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DIPLOMA THESIS

Map Transparency and Trustworthiness

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(Signature of Author) (Signature of Supervisor)

Declaration of Authorship

I hereby declare that I have written this Diploma Thesis independently, that I have completely specified the utilized sources and resources, and that I have marked all parts of the work - including tables, maps, and figures - which belong to other works or to the internet, literally or extracted, by referencing the source as borrowed.

Jakob Thummerer

Wien, 22.04.2025

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Abstract

Over recent years the easier access to mapmaking technologies and the presence of social media for distributing digital maps has led to an increased focus of cartographic research in the topic of map trustworthiness.

This thesis tries to examine how trustworthiness of maps can be secured and improved, by giving the map readers information about mapmaking decisions and data sources. For that purpose, an online survey with three different thematic maps has been conducted, to find out how trustworthiness of maps is affected by giving this additional information.

The results of the survey show that the trustworthiness in maps is significantly increased when providing users with additional information about mapmaking decisions and data sources. Furthermore, the results of the survey give way to a range of subtopics that should be investigated in more detailed studies.

Kurzfassung

Im Laufe der letzten Jahre führte der einfachere Zugang zu Kartenerstellungstechnologien und die Nutzung von Social Media zur Verbreitung von digitalen Karten zu einem erhöhten Interesse an der Forschung zum Thema der Vertrauenswürdigkeit von Karten.

Diese Arbeit versucht herauszufinden, wie die Vertrauenswürdigkeit von Karten sichergestellt und möglicherweise erhöht werden kann, indem der Nutzer der Karte zusätzliche Informationen über Entscheidungen, die im Kartenerstellungsprozess getroffen wurden, sowie über die Datenquellen erhält. Dafür wurde eine Online-Studie mit drei verschiedenen thematischen Karten durchgeführt, um herauszufinden wie sich die Vertrauenswürdigkeit von Karten verändert, wenn der Nutzer diese zusätzlichen Informationen erhält.

Die Resultate der Studie zeigen, dass die Vertrauenswürdigkeit von Karten durch zusätzliche Information über Entscheidungen im Kartenerstellungsprozess und Datenquellen signifikant erhöht wird. Weiters geben die Resultate einen guten Startpunkt und Fragestellungen für detailliertere Studien.

Content

1 Introduction

Trustworthy maps have been important for society for a long time, since they are being used for decision making in many different situations. This ranges from personal decisions about wayfinding up to political decisions with high impact that affect a lot of people. Researchers have claimed that for many years, maps have been seen as a trustworthy source of information (Griffin (2020), Kent (2017)). In more recent time, i.e., over the last couple of years, the group of people who can create proper maps for the public has widened. This is on the one hand, due to mapmaking tools and open data initiatives that are available through the internet for everyone. On the other hand, the use of social media makes it easier to distribute maps to larger amounts of people.

With the increased amount of fake news circulating around in social media, this leads to the problem that maps may no longer be seen as a trusted source of information, as it is easier to spread misinformation to a wide audience through maps. Also, in modern times there seem to be increasingly global problems, like climate change, pandemic disease, refugee crises, and more, which often demand to communicate important data through maps. This highlights the critical importance of mapmakers being aware of their responsibility of creating trustworthy maps, as maps can have a high influence on a large number of people.

Another factor that comes into play is the rapid development in artificial intelligence, which will make it harder to distinguish between maps created by humans and maps created by AI.

Because of the factors mentioned above, trust in maps has recently gained more attention in cartographic research. As a consequence, frameworks that aim to fight the danger of losing trust in maps have been developed (Gartner (2022), Griffin (2020)). One of the most common suggestions is that transparency on mapmaking decisions and data sources could help to secure the trustworthiness of maps. Mode (2017) states that it is important to understand and analyse the intentions and motives behind maps, to further understand how trust in maps can be improved.

For future research, it will be important to find out how we can create maps, that are more trustworthy than maps from non-experts or AI, where the latter two have a potential of providing misleading information.

The main research objective of this work is therefore to identify a link between the transparency about decisions in the mapmaking process and the influence on the trustworthiness of maps and

the topics presented in the maps. Furthermore, this study aims to give an overview about the factors that might have an influence on the trustworthiness of maps, and to find out in which areas more detailed research is necessary.

The results of this study aim to help cartographers create maps of especially pressing and controversial global problems, that sometimes lack trust in parts of the society, with further ambitions to improve decision-making processes of stakeholders and gain trust from larger parts of the society. Also, this thesis aims to contribute to the discussion about how maps produced by professional cartographers and maps produced by AI or amateur cartographers can be distinguished easier by professionals as well as the usual map readers.

Therefore, the main research questions (RQ) of this thesis are:

- RQ1: Can we enhance map trustworthiness by higher transparency about data sources and decisions taken in the mapmaking process?
- RQ2: Does the level of controversy of the topic presented in a map affect how trustