand, the participant is introduced with the following sentence: "Your country has now to vote about migration, hospitality and policies implementation. You are asked to express an opinion on the following 4 decisions" (see Appendix B). In the first case, the formulation intends to inform the participant about an upcoming vote, whereas in the second case the participant is specifically asked to vote on these subjects.

6.4. Video Comparison

Before beginning with the main study, i.e. before working with either one or the other map, the participants are asked to evaluate both visualizations at a first glance, for a series of criteria. A short video comparison shows the same time snippet with both visualizations side by side. The participant should then grade the two map types according to some criteria by giving an amount of points, from *I don't like it / Not clear at all* to *I like it / Very clear*. The following criteria are assessed: general look, border policies, migrants' arrivals, link arrivals-policies, time (date), migration routes. Finally, the participant is asked to express a preference for either one or the other map style. The same video comparison is proposed at the end of the survey, after the participants have worked with either vis1 or vis2. The main part of the study should enable the participants to make a more informed decision regarding which map type they prefer, and which features are best represented in which visualization.

6.5. Main Study

In the main part of this survey the participants work with either one or the other visualization (vis1 or vis2), and are asked to answer the same questions regardless of the visualization they are assigned to. It is important to notice that the interactive maps are transformed into videos for this questionnaire (for further details, see below). Moreover, each participant works with two different extents or scales, displayed with the same visualization type, but with different zoom-levels and diverse time snippet. In FIGURE 20, and in the following chapters, these two extents are called ext1 and ext2. As shown in the figure, there are three principal elements to consider: task type, map extents and groups division.

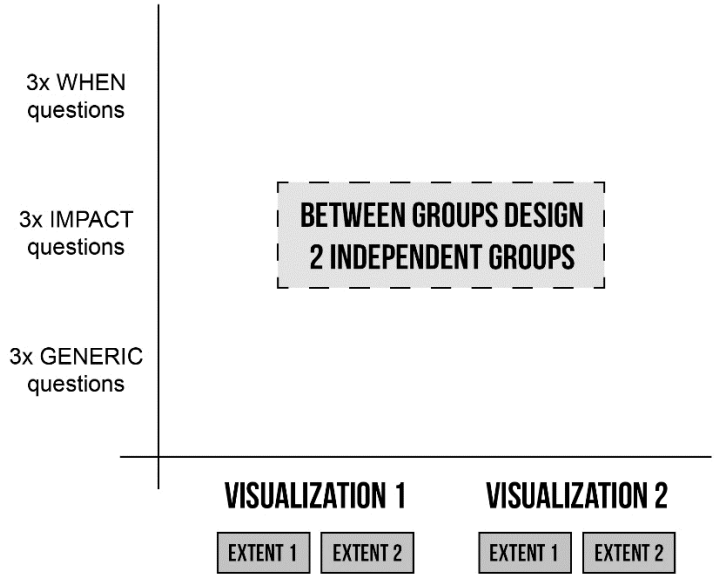


FIGURE 20: Features and elements of the user study

6.5.1. Video Conversion

Before explaining the other elements, it is important to mention that, in order to reduce the influence of confounding variables (Field 2013), the visualizations were converted to videos. This step is of critical importance for the analysis of the results. Indeed, interaction possibilities persist, but they refer only to the temporal aspect of the visualization, namely, the ability to browse through the different dates and play/stop the animation. The interactivity loss consists in the ability to zoom, pan, and click the map

elements. Even though this reduction might affect the discussed results, a simplification was necessary. Indeed, as already mentioned above, an online environment gives less control over confounding variables. Therefore, it is essential to reduce the number of confounding factors, in order to properly discuss the obtained results. This was done with a conversion of the fully interactive visualizations into partially interactive videos. Nevertheless, the interactivity is also addressed both in the results and in the discussion. In fact, the interaction is possible for both vis1 and vis2. The intrinsic visualization includes the information about border policies in the map, and this can be explored interactively by browsing through the displayed days. On the other hand, the extrinsic visualization does not include any interaction between the user and the border policies, which are simply displayed as a static table.

6.5.2. Map Extents

The participants work with one specific visualization (vis1 or vis2), and with two different extents (ext1 and ext2). The first visualization is a close-up view of the northern Balkan route (Hungary, Croatia, Slovenia, Austria), while the second visualization presents a larger scale that comprehends the whole route from Turkey to Austria. In the following chapters, the two extents are referred to as ext1 (i.e. northern Balkan focus) and ext2 (general overview). The two visualizations refer to different time periods, thus, the questions are also different, but the task types are maintained.

6.5.3. Task Types

There are three kinds of tasks: WHEN-questions, IMPACT-questions and GENERIC- questions. Here, all three types are discussed and described and some examples presented.

WHEN-questions. These questions are mostly formulated so that the participant should both identify a piece of information and interpret it along other data displayed on the map. For instance, participants may be asked to indicate the time when a border policy was implemented and – if possible –

further explain the reasons behind this border control measure (FIGURE 21). The intention with this kind of questions is to assess whether there is a difference in interpretation abilities between the two visualizations (vis1 and vis2). If a vis1 allows the participant to achieve a faster and more complete understanding of the displayed phenomena than vis2, or vice-versa.

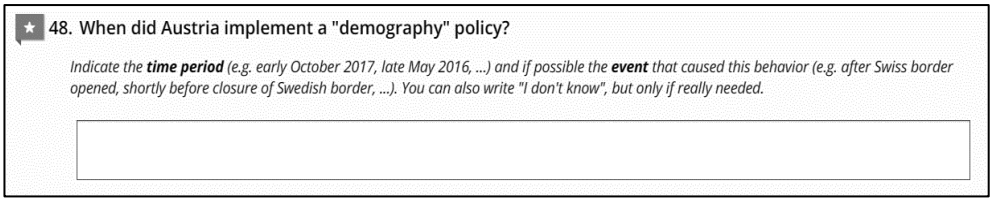


FIGURE 21: Example of WHEN-question

IMPACT-questions. These questions assess the level of understanding of how the border policies influence the number of migrants' arrivals (FIGURE 22). As opposed to the *WHEN-questions,* here the participants only need to observe the animation and focus on what comes before and after a policy. A specific concentration on the displayed date is not required. The intention with this type of questions is to compare the readability of the two maps concerning the link between border policies and arrivals in the following days. Put differently, if a map type allows the participant to achieve a faster and more complete understanding of border policies and migration movements.

FIGURE 22: Example of IMPACT-question

GENERIC-questions. Alongside the more defined WHEN- and IMPACT-questions, three other questions were asked for each map session. For instance, the users are asked to locate countries or to identify migrants' arrivals numbers.

6.6. Evaluation

The evaluation part consists of seven questions, which allow the participants to assess the map type they worked with according to different features. In general, the participants are asked to evaluate the following aspects: dates box, animation speed, questions difficulty and policies-dates linking. Furthermore, the participants are also asked to express what the most helpful/useful and the most incomprehensible/difficult features in the map are, and further explain the answering strategy used to complete the questionnaire.

6.7. Recruitment of Participants

Participants were recruited mostly through three distinct channels: email, WhatsApp and Facebook. The participants come mainly from the author's acquaintances and from colleagues and friends of the supervisors. The duration of the survey (approximately 30 minutes) probably discouraged several people who started the survey but did not finish it. In total, 199 people started the survey and 77 of them completed it (39%). Several participants started the questionnaire but left it already in the first sections.

As mentioned above, the survey was promoted by sending a private message to several WhatsApp and Facebook contacts. Moreover, the survey was advertised to all currently enrolled master's students in Geographic Information System (GIS), Geocomputation, Geovisualization (GIVA), Human Geography, Political Geography and Economic Geography at the Geography Department of the University of Zurich. Furthermore, the survey was shared either as private or public message on different Facebook pages like Radiotelevisione svizzera (RSI), Schweizer Radio und Fernsehen (SRF), The Hague Process on Refugees and Migration (THP), Migration Hub Network and Gente che Accende la Società (GAS) and groups like Stadtzürcher Steichehrer (175 UZH geography students) and fügitiv (a Swiss scouts project for refugees counting 418 Facebook members). According to the LamaPoll survey platform, which allows gathering information regarding the "internet origin" of the participant, the most effective recruitment

strategy was the personal contacting of people rather than the sharing of the link through social platforms, as e.g. Facebook.

6.8. Pilot Study

Before recruiting participants, some pilot runs of the study were necessary: in total, two pilot studies were accomplished. The first time, the supervisors of this thesis completed the study, which was then ameliorated according to their feedbacks. After having corrected the suggested elements, the study was piloted with two people, who were unaware of the content of the survey and of the thesis. This poses an important difference from the previous pilot, in which case the involved participants already knew the design of the questionnaire and the goal behind it. In fact, the second pilot run gave many other indications which were particularly useful to complete the final version of the user study. In particular, the amount of time necessary to complete the study was largely underestimated, thus a considerable part of the survey was reduced and other parts were completely removed from the final version of the questionnaire. During this delicate shortening procedure, specific focus lied on preventing essential information loss.

6.9. Experimental Design

The online environment of the study is peculiar. On the one hand, it gives less control over confounding variables and the general conditions that each participant faces while taking the survey. For instance, a potential participant might be drinking a coffee and listening to some music, another could be talking to a friend, or be totally concentrated on the survey. On the other hand, an online survey provides a realistic setting that resemble the journalistic context – defined by thesis' framework – where such interactive visualizations might be implemented.

As FIGURE 20 shows, this study was structured in a between-subject design (Courage and Baxter 2005; Keppel and Wickens 2004; Winer, Brown, and Michels 1991; Martin 1985). This means that participants were divided in two groups and completed a specific survey accordingly. The variation

between the two groups is strictly related to the research questions and should be maintained as minimal as possible. Otherwise it could be complicated to compare the results of one group with the results of the other. A between-subject design was chosen mainly for two reasons. First, it allows participants to be more engaged with only one visualization approach, become more accustomed to this type of map and thus to have a greater information gain. Second, this engagement with only one specific map type should enhance the effect of the visualization on the opinion of the participants or, at least, a potential opinion's change or the absence of it would be ascribable to the specific visualization type. Participants were randomly assigned to one or the other group (i.e. they worked with vis1 or vis2) based on a "sorting question" present in the survey.

7. Experts Interviews

Alongside the online user study, four interviews with migration and/or visualization experts of the Geography Department of the University of Zurich were conducted. The experts were asked to work with both visualizations (vis1, vis2) and extents (ext1, ext2), thus, gaining an overview of both the intrinsic and the extrinsic visualization approaches as well as analyzing the two map extents. Answers to the survey's questions were not recorder for two reasons. First, the setup of the interviews caused several interruptions during the time the experts were conducting the survey, leading to a difficult comparability between the results. Second, the aim of the interviews with experts is to discuss the visualizations in detail rather than assess performance metrics. Furthermore, the experts had the possibility to explore the online visualization, hence experiencing also the other interactive elements that were absent in the videos. A complete report of the interviews is available at the end of this thesis (see Appendix C). In this chapter, only the general structure of the interview is illustrated, while the answers will be discussed in chapter 9.

The interview starts with a general assessment of both map types and extents. After that, the interviewer illustrates the idea behind the implemented visualization, namely the step away from a simple origin-destination (OD) map and the combination of border policies and arrivals in an interactive environment. The experts are asked to express their opinion and thoughts concerning the purpose of the map and the impression they had while exploring it. A couple of questions about the qualitative nature of the data and the power of the map (e.g. opinion change) follow. Then, the experts are asked to propose ameliorations and improvements to the map. In conclusion, after exploring the online version of the visualization, the experts express their thoughts on the differences and similarities between the online version and the videos.

8. Results

This chapter presents the results obtained from the user study and the interviews. These aspects are discussed in further details in the next chapter. After showing the results of the questionnaire, and the internal heterogeneity of the groups, the statistical analysis of the data follows.

8.1. User Study: Outcomes

Formally, a total amount of 75 participants finished the survey, but this number was extended to 77. This increase is due to a problem that two users came upon on the last page while trying to end the survey. The "FINISH" button was not visible on the screen thus the results were accounted as incomplete by the LamaPoll server. However, since the last page presents only a non-mandatory comment field, these two results are included in the statistical analysis. The characteristics of the sample need to be considered before presenting the statistical results. The following figures summarize these information by dividing the data in two groups (vis1 and vis2).

The automatic division of participants was successful, giving two balanced groups with 38 and 39 participants. However, to accurately interpret the results it is important to assess whether the groups have a similar *internal heterogeneity*. FIGURE 23 displays the amount of male and female per group. In both groups, the male participants number exceeds the count of female participants; this divergence is bigger for vis1.

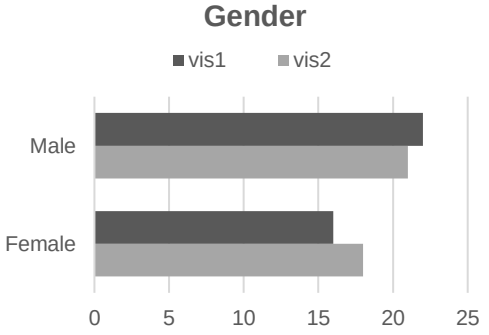


FIGURE 23: Participants' gender distribution for vis1 and vis2

While the age distribution is heavily unbalanced between younger and older generations – the large number of young people can be a result of the online recruitment strategy – the distribution between groups is more evenly scattered (FIGURE 24).

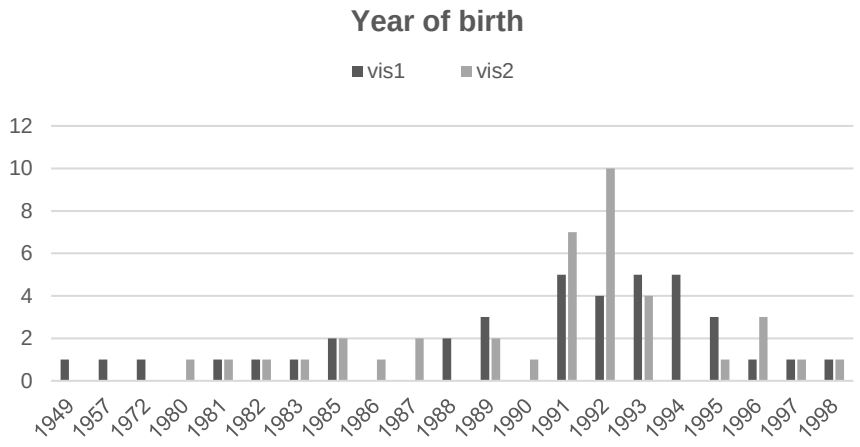


FIGURE 24: Counts of the birthyears for vis1 and vis2

The distribution of highest educational degrees is shown in FIGURE 25. The educational degrees distribution shows a balanced situation between vis1 and vis2 and in both cases the data visually resemble a normal distribution, with "Bachelor" as the dominant choice. Moreover, another question shows that the number of students overpasses the workers, a situation that holds true for both groups (vis1 and vis2).

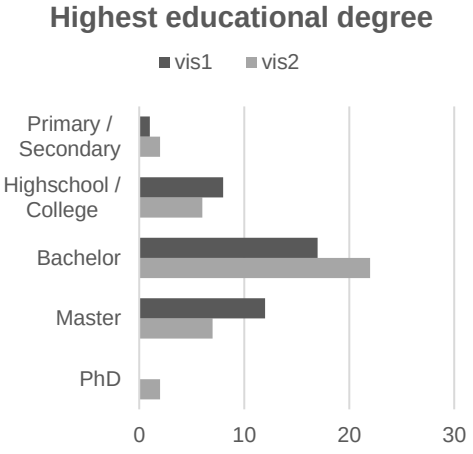


FIGURE 25: Counts of highest educational degree for vis1 and vis2

Subsequently, university students were asked to provide their field of study. The environment in which this study was conducted, stately, the Department of Geography, might have influenced this information, as the majority of users chose geography as their study area.

Even though the survey had no restriction of nationality, almost all participants have Swiss origins. Both groups show a significantly larger number of Swiss participants (more than 75%) alongside a few participants from other countries: Germany, Italy, Netherlands, Greece, China, United States of America and United Kingdom. An analogous situation is presented when dealing with the country of residence. Here as well, most of the participants indicated "Switzerland" as their current state of residence. Moreover, only a small amount of people has an immigrate background, but the number of parents or grandparents indicated as immigrants makes up for one third to half of the total participants in both groups (FIGURE 26).

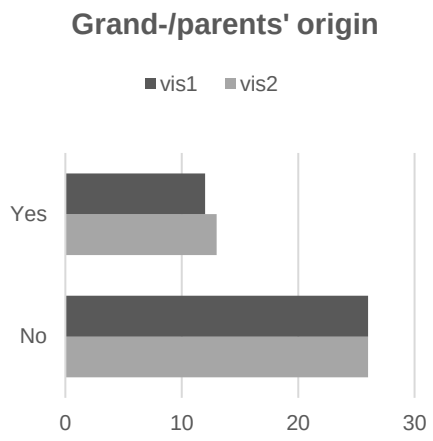


FIGURE 26: Number of participants with immigrant grand-/parents

The Swiss participants were also asked to specify the canton of origin and residence. Similarly, to what discussed before, the influence of the author's background is evident when analyzing these data. In fact, the most chosen answer for the canton of origin is "Ticino" followed by "Zurich". On the other hand, the canton of residence shows a slightly different trend between the two groups. Participants of vis1 live mostly in Zurich, followed by Ticino, while for vis2 the situation is inverted.

Figure 27, 28, 29, 30 and 31 show the level of experience/knowledge in five fields related to the study. The choice varies from "None" to "Expert" with 5 different possibilities. All the graphs display a relatively similar trend between participants from vis1 and vis2. Nonetheless, one should consider that participants form vis1 assessed their experience/knowledge in "GIS" with a slightly higher score. On the contrary, vis2 users indicated a slightly higher competence in "Migration" and "Politics".

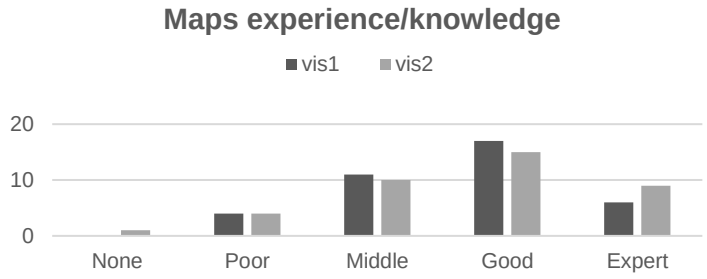


Figure 27: Level of experience/knowledge with maps

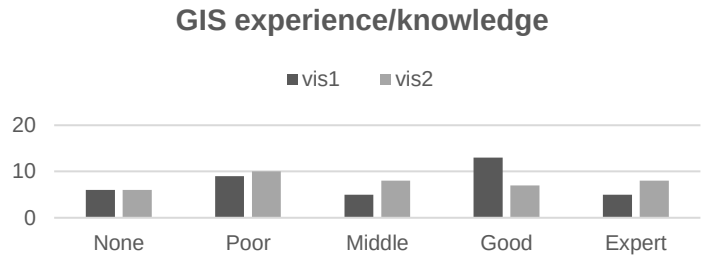


Figure 28: Level of experience/knowledge with GIS

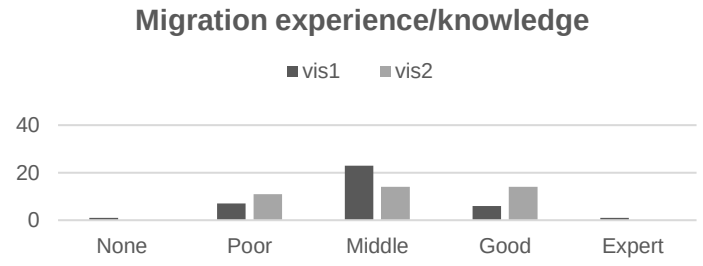


Figure 29: Level of experience/knowledge with migration related topics

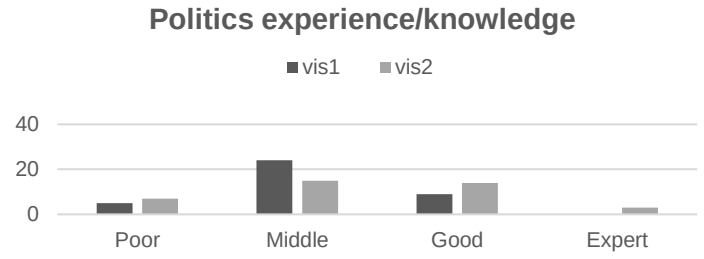


FIGURE 30: Level of experience/knowledge with political discourses

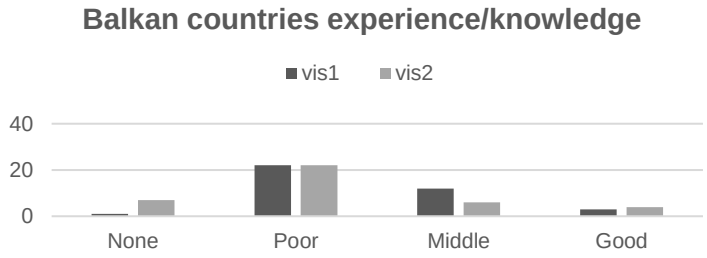


FIGURE 31: Level of experience/knowledge with Balkan countries

Finally, participants indicated an answer for questions specifically related to the field of interactive data journalism. The results show a similar distribution between groups for all three questions, particularly for the query regarding the disposition to reading migration news (FIGURE 32) and concerning the most often used media environment (FIGURE 33). The inclination to explore interactive maps online (FIGURE 34) also display an analogous trend between groups; nevertheless, participants from vis2 indicated a higher propensity to the exploration of maps.

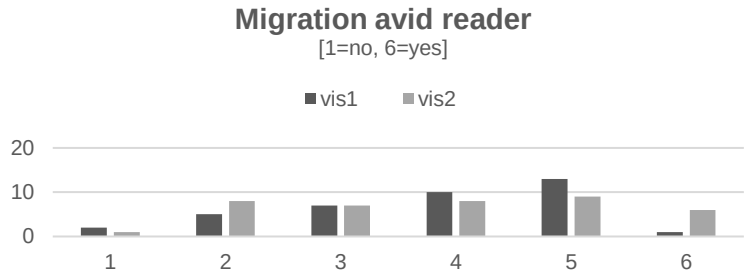


FIGURE 32: Propensity to read migration news articles

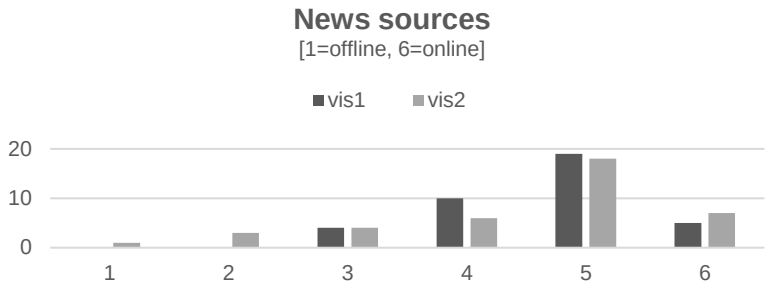


FIGURE 33: Participants' source of news articles and information

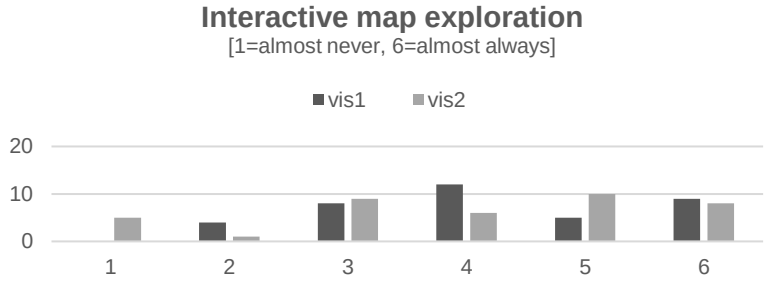


FIGURE 34: Propensity to explore encountered interactive visualizations

8.2. Structuring of the Data

Before discussing the statistical analysis of the results, it is important to mention how the provided information were structured to be analyzed. In fact, some answers already offer operational values that can directly be examined through statistical tests. Other responses are in the form of written report or need to be validated in terms of accuracy against a set of correct answers. To explain this procedure, a mock example is presented.

TABLE 3: Manipulation of the survey's results

ID	vis	Q34 - ANSWER		Q34 - SOLUTION		Q34 - POINTS
1	1	I do not know		Greece and/or Turkey		0 (=wrong)
3	1	Greece, Serbia, Bulgaria		Greece and/or Turkey		0 (=wrong)
4	1	Turkey	→	Greece and/or Turkey	→	1 (=right)
2	2	Greece, Turkey		Greece and/or Turkey		1 (=right)
5	2	Hungary		Greece and/or Turkey		0 (=wrong)

As TABLE 3 shows, only participants who wrote the answers "Greece" and/or "Turkey" are considered correct. If other countries are mentioned of if the participant does not give any answers (or a "I do not know" response), the cell is encoded as incorrect. By repeating this procedure on the whole dataset, all the questions with right/wrong answers are coded and the accuracy point is then calculated. Nonetheless, there are also open, unstructured questions that do not necessarily have a right/wrong solution. These questions are not included in the statistical analyses.

8.3. User Study: Statistical Analysis

This section presents the results from the statistical analysis of the user study. The statistical analysis of the results was implemented with the software SPSS[12]. The statistical tests are carried out following the guidelines of Field (2013). Comparisons of means for independent or paired-samples were conducted, according to normality tests, with either t-test, Mann-Whitney, ANOVA, Kruskal-Wallis or Wilcoxon (Field 2013). For each result the mean value, the standard deviation (STDV), the standard error of the mean (SEM) and the test values were reported. Significance values are reported following the convention: p≤0,05 (*), p≤0,001 (**), p≤0,005 (***). Before running each test, the variables were tested for normality using Shapiro-Wilk and by observing the respective QQ-plot and histogram (Field 2013; Yap and Sim 2011). Additionally, the outliers were removed using the outliers labelling rules (Hoaglin and Iglewicz 1987; Hoaglin, Iglewicz, and Tukey 1986; Tukey 1977). The effect size was computed for both significant and not-significant results. The interpretation follows Cohen's standards, where r=0,1 is a small, r=0,3 a medium and r=0,5 is a large effect (Field 2013). Cohen's d is interpreted according to Cohen's explanation as well; d≤0,2 is a small, d≤0,5 a medium and d>0,5 a large effect size (Field 2013).

[12] IBM SPSS Statistics Version 26

8.3.1. Accuracy

Accuracy is measured in percent of correct answers. A single value for each question is available, but the following statistical analysis is implemented per each survey page. The reason for the choice of a bigger granularity is twofold. On the one side, the questions are already grouped in different tasks in the questionnaire, so it makes sense to analyze them together. On the other hand, the available time data (see below) are recorded for each page, thus a comparison between time and accuracy could only be achieved at a bigger (i.e. per page) granularity. Overall, there is a difference between the accuracy of the two groups: the mean accuracy for vis1 is lower (M_{vis1}=70,78; SE_{vis1}=4,57) than the one of vis2 (M_{vis2}=77,94; SE_{vis2}=3,92).

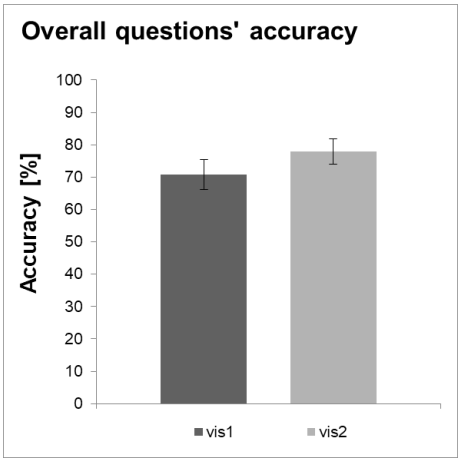


FIGURE 35: Mean accuracy in percentage (±SEM) for overall questions across visualization types

As FIGURE 35 shows, it exists a difference between groups but this variation is not statistically significant (U=575; n1=38; n2=39; p=0,089), and the effect size is small (r=0,19). To better understand the reasons behind this difference between vis1 and vis2, further analyses of data subsets have been implemented. First, the difference for each map extent was computed. A similar trend to the overall results can be observed, with vis2 that shows always better accuracy for both ext1 (M_{vis1}=70,76; SE_{vis1}=5,49 / M_{vis2}=75,50; SE_{vis2}=4,38) and ext2 (M_{vis1}=72,67; SE_{vis1}=3,82 / M_{vis2}=87,96; SE_{vis2}=2,67).

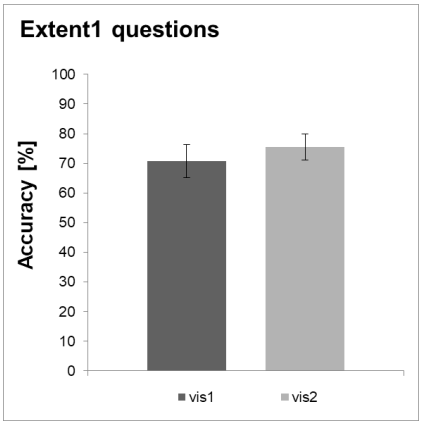


FIGURE 36: Mean accuracy in percentage (±SEM) for ext1 questions across visualization types

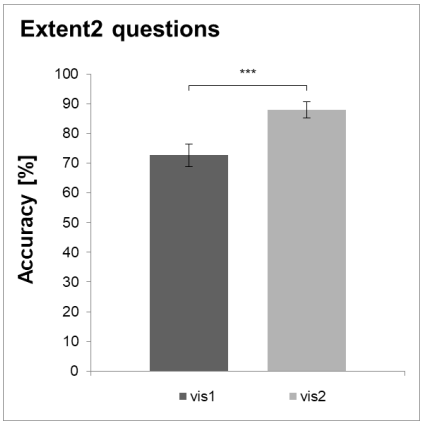


FIGURE 37: Mean accuracy in percentage (±SEM) for ext2 questions across visualization types

As FIGURE 36 shows, the difference between vis1 and vis2 for ext1 is relatively small, not statistically significant (U=713; n1=38; n2=39; p=0,773), and the effect size is small (r=0,03). On the contrary (FIGURE 37), the variation for ext2 is quite large and statistically significant (U=340,5; n1=37; n2=36; p=0,000). The effect size in this case is medium (r=0,43).

Another possibility is the analysis of the questions according to the task type. Again, there is a trend that suggests a better accuracy for vis2 with respect to vis1 for the task "Impact" (M_{vis1}=64,91; SE_{vis1}=4,35 / M_{vis2}=74,36; SE_{vis2}=4,62), "When" (M_{vis1}=70,18; SE_{vis1}=5,83 / M_{vis2}=78,21; SE_{vis2}=5,38) and "Generic" (M_{vis1}=77,19; SE_{vis1}=5,12 / M_{vis2}=83,33; SE_{vis2}=3,18).

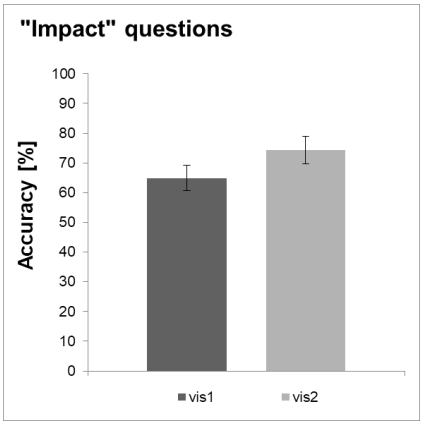


FIGURE 38: Mean accuracy in percentage (±SEM) for "Impact" questions across visualization types

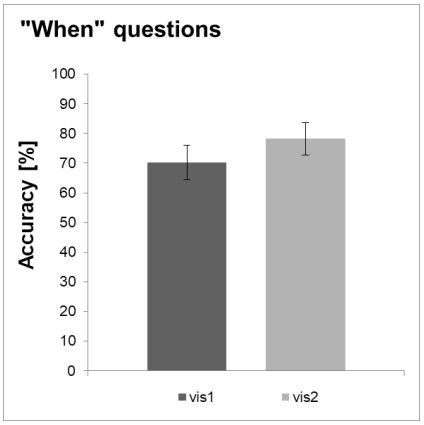


FIGURE 39: Mean accuracy in percentage (±SEM) for "When" questions across visualization types

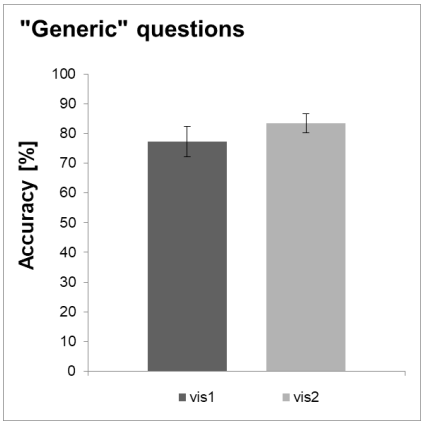


FIGURE 40: Mean accuracy in percentage (±SEM) for "Generic" questions across visualization types

FIGURE 38, 39 and 40 show a persistent trend but without a supporting statistical significance for the task "Impact" (U=589,5; n1=38; n2=39; p=0,116), the task "When" (U=593,5; n1=38; n2=39; p=0,108) and the task "Generic" (U=717; n1=38; n2=39; p=0,799). The effect size for the tasks "Impact" (r=0,18) and "When" (r=0,18) is considered medium, whereas the task "Generic" show a small effect size (r=0,03).

When considering both the task type and the map extent the analysis delivers other interesting results. First, one can consider the tasks only for ext1. Interestingly, while for the tasks "Impact" (M_{vis1}=67,54; SE_{vis1}=6,35 / M_{vis2}=78,63; SE_{vis2}=5,93) and "When" (M_{vis1}=70,18; SE_{vis1}=6,86 / M_{vis2}=73,50; SE_{vis2}=6,50) the previous trend persists, the task "Generic" is the only case with slightly better accuracy for vis1 than for vis2 (M_{vis1}=74,56; SE_{vis1}=5,40/ M_{vis2}=74,36; SE_{vis2}=3,96). The statistical analysis does not provide significant results neither for the task "Impact" (U=627; n1=38; n2=39; p=0,229), nor for "When" (U=711,5; n1=38; n2=39; p=0,728) or "Generic" (U=681,5; n1=38; n2=39; p=0,510). There is a small effect size for the tasks "When" (r=0,04) and "Generic" (r=0,08) and a medium effect size for the task "Impact" (r=0,14).

As expressed above, ext2 shows a significant difference between visualization groups. The following analysis allows to reconstruct which tasks are responsible for this strong variation. Whereas for all task types participants from vis2 performed better, the "Impact" task only shows a small difference (M_{vis1}=67,62; SE_{vis1}=3,48 / M_{vis2}=70,09; SE_{vis2}=5,31). On the other hand, the

tasks “When” (M_{vis1}=70,18; SE_{vis1}=5,59 / M_{vis2}=82,91; SE_{vis2}=5,18) and “Generic” (M_{vis1}=79,82; SE_{vis1}=5,70 / M_{vis2}=92,79; SE_{vis2}=4,11) display a greater dissimilarity.

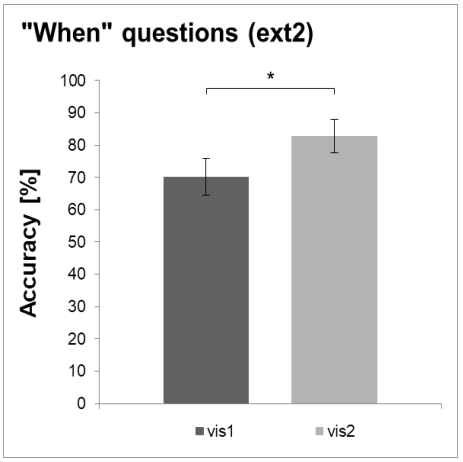


FIGURE 41: Mean accuracy in percentage (±SEM) for “When” questions of ext2 across visualization types

The statistical analysis shows a non-significant difference with a medium effect size for tasks “Impact” (U=593; n1=35; n2=39; p=0,298; r=0,12) and “Generic” (U=553,5; n1=38; n2=37; p=0,070; r=0,21) and – as shown in FIGURE 41 – a statistical significance as well as a medium effect size for the variation in the task “When” (U=552; n1=38; n2=39; p=0,030; r=0,25).

8.3.2. Response Time

The response time is measured in seconds and – as expressed above – the measurement occurs per page and not for each survey’s question. The time was analyzed only for correct and complete answers. As FIGURE 42 shows, the overall mean response times for vis1 (M_{vis1}=1080; SE_{vis1}=90) and vis2 (M_{vis1}=991; SE_{vis1}=57) are relatively similar, with a lower mean response time value for the second group (vis2).

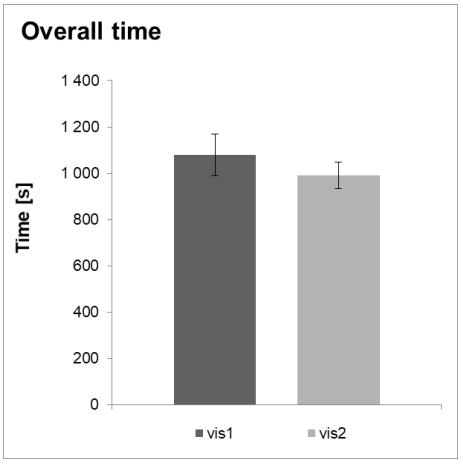


FIGURE 42: Mean response time in seconds (±SEM) for overall questions across visualization types

As FIGURE depicts, there is not statistical difference between the two groups (U=271,5; n1=25; n2=24; p=0,569) and the effect size is small (r=0,08).

The response time for map exploration and related questions with ext1 is higher for vis1 than vis2 (M_{vis1}=696; SE_{vis1}=63 / M_{vis2}=585; SE_{vis2}=34), while the opposite happens when analyzing the mean response time with ext2 (M_{vis1}=404; SE_{vis1}=32 / M_{vis2}=416; SE_{vis2}=23).

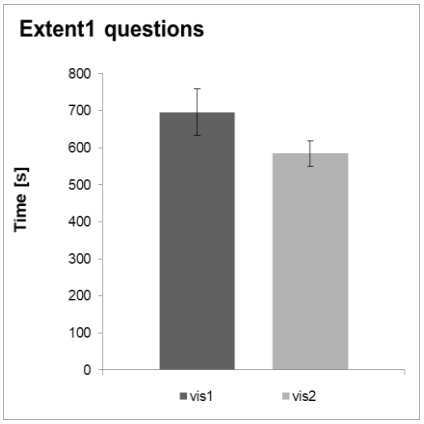


FIGURE 43: Mean response time in seconds (±SEM) for ext1 questions across visualization types

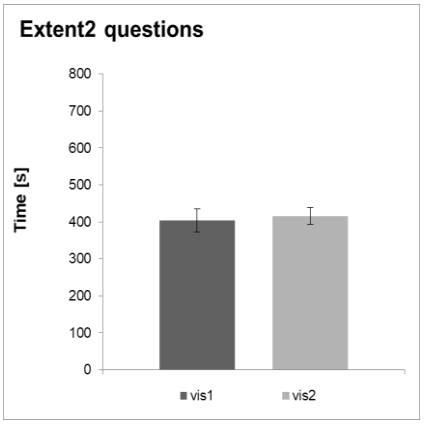


FIGURE 44: Mean response time in seconds (±SEM) for ext2 questions across visualization types

The differences for ext1 (U=553,5; n1=27; n2=26; p=0,070; r=0,21) and ext2 (U=553,5; n1=26; n2=31; p=0,070; r=0,21) are not statistically significant, as FIGURE 43 and FIGURE 44 illustrate. The effect size for ext2 is small (d=0,08), whereas ext1 has a medium effect size (d=0,44).

A similar trend is observable when analyzing the different task, while not considering the difference between ext1 and ext2 (FIGURE 45, 46, 47, 48). There is a trend suggesting that participants from vis2 were faster at answering the proposed questions for "Exploration" (M_{vis1}=191; SE_{vis1}=17 / M_{vis2}=176; SE_{vis2}=12), task "Impact" (M_{vis1}=324; SE_{vis1}=31 / M_{vis2}=307; SE_{vis2}=26), task "When" (M_{vis1}=402; SE_{vis1}=45 / M_{vis2}=339; SE_{vis2}=27) and task "Generic" (M_{vis1}=167; SE_{vis1}=15 / M_{vis2}=166; SE_{vis2}=11).

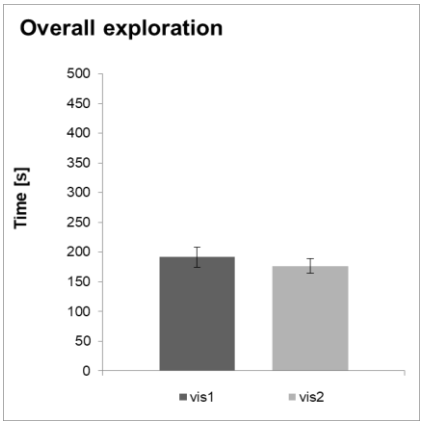


FIGURE 45: Mean response time in seconds (±SEM) for map exploration across visualization types

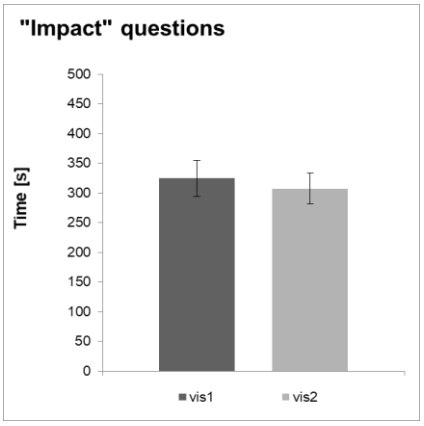


FIGURE 46: Mean response time in seconds (±SEM) for "Impact" questions across visualization types

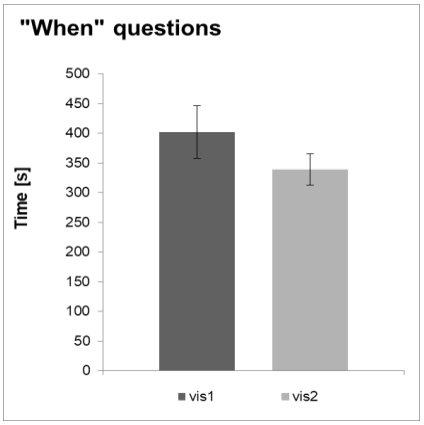


FIGURE 47: Mean response time in seconds (±SEM) for "When" questions across visualization types

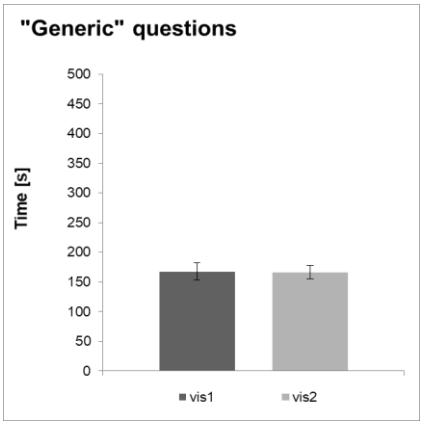


FIGURE 48: Mean response time in seconds (±SEM) for "Generic" questions across visualization types

However, as the results of the t-test and Mann-Whitney test advise, this difference does not reach a statistically significant level neither for the

"Exploration" (t=0,724; n1=33; n2=37; p=0,472), nor for the task "Impact" (t=0,431; n1=38; n2=37; p=0,668), nor for the task "When" (U=363; n1=28; n2=30; p=0,375) or even the task "Generic" (t=0,046; n1=32; n2=32; p=0,963). Furthermore, the effect sizes for these tests are small (d=0,18 / d=0,11 / r=0,12 / d=0,01).

Other observations show that for ext1 the amount of time necessary to complete the task "Exploration" (M_{vis1}=132; SE_{vis1}=16 / M_{vis2}=105; SE_{vis2}=8), task "Impact" (M_{vis1}=214; SE_{vis1}=22 / M_{vis2}=180; SE_{vis2}=16) task "When" (M_{vis1}=296; SE_{vis1}=31 / M_{vis2}=220; SE_{vis2}=17) was higher for participants from vis1, while the opposite is true for the task "Generic" (M_{vis1}=73; SE_{vis1}=6 / M_{vis2}=77; SE_{vis2}=6).

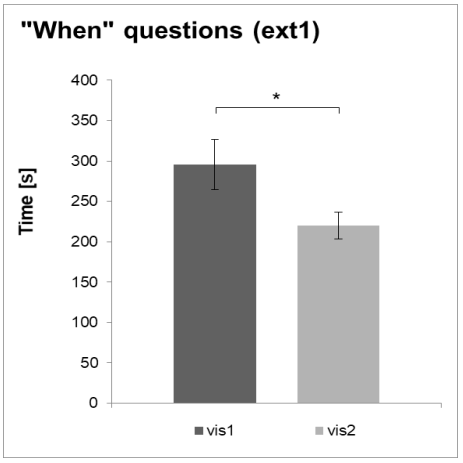


FIGURE 49: Mean response time in seconds (±SEM) for "When" questions of ext1 across visualization types

As displayed in FIGURE 49, the difference for task "When" is statistically significant (t=2,153; n1=29; n2=30; p=0,037) and the effect size is large (d=0,66). On the contrary, the statistical tests do not provide significant results neither for the "Exploration" (U=597,5; n1=35; n2=38; p=0,456), nor for the task "Impact" (t=1,221; n1=33; n2=34; p=0,226) or "Generic" (t=0,476; n1=33; n2=35; p=0,636). There is a small effect size for "Exploration" (r=0,09) and "Generic" (d=0,12) and a medium effect size for the task "Impact" (d=0,30). On the contrary, ext2 does not suggest any clear trend and the values for the tasks "Exploration" (M_{vis1}=73; SE_{vis1}=6 / M_{vis2}=74; SE_{vis2}=7), "Impact" (M_{vis1}=121; SE_{vis1}=11 / M_{vis2}=135; SE_{vis2}=13), "When" (M_{vis1}=122; SE_{vis1}=16 / M_{vis2}=122; SE_{vis2}=10) and "Generic"

(M_{vis1}=95; SE_{vis1}=10 / M_{vis2}=86; SE_{vis2}=6) do not significantly differ from vis1 to vis2. The statistical tests do not suggest a significant difference and the effect sizes are small (all values visible in Appendix D).

8.3.3. Generic Knowledge

The generic knowledge is measured as an accuracy trait, in percent of correct answers. These questions were asked before and after the survey, in the so-called opinion sections.

Before working with the maps, participants from vis1 have better results than vis2 (M_{vis1}=63,75; SE_{vis1}=4,50 / M_{vis2}=57,75; SE_{vis2}=4,80). On the contrary, the answer's accuracy afterward displays an opposite situation (M_{vis1}=73,75; SE_{vis1}=3,93 / M_{vis2}=79,50; SE_{vis2}=3,50).

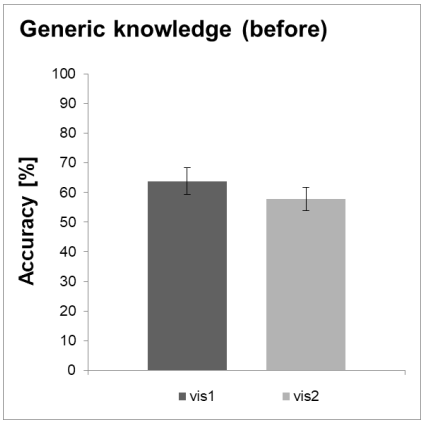


FIGURE 50: Mean accuracy in percentage (±SEM) for Generic knowledge (before) questions across visualization types

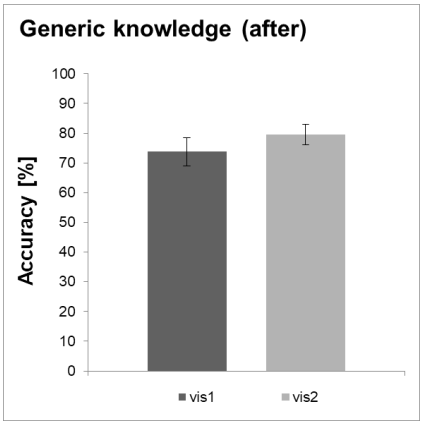


FIGURE 51: Mean accuracy in percentage (±SEM) for Generic knowledge (after) questions across visualization types

As FIGURE 50 and FIGURE 51 show, there is no statistical significant difference between vis1 and vis2 and the effect sizes are small for the "Before" section (U=643; n1=38; n2=39; p=0,299; r=0,12) and the "After" section (U=669,5; n1=38; n2=39; p=0,561; r=0,07).

The analysis of the differences inside each group between the answers before and after having worked with the maps delivers more meaningful results. There is an increase in the percentage of correct answers both for vis1

(M_{before}=63,75; SE_{before}=4,50 / M_{after}=73,75; SE_{after}=4,80) and vis2 (M_{before}=57,75; SE_{before}=3,93 / M_{after}=79,50; SE_{after}=3,50).

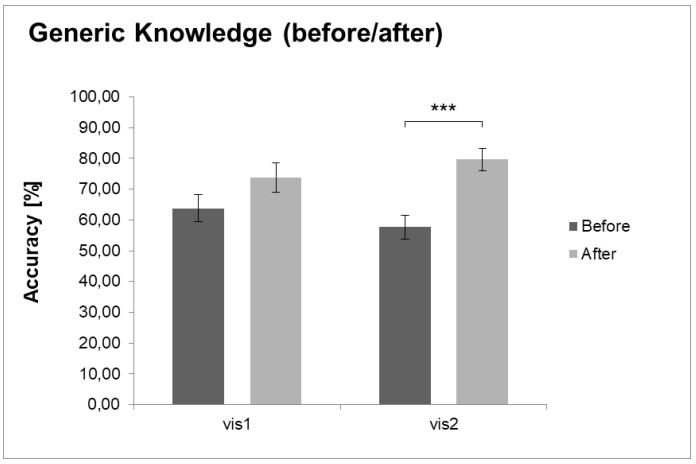


FIGURE 52: Mean accuracy in percentage (±SEM) for Generic knowledge (before/after) questions across visualization types

As FIGURE 52 depicts, the test for vis1 show no statistical significance (Z=1,918; p=0,055), while the comparison for vis2 confirms the visual impression of a statistically significant difference (Z=4,196; p=0,000). Moreover, the effect size for vis1 is small (r=0,22), whereas vis2 shows a large effect size (r=0,48).

8.3.4. Video Tactic

The video settings questions are in the form of a Likert scale. To better understand the results of the statistical analysis, these data are reported as percentage values of the maximum Likert scale points (Carifio and Perla 2007). The following settings are analyzed: “Switch”, “Pause” and “Watch”. Concerning ext1, there is no visible trend, no statistically significant difference between vis1 and vis2 and only a small effect size for “Switch” (M_{vis1}=80,26; SE_{vis1}=4,02 / M_{vis2}=77,78; SE_{vis2}=4,64 / U=730; n1=38; n2=39; p=0,905; r=0,01), “Pause” (M_{vis1}=76,32; SE_{vis1}=4,52 / M_{vis2}=77,78; SE_{vis2}=4,83 / U=706; n1=38; n2=39; p=0,705; r=0,04) and “Watch” (M_{vis1}=65,79; SE_{vis1}=4,35 / M_{vis2}=65,38; SE_{vis2}=4,64 / U=740,5; n1=38; n2=39; p=0,996; r=0,00). The same pattern is valid for ext2: “Switch”

(M_{vis1}=77,19; SE_{vis1}=4,51 / M_{vis2}=79,49; SE_{vis2}=4,39 / U=702,5; n1=38; n2=39; p=0,677; r=0,05), “Pause” (M_{vis1}=77,19; SE_{vis1}=4,51 / M_{vis2}=70,77; SE_{vis2}=4,35 / U=663; n1=38; n2=39; p=0,398; r=0,1) and “Watch” (M_{vis1}=59,21; SE_{vis1}=4,69 / M_{vis2}=66,67; SE_{vis2}=4,46 / U=632,5; n1=38; n2=39; p=0,261; r=0,13).

8.3.5. Video Evaluation

The questions concerning the evaluation of the videos are in the form of a Likert scale. To better understand the results of the statistical analysis, these data are reported as percentage values of the maximum Likert scale points (Carifio and Perla 2007). The following settings are analyzed: “Dates”, “Speed” and “Difficulty” and “Link”. Overall, there is no visible trend, no statistically significant difference between vis1 and vis2 and only a small effect size for “Dates” (M_{vis1}=58,77; SE_{vis1}=4,20 / M_{vis2}=52,56; SE_{vis2}=3,90 / U=634; n1=38; n2=39; p=0,226; r=0,13), “Speed” (M_{vis1}=74,12; SE_{vis1}=2,93 / M_{vis2}=72,81; SE_{vis2}=2,77 / U=691,5; n1=38; n2=39; p=0,742; r=0,04), “Difficulty” (M_{vis1}=52,63; SE_{vis1}=3,53 / M_{vis2}=55,56; SE_{vis2}=3,20 / U=671; n1=38; n2=39; p=0,464; r=0,08) and “Link” (M_{vis1}=64,04; SE_{vis1}=4,33 / M_{vis2}=63,68; SE_{vis2}=4,74 / U=731,5; n1=38; n2=39; p=0,921; r=0,01).

8.3.6. Opinion

The opinion measurement is divided in two categories: the voting sessions and questions about the hospitality of migrants. These questions are framed as Likert scales; but to better understand the statistical analysis, these data are reported as percentage values of the maximum Likert scale points (Carifio and Perla 2007). A high value stands for on open attitude toward migrants, whereas a low value means a rather close attitude toward them. All these values were measured at the beginning and at the end of the survey, to assess the influence the map on the participants’ answers. Overall, there is a slightly difference between values from vis1 and vis2, both before (M_{vis1}=70,75; SE_{vis1}=1,64 / M_{vis2}=72,75; SE_{vis2}=2,03) and after (M_{vis1}=70,82; SE_{vis1}=2,18 / M_{vis2}=75,54; SE_{vis2}=1,80) having worked with the intrinsic or the extrinsic visualization.

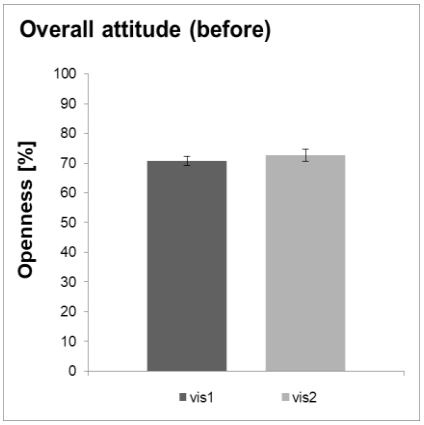


FIGURE 53: Mean openness in percentage (±SEM) for Overall attitude (before) questions across visualization types

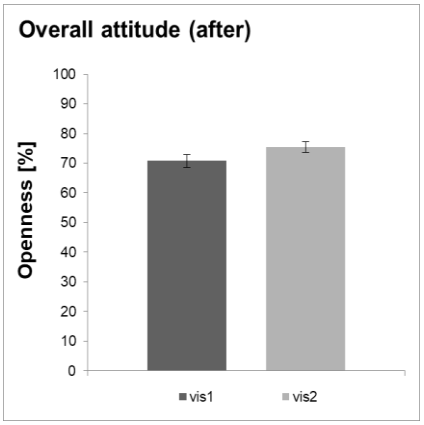


FIGURE 54: Mean openness in percentage (±SEM) for Overall attitude (before) questions across visualization types

As FIGURE 53 and FIGURE 54 show, there is no statistical significance in the observed difference neither in the "Attitude before" (U=616; n1=37; n2=38; p=0,354) nor in the "Attitude after" (U=535; n1=35; n2=39; p=0,108), and the effect sizes are small (r=0,11 / r=0,19). A more detailed analysis of the results reveals a similar trend for most of the questions that build this overall attitude index. Namely, a more open attitude toward migrants for vis2. However, the only statistically significant difference (see FIGURE 55) concerns the hospitality of migrants who flee from war regions (U=495,5; n1=35; n2=39; p=0,025). Here the effect size is small to medium (r=0,26). The statistical tests for the other questions do not suggest a significant difference and the effect sizes are small (all values visible in Appendix D).

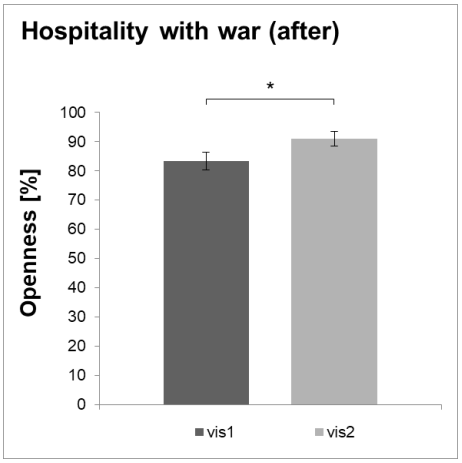


FIGURE 55: Mean openness in percentage (±SEM) for Hospitality with war question (after) questions across visualization types

The analysis of the differences inside each group between overall opinion before and after having explored the map delivers interesting results. Whereas for vis1 there is no visible change (M_{before}=70,75; SE_{before}=1,64 / M_{after}=70,82; SE_{after}=2,18), vis2 has an increase in the attitude percentage value (M_{before}=72,75; SE_{before}=2,03 / M_{after}=75,54; SE_{after}=1,80).

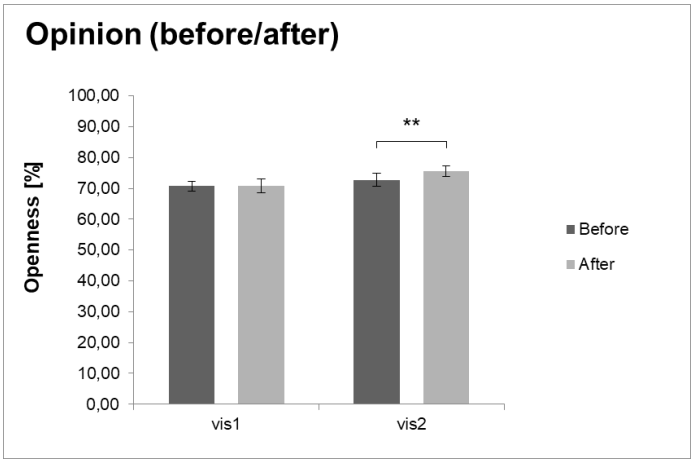


FIGURE 56: Mean openness in percentage (±SEM) for Opinion questions (before/after) questions across visualization types

FIGURE 56 indicate that the difference in vis1 is not statistically significant and has a small effect size (Z=0,370; n1=37; n2=35; p=0,711; r=0,04). On the contrary, the change in vis2 is statically significant and has a small to medium effect size (Z=2,423; n1=38; n2=39; p=0,015; r=0,28).

The analysis of the pre-vote and vote subjects shows no observable trend for vis1 on vote "Subject1" (M_{before}=89,47; SE_{before}=3,22 / M_{after}=86,84; SE_{after}=3,74), "Subject2" (M_{before}=59,21; SE_{before}=3,82 / M_{after}=59,21; SE_{after}=4,26), "Subject3" (M_{before}=40,13; SE_{before}=4,21 / M_{after}=42,11; SE_{after}=3,14) and "Subject4" (M_{before}=73,68; SE_{before}=4,21 / M_{after}=70,39; SE_{after}=4,31). On the other hand, participants from vis2 often adjusted their percentage toward a more open attitude. This is true for "Subject1" (M_{before}=86,54; SE_{before}=3,66 / M_{after}=90,38; SE_{after}=2,85), "Subject2" (M_{before}=66,67; SE_{before}=4,24 / M_{after}=69,23; SE_{after}=3,84) and "Subject3" (M_{before}=33,97; SE_{before}=2,83 / M_{after}=36,54; SE_{after}=3,29), while "Subject4" (M_{before}=78,21; SE_{before}=4,42 / M_{after}=77,56; SE_{after}=3,76) displays an opposite situation. None of the statistical tests for these questions suggests a

significant difference and the effect sizes are small (all values visible in Appendix D). The analysis of the hospitality questions asked at the beginning and at the end of the questionnaire shows a general increase in the percentage values for the questions set after having explored the map. For vis1, the "after" values are higher for "Hospitality" (M_{before}=73,00; SE_{before}=2,98 / M_{after}=76,17; SE_{after}=3,77) and "Hospitality war" (M_{before}=82,83; SE_{before}=2,53 / M_{after}=83,33; SE_{after}=3,13). The trend is even more noticeable for vis2, where "Hospitality" (M_{before}=75,67; SE_{before}=2,45 / M_{after}=79,00; SE_{after}=3,05) and "Hospitality war" (M_{before}=86,33; SE_{before}=3,20 / M_{after}=91,00; SE_{after}=2,52) show even larger variations.

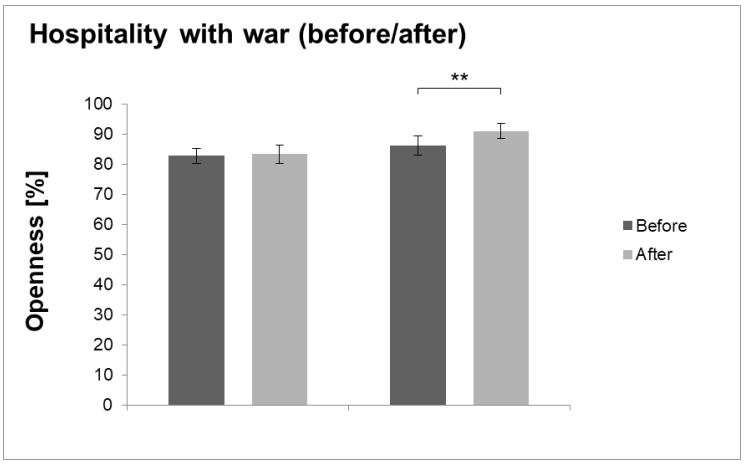


FIGURE 57: Mean openness in percentage (±SEM) for Hospitality with war question (before/after) questions across visualization types

As FIGURE 57 depicts, the difference between "Hospitality war" for vis2 is statistically significant with a medium effect size (Z=2,324; n1=38; n2=39; p=0,020; r=0,26). On the contrary, there are no statistical significant difference and small effect sizes for vis1 "Hospitality" (Z=0,947; n1=37; n2=35; p=0,343; r=0,11) and "Hospitality war" (Z=0,000; n1=37; n2=35; p=1,000; r=0,00), and for vis2 "Hospitality" (Z=1,604; n1=38; n2=39; p=0,109; r=0,18).

8.3.7. Visualizations Rating

An overall preference question is proposed at the beginning and at the end of the survey, which indicates an almost unanimous preference for vis2 (FIGURE 58).

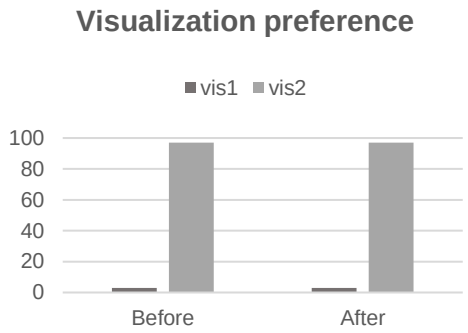


FIGURE 58: Visualizations' preference questions (before and after)

The visualizations rating questions are proposed in the form of a Likert scale, and are meant to be an evaluation of the two visualization types. To better understand the results of the statistical analysis, these data are reported as percentage values of the maximum Likert scale points (Carifio and Perla 2007). The following aspects are analyzed: "Look", "Borders", "Arrivals", "Link", "Time" and "Routes". Since there is no observable trend for both vis1 and vis2, no statistically significant difference and only small effect sizes, the data of the two groups and the statistical analyses are not presented in this section (all values available in Appendix D). Similar to the opinion questions, the visualizations rating is proposed at the beginning of the survey and after having explored one of the other visualization type. Therefore, another analysis level is available, namely, the variation of the ratings during the study. The analysis of the evaluation done by participant from vis1 shows a general increase in the percentage values for the questions set after having explored the map. For participants from vis1, there is an increase in all aspects: "Look" (M_{before}=57,02; SE_{before}=3,12 / M_{after}=57,46; SE_{after}=3,48), "Borders" (M_{before}=45,61; SE_{before}=3,81 / M_{after}=46,05; SE_{after}=4,37), "Arrivals" (M_{before}=59,21; SE_{before}=3,48 / M_{after}=63,16; SE_{after}=3,45), "Link" (M_{before}=34,65; SE_{before}=3,46 / M_{after}=40,79; SE_{after}=4,11), "Time" (M_{before}=46,93; SE_{before}=3,76 / M_{after}=52,19; SE_{after}=3,67) and "Routes"

(M_{before}=51,75; SE_{before}=3,97 / M_{after}=53,07; SE_{after}=3,49). The participants of vis2 also show an increase in "Borders" (M_{before}=38,89; SE_{before}=3,84 / M_{after}=41,88; SE_{after}=3,96), "Arrivals" (M_{before}=58,40; SE_{before}=4,19 / M_{after}=61,97; SE_{after}=3,18), "Link" (M_{before}=32,91; SE_{before}=2,49 / M_{after}=42,31; SE_{after}=3,77) and "Routes" (M_{before}=43,16; SE_{before}=3,61/ M_{after}=52,14; SE_{after}=3,83), and a slight decrease in "Look" (M_{before}=55,13; SE_{before}=2,95 / M_{after}=53,85; SE_{after}=2,90) and "Time" (M_{before}=55,98; SE_{before}=4,22 / M_{after}=50,85; SE_{after}=4,46).

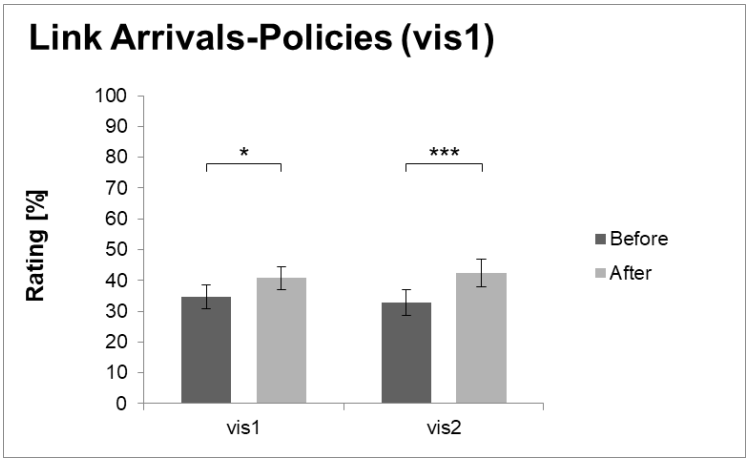


FIGURE 59: Mean rating in percentage (±SEM) for Link Arrivals-Policies regarding vis1, across visualization types

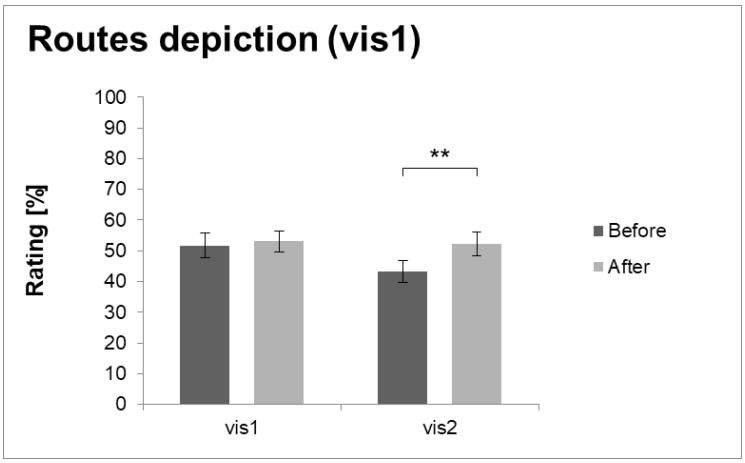


Figure 60: Mean rating in percentage (±SEM) for Route depiction regarding vis1, across visualization types

As FIGURE 59 depicts, the change for "Link" is statistically significant with a small to medium effect size both for vis1 (Z=2,148; p=0,032; r=0,25) and vis2 (Z=2,819; p=0,005; r=0,32). Correspondingly, as shown in FIGURE 60, the difference between "Routes" *before* and *after* is statistically significant for vis2 with a small to medium effect size (Z=2.631; p=0,009; r=0,29). On the other hand, there are no statistical significant variations and small effect sizes for all the other variables (for detailed values see Appendix D).

The analysis of the evaluation done by participants from vis2 shows a general increase in the percentage values for the questions set after having explored the map. For participants from vis1, there is an increase in all aspects: "Look" (M_{before}=62,72; SE_{before}=3,52 / M_{after}=67,11; SE_{after}=3,74), "Borders" (M_{before}=67,11; SE_{before}=3,90 / M_{after}=69,74; SE_{after}=3,82), "Arrivals" (M_{before}=60,09; SE_{before}=3,64 / M_{after}=64,47; SE_{after}=3,51), "Link" (M_{before}=56,14; SE_{before}=4,33 / M_{after}=64,04; SE_{after}=3,95), "Time" (M_{before}=46,93; SE_{before}=3,66 / M_{after}=51,32; SE_{after}=3,69) and "Routes" (M_{before}=57,02; SE_{before}=3,59 / M_{after}=61,84; SE_{after}=3,82). The participants of vis2 show an increase in and "Look" (M_{before}=58,55; SE_{before}=3,35 / M_{after}=64,10; SE_{after}=3,09), "Borders" (M_{before}=72,65; SE_{before}=3,90 / M_{after}=76,50; SE_{after}=3,50), "Arrivals" (M_{before}=58,12; SE_{before}=3,87 / M_{after}=64,10; SE_{after}=3,27), "Link" (M_{before}=40,72; SE_{before}=3,74 / M_{after}=63,68; SE_{after}=3,51) and "Routes" (M_{before}=51,28; SE_{before}=3,59 / M_{after}=57,69; SE_{after}=3,46), and a slight decrease in "Time" (M_{before}=51,71; SE_{before}=4,01 / M_{after}=48,72; SE_{after}=4,47).

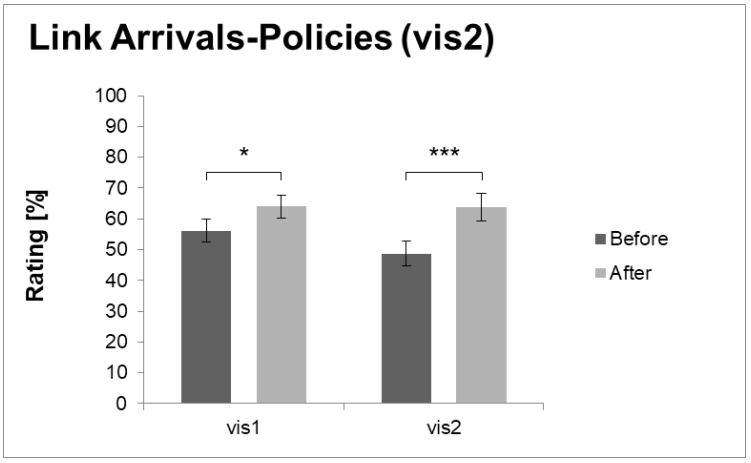


FIGURE 61: Mean rating in percentage (±SEM) for Link Arrivals-Policies regarding vis2, across visualization types

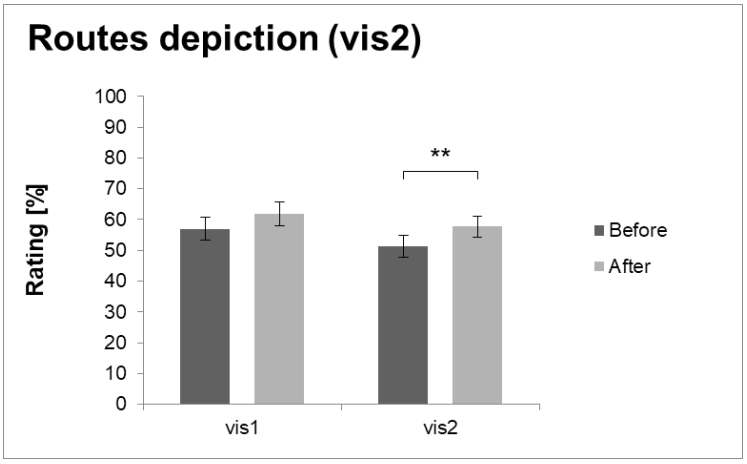


FIGURE 62: Mean rating in percentage (±SEM) for Routes depiction regarding vis1, across visualization types

As FIGURE 61 shows, the difference between "Link" *before* and *after* is statistically significant with a small to medium effect size both for vis1 (Z=2,492; p=0,013; r=0,29) and vis2 (Z=3,296; p=0,001; r=0,37). Similarly, as displayed by FIGURE 62, the variation for "Routes" is statistically significant for vis2 with a small to medium effect size (Z=2,487; p=0,013; r=0,28). On the contrary, there are no statistical significant differences and small effect sizes for all the other variables (detailed values in Appendix D).

9. Discussion

RSQ 1: Do border policies influence migration trajectories?

"Borders, far from serving simply to block or obstruct global flows, have become essential devices for their articulation" (Mezzadra and Neilson 2012, 64). This quote perfectly encapsulates the idea behind this research question, and the results that both previous research and the proposed visualization suggest. Borders are not only obstacles, or rather, borders can also obstruct a migration route, but the migration movement itself is only rearticulated and rearranged according to the new travel possibilities. Therefore, it is central to study borders (i.e. border policies) and migration as dependent factors that influence each other. As Raeymaekers argues:

> It is not sufficient to simplistically associate territorial state boundaries with fixity [...]. Useful as this imagery might be for staging resistance, it does not do justice to the often complex and intricate ways in which sovereign power reaches across multiple scales and spaces. (Raeymaekers 2014).

A first step in this direction is to assess the rules, hence the policies, enacted at the border, which give a whole different meaning to the border itself. The same border line might gain a rather diverse, sometimes even opposite, power depending on the policies implemented there. Furthermore, these shaping and reassembling actions have a life of their own, meaning that the temporal dimension needs to be considered as well. In fact, the implementation and eradication of policies is a process that stretches over a long period of time.

Results of the online survey suggest that the combination of the numbers of arrivals and border policies as intrinsic information on a map allows to accurately analyze the impact of one phenomenon on the other, and vice-versa. A similar understanding might also be gained by assessing mapped arrivals data and extrinsic information about policies implementation in a separate form, but the link is less evident and – as both the survey and the interviews shows – less preferred. Thus, in the rest of this section, the interesting findings from the exploration of the implemented visualization are described, with the support of other studies, reports and journal articles on the topic. As REACH (2004) and Bojadzijev and Mezzadra (2015) also

illustrate, there are evidences of the interplay between border policies and migrants' arrivals. In order to show this, one explicative case, namely, the "Northern Balkan shift", can suffice. Since it is not possible to directly report the animation in the thesis, daily snapshots will be presented (FIGURE 63).

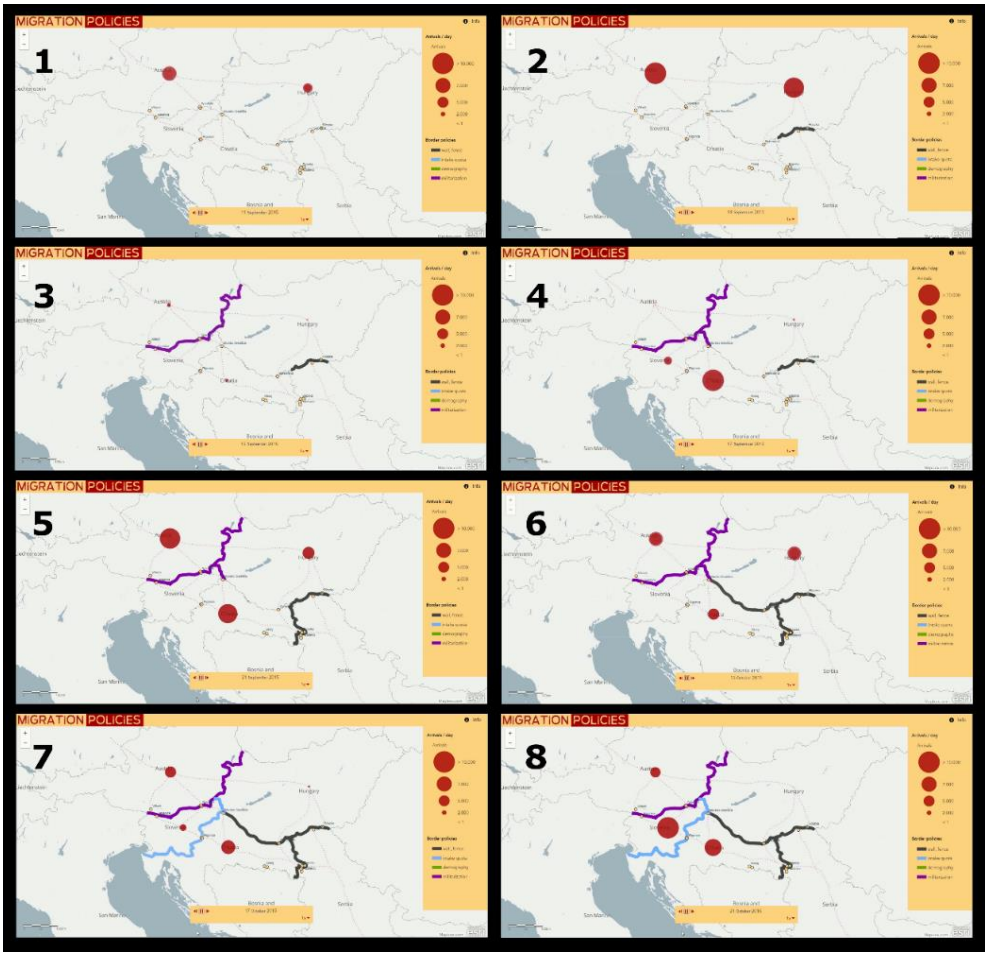


FIGURE 63: Daily snapshots of the "Northern Balkan shift". Displayed days are: 11.09.2015 (1), 14.09.2015 (2), 15.09.2015 (3), 17.09.2015 (4), 21.09.2015 (5), 15.10.2015 (6), 17.10.2015 (7) and 21.10.2015 (8)

As displayed in FIGURE 63.1, the initial situation shows migrants coming from Serbia crossing the Hungarian border and then travelling to Austria. Croatia and Slovenia are momentarily not part of the Balkan route (Borić and Sabic 2016). In FIGURE 63.2, one can observe that the number of arrivals has increased and Hungary implemented a policy, namely "wall/fence" (ACAPS 2016; Musarò 2016). This policy has caused a drastic reduction in the arrivals in the following days for Hungary and Austria, which, as FIGURE

63.3 shows, also implemented a "militarization" policy (Borić and Sabic 2016). As FIGURE 63.4 shows, after three days, Croatia experienced a large influx of migrants, while Hungary was still under a low arrivals period (Brouwer and Amsterdam 2015). Interestingly, in the following days, the migration focal route was passing again through Hungary (FIGURE 63.5). The border between Hungary and Serbia still shows a "wall/fence" policy, thus, migrants travelled via Croatia. Croatia implemented a "wall/fence" policy as well, which nevertheless did not have the same efficacy at obstructing the migration movement. One of the possible reasons is that the government focused on organized, quickly transfer transit of migrants from the Serbian border to the Hungarian border (ACAPS 2016). After entering Croatia, the route turned again to Hungary before reaching Austria, instead of passing through Slovenia. Thus, the implemented policy only shifted the route to other less controlled locations (Jones 2016; Pluim and Bilger 2016).

> Migrants began entering Slovenia after Hungary closed its border with Serbia, and the entire Western Balkan route was redirected through Croatia. However, in the first couple of weeks of the crisis, Croatia directed migrants back to Hungary. The massive inflow to Slovenia started only after Hungary erected a fence along its Croatian border (Borić and Sabic 2016, 15).

The Hungarian implementation of a "wall/fence" policy at the border with Croatia is visible in FIGURE 63.6, and the consequences of this policy are shown in FIGURE 63.7. The arrivals in Hungary stopped, while Croatia and Slovenia experienced a large influx of migrants. Slovenia preventively enforced an "intake quota" policy at its borders with Hungary and Croatia, stating a maximum number of arrivals per day. The shift in the Northern Balkan route was ultimately completed and the magnitude of the arrivals per day was going to remain stable, if not increasing, for the following weeks (FIGURE 63.8). This example highlights the need for intrinsic policy visualization for understanding the link between policies and migration. Indeed, the connection between arrivals and policies, but, more importantly, the understanding of the influence that these two variables have on each other, is facilitated by such a visual approach. The preference for an intrinsic approach over an extrinsic one for understanding policies and migration is also shown by the participants of the user study. Participants were asked to evaluate both visualizations at the beginning of the study. Then, after

answering the question by looking at either the extrinsic (vis1) or the intrinsic (vis2) visualization, they were asked to evaluate both visualization a second time. One of the proposed questions shows exactly the appreciation rating for the link between arrivals and policies (if it was understandable and how easily so). Before working with either one of the visualizations, participants show an appreciation rating of only 30% to 50% for both the vis1 (extrinsic) and vis2 (extrinsic). After exploring either one of the visualizations and completing the survey, an increase in the appreciation rating of 45% to 65% is observable in both visualizations. This difference is statistically significant for both visualizations, but the values and the increase for vis2 shows a higher significance level, thus suggesting that the extrinsic visualization had a more positive impact on participants for allowing them to understand the link between arrivals and policies. The experts expressed a similar opinion about the visualizations. Most of them prefer vis2 with respect to vis1 concerning the understanding of the influence of border policies on migration patterns. One argues that the intrinsic visualization has the "very clear visual effect of seeing a border come up between states. That was very powerful in the second map. And I enjoyed it! It really shows the effect". Therefore, the short answer to the research question is "yes". The hypothesis might be accepted; indeed, border policies have a considerable influence on migration trajectories and have also changed and reshaped the Balkan route.

RSQ 2: How does intrinsic border policies visualization compare to an information equivalent extrinsic visualization regarding *performance metrics* and *subjective metrics* in the context of data journalism?

The performance metrics are divided in accuracy and response time results. Therefore, the following paragraph presents both parameters and a final combination of the two by integrating survey's and interviews' outcomes.

The overall accuracy shows a higher value for vis2, suggesting that participants who worked with the extrinsic vis2 achieved better results than their counterpart with vis1. However, this difference has no statistically significant meaning. Notwithstanding this apparently insufficient result, a more minute analysis of the different parts of the survey reveals noteworthy

information. The accuracy divided by answer task type confirms the previously described trend. Indeed, vis2 shows better accuracy results than vis1 for all task types. Nevertheless, this difference, even if consistent with other observed changes, has no statistical significance. In a similar fashion, the difference in the accuracy for ext1 (i.e. zoomed map focused on the "Northern Balkan shift") show better outcomes with the intrinsic vis2. Accuracy for ext2 (i.e. map showing whole Balkan route) shows a better result for vis2 as well, but this variance (70% for vis1 and almost 90% for vis2) is statistically significant. This comparison suggests that the intrinsic visualization of border policies is significantly better at displaying overall changes on continental scale maps. This result is consistent with the advantages and limitation identified by Slocum et al. (2003). Indeed, they argue that intrinsic symbolization is specifically suited for displaying complex visualization. In this case, the more complex ext2, which contains more information and more visual variables, shows significant better results for participants working with the intrinsic vis2. The statistically significant difference might be further explained if one analyzes the single task types for ext1 and ext2. The trend of better results for vis2 is still valid for all tasks, and the major difference is observable for the "WHEN" questions of ext2. In this case, the accuracy of 70% of vis1 is surpassed by the accuracy score of more than 80% of participants from vis2.

Another aspect related to the accuracy results concerns the answers of so called "generic knowledge" questions. These questions are asked before starting to work with the visualizations and are repeated afterwards. The trend here indicates that the situation before and after is inverted. Indeed, before starting the study, participants from vis1 performed better (i.e. higher accuracy) than participants from vis2, but in the repetition, participants from vis2 have much higher accuracy scores. This difference between vis1 and vis2 is not statistically significant, but on the other hand, the improvement occurred for vis2 has a high statistical significance. This suggests that the learning process for participants working with an intrinsic visualization (vis2) is more efficient than the one for an extrinsic visualization (vis1). While an amelioration is also observable for vis1 (from more than 60% to more than 70%), the improvement showed by participants from vis2 is much more evident and significant (from less than 60% to almost 80%).

The trend suggested by all the results and the statistical significance of a couple of them, leads to a conclusion that confirms previous research (Slocum et al. 2003; Brügger, Fabrikant, and Çöltekin 2016; Štěrba et al. 2014; Gershon 1998). In fact, the intrinsic visualization of border policies shows better accuracy results as opposed to an extrinsic visualization of these policies. Brügger, Fabrikant, and Çöltekin (2016) argue that these difference might be due to the split-attention effect. This explanation also fits in the visualizations compared in this thesis. Indeed, with vis1 participants have to divide the attention amongst multiple sources of information. This cognitive load does not persist with vis2, where users need to focus only on the map, since all the relevant information is being displayed there. However, if one considers the different interactive nature of the two visualizations, the results are more unexpected. On the one hand, border policies in vis1 are static and do not change while interacting with the temporal settings. On the other hand, border policies in vis2 show an interactive behavior as well. Indeed, while scrolling through the different dates, border policies appear and disappear on the map. Therefore, the accuracy results of the online survey might be opposing what previous studies suggest. Namely, that static visualizations favor a better understanding of the displayed phenomena and interactive visualizations usually fail to do so (Tversky, Morrison, and Bétrancourt 2002; Morrison and Tversky 2001; Hegarty and Just 1993; Hegarty 1992; Cinnamon et al. 2009; Bétrancourt and Tversky 2000; Hegarty 1992; Hegarty and Just 1993; Hegarty et al. 2009; Poplin 2015). Nevertheless, the comparison between this thesis and the mentioned studies is subtler as opposed to the discourse of intrinsic/extrinsic visualization. Therefore, it is fitting to claim that accuracy results are supported by current literature.

The overall time result indicates that participants from vis1 needed almost 100 seconds more to complete the "Main Part" of the user study than participants from vis2. Even if the difference is not statistical significant, this might suggest that working with intrinsically presented information might require less time than working with an extrinsic visualization of border policies. The time measurements divided by extent or by task type show the following tendency: either no difference between vis1 and vis2, or higher time values for vis1 with respect to vis2. Apart from the result for "WHEN" questions for ext1, almost all other results are not statistically significant. It

appears that to answer questions regarding the date of occurrence of specific events and possible causes might require a significantly shorter period of time when working with a visualization focus on few visual variables.

In order to assess the value of the overall performance metrics results, it is important to link the accuracy percentages with time measurements. Indeed, if the difference in the accuracy results is mirrored by a higher need of time, the finding might not be as noteworthy as if the higher accuracy was not reached at the expense of a higher time implementation. The results, however, do not indicate an accuracy increase only with higher response time. On the contrary, the intrinsic visualization appears to link higher accuracy with equal response time, or even less, with respect to the extrinsic visualization (FIGURE 64). The lines in the mentioned figure display the linear trendline for vis1 and vis2. This behavior is also confirmed by Brügger, Fabrikant, and Çöltekin (2016), who argue that tasks using an intrinsic visualization require less time as opposed to an information equivalent extrinsic visualization. Here as well, a possible explanation might be the split-attention effect, that alongside worse accuracy is also responsible for higher response time measurements. As in the case of accuracy results, the literature on static and interactive visualizations suggest that the time need is higher for the latter, and this trend is not visible in the results of this thesis. However, as expressed above, the most relevant link is rather with researches on intrinsic/extrinsic visualization that, in fact, confirm the performance metrics analyzed here.

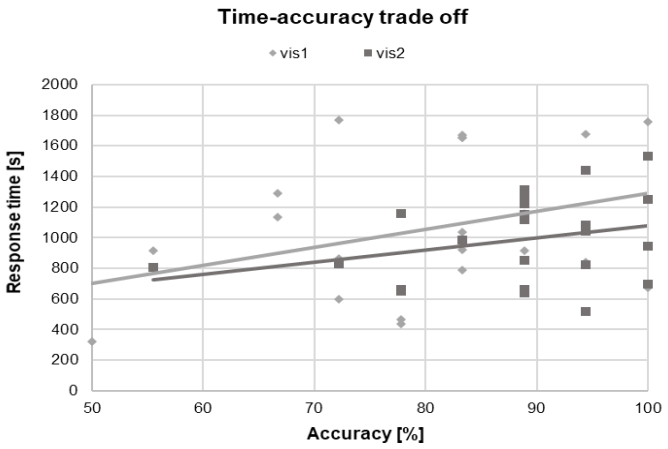


FIGURE 64: Time-accuracy trade off graph displaying mean accuracy in percentage against response time in seconds

After having discussed the performance metrics, the chapter continues by presenting the subjective metrics, which comprehend the following results: video tactic, video evaluation and visualizations evaluation. All these categories are addressed in the next paragraphs. In general, there is a clear preference for the intrinsic visualization (vis2). The most direct question concerning this comparison shows an almost unanimous predilection for vis2, both before and after having worked through the questionnaire. This outcome is partially supported by the more detailed analysis of the other results explained in the following paragraphs.

With the data collected from the questions about the video tactics, no statement could be made about the evaluation of the two videos (i.e. visualizations). It seems that there is no difference in the approach used to explore the two videos either between the vis1 and vis2, or between the different extents of the same visualization. The number of pauses needed, the number of switches between questions and video, as well as the total number of times that participants have watched the video overall do not show any trend, not even non-significant hints. The reason for this result is, perhaps, that the two visualizations are too similar. In fact, the allowed interaction with videos is very similar, since only the border policies change. Moreover, there is no effect of the visualization type on the evaluation of video settings and depiction. The difficulty of the proposed questions, the animation speed, the link between policies and arrivals and the depiction of the dates are rated similarly between vis1 and vis2. Interestingly, the link between policies and arrivals is rated differently in the context of the video evaluation to what it is rated in the context of evaluation of the visualizations. No explanation could be found for this particular behavior.

The evaluation of the visualizations is central to this research question. The following aspects of the visualizations are discussed: Look, Borders, Arrivals, Link, Time and Routes. With the data collected from these questions, no statement could be made concerning differences in the comparison between vis1 and vis2. Nonetheless, this set of questions was proposed at the beginning and at the end of the user study, and the comparison from answers before and after having worked with the visualizations lead to more interesting findings. For participants working with vis1, the “Link” and the “Routes” experienced a statistically significant increase in the evaluation percentage

values for vis1 (only “Link”), and more strongly for vis2. This suggests that if one works and explores vis1, their evaluation of the capacity to link policies and arrivals and the quality of the depiction of migration routes for the other visualization (vis2) rises significantly. This might be interpreted as follows: the understanding of the difficulty to grasp these feature in one’s own visualization (extrinsic vis1) favors a better evaluation of the other visualization (intrinsic vis2) concerning these problematic aspects. In the eyes of participants from vis1, the problems encountered while working with vis1, appear to be resolvable with the help of vis2. A similar trend is true for participants from vis2. Here as well, the evaluation of “Link” and “Routes” shows a statistically significant improvement regarding vis2, as well as “Link” for vis1. Differently from what discussed before, in this case the difference shows a reinforcement of the evaluation of one’s own visualization. Indeed, after having worked through all the questions, participants from vis2 rated their own visualization much better than before. The convincing factor for this improvement might have been precisely the possibility of experiencing the visualization, which convinced the participants of its utility, specifically for “Links” and “Routes”. A clear preference for vis2 was also expressed by experts while trying to solve the proposed questions (see Appendix C).

The results obtained from the participants subjective metrics and the experts interviews follow what Hegarty et al. (2009) suggest, namely that participants tend to favor the animated version of a visualization instead of the static counterpart. However, as discussed above, in this thesis the comparison does not precisely involve static and animated visualizations. Indeed, both visualizations used for the comparison are generally animated, but only vis2 displays also border policies in an animated fashion, whereas vis1 uses a static policies’ representation. Therefore, for this research question there is no short and straightforward answer. On the one hand, the intrinsic border policies visualization shows better accuracy results, higher learning scores and less or equal time measures with respect to an extrinsic policies visualization. Only a small portion of the results indicates a statistically significant difference, but the trend explained above is consistent throughout all questions. Therefore, the hypothesis that intrinsic visualization shows better performance metrics than an extrinsic approach might be accepted with some level of insecurity concerning the statistically non-significant results. These

results are also supported by previous studies (Brügger, Fabrikant, and Çöltekin 2016; Gershon 1998; Štěrba et al. 2014). On the other hand, there is a need to focus on increasing the number of evidences that support the second part of the research question: namely, the subjective metrics of the visualizations. Indeed, some results suggest a preference – significant at times – for the intrinsic policies visualization, but instead numerous variables do not indicate any difference between the two visualization's approaches. Nonetheless, the most simple and direct question that compares the two visualizations suggests a clear predilection for the intrinsic vis2.

RSQ 3: Do participants' opinion change according to the visualization method, in the context of data journalism?

It is difficult and possibly arbitrary to measure the participants' opinion in a survey structured like the one used in this context. The modality in which the questions are formulated, as well as the order in which they are asked, can influence the users' response. Nevertheless, the results from the user study are designed to provide an answer to this research questions. The questions evaluating the opinion of participants are divided in two types: questions about hospitality of migrants, and voting subjects. Both these aspects are repeated before and after the study in order to observe the difference possibly caused by working with one or the other visualization.

The overall opinion measure, which brings together the voting and the hospitality results, indicates no significant difference between vis1 and vis2, neither before nor after having worked with the visualizations. This absent tendency is also true for the single analyses of each voting subject and most of the hospitality questions. Nevertheless, a significant difference stands out for a question regarding the attitude for the hospitality of migrants that flee from war regions. While at the beginning no difference is observable between vis1 and vis2, participants from vis2 show a more open attitude towards migrants when the question is repeated at the end of the survey. An explanation for this trend is difficult to provide, since a change is observable only in one single question. However, one can observe the differences between the answers provided before and after having worked with either one of the visualizations. The analysis of the overall opinion measure delivers some

interesting results. While almost no change is noticeable for vis1, the participants from vis2 show a significant increase in the opinion value. With all due consideration and premises regarding the difficulty of truly measuring people's opinions, the results of the study suggest that the answer to the research question should be partly positive. Indeed, as previous literature (Monmonier 1991; Wood, Fels, and Krygier 2010; McGhee 2016) suggest, different visualizations can indeed influence people's opinion accordingly. In fact, evidences show that there is no direct difference between opinion from vis1 and opinion from vis2, but only one visualization caused and increase in participants' openness toward migrants. Therefore, one can argue that changing visualization type does not directly change the opinion of people, but the difference in the opinion's change for vis2 is larger.

Moreover, the experts indicated the possibility of influencing people's opinion with this visualization. One claims "this map can bring people to strengthen their opinion, mostly for people against the hospitality of migrants" (see Appendix C). As a couple of experts argue, the problem is that the map can only show a limited amount of information. Therefore, it suggests that the policies have an effect, while other things are influencing the pattern as well. However, one of the expert points out that in this kind of humanitarian topics the problem of influencing people is always present on both ends. "I would not be surprised personally to hear that that pushed people into a different direction. But likewise, you can push people opposite-wise by showing them a dead 6 years old and say this person died by trying an illegal crossing because the border was closed. In a way, it is a game of manipulation of images and information" (see Appendix C).

9.1. Limitations and Future Research

Both the visualization and the online survey can be ameliorated for future research. In this chapter, inputs are provided along with possible solutions. The opinion of the experts is addressed as well, in order to provide a critical – and not only personal – analysis of the limitations and possible improvements the could be implemented for this intrinsic visualization.

Concerning the intrinsic visualization, several adjustments and improvements can be implemented, as also suggested by some experts during the interviews (see Appendix C). First, some visual variables could be designed differently. For instance, several experts proposed a timeline interactive box that allows to quickly scroll through the different dates, instead of only allowing the possibility of browsing day-by-day with single clicks. The red dotted routes have also been critically analyzed and most of the experts propose to either enhance this visual variable – e.g. by making it interactive – or to completely remove it from the visualization. Furthermore, the borders were also object of some improvements hints. An expert suggested that directionality of the border should also be included (even if it might appear obvious), while the choice of coloring the border sections is solid, but it would be interesting to attempt to visualize it with other alternatives. Finally, all the experts suggested to include an static table in the intrinsic visualization as well. As one of them argued: "if it is feasible from the visualization point of view, I think it is best to have both the colored borders with the particular policies but also kind of an overview in a table". This is indeed a very interesting suggestion that would open the field for a completely new study. Indeed, in this thesis the purpose was to compare the current possibility against a newly implemented visualization. Even though the results are promising, the ideal solution might be to combine the two visualization approaches, as all the experts recommended.

Another important improvement concerns the difference between videos and interactive visualizations. In fact, the interactive visualization was converted into a video for comparability reasons, given the online environment of the survey. Thus, the next logical step would be to implement a new user study that aims at assessing performance and subjective metrics using interactive visualizations, instead of videos. The results of this thesis are partially weakened by this conversion; therefore, the next step would be to further reinforce the outcomes and claims with a newly designed study.

Another limitation of the current study regards the assessment of participants' opinion changes. As mentioned above, it is difficult to adequately measure opinion – and more so a shift in opinion – without influencing the results. Therefore, a user study specifically focused on the power of these visualizations in influencing people's opinion is necessary.

Concerning the power of the visualization implemented for this thesis, all experts argue that it is highly probable to influence people's opinion with such maps. One of them said: "The sheer size of the numbers, these large red dots. It is a very fear based process. You just suddenly see this big red dot pulsing and flashing and it was very effective in scaring me. So, I would not be surprised personally to hear that that pushed people into a different direction". However, every expert agrees that the visualization try to be as objective as possible by displaying the policies without omitting delicate information. Therefore, the possibility of influencing people's opinion appears to be relatively high – even if results only partially support this statement. Nevertheless, one of the expert identified but also critically assessed the possible misuse of the visualization to affect user's opinion (see Appendix C):

> [...] there is the danger of supporting a closed attitude towards migrants, because that is what the map somewhat conveys. But I would be against this direct link. Because the map displays correlation not causation! But for the viewer it suggests that these policies had these effect, while there could also be other things happening (not displayed or displayable in the map). It is really difficult in general to decide what to include and what to exclude in this kind of maps. For instance, I also had the impression that policies in faraway countries had an effect on countries located before or after. That is something that this map emphasizes: a complex set of relationships.

Finally, the implemented visualization could be used for other migration situations and, following the existing methodology, a comparison between the results could be illustrated. The discussion could either find similarities and thus prove the validity of this research, or different values could emerge, which would suggest that further studies are needed in order to draw solid conclusions about intrinsic barrier visualization.

10. Conclusion

The outcomes of this thesis suggest that the current absence of an intrinsic visualization of border policies and arrivals number is not justified. Indeed, the results of the thesis show a consistent trend that favors an intrinsic approach instead of the current extrinsic policies visualization. Moreover, the users express a preference for the intrinsic version, suggesting that higher performance metrics are accompanied by higher subjective metrics. Therefore, one might argue that the deceptive linear, uninterrupted representation of migratory movements identified by Crawley et al. (2016b) could be at least partially solved with an intrinsic visualization of border policies. However, as expressed in different chapters, the factors influencing migration are much more variegated, and an exclusive focus on border policies only disentangle a single aspect of a much more complex phenomenon. Nonetheless, results suggest that the intrinsic visualization of border policies might be a first step in the right direction.

> [The] image of the wall could not possibly explain the new processes of border construction. Nonetheless the factors that make it necessary to question this dominant image of the border as a wall do not signal the disappearance of processes of hierarchization and control. On the contrary, they point in many ways to the proliferation or multiplication of walls and borders of various kinds (Mezzadra and Neilson 2012, 71)

It is critical to extend the proposed approach to other migration routes or to the current situation in the Balkan states and in neighboring regions. In fact, even though the Balkan route officially closed in March 2016 (Borić and Sabic 2016; REACH 2004) the migration patterns have only rearranged rather than stopped – as the results of this study also show. Indeed, as migration studies show, although the numbers of arrivals have reduced, people are still crossing the borders, though through more dangerous routes (Tusk 2016). Moreover, since the EU-Turkey Agreement and the official closure of the Balkan route, the number of illegal attempts of border crossing has increased (DRC 2016).

> The introduction of border closures and incoherent migration policies across the Western Balkans has further increased the vulnerability of people in transit. People who continue to travel despite new restrictions have been

> forced to take illegal routes, exposing them to increasing levels of personal risk such as physical violence, trafficking, exploitation (REACH 2004, 4).

Since the use of intrinsic border visualizations has rarely been studied so far, the results of this thesis need further exploration. The possibilities to implement a similar research are numerous, ranging from current trends in migration to Europe, to other human migration patterns worldwide, or even consider the use of intrinsic obstacles' visualization for animal migration.

Lastly, it is worth mentioning the apparently probable possibility to influence people's opinion with this visualization. In this case, results are more controversial. On the one hand, the reviewed literature suggests that maps can indeed influence the opinion of the viewers. This claim is supported also be the experts, who acknowledged this problem during the interviews. On the other hand, results of the questionnaire do not indicate a comparable trend. A possible explanation could be that the literature suggesting an influence of maps on people's opinion often consider propaganda visualizations or maps designed with the goal of delivering a specific message. This is deliberately not the case in the visualization implemented for this research. Thus, the impact of the map on viewer's judgement might be less evident. Therefore, further research is needed in order to accept or reject the possibility of unintentionally influencing people's opinion with an intrinsic visualization of border policies.

In general, this thesis has shown that migration patterns and migration discourses need to be addressed and further explored, since they "posits fundamental challenges that are signal of our times" (Mezzadra and Neilson 2012, 60).

11. Bibliography

ACAPS. 2016. The Balkan Migrant Crisis: An Introduction, March: 1–7.

Andrienko, G., N. Andrienko, I. Kopanakis, A. Ligtenberg, and S. Wrobel. 2008a. "Visual Analytics Methods for Movement Data." In *Mobility, Data Mining and Privacy*, ed. Fosca Giannotti and Dino Pedreschi, 375–410. Berlin, Heidelberg: Springer Berlin Heidelberg.

Andrienko, G., N. Andrienko, N. Pelekis, and S. Spaccapietra. 2008b. "Basic Concepts of Movement Data." In *Mobility, Data Mining and Privacy*, ed. Fosca Giannotti and Dino Pedreschi, 15–38. Berlin, Heidelberg: Springer Berlin Heidelberg.

Bétrancourt, Mirielle, and Barbara Tversky. 2000. Effect of computer animation on users' performance: A review. *Le travail humain* 63, no. 4: 311.

Bojadzijev, Manuela, and Sandro Mezzadra. 2015. "Refugee crisis" or crisis of European migration policies? http://www.focaalblog.com/2015/11/12/manuela-bojadzijev-and-sandro-mezzadra-refugee-crisis-or-crisis-of-european-migration-policies/. [last access 19.09.2017].

Borić, Sonja, and Senada S. Sabic. 2016. At the Gate of Europe: A Report on Refugees on the Western Balkan Route. *SOE Dialog Südosteuropa*, March.

Börner, Katy. 2012. Visualization: Picturing science. *Nature* 487, no. 7408: 430–31.

Bounegru, Liliana, Lucy Chambers, and Jonathan Gray. 2012. *The data journalism handbook*. Sebastopol CA: O'Reilly & Associates.

Brouwer, Evelien, and Vrije U. Amsterdam. 2015. Migration flows and the reintroduction of internal border controls: Assessing necessity and proportionality. http://eumigrationlawblog.eu/migration-flows-and-the-reintroduction-of-internal-border-controls-assessing-necessity-and-proportionality/. [last access 19.09.2017].

Brügger, Annina, Sara I. Fabrikant, and Arzu Çöltekin. 2016. An empirical evaluation of three elevation change symbolization methods along routes in bicycle maps. *Cartography and Geographic Information Science* 44, no. 5: 436–51.

Capstone Course Mapping Global Refugee Movements. 2017. Refugee Movements. https://refugeemovements.com/. [last access 19.09.2017].

Carifio, James, and Rocco J. Perla. 2007. Ten Common Misunderstandings, Misconceptions, Persistent Myths and Urban Legends about Likert Scales and Likert Response Formats and their Antidotes. *Journal of Social Sciences* 3, no. 3: 106–16.

Cataldi, Giuseppe. 2016. *A mediterranean perspective on migrants' flows in the European Union: Protection of rights, intercultural encounters and integration policies*. Napoli: Editoriale Scientifica.

Cecconi, Alesandro, and Martin Galanda. 2002. Adaptive Zooming in Web Cartography. *Computer Graphics Forum* 21, no. 4: 787–99.

Chandler, Paul, and John Sweller. 1992. The split-attention effect as a factor in the design of instruction. *British Journal of Educational Psychology* 62, no. 2: 233–46.

Cinnamon, Jonathan, Claus Rinner, Michael D. Cusimano, Sean Marshall, Tsegaye Bakele, Tony Hernandez, Richard H. Glazier, and Mary L. Chipman. 2009. Evaluating web-based static, animated and interactive maps for injury prevention. *Geospatial health* 4, no. 1: 3–16.

Clark, Dorie. 2014. Data Visualization Is The Future - Here's Why. https://www.forbes.com /forbes/welcome/?toURL=https://www.forbes.com/sites/dorieclark/2014/03/10/data-visualization-is-the-future-heres-why/&refURL=&referrer=. [last access 19.09.2017].

Courage, Catherine, and Kathy Baxter. 2005. *Understanding your users: A practical guide to user requirements methods, tools, and techniques. Morgan Kaufmann series in interactive technologies*. San Francisco CA: Morgan Kaufmann Publishers.

Crampton, Jeremy W. 2002. Interactivity Types in Geographic Visualization. *Cartography and Geographic Information Science* 29, no. 2: 85–98.

Crawley, Heaven, Franck Duvell, Nando Sigona, Simon McMahon, and Katharine Jones. 2016a. Unpacking a rapidly changing scenario: Migration flows , routes and trajectories across the Mediterranean, no. 1: 1–12.

Crawley, Heaven, Franck Düvell, Katharine Jones, Simon McMahon, and Nando Sigona. 2016b. Destination Europe? Understanding the dynamics and drivers of Mediterranean migration in 2015. *MEDMIG Final Report*, November: 1–84.

Curzi, Corallina L. 2016a. Il processo di esternalizzazione delle frontiere europee: Tappe e conseguenze di un processo pericoloso. https://openmigration.org/analisi/il-processo-di-esternalizzazione-delle-frontiere-europee-tappe-e-conseguenze-di-un-processo-pericoloso/. [last access 19.09.2017].

———. 2016b. La detenzione amministrativa dei migranti in Europa e il pericolo di un doppio standard di protezione delle libertà personali La nascita della Fortezza Europa e dei campi di detenzione per stranieri. http://openmigration.org/analisi/la-detenzione-amministrativa-dei-migranti-in-europa-e-il-pericolo-di-un-doppio-standard-di-protezione-delle-liberta-personali/. [last access 19.09.2017].

DiBiase, David, Alan M. MacEachren, John B. Krygier, and Catherine Reeves. 1992. Animation and the Role of Map Design in Scientific Visualization. *Cartography and Geographic Information Science* 19, no. 4: 201–14.

DRC. 2016. Summary of Regional Migration Trends.

Dustmann, Christian, Francesco Fasani, Tommaso Frattini, Luigi Minale, and Uta Schönberg. 2016. On the Economics and Politics of Refugee Migration. *CESifo Working Paper*, no. 6111.

Elliot, Andrew J., Markus A. Maier, Arlen C. Moller, Ron Friedman, and Jörg Meinhardt. 2007. Color and psychological functioning: The effect of red on performance attainment. *Journal of experimental psychology. General* 136, no. 1: 154–68.

European Council. 2016. Timeline: Response to migratory pressures. http:// www.consilium.europa.eu/en/policies/migratory-pressures/history-migratory-pressures/. [last access 19.09.2017].

Fabrikant, Sara I., Stephanie Tuggener, and Arzu Coltekin. 2012. *Mobility and social inequality: exploring the nexus by the means of sequence analysis and geovisualisation*, 2012.

Few, Stephen. 2013. Data visualization for human perception. *The Encyclopedia of Human-Computer Interaction, 2nd Ed.*

Field, Andy. 2013. *Discovering statistics using IBM SPSS statistics: (and sex and drugs and rock 'n' roll)*. 4. ed. London: Sage.

Follett, Jonathan. 2009. The Ever-Evolving Arrow: Universal Control Symbol. http://www.uxmatters.com/mt/archives/2009/10/the-ever-evolving-arrow-universal-control-symbol.php. [last access 19.09.2017].

Frontex. 2016a. *Risk Analysis for 2016*. Warsaw, 2016.

———. 2016b. Western Balkan Route. http://xchange.org/western-balkan-report/. [last access 19.09.2017].

Frutiger, Adrian. 1989. *Signs and symbols: Their design and meaning*. New York: Van Nostrand Reinhold.

FTReporters. 2016. Paths to Europe: As a key route closes , migrants look for others Gates closing on one passage prompt exploration of new pathways. https://www.ft.com/content/f5418000-e5f3-11e5-bc31-138df2ae9ee6. [last access 19.09.2017].

Genova, Nicholas de. 2013. Spectacles of migrant 'illegality': the scene of exclusion, the obscene of inclusion. *Ethnic and Racial Studies* 36, no. 7: 1180–98.

Gerend, Mary A., and Tricia Sias. 2009. Message framing and color priming: How subtle threat cues affect persuasion. *Journal of Experimental Social Psychology* 45, no. 4: 999–1002.

Gershon, N. 1998. Visualization of an imperfect world. *IEEE Computer Graphics and Applications* 18, no. 4: 43–45.

Grossi, Gianluca. 2016. *Infiniti passi*. Bellinzona: Salvioni edizioni.

Guo, Diansheng. 2009. Flow mapping and multivariate visualization of large spatial interaction data. *IEEE Transactions on Visualization and Computer Graphics* 15, no. 6: 1041–48.

Heer, Jeffrey, Michael Bostock, and Vadim Ogievetsky. 2010. A tour through the visualization zoo. *Communications of the ACM* 53, no. 6: 59.

Hegarty, Mary. 1992. Mental animation: Inferring motion from static displays of mechanical systems. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 18, no. 5: 1084.

Hegarty, Mary, and Marcel-Adam Just. 1993. Constructing mental models of machines from text and diagrams. *Journal of memory and language* 32, no. 6: 717–42.

Hegarty, Mary, Harvey S. Smallman, Andrew T. Stull, and Matt S. Canham. 2009. Naïve Cartography: How Intuitions about Display Configuration Can Hurt Performance. *Cartographica: The International Journal for Geographic Information and Geovisualization* 44, no. 3: 171–86.

Hoaglin, David C., and Boris Iglewicz. 1987. Fine-tuning some resistant rules for outlier labeling. *Journal of the American Statistical Association* 82, no. 400: 1147–49.

Hoaglin, David C., Boris Iglewicz, and John W. Tukey. 1986. Performance of some resistant rules for outlier labeling. *Journal of the American Statistical Association* 81, no. 396: 991–99.

IOM. 2015. Migration Flows - Europe. http://iom.maps.arcgis.com/apps/MapAndAppGallery/index.html?appid=3af3e9630ab849e99e6970a29aa25ff5. [last access 19.09.2017].

———. 2016. Migration Flows - Europe. http://iom.maps.arcgis.com/apps/MapAndAppGallery/index.html?appid=3af3e9630ab849e99e6970a29aa25ff5. [last access 19.09.2017].

Jenny, Bernhard, Helen Jenny, and Stefan Räber. 2008. "Map design for the Internet." In *International Perspectives on Maps and the Internet*, ed. Michael P. Peterson. *Lecture*

Notes in Geoinformation and Cartography, 31–48. Berlin, Heidelberg: Springer Berlin Heidelberg.

Jenny, Bernhard, Daniel M. Stephen, Ian Muehlenhaus, Brooke E. Marston, Ritesh Sharma, Eugene Zhang, and Helen Jenny. 2017. Design principles for origin-destination flow maps. *Cartography and Geographic Information Science* 11: 1–15.

Jones, Reece. 2016. Borders and Walls: Do Barriers Deter Unauthorized Migration ? *The Online Journal of the Migration Policy Institute*.

Kasparek, Bernd. 2016. Routes, Corridors, and Spaces of Exception: Governing Migration and Europe. http://nearfuturesonline.org/routes-corridors-and-spaces-of-exception-governing-migration-and-europe/. [last access 19.09.2017].

Keppel, Geoffrey, and Thomas D. Wickens. 2004. *Design and analysis: A researcher's handbook*. Upper Saddle River N.J.: Pearson Prentice Hall.

Kraak, Menno-Jan. 2003. Geovisualization illustrated. *ISPRS Journal of Photogrammetry and Remote Sensing* 57, 5-6: 390–99.

Krisp, Jukka M. 2004. Three-dimensional visualisation of ecological barriers. *Applied Geography* 24, no. 1: 23–34.

———. 2006. Geovisualization and knowledge discovery for decision-making in ecological network planning. Doctor. Helsinki University of Technology.

Kuschminder, Katie, Julia de Bresser, and Melissa Siegel. 2015. Irregular Migration Routes to Europe and Factors Influencing Migrants' Destination Choices. Maastricht Graduate School of Governance.

MacEachren, Alan M. 1995. *How maps work: representation, visualization, and design*. Guilford Press.

MacEachren, Alan M., and Menno-Jan Kraak. 2001. Research challenges in geovisualization. *Cartography and Geographic Information Science* 28, no. 1: 3–12.

Martin, David W. 1985. *Doing Psychology Experiments. 2nd ed*. Vol. 30.

Mayer, Richard E., and Roxana Moreno. 1998. A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology* 90, no. 2: 312.

McGhee, Geoff. 2016. How to Make Maps and Influence People, National Geographic. http://news.nationalgeographic.com/2015/10/151022-data-points-how-make-maps-influence-people/. [last access 19.09.2017].

Mezzadra, S., and B. Neilson. 2012. Between Inclusion and Exclusion: On the Topology of Global Space and Borders. *Theory, Culture & Society* 29, 4-5: 58–75.

Monmonier, Mark. 1991. *How to lie with maps*. Chicago: The University of Chicago Press.

Morrison, Julie B., and Barbara Tversky. 2001. The (in)effectiveness of animation in instruction. In *Extended abstracts on Human factors in computing systems*, ed. Marilyn (M) Tremaine, 377. New York, New York, USA: ACM Press.

Mousavi, Seyed Y., Renae Low, and John Sweller. 1995. Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology* 87, no. 2: 319–34.

Muehlenhaus, Ian. 2014. *Web cartography: Map design for interactive and mobile devices*. Boca Raton, FL: CRC Press.

Musarò, Pierluigi. 2016. Un viaggio pericoloso? I limitati effetti delle campagne per scoraggiare le migrazioni irregolari. http://openmigration.org/idee/limitato-effetto-deterrente-delle-campagne-per-scoraggiare-migrazioni-irregolari/. [last access 19.09.2017].

Pandey, Anshul V., Anjali Manivannan, Oded Nov, Margaret Satterthwaite, and Enrico Bertini. 2014. The Persuasive Power of Data Visualization. *IEEE Transactions on Visualization and Computer Graphics* 20, no. 12: 2211–20.

PeaceGeeks. 2015. New Paths: How Social Media & Technology are Changing REfugee Journeys. https://peacegeeks.org/news/new-paths-how-social-media-technology-are-changing-refugee-journeys. [last access 19.09.2017].

Piesse, Mervyn. 2014. Factors Influencing Migration and Population Movements. *Strategic Analysis Paper*.

Pinto, Naiara, and Timothy H. Keitt. 2009. Beyond the least-cost path: Evaluating corridor redundancy using a graph-theoretic approach. *Landscape Ecology* 24, no. 2: 253–66.

Pirnat, Janez. 2000. Conservation and management of forest patches and corridors in suburban landscapes. *Landscape and Urban Planning* 52, 2-3: 135–43.

Pluim, Martijn, and Veronika Bilger. 2016. How closed borders detour migrant routes. https://www.icmpd.org/news-centre/news-detail/qa-how-closed-borders-detour-migrant-routes/. [last access 19.09.2017].

Poplin, Alenka. 2015. How user-friendly are online interactive maps?: Survey based on experiments with heterogeneous users. *Cartography and Geographic Information Science* 42, no. 4: 358–76.

Raeymaekers, Timothy. 2014. Liminal Geographies What is a border ? http://www.timothyraeymaekers.net/2014/10/518/. [last access 19.09.2017].

REACH. 2004. Migration to Europe through the Western Balkans. *Ecology*: 0–9.

Sagan, C. 1975. The Recognition of Extraterrestrial Intelligence. *Proceedings of the Royal Society B: Biological Sciences* 189, no. 1095: 143–53.

Saussure, Ferdinand d. 1999. "Nature of the Linguistic Sign." In *The critical tradition: Classic texts and contemporary trends*. 2nd ed., 3rd. print, ed. David H. Richter. Boston, Mass., [etc.]: Bedford/St. Martin's.

Segel, Edward, and Jeffrey Heer. 2010. Narrative visualization: telling stories with data. *IEEE Transactions on Visualization and Computer Graphics* 16, no. 6: 1139–48.

Singer, J. 2011. "Journalism and Digital Technologies." In *Changing the news: The forces shaping journalism in uncertain times*, ed. Wilson Lowrey and Peter J. Gade. New York, London: Routledge.

Slocum, Terry A., Daniel C. Cliburn, Johannes J. Feddema, and James R. Miller. 2003. Evaluating the Usability of a Tool for Visualizing the Uncertainty of the Future Global Water Balance. *Cartography and Geographic Information Science* 30, no. 4: 299–317.

Smale, Alison. 2016. With EU paralyzed, 10 Nations try to stem migrant flow. https://www.nytimes.com/2016/02/25/world/europe/refugees-migrants-austria-greece.html?mcubz=3. [last access 19.09.2017].

Stanojoska, Angelina. 2016. Migrant and refugee crisis in Europe: was pandora's box open? *Journal of Liberty and International Affairs*, no. 1.

Štěrba, Zbyněk, Čeněk Šašinka, Zdeněk Stachoň, Petr Kubíček, and Sascha Tamm. 2014. Mixed research design in cartography: A combination of qualitative and quantitative approaches. *Kartographische Nachrichten* 64, no. 5: 262–69.

Tukey, John W. 1977. Exploratory data analysis.

Tusk, Donald. 2016. Tens of thousands migrate through Balkans since route declared shut. https://www.theguardian.com/world/2016/aug/30/tens-of-thousands-migrate-through-balkans-since-route-declared-shut. [last access 19.09.2017].

Tversky, Barbara, Julie B. Morrison, and Mirielle Bétrancourt. 2002. Animation: Can it facilitate? *International Journal of Human-Computer Studies* 57, no. 4: 247–62.

UNHCR. 2016. Operation Portal - Refugee Situation. https://data2.unhcr.org/en/documents/details/50832. [last access 19.09.2017].

Winer, B. J., Donald R. Brown, and Kenneth M. Michels. 1991. *Statistical principles in experimental design*. 3. ed. Boston: McGraw-Hill.

Wolf, Anna. 2016. Border Regimes in Motion An analysis of contemporary border studies through the lens of the mobilities paradigm.

Wood, Denis, John Fels, and John Krygier. 2010. *Rethinking the power of maps*. New York: Guilford Press.

Yap, B. W., and C. H. Sim. 2011. Comparisons of various types of normality tests. *Journal of Statistical Computation and Simulation*, no. 12: 2141–55.

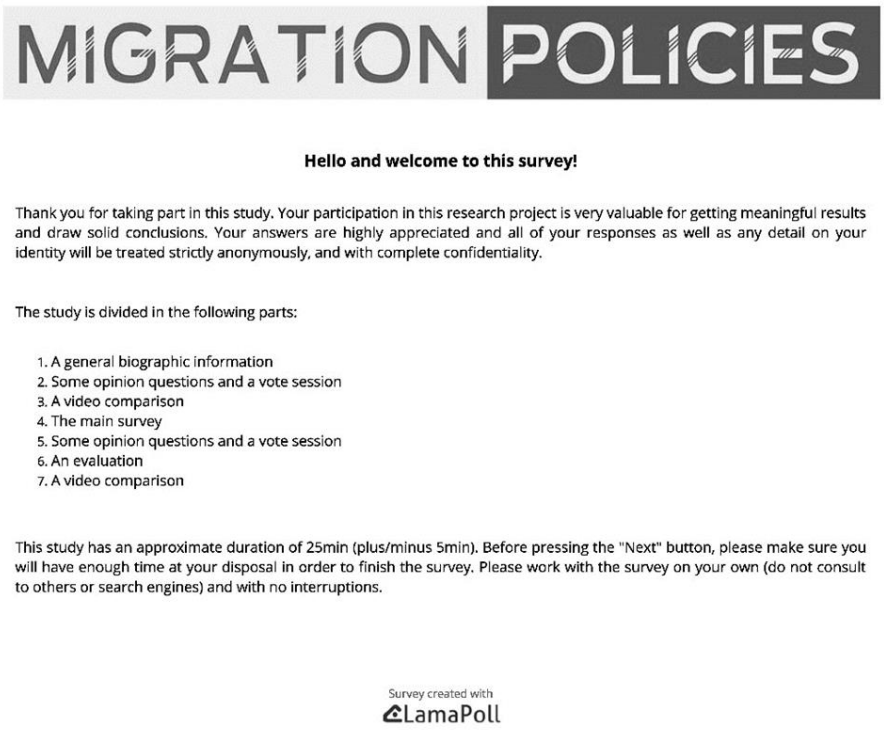
Zambrano, Raul N., and Yuri Engelhardt. 2008. "Diagrams for the Masses: Raising Public Awareness – From Neurath to Gapminder and Google Earth." In *Diagrammatic Representation and Inference*, ed. Gem Stapleton, John Howse, and John Lee. *Lecture Notes in Computer Science*, 282–92. Berlin, Heidelberg: Springer Berlin Heidelberg.

Appendices

Appendix A: Summary of Migration Visualizations

ID	Map/provider name	OD map	Choropleth	Proportional symbols	Other map type	Interactivity	Migrants number	Push factors	Border policies	Demography	Environment	Citizenship	Consequences
1	swissinfo	×	✓	×	×	✓	✓	×	×	×	×	×	✓
2	ThomsonReuters	✓	×	×	×	×	×	×	×	×	×	×	×
3	Economist	×	×	×	✓	✓	×	×	✓	×	×	×	×
4	UNHCR	✓	×	✓	×	✓	✓	✓	×	✓	×	✓	×
5	UNHCR Weather	×	×	×	✓	×	×	×	×	×	✓	×	×
6	Jakubmarian	×	✓	×	×	×	✓	×	×	✓	×	✓	✓
7	ACAPS Report	✓	×	✓	×	×	×	×	✓	×	×	×	×
8	IOM Flow Report	×	×	×	✓	✓	×	×	×	✓	×	✓	×
9	EUROPOL	✓	×	×	×	×	×	×	×	×	×	×	×
10	MigrationsMap	✓	✓	×	×	✓	✓	×	×	✓	×	×	×
11	Lucify Europe Flow	✓	×	×	×	✓	✓	×	×	✓	×	×	×
12	i-Map	✓	×	×	×	✓	×	✓	×	✓	×	×	✓
13	AFP	✓	×	×	×	×	✓	×	×	×	×	×	×
14	Business Insider	✓	×	×	×	×	×	×	✓	×	×	×	×
15	ESRI storymap	✓	×	×	×	✓	×	×	×	×	×	×	×
16	Reuters flow diagram	✓	×	×	✓	✓	×	✓	✓	×	×	×	×
17	Migration Europe	✓	×	✓	×	×	×	×	✓	×	×	×	✓
18	xchange	×	×	✓	×	✓	✓	×	×	✓	×	×	×
19	theguardian	✓	×	×	×	×	×	×	×	×	×	×	×
20	DW.com	✓	×	×	×	×	×	×	✓	×	×	×	×
21	edmaps.com	✓	×	×	×	×	×	×	✓	×	×	×	×
22	BBC	✓	×	×	×	×	×	×	×	×	×	×	×
23	POLITICO.eu	×	×	✓	×	✓	✓	×	×	×	×	×	×
24	The Telegraph	✓	×	×	×	✓	✓	×	×	✓	×	✓	×
25	BuzzFeed	✓	×	×	×	×	×	×	×	×	×	×	×
26	RILOS	×	×	×	✓	✓	×	×	×	×	×	×	✓
27	Washington Post (1)	×	×	×	✓	×	✓	×	✓	×	×	×	×
28	Refugee Migration	✓	×	×	×	✓	×	×	✓	×	×	✓	×
29	Washington Post (2)	✓	×	✓	×	×	×	×	×	×	×	×	×
30	Migration policy Inst.	×	✓	×	×	×	×	×	✓	×	×	×	×

Appendix B: Online Survey



MIGRATION POLICIES

Hello and welcome to this survey!

Thank you for taking part in this study. Your participation in this research project is very valuable for getting meaningful results and draw solid conclusions. Your answers are highly appreciated and all of your responses as well as any detail on your identity will be treated strictly anonymously, and with complete confidentiality.

The study is divided in the following parts:

1. A general biographic information
2. Some opinion questions and a vote session
3. A video comparison
4. The main survey
5. Some opinion questions and a vote session
6. An evaluation
7. A video comparison

This study has an approximate duration of 25min (plus/minus 5min). Before pressing the "Next" button, please make sure you will have enough time at your disposal in order to finish the survey. Please work with the survey on your own (do not consult to others or search engines) and with no interruptions.

Survey created with
LamaPoll

MIGRATION POLICIES

Biographic Information

★ **1. What year were you born in?**

Year of birth

★ **2. Please specify your gender**

- ◯ Male
- ◯ Female
- ◯ not specified

★ **3. What is your current employment/occupation?**

- ◯ Student
- ◯ Other (specify)

★ **4. Please select your highest educational degree**

- ◯ Primary / Secondary school
- ◯ Highschool / College
- ◯ Bachelor
- ◯ Master
- ◯ PhD
- ◯ Other (specify)

5. Please specify your field(s) of study

Notice: This questions has only to be answered if at Question 3: "What is your current employment/occupati..." the answer "Student" was chosen.

★ **6. Please state your country of origin**

★ **7. Please state your current country of residence**

8. Please state your Swiss canton of origin

Notice: This questions has only to be answered if at Question 6: "Please state your country of origin" the answer "Switzerland" was chosen.

9. Please state your current Swiss canton of residence

Notice: This questions has only to be answered if at Question 7: "Please state your current country of res..." the answer "Switzerland" was chosen.

MIGRATION POLICIES

Background knowledge & opinion

★ **10. Please rate your level of experience/knowledge in the following fields**

	None	Poor	Middle	Good	Expert
Maps	○	○	○	○	○
Cartography and/or GIS	○	○	○	○	○
Migration	○	○	○	○	○
Politics	○	○	○	○	○
Balkan countries	○	○	○	○	○

★ **11. Are you an immigrant?**

○ Yes ○ No

★ **12. Are your parents or grandparents immigrants?**

○ Yes ○ No

★ **13. Are you an avid reader of news about migration?**

definitely not [ ] (1 - 6) definitely yes

★ **14. Your news sources are ...**

mostly offline [ ] (1 - 6) mostly online

★ **15. If you see an interactive map in a news story, do you click and explore?**

no (almost never) [ ] (1 - 6) yes (almost always)

MIGRATION POLICIES

Opinion pre-study

★ **16. At which border are the migrants (those who attempt to take the Balkan route) stopped today?**

You can also write "I don't know", but only if really needed.

★ **17. Roughly how many migrants do you think arrived in Greece per day during the intense migration due to Syrian war?**

- ◯ 500 - 1000
- ◯ 1000 - 5000
- ◯ 5000 - 10000
- ◯ 10000 - 15000
- ◯ 15000 - 20000
- ◯ 20000 - 25000
- ◯ 25000 - 30000
- ◯ I don't know *(use this option only when really needed)*

★ **18. Where do you think migrants go if a border gets closed or becomes less penetrable?**

You can also write "I don't know", but only if really needed.

★ **19. In general, how do you think your country's policy towards migration and migrants should be?**

rather strict ☐ (1 - 6) rather open

★ **20. How do you think your country's policy towards refugees fleeing from war regions should be?**

rather strict ☐ (1 - 6) rather open

★ **21. In your opinion, are walls and fences at the borders effective tools in obstructing migration?**

no (ineffective) ☐ (1 - 6) yes (effective)

★ **22. In the case of Syria, migrants flee from their territories and seek refuge in neighboring nations such as Turkey or Lebanon. Why do you think that migrants then try to reach central European states, travelling through the Balkan route?**

- ☐ Vital necessity
- ☐ Feeling hopeless for future in their current place
- ☐ Better opportunities
- ☐ Take advantage of the situation
- ☐ Friends / Acquaintances
- ☐ Follow the migration movement
- ☐ Other (specify)
- ☐ I don't know *(use this option only when really needed)*

★ **23. What measures/policies do you think most Balkan countries implemented to reduce and obstruct migration in recent years?**

You can also write "I don't know", but only if really needed.

MIGRATION POLICIES

Voting session

Your country has an upcoming popular vote about migration, hospitality and policies implementation.
You will be asked to express an opinion on the following 4 decisions. Imagine that you are voting for a policy.

★ **24. VOTE NR. 1: In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept implementing a wall or a fence as a border policy?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **25. VOTE NR. 2: In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept to guard the border by deploying military and police forces?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **26. VOTE NR. 3: In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept that your nation should host 10'000 migrants until the crisis is over?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **27. VOTE NR. 4: In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept that your nation should host or refuse migrants according to their country of origin (nationality)?**

Yes, I accept [ ] (1 - 4) No, I don't accept

Survey created with LamaPoll

MIGRATION POLICIES

Main survey: Instructions

GENERAL INFORMATION

In this study, after a brief video-comparison, you will watch **2 videos (of interactive maps)** about migration, including information on border policies. For each video we will ask you **9 questions**, of the following kind: *WHEN-questions (time of the event), EFFECT-questions (consequences of a policy) and OTHER-questions (other).*

At the end of each video+questions session, we will ask you to tell us how many times you watched the video and to specify other information about your **answering strategy**.

In order to separate the users in **two evenly distributed groups**, we ask you to fill in the following request...

★ **28. Please choose the option with the lower % value. If the % values are equal, select an option randomly.**

Example 1: If Group1 has 44% and Group2 56% you must select Group1 (lower %)
Example 2: If Group1 has 50% and Group2 also 50% you can choose Group1 or Group2

◯ Group 1

◯ Group 2

Survey created with LamaPoll

MIGRATION POLICIES

Main survey: Instructions

INFORMATION ABOUT POLICIES

Many different policies have been implemented in the Balkan route, thus we decided to group these regulations into classes. Here we give a brief description of these categories, created for the following maps (i.e. videos). It is important for you to learn these, as they will occur in the questions later.

- "**demography**" = policies that allow or prohibit passage according to the migrants' country of origin
- "**intake quota**" = policies that set a maximum number of migrants' intake per day
- "**wall/fence**" = a border wall or fence is built alongside sensible parts or the entire border
- "**militarization**" = military or police forces are deployed at the border in order to enhance controls and surveillance

Please pay attention that according to the groups you have been assigned, these policies are shown differently on the map (you will get only one of these two, it is randomly assigned):

- In one case the video (map) shows a **table** where the policies (which are implemented in the displayed time period) are listed. The date written next to each policy represent the implementation date of these regulations. Furthermore, two columns state who implemented the policy and at which border.
- If you are assigned to the other case, you will get two videos (map) that show a **colored line** when a policies is implemented, and this line stays as long as the policy is in place or as long as other policies is implemented at the same border. The displayed policies are always implemented by the country that is possibly receiving migrants coming from those borders.

MIGRATION POLICIES

Map comparison

Before beginning with the main study, we ask you to watch two videos for comparing the two map types created for this research project. You will be asked to answer some evaluation-related questions (below). Then you will start the main survey, and according to the group you have been assigned to, you will work with one of the two map types.

CLICK HERE TO WATCH THE VIDEO-COMPARISON

THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE EVALUATION QUESTIONS

* **29. Please evaluate MAP 1 (above) according to the following categories**

Rate from 1 = I don't like it / Not clear at all, 6 = I like it / Very clear

General look	☆ ☆ ☆ ☆ ☆ ☆
Border policies	☆ ☆ ☆ ☆ ☆ ☆
Migrants' arrivals	☆ ☆ ☆ ☆ ☆ ☆
Link arrivals-policies	☆ ☆ ☆ ☆ ☆ ☆
Time (date)	☆ ☆ ☆ ☆ ☆ ☆
Migration routes	☆ ☆ ☆ ☆ ☆ ☆

* **30. Please evaluate MAP 2 (below) according to the following categories**

Rate from 1 = I don't like it / Not clear at all, 6 = I like it / Very clear

General look	☆ ☆ ☆ ☆ ☆ ☆
Border policies	☆ ☆ ☆ ☆ ☆ ☆
Migrants arrivals	☆ ☆ ☆ ☆ ☆ ☆
Link arrivals-policies	☆ ☆ ☆ ☆ ☆ ☆
Time (date)	☆ ☆ ☆ ☆ ☆ ☆
Migration routes	☆ ☆ ☆ ☆ ☆ ☆

* **31. Which map type do you prefer?**

MIGRATION POLICIES

Main survey: How to watch the video

HOW TO WATCH THE VIDEO

- We strongly recommend that you **first have a look at the policies shown in the table or in the legend** (depending on your group) on the right side of the screen and then proceed to play the video.
- When watching the video(s), imagine that you are trying to inform yourself about border policies and their consequences in order to make an **informed decision regarding an upcoming popular vote** (similar to the one you made a couple of minutes ago).
- You can watch the video as many time as you feel necessary and **you can leave the video-tab open and switch back and forth while answering the questions!** Please answer the questions **as accurately and as quickly** as possible. Once you are done with the questions please close the video-tab and continue with the next video+question session.

Survey created with
LamaPoll

MIGRATION POLICIES

Main survey: ***MAP1***

On this map you can see several yellow dots (some of them named). These dots represent the official border crossing points, where migrants, depending on the current border policies, had the possibility to cross the border legally.

CLICK HERE TO WATCH THE VIDEO

THEN LEAVE IT OPEN, COME BACK ON THIS PAGE
AND PROCEED WITH THE SURVEY

CLICK HERE TO WATCH THE VIDEO

THEN LEAVE IT OPEN, COME BACK ON THIS PAGE
AND PROCEED WITH THE SURVEY

Survey created with
LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP2** (1)*

★ **32. What was the effect of the "wall/fence" policy between Hungary and Serbia for Hungary's arrivals number in the following period (about 5 days)?**

arrivals strongly decreased ☐ (1 - 5) arrivals strongly increased

★ **33. How did Slovenia react to the Hungarian "wall/fence" policies that completely monitored the border between Hungary and Croatia?**

Check the correct option(s)

- ☐ implemented a border policy
- ☐ number of arrivals increased
- ☐ number of arrivals decreased
- ☐ no implementation of policies
- ☐ I don't know
  (use this option only when really needed)

★ **34. What was the effect of the "wall/fence" policy between Hungary and Croatia on Hungary's arrivals number in the following period (about 5 days)?**

arrivals strongly decreased ☐ (1 - 5) arrivals strongly increased

Survey created with LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP1** (2)*

★ **35. When did the migrants start travelling through Slovenia?**

*Indicate the **time period** (e.g. early October 2017, late May 2016, ...) and if possible the **event** that caused this behavior (e.g. after Swiss border opened, shortly before closure of Swedish border, ...). You can also write "I don't know", but only if really needed.*

★ **36. When did Croatia implemented a policy at the Serbian border?**

*Indicate the **time period** (e.g. early October 2017, late May 2016, ...) and if possible the **event** that caused this behavior (e.g. after Swiss border opened, shortly before closure of Swedish border, ...). You can also write "I don't know", but only if really needed.*

★ **37. When did the migrants start travelling through Croatia**

*Indicate the **time period** (e.g. early October 2017, late May 2016, ...) and if possible the **event** that caused this behavior (e.g. after Swiss border opened, shortly before closure of Swedish border, ...). You can also write "I don't know", but only if really needed.*

Survey created with LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP1** (3)*

★ **38. Which were the most common border policy on this map?**

Check the correct option(s)

- ☐ militarization
- ☐ intake quota
- ☐ wall/fence
- ☐ demography
- ☐ I don't know
  (use this option only when really needed)

★ **39. Which type was Hungary's first policy?**

- ◯ militarization
- ◯ demography
- ◯ intake quota
- ◯ wall/fence
- ◯ I don't know
  (use this option only when really needed)

★ **40. After the implementation of a "wall/fence" policy between Croatia and Hungary, where were the migrants in Croatia headed?**

Check the correct option(s)

- ☐ Macedonia
- ☐ Turkey
- ☐ Austria
- ☐ Hungary
- ☐ Greece
- ☐ Croatia (stayed there)
- ☐ Slovenia
- ☐ Serbia
- ☐ I don't know
  (use this option only when really needed)

MIGRATION POLICIES

Main survey: Strategy information ***MAP1***

★ **41. How often did you switch between the video window and the questions window?**

If the video remained open on the side, please answer according to how often you looked at the 'video' window.

Never [ ] (1 - 6) Very often (> 5 times)

★ **42. How often did you pause the video?**

Never [ ] (1 - 6) Very often (> 5 times)

★ **43. In total, how many times did you watch the video?**

Once [ ] (1 - 6) Very often (> 5 times)

Survey created with LamaPoll

MIGRATION POLICIES

Main survey: ***MAP2***

CLICK HERE TO WATCH THE VIDEO

THEN LEAVE IT OPEN, COME BACK ON THIS PAGE
AND PROCEED WITH THE SURVEY

CLICK HERE TO WATCH THE VIDEO

THEN LEAVE IT OPEN, COME BACK ON THIS PAGE
AND PROCEED WITH THE SURVEY

Survey created with LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP2** (1)*

★ **44. What was the effect of the "demography" policy at the Austria border for the Austria's arrivals number in the following period (about 5 days)?**

arrivals strongly decreased [ ] (1 - 5) arrivals strongly increased

★ **45. What was the effect of the "intake quota" policies for the arrivals number in the Balkan countries in the following period (about 5 days)?**

arrivals strongly decreased [ ] (1 - 5) arrivals strongly increased

★ **46. What was the effect of the "EU-Turkey Agreement" policy for the arrivals number in the Balkan countries in the following period (about 5 days)?**

arrivals strongly decreased [ ] (1 - 5) arrivals strongly increased

Survey created with LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP2** (2)*

★ **47. When was the EU-Turkey Agreement reached?**

*Indicate the **time period** (e.g. early October 2017, late May 2016, ...) and if possible the **event** that caused this behavior (e.g. after Swiss border opened, shortly before closure of Swedish border, ...). You can also write "I don't know", but only if really needed.*

★ **48. When did Austria implement a "demography" policy?**

*Indicate the **time period** (e.g. early October 2017, late May 2016, ...) and if possible the **event** that caused this behavior (e.g. after Swiss border opened, shortly before closure of Swedish border, ...). You can also write "I don't know", but only if really needed.*

★ **49. When was the "intake quota" policy generally used?**

- ◯ as a first policy
- ◯ after other policies
- ◯ no trend visible
- ◯ I don't know
  (use this option only when really needed)

Survey created with LamaPoll

MIGRATION POLICIES

*Main survey: Questions **MAP2** (3)*

★ **50. Roughly, how many migrants reached Hungary in the period displayed in the map?**

- ◯ Almost none
- ◯ Some
- ◯ Many
- ◯ I don't know
  (use this option only when really needed)

★ **51. After the EU-Turkey Agreement, where were the migrants arrived in Greece travelling to?**

Check the correct option(s)

- ☐ Austria
- ☐ Croatia
- ☐ Greece (stayed there)
- ☐ Hungary
- ☐ Serbia
- ☐ Slovenia
- ☐ Turkey
- ☐ Macedonia
- ☐ I don't know
  (use this option only when really needed)

★ **52. Which was/were the last country to host refugee in the time period displayed in the map?**

Check the correct option(s)

- ☐ Slovenia
- ☐ Austria
- ☐ Serbia
- ☐ Greece
- ☐ Macedonia
- ☐ Hungary
- ☐ Croatia
- ☐ Turkey
- ☐ I don't know
  (use this option only when really needed)

MIGRATION POLICIES

Main survey: Strategy information ***MAP2***

★ **53. How often did you switch between the video window and the questions window?**

If the video remained open on the side, please answer according to how often you looked at the 'video' window.

Never ☐ (1 - 6) Very often (> 5 times)

★ **54. How often did you pause the video?**

Never ☐ (1 - 6) Very often (> 5 times)

★ **55. In total, how many times did you watch the video?**

Once ☐ (1 - 6) Very often (> 5 times)

MIGRATION POLICIES

Opinion post-study

★ **16. At which border are the migrants (those who attempt to take the Balkan route) stopped today?**

You can also write "I don't know", but only if really needed.

★ **17. Roughly how many migrants do you think arrived in Greece per day during the intense migration due to Syrian war?**

- ◯ 500 - 1000
- ◯ 1000 - 5000
- ◯ 5000 - 10000
- ◯ 10000 - 15000
- ◯ 15000 - 20000
- ◯ 20000 - 25000
- ◯ 25000 - 30000
- ◯ I don't know *(use this option only when really needed)*

★ **18. Where do you think migrants go if a border gets closed or becomes less penetrable?**

You can also write "I don't know", but only if really needed.

★ **19. In general, how do you think your country's policy towards migration and migrants should be?**

rather strict ☐ (1 - 6) rather open

★ **20. How do you think your country's policy towards refugees fleeing from war regions should be?**

rather strict ☐ (1 - 6) rather open

★ **21. In your opinion, are walls and fences at the borders effective tools in obstructing migration?**

no (ineffective) ☐ (1 - 6) yes (effective)

★ **22. In the case of Syria, migrants flee from their territories and seek refuge in neighboring nations such as Turkey or Lebanon. Why do you think that migrants then try to reach central European states, travelling through the Balkan route?**

- ☐ Vital necessity
- ☐ Feeling hopeless for future in their current place
- ☐ Better opportunities
- ☐ Take advantage of the situation
- ☐ Friends / Acquaintances
- ☐ Follow the migration movement
- ☐ Other (specify)
- ☐ I don't know *(use this option only when really needed)*

★ **23. What measures/policies do you think most Balkan countries implemented to reduce and obstruct migration in recent years?**

You can also write "I don't know", but only if really needed.

MIGRATION POLICIES

Voting session

Your country has now to vote about migration, hospitality and policies implementation.
You are asked to express an opinion on the following 4 decisions. Imagine that you are voting for a policy.

★ **64.** VOTE NR. 1: **In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept implementing a wall or a fence as a border policy?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **65.** VOTE NR. 2: **In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept to guard the border by deploying military and police forces?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **66.** VOTE NR. 3: **In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept that your nation should host 10'000 migrants until the crisis is over?**

Yes, I accept [ ] (1 - 4) No, I don't accept

★ **67.** VOTE NR. 4: **In the event of a significant incoming migration due to conflict or disasters, such as the one experienced by the Balkan countries, do you accept that your nation should host or refuse migrants according to their country of origin (nationality)?**

Yes, I accept [ ] (1 - 4) No, I don't accept

MIGRATION POLICIES

Evaluation

★ **69. Were you able to follow the displayed dates?**

definitely no [ ] (1 - 6) definitely yes

★ **73. How would you rate the animation speed?**

too slow [ ] (1 - 6) too fast

★ **70. How would you rate the difficulty of the map-related questions?**

very difficult [ ] (1 - 6) very easy

★ **71. Were you able to link the policies to the corresponding dates?**

definitely no [ ] (1 - 6) definitely yes

★ **68. How did you study the maps? What grabbed your attention? What were you most focused on? If you had one, what was your "tactic" (strategy) to study the map with the goal to answer the questions?**

Please describe using free text below (max 500 words)

★ **74. What did you find most difficult to understand/follow in the maps you have used for the main study?**

(max 500 words)

★ **72. What did you find most useful/helpful in the maps you have used for the main study?**

(max 500 words)

MIGRATION POLICIES

Map comparison

Now that you have finished the main study and you have some experience with one of the map types, we ask you to evaluate these two maps one more time. Compare the two maps now also considering the questions you had to answer in the study. Please have a look at the video in order to refresh your memory.

CLICK HERE TO WATCH THE VIDEO-COMPARISON

THEN PLEASE CLOSE IT, COME BACK ON THIS PAGE
AND ANSWER THE EVALUATION QUESTIONS

* **75. Please evaluate MAP 1 (above) according to the following categories**

Rate from 1 = I don't like it / Not clear at all, 6 = I like it / Very clear

General look	☆ ☆ ☆ ☆ ☆ ☆
Border policies	☆ ☆ ☆ ☆ ☆ ☆
Migrants' arrivals	☆ ☆ ☆ ☆ ☆ ☆
Link arrivals-policies	☆ ☆ ☆ ☆ ☆ ☆
Time (date)	☆ ☆ ☆ ☆ ☆ ☆
Migration routes	☆ ☆ ☆ ☆ ☆ ☆

* **76. Please evaluate MAP 2 (below) according to the following categories**

Rate from 1 = I don't like it / Not clear at all, 6 = I like it / Very clear

General look	☆ ☆ ☆ ☆ ☆ ☆
Border policies	☆ ☆ ☆ ☆ ☆ ☆
Migrants arrivals	☆ ☆ ☆ ☆ ☆ ☆
Link arrivals-policies	☆ ☆ ☆ ☆ ☆ ☆
Time (date)	☆ ☆ ☆ ☆ ☆ ☆
Migration routes	☆ ☆ ☆ ☆ ☆ ☆

* **77. Which map type do you prefer?**

78.

Thank you!

Thank you for taking the time to complete this survey. We truly value the information you have provided; your responses will contribute to our analyses. We hope you enjoyed it! If you want to know more, do not hesitate to contact us at matteo.riva@uzh.ch. If you have any comments, feel free to write them in the box below.

Many thanks,
Matteo Riva

Appendix C: Interviews Report

For clarity and homogeneity reasons the responses were transcribed without keeping the abbreviations (e.g. can't, gonna, etc.), without reporting the short pauses that the interviewees did in their speeches, and without incomplete or repeated phrases. Since these interviews are mostly useful for their contents and not for the emphasis of the discourses or for other investigation such as words counting, the transcription choices explained above do not lead to any incompleteness in the data or in the analysis. Furthermore, the report is anonymized, since there is no need to know which expert expressed which idea or thought.

M: **You will work with both visualization types (table and colored borders), trying to answer some map-related questions. When you are finished, I will ask you some questions about the maps, their strong and weak points. You will also have the chance to suggest changes for improving these visualizations.** *[The interviewees work through the expert version of the survey alone. They have the possibility to ask if they encounter any unclarity but not for issues concerning the content of the maps or the map-related questions.]*

M: **First, what do you think in general of the two maps?**

E1: Really great! Maybe I would even combine the two maps. I think there is advantages to both maps. But in my understanding the second map was superior. It changed during the course of the study. At the beginning, I liked the first one better, because the table serves to provides exact dates for the implementation of policies and what kind of policies, and that sorts of data is very necessary. On the other hand, it is missing the very clear visual effect of seeing a border come up between states. That was very powerful in the second map. And I enjoyed it! It really shows the effect. You could also have arrows and then a border would come up, they cannot go this way they are going through that border. When the border is closed you immediately see the effect also in neighboring regions. And that was missing in the first map entirely for me.

E2: I really liked the maps. In both voting sessions, I chose the second map, I liked it more. But I also really appreciated the table with more detailed information. I just realized while working with the second map that the exact dates in written form are really missing in that version. But I still voted for the second one, because the differentiation with colors was clearer.

E3: If it is about knowing when happened what I preferred to have a table. Otherwise I would suggest snapshots, to have it all together. For mechanisms, I preferred the map with the colored lines. But I am a snapshot person, animation is generally too fast for me.

E4: The idea is very interesting, to link migration trajectories border policies and the numbers of people travelling through these countries. I like that. And I also think

the general layout of the map is really good. I like the map where the policies are displayed as colored lines better, otherwise it is really hard to know where and when these policies were applied as the map proceeds.

M: **The whole study started by analyzing already implemented maps and visualization (both static and interactive) to find a research gap. Several of the maps that we have found are in the form of origin-destination map. Do the maps implemented for this thesis differ from an OD map? What do these maps deliver? Which are the differences between these maps and an OD map?** *[an example of an OD map is shown to the interviewee]*

E1: Yes, of course, there are differences. Both of the maps are significantly more detailed than an OD map. An OD map is insufficient. It lacks the details. Does not tell that there are multiple routes. If you only look at this OD map you do not understand the politics of what is actually happening on the ground. How different states are closing their borders and how one state closing its border causes a political reaction in another state. Both of your maps convey this information while this OD map does not. It looks like a single highway.

E2: I mean, in general it is very important to have the information in between, because it is happening so much. And I would say that in most of the cartographic visualization of migration movements, exactly what is happening on the route during the travelling in somewhat missing. You really only have the country of origin and then they take a plane to Germany, which is clearly not the case.

E3: I would prefer a static map like the OD map and then some sentences. Because in this case I have to analyze everything for myself. I really liked it to watch the movie but I have to be too concentrated to get information out of it. If I read something the analysis is already done. If I would have to get information as quickly and as easy as possible I would like to have snapshots and a description. But I think the visualization is really nice.

E4: Certainly it adds valuable information. What was difficult for me was that it was almost too much information in one map (borders, policies, arrivals, …). It is really hard to link them visually. But I do not know if there is a possibility to make it easier for the reader to study the map, to disentangle this information.

M: **Usually information about migrants and border policies is treated and discussed in a more qualitative form with stories, observations, interviews, photos, …. Here instead the focus is laid on the quantitative information. Did you wish to have more qualitative data? What about the emotional aspect that can be delivered through pictures or narratives? Is that still present?**

E1: Honestly it inspired a more fearful reaction from me. It is nice to have the quantitative data, it is nice to see the numbers. I vastly underestimated the number of daily arrivals until I saw your maps. Your maps drove home the size of the

situation. The thing that I noticed in myself with the quantitative data was a more fearful reaction. Because 10'000 people arriving every day, I started thinking, honestly, my god, I do not blame them for closing the border while they figure out what to do. Because that is an unmanageable number of people, and you do not know who any of them are, and I started thinking automatically about the logistical problems. Where are you going to house these people? Well, politically I remain committed to open borders and helping these people as rapidly as possible but the sheer size, the sheer number of people arriving is something that I had not understood. Ideally what you do, as ever, you have a combined situation where we do not stop seeing the pictures of children or dead people. Those are real problem and there is a humanity there that needs to be addressed, but I think it is also good to remind ourselves that this is a huge problem, with an enormous number of people and they really do pose realistic logistical problems. And as politically open as we want to be, we cannot simply open the doors and host everybody without some kind of procedure in place.

E2: I am not sure. You would never use such a map without any other information format. I would suppose that if you produce an interactive map it is always somehow integrated in online features, reportage, longer text, presentation even scientific presentation. I think that the map is more effective if you abstract from the really qualitative (what is happening to the people, stories, …) and rather focus on the more quantitative numbers. I really like that it was quantitative information but combined, that was really central. I am really interested in this topic and to know more about what happened is not easy, but this visualization gave me new knowledge about the situation. It was really helpful. I would not expect to find qualitative persons' stories and so on.

E3: Qualitative information in this map would be too much. What kind of qualitative information would you give anyway? It would be really good to have also other information to play around with. But it depends all on the purpose. But if I have to get information to answer questions, then it is always more and more if you add qualitative data. There is the danger to get lost. If you want that the people are informed, I think less is more. One needs guiding lines or leads!

E4: Policies are indeed qualitative data! I did not miss the qualitative data here. It is not the purpose of the map to show much qualitative information. The purpose is to trace the connection between policies and the numbers. I would not add, rather take away information. More information distracts the viewer probably. It is important to think about how to visualize other qualitative data as well, but there I would take another approach and a whole new map setting.

M: What do you think about the power of these maps? Can they influence people's opinions? If so, how? A common problematic by presenting such a topic is that these maps might be used to strengthen or weaken certain ideas. What do you think about this issue?

E1: It absolutely could be. But I had to restate my ethical and moral political principle to myself before answering. The sheer size of the numbers, these large red dots. It is a very fear based process. You just suddenly see this big red dot pulsing and flashing and it was very effective in scaring me. So, I would not be surprised personally to hear that that pushed people into a different direction. But likewise, you can push people opposite-wise by showing them a dead 6 years old and say this person died by trying an illegal crossing because the border was closed. In a way, it is a game of manipulation of images and information in order to bring about a political result that matches your principles. It would not be bad if you could show a sort of more left wing, open border imaginary to people who are more on the right and show this information to people who are on the left so we could all kind of make a rational decision.

E2: I think this argument can also only be made after we document the effect. When I started it, I answered that walls and fences are completely ineffective, they do not work. But it seems to be that in your timeframe at least when a fence/wall is completed it is the most effective tool, but this is strictly related to the single countries. Hungary managed to keep people out this way, but the number are also only the official. In general, I do not think that such a tool would legitimize harsher policies. If you are documenting what happened in the last years it is important to show what happened without keeping secret or hiding information.

E3: If they want to reduce refugees than they see which one works and they go for it. If they are against policies, then the map has no particular effect. This map can bring people to strengthen their opinion, mostly for people against the hospitality of migrants. Maybe it is not only about what works, but also shows what is not working. If one wants to reduce it can also see what is not working.

E4: Hard to say. I think the numbers have a profound impact on what people think or might vote. We call it politics of numbers. As a policy maker, I would say the map is not enough to convey all that happened on these migration routes. It is important to have also some explanations to the map. The map also collapses things, and you do not know where people attention is. In a text, it is easier to make sure that everyone looks at everything. But there is the danger of supporting a closed attitude towards migrants, because that is what the map somewhat conveys. But I would be against this direct link. Because the map displays correlation not causation! But for the viewer it suggests that these policies had these effect, while there could also be other things happening (not displayed or displayable in the map). It is really difficult in general to decide what to include and what to exclude in this kind of maps. For instance, I also had the impression that policies in faraway countries had an effect on countries located before or after. That is something that this map emphasizes: a complex set of relationships.

M: Do have any comments on the maps (vis1, vis2)? Which one do you prefer?

E1: The map with the table [vis1] was asking questions about dates and obviously that was super convenient, it was the right tool for the problem. What was very difficult about that, was determining where the policies were enacted at different times. Because you are given two pieces of information but not the third, you are given the states and the date but you do not know where on the map. It does not appear! The very helpful lines from the other map [vis2] were missing. So, what that meant was that I had to scroll back and forth and watch moment much more clearly rather than seeing a giant purple line appear and knowing where to focus my attention. I found myself having to really concentrate on that map [vis1]. That was much more difficult than with the other map type. Absolutely useful the colored lines [vis2], but conversely the tricky thing was the date, the exact date and I think I reflected this in my questions. I would say the second map was be superior if you would just add a table that shows the dates.

E2: In the first one [vis1] I had to train myself, learn how to work with the table. An idea there would be that, parallel to the date in the middle, you could highlight the table when the specific dates comes. But I liked the other map better [vis2]. Why not combining the two maps? I think it would not be too much information but very helpful. Because especially when there is the slow decrease in spring 2016, it would have been much more compelling to have an overview with a table.

E3: I want to have the table in the other visualization. It is the same information but it would really help to understand and keep up with the animation.

E4: It might be better to have the table in the other map [vis2] as well. It is fine if time progresses, but basically you have to slow down or stop to get everything.

M: Which was your tactic/strategy in watching the video to answer the questions?

E1: I pause the video and scrolled around a lot. In fact, the second time I watched the video I did not even watch the video the whole way through, I just paused it and looked at the questions and then answered the question while watching the video. I mean in total I watched the second video only once. Another strategy was looking at the questions specifically before checking out the map. The first time I watched the map and I was trying to remember it. That is silly, let me go see the questions and search the map for that answer!

E2: I mean when you only see it once it is still a lot of information. So, I always look it once, trying to grasp as much information as possible. But then I read the questions and went back to the map for particular things I wanted to know. For answering the particular questions I had of course to look back, pause the video, get an overview on what caused the situation and then press play again for five or ten days to see the effect. But I think this was a very convenient strategy. Another strategy was to pause and use the scroll feature of the video.

E3: For the map with the colored borders I just waited for the line to pop up and then used the stop button a lot. I wanted to make a snapshot for myself.

E4: *[This topic was not addressed in this interview]*

M: Did you encounter problems? Do you have any suggestions to make? Ameliorations to propose?

E1: The legend with the second map, initially I found it unclear. What is a wall? A fence? A quota? Visually they all look like fences. I would not be bad to have different graphics (soldiers for militarization, papers for quota, …) not just distinct colors. That would have been more understandable.

E2: I did not immediately like and get the routes. It distracted me a bit in the beginning. In the Aegean Sea, you had a circle marking the whole region while elsewhere lines. But after some seconds I understood it. It was a first look problem. Maybe the routes could be visualized interactively as well. But in the end, it is a good compromise to have these dotted lines. For instance, after Hungary closed the border to Serbia than many migrants just made this detour via Croatia and again to Hungary, there it was helpful to have this dotted line. I thought ok but why anyone is arriving in Slovenia, and then I realized they just go back to Hungary via this route (represented by the red line).

E3: I would not reduce the speed in general. But it would be useful if the speed would be reduced at specific points. But I would not reduce the overall speed, otherwise it gets too long and too boring.

Furthermore, I mostly ignored the red dashed lines. For me it was really a lot of information therefore I ignored the red lines since they are the less highlighted and easier to ignore. Further improvements depend on the aim of the map. If you want that the people see the routes, then these must be more highlighted. For instance, for the routes it is possible to insert arrows to make it clearer to the user. But if that is not important, then this is not useful.

E4: What I would recommend is to have the time in a scale (arrow). There you can see the whole timespan, not just dates, and then you could even mark when these different policies are implemented, so you could attract the reader of the map to these ruptures in the timeframe. The other map displaying the whole continent was more difficult to read. The dots were smaller. It makes more sense to take only the extent where things are happening. It might also be an idea to shift the extent according to where the changes are happening. That could help the viewer to focus on the important parts.

I also thought about the choice of dots. Why not choropleth? You could work with hues. The dots attract your attention away from the border lines. Then it is clear and you would rather have the relative size. Better than have the absolute numbers.

You do not gain a lot by using absolute numbers. I did not look at the scale at all. I just considered the small vs. big. It is another level of information.

The border crossing points on the borders. It is good to have these information in general, but for what you want to convey I do not think it is necessary. The scale was not fine grained enough to really look at these crossing points. If the map would show information of the borders' life, crossing and stories it would be ok to display the border crossing points, otherwise they can be left out.

The routes could be emphasized more. If the data are available, include some type of vectors displaying the number of border crossing, like arrows growing and stretching. That could display the border crossing and then the choropleth could display the number of migrants in the country.

M: *[After exploring the interactive version of the map]*

What differences did you notice between the videos and this interactive version of the map? The old suggestions are still valid? Any new ones?

E1: Beautiful! This version is really cool. You did a really god job with this. Maybe it is not a bad idea to show directionality of the border. We understand of course that the movement is south to north, so it would not be bad to have little arrows showing that it is militarized in this direction. Also, really interesting on the 16th of September this fence is built and it is just not having any effect and then it happens. But where are they coming from six or seven days after the wall was built? Being able to step through it like this it is cool because it shows the granularity. I can see that now it is decreasing over time. You know the size of the circle and it is less but it took a month for that wall to make a dent in it. And when I was watching the video I thought the effect was much faster. This map is fun! It can actually show a lot. The interactivity is great. But this is really cool and it is not too much information. I would like more information. I would for instance like to see the exact calendar, like from when to when does this run. I do not know how long it goes for and I want to see that information. I would like to be able to jump back and forth and it would be really nice to be able to play with the quantitative data and be able to filter. And to be able to filter through policies type, to toggle all that information. Great map!

E2: I really like the colored borders and the colors in general, but depending on the scale it also a little bit by chance that you realize that a measure was introduced. I wanted to know when a specific measure was introduced and I had to click back for quite a long time to get to that point. If it is feasible from the visualization point of views I think it is best to have both the colored borders with the particular policies but also kind of an overview in a table. And you always depict the latest introduced measure. Sure, it is better from a visualization perspective. Better than combining colors, there it could become quite a mess. But if you start from a certain point then you cannot know what happened before... Also, I had the impulse to scroll and it was not possible. It would be the most important improvement to the map. Much more convenient.

Have a bar here at the bottom that you can scroll through the date. I really like it was on a daily basis. It would be easier with weeks, but on a daily basis it is really the best solution. But without the scroll function it is really uncomfortable to go back and forth for a month or so. To make it geographically more precise concerning Greece. There are concrete islands where people travelled. So, I would maybe only use the more important islands there and show the routes from there.

E3: I am really a person that get quickly confused, but I think this map is really well structured. This is sadly only a desktop version, since with a smartphone it would be really difficult to understand anything. But another interesting use would be for school and educational purpose. Really useful!

E4: A possible danger might be that the common user is lost in the multiple possibilities. One can zoom in much more than it makes sense. But if you are used to this type of data then it is nice that you can zoom and look what these policies are doing to these two countries, focusing just on these. But I think here again I miss the timeline instead of dates. Then the circles displaying the sea crossing distracted me a bit. I would take the main islands and only display the routes on the land. Since also the route on the land are not precise, I would do the same in the sea. The general layout is really nice: the coloring and the simple visualization! I would maybe display the policies with the neighboring countries. Not the arrivals, only the policies. Or emphasize that it is only about the Balkan route and not about neighboring countries. By highlighting the important countries and graying out the other, for instance. To make it clearer.

M: Thank you for your time and your collaboration.

Appendix D: Statistical Analysis

ACCURACY		Overall	Extent1	Extent2	Impact	When	Generic	I (ext1)	W (ext1)	G (ext1)	I (ext2)	W (ext2)	G (ext2)
	Test	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	U-value	575,0	713,0	340,5	589,5	593,5	717,0	627,0	711,5	681,5	593,0	552,0	553,5
	Z-value	-1,703	-0,289	-3,699	-1,574	-1,605	-0,255	-1,202	-0,348	-0,659	-1,041	-2,169	-1,813
	Effect size	0,19	0,03	0,43	0,18	0,18	0,03	0,14	0,04	0,08	0,12	0,25	0,21
	Sig.	0,089	0,773	0,000	0,116	0,108	0,799	0,229	0,728	0,510	0,298	0,030	0,070
GROUP1	Count	38	38	37	38	38	38	38	38	38	35	38	38
	Mean	70,78	70,76	72,67	64,91	70,18	77,19	67,54	70,18	74,56	67,62	70,18	79,82
	STDV	28,14	33,82	23,22	26,79	35,97	31,58	39,12	42,30	33,27	20,59	34,48	35,12
	SE	4,57	5,49	3,82	4,35	5,83	5,12	6,35	6,86	5,40	3,48	5,59	5,70
GROUP2	Count	39	39	36	39	39	39	39	39	39	39	39	37
	Mean	77,94	75,50	87,96	74,36	78,21	83,33	78,63	73,50	74,36	70,09	82,91	92,79
	STDV	24,50	27,36	16,02	28,83	33,59	19,87	37,06	40,59	24,73	33,15	32,33	25,01
	SE	3,92	4,38	2,67	4,62	5,38	3,18	5,93	6,50	3,96	5,31	5,18	4,11

TIME		Overall	Extent1	Extent2	Exploration	Impact	When	Generic	E (ext1)	I (ext1)	W (ext1)	G (ext1)	E (ext2)	I (ext2)	W (ext2)	G (ext2)
	Test	MW	T-test	T-test	T-test	T-test	MW	T-test	MW	T-test	T-test	T-test	T-test	T-test	MW	MW
	U-value	271,5	-	-	-	-	363,0	-	597,5	-	-	-	-	-	478,5	576,5
	Z-value	-0,570	-	-	-	-	-0,887	-	-0,745	-	-	-	-	-	-0,840	-0,012
	Effect size	0,08	-	-	-	-	0,12	-	0,09	-	-	-	-	-	0,10	0,00
	t-value	-	1,557	-0,306	0,724	0,431	-	0,046	-	1,221	2,153	-0,476	-0,110	-0,827	-	-
	df	-	51	55	68	63	-	57	-	65	43	66	68	64	-	-
	Cohen's d	-	0,44	0,08	0,18	0,11	-	0,01	-	0,30	0,66	0,12	0,03	0,21	-	-
	Sig.	0,569	0,127	0,760	0,472	0,668	0,375	0,963	0,456	0,226	0,037	0,636	0,913	0,411	0,401	0,990
GROUP1	Count	25	27	26	33	34	28	32	35	33	29	33	33	33	32	33
	Mean	1080	696	404	191	324	402	167	132	214	296	73	73	121	122	95
	STDV	450	327	164	98	178	237	83	95	127	167	34	43	65	90	59
	SE	90	63	32	17	31	45	15	16	22	31	6	7	11	16	10
GROUP2	Count	24	26	31	37	31	30	32	38	34	30	35	37	33	34	35
	Mean	991	585	416	176	307	339	166	105	180	220	77	74	135	122	86
	STDV	278	173	126	75	143	146	61	47	93	92	34	41	74	61	37
	SE	57	34	23	12	26	27	11	8	16	17	6	7	13	10	6

OPINION		Attitude (b)	Attitude (a)	Prevote1	Prevote2	Prevote3	Prevote4	Vote1	Vote2	Vote3	Vote4	Hospitality (b)	Hosp. war (b)	Hospitality (a)	Hosp. war (a)
	Test	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	U-value	616,0	535,0	691,5	624,0	601,0	661,0	704,5	580,5	601,5	630,5	647,0	566,0	643,5	495,5
	Z-value	-0,927	-1,605	-0,626	-1,239	-1,692	-0,881	-0,462	-1,702	-1,622	-1,183	-0,795	-1,550	-0,438	-2,235
	Effect size	0,11	0,19	0,07	0,14	0,19	0,10	0,05	0,19	0,18	0,13	0,09	0,18	0,05	0,26
	Sig.	0,354	0,108	0,532	0,215	0,091	0,378	0,644	0,089	0,105	0,237	0,427	0,121	0,661	0,025
GROUP1	Count	37	35	38	38	38	38	38	38	38	38	37	37	35	35
	Mean	70,75	70,82	89,47	59,21	40,13	73,68	86,84	59,21	42,11	70,39	73,00	82,83	76,17	83,33
	STDV	9,99	12,86	19,82	23,55	19,74	25,96	23,06	26,27	19,37	26,54	18,15	15,47	22,25	18,52
	SE	1,64	2,18	3,22	3,82	3,20	4,21	3,74	4,26	3,14	4,31	2,98	2,53	3,77	3,13
GROUP2	Count	38	39	39	39	39	39	39	39	39	39	39	38	39	39
	Mean	72,75	75,54	86,54	66,67	33,97	78,21	90,38	69,23	36,54	77,56	75,67	86,33	79,00	91,00
	STDV	12,49	11,22	22,83	26,49	17,67	27,61	17,78	23,97	20,56	23,50	21,58	19,70	19,02	15,70
	SE	2,03	1,80	3,66	4,24	2,83	4,42	2,85	3,84	3,29	3,76	3,45	3,20	3,05	2,52

VIDEO EVALUATION		Dates	Speed	Difficulty	Link
	Test	MW	MW	MW	MW
	U-value	634,0	691,5	671,0	731,5
	Z-value	-1,111	-0,329	-0,732	-0,099
	Effect size	0,13	0,04	0,08	0,01
	Sig.	0,266	0,742	0,464	0,921
GROUP1	Count	38	38	38	38
	Mean	58,77	74,12	52,63	64,04
	STDV	25,92	18,05	21,76	26,71
	SE	4,20	2,93	3,53	4,33
GROUP2	Count	39	39	39	39
	Mean	52,56	72,81	55,56	63,68
	STDV	24,34	17,08	19,99	29,59
	SE	3,90	2,77	3,20	4,74

VIDEO TACTIC		Switch (ext1)	Pausa (ext1)	Watch (ext1)	Switch (ext2)	Pausa (ext2)	Watch (ext2)
	Test	MW	MW	MW	MW	MW	MW
	U-value	730,0	706,0	740,5	702,5	663,0	632,5
	Z-value	-0,120	-0,379	-0,005	-0,417	-0,846	-1,125
	Effect size	0,01	0,04	0,00	0,05	0,10	0,13
	Sig.	0,905	0,705	0,996	0,677	0,398	0,261
GROUP1	Count	38	38	38	38	38	38
	Mean	80,26	76,32	65,79	77,19	77,19	59,21
	STDV	24,77	27,84	26,83	27,79	27,79	28,92
	SE	4,02	4,52	4,35	4,51	4,51	4,69
GROUP2	Count	39	39	39	39	39	39
	Mean	77,78	77,78	65,38	79,49	80,77	66,67
	STDV	28,95	30,19	28,96	27,43	27,18	27,84
	SE	4,64	4,83	4,64	4,39	4,35	4,46

RATING VIS1		Look (b)	Borders (b)	Arrivals (b)	Link (b)	Time (b)	Routes (b)	Look (a)	Borders (a)	Arrivals (a)	Link (a)	Time (a)	Routes (a)
	Test	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	U-value	736,5	595,0	734,0	730,0	589,0	582,5	677,0	680,5	713,0	697,5	708,5	729,5
	Z-value	-0,048	-1,543	-0,073	-0,118	-1,580	-1,655	-0,675	-0,633	-0,295	-0,457	-0,339	-0,120
	Effect size	0,01	0,18	0,01	0,01	0,18	0,19	0,08	0,07	0,03	0,05	0,04	0,01
	Sig.	0,962	0,123	0,942	0,906	0,114	0,098	0,500	0,527	0,768	0,647	0,735	0,904
GROUP1	Count	38	38	38	38	38	38	38	38	37	37	35	35
	Mean	57,02	45,61	59,21	34,65	46,93	51,75	57,46	46,05	63,16	40,79	52,19	53,07
	STDV	19,23	23,47	21,47	21,36	23,20	24,44	21,47	26,97	21,28	25,32	22,65	21,52
	SE	3,12	3,81	3,48	3,46	3,76	3,97	3,48	4,37	3,45	4,11	3,67	3,49
GROUP2	Count	39	39	39	39	39	39	39	39	39	38	39	39
	Mean	55,13	38,89	59,40	32,91	55,98	43,16	53,85	41,88	61,97	42,31	50,85	52,14
	STDV	18,40	23,98	26,16	15,53	26,35	22,53	18,12	24,74	19,85	23,52	27,82	23,93
	SE	2,95	3,84	4,19	2,49	4,22	3,61	2,90	3,96	3,18	3,77	4,46	3,83

RATING VIS2		Look (b)	Borders (b)	Arrivals (b)	Link (b)	Time (b)	Routes (b)	Look (a)	Borders (a)	Arrivals (a)	Link (a)	Time (a)	Routes (a)
	Test	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
	U-value	648,0	637,0	709,0	618,5	664,5	633,5	671,0	611,0	725,0	730,5	687,5	647,5
	Z-value	-0,980	-1,085	-0,334	-1,274	-0,799	-1,128	-0,738	-1,368	-0,168	-0,110	-0,556	-0,977
	Effect size	0,01	0,02	0,00	0,02	0,01	0,02	0,01	0,02	0,00	0,00	0,00	0,01
	Sig.	0,327	0,278	0,738	0,203	0,424	0,259	0,460	0,171	0,866	0,913	0,578	0,329
GROUP1	Count	38	38	38	38	38	38	38	38	37	37	35	35
	Mean	62,67	67,17	60,17	56,17	47,00	57,00	67,17	69,67	64,50	64,00	51,33	61,83
	STDV	21,73	24,04	22,44	26,68	22,55	22,14	23,08	23,52	21,63	24,36	22,72	23,54
	SE	3,52	3,90	3,64	4,33	3,66	3,59	3,74	3,82	3,51	3,95	3,69	3,82
GROUP2	Count	39	39	39	39	39	39	39	39	39	38	39	39
	Mean	58,55	72,65	58,12	48,72	51,71	51,28	64,10	76,50	64,10	63,68	48,72	57,69
	STDV	20,90	24,33	24,14	23,38	25,01	22,42	19,32	21,87	20,43	21,92	27,94	21,58
	SE	3,35	3,90	3,87	3,74	4,01	3,59	3,09	3,50	3,27	3,51	4,47	3,46

KNOWLEDGE			Knowledge
GROUP1	Test	Test	W
		Z-value	-1,918
		Eta squared	0,220
		Sig.	0,055
	Before	Count	38
		Mean	63,75
		STDV	27,70
		SE	4,50
	After	Count	38
		Mean	73,75
		STDV	29,60
		SE	4,80
GROUP2	Test	Test	W
		Z-value	-4,196
		Eta squared	0,478
		Sig.	0,000
	Before	Count	39
		Mean	57,75
		STDV	24,43
		SE	3,93
	After	Count	38
		Mean	79,50
		STDV	21,63
		SE	3,50

OPINION			Hospitality	Hosp. war
GROUP1	Test	Test	W	W
		U-value	-0,947	0,000
			-0,112	0,000
		Sig.	0,343	1,000
	Before	Count	37	37
		Mean	73,00	82,83
		STDV	18,15	15,47
		SE	2,98	2,53
	After	Count	35	35
		Mean	76,17	83,33
		STDV	22,25	18,52
		SE	3,77	3,13
GROUP2	Test	Test	W	W
		U-value	-1,604	-2,324
			-0,182	-0,265
		Sig.	0,109	0,020
	Before	Count	39	38
		Mean	75,67	86,33
		STDV	21,58	19,70
		SE	3,45	3,20
	After	Count	39	39
		Mean	79,00	91,00
		STDV	19,02	15,70
		SE	3,05	2,52

VOTING			Subject1	Subject2	Subject3	Subject4
GROUP1	Test	Test	W	W	W	W
		U-value	-0,791	0,000	-0,734	-1,249
		Eta squared	0,091	0,000	0,084	0,143
		Sig.	0,429	1,000	0,463	0,212
	Before	Count	38	38	38	38
		Mean	89,47	59,21	40,13	73,68
		STDV	19,82	23,55	19,74	25,96
		SE	3,22	3,82	3,20	4,21
	After	Count	38	38	38	38
		Mean	86,84	59,21	42,11	70,39
		STDV	23,06	26,27	19,37	26,54
		SE	3,74	4,26	3,14	4,31
GROUP2	Test	Test	W	W	W	W
		U-value	-1,190	-0,700	-1,000	-0,229
		Eta squared	0,135	0,079	0,113	0,026
		Sig.	0,234	0,484	0,317	0,819
	Before	Count	39	39	39	39
		Mean	86,54	66,67	33,97	78,21
		STDV	22,83	26,49	17,67	27,61
		SE	3,66	4,24	2,83	4,42
	After	Count	39	39	39	39
		Mean	90,38	69,23	36,54	77,56
		STDV	17,78	23,97	20,56	23,50
		SE	2,85	3,84	3,29	3,76

		OPINION	Overall
GROUP1	Test	Test	W
		U-value	-0,370
			-0,044
		Sig.	0,711
	Before	Count	37
		Mean	70,75
		STDV	9,99
		SE	1,64
	After	Count	35
		Mean	70,82
		STDV	12,86
		SE	2,18
GROUP2	Test	Test	W
		U-value	-2,423
			-0,276
		Sig.	0,015
	Before	Count	38
		Mean	72,75
		STDV	12,49
		SE	2,03
	After	Count	39
		Mean	75,54
		STDV	11,22
		SE	1,80

		RATING VIS1	Look	Borders	Arrivals	Link	Time	Routes
GROUP1	Test	Test	W	W	W	W	W	W
		Z-value	-0,220	-0,085	-1,283	-2,148	-1,378	-0,030
		Eta squared	0,025	0,010	0,147	0,246	0,158	0,003
		Sig.	0,826	0,932	0,200	0,032	0,168	0,976
	Before	Count	38	38	38	38	38	38
		Mean	57,02	45,61	59,21	34,65	46,93	51,75
		STDV	19,23	23,47	21,47	21,36	23,20	24,44
		SE	3,12	3,81	3,48	3,46	3,76	3,97
	After	Count	38	38	38	38	38	38
		Mean	57,46	46,05	63,16	40,79	52,19	53,07
		STDV	21,47	26,97	21,28	25,32	22,65	21,52
		SE	3,48	4,37	3,45	4,11	3,67	3,49
GROUP2	Test	Test	W	W	W	W	W	W
		U-value	-0,653	-0,766	-0,379	-2,819	-1,645	-2,631
		Eta squared	0,074	0,087	0,043	0,319	0,186	0,298
		Sig.	0,514	0,443	0,705	0,005	0,100	0,009
	Before	Count	39	39	39	39	39	39
		Mean	55,13	38,89	59,40	32,91	55,98	43,16
		STDV	18,40	23,98	26,16	15,53	26,35	22,53
		SE	2,95	3,84	4,19	2,49	4,22	3,61
	After	Count	39	39	39	39	39	39
		Mean	53,85	41,88	61,97	42,31	50,85	52,14
		STDV	18,12	24,74	19,85	23,52	27,82	23,93
		SE	2,90	3,96	3,18	3,77	4,46	3,83

		RATING VIS2	Look	Borders	Arrivals	Link	Time	Routes
GROUP1	Test	Test	W	W	W	W	W	W
		Z-value	-1,521	-0,662	-1,250	-2,492	-1,170	-1,330
		Eta squared	0,17	0,08	0,14	0,29	0,13	0,15
		Sig.	0,128	0,508	0,211	0,013	0,242	0,183
	Before	Count	38	38	38	38	38	38
		Mean	62,72	67,11	60,09	56,14	46,93	57,02
		STDV	21,73	24,04	22,44	26,68	22,55	22,14
		SE	3,52	3,90	3,64	4,33	3,66	3,59
	After	Count	38	38	38	38	38	38
		Mean	67,11	69,74	64,47	64,04	51,32	61,84
		STDV	23,08	23,52	21,63	24,36	22,72	23,54
		SE	3,74	3,82	3,51	3,95	3,69	3,82
GROUP2	Test	Test	W	W	W	W	W	W
		Z-value	-1,922	-0,811	-1,268	-3,296	-1,188	-2,487
		Eta squared	0,22	0,09	0,14	0,37	0,13	0,28
		Sig.	0,055	0,417	0,205	0,001	0,235	0,013
	Before	Count	39	39	39	39	39	39
		Mean	58,55	72,65	58,12	48,72	51,71	51,28
		STDV	20,90	24,33	24,14	23,38	25,01	22,42
		SE	3,35	3,90	3,87	3,74	4,01	3,59
	After	Count	39	39	39	39	39	39
		Mean	64,10	76,50	64,10	63,68	48,72	57,69
		STDV	19,32	21,87	20,43	21,92	27,94	21,58
		SE	3,09	3,50	3,27	3,51	4,47	3,46

Personal Declaration

I hereby declare that the submitted thesis is the result of my own, independent work. All external sources are explicitly acknowledged in the thesis.

Matteo Riva

Zurich, 28.09.2017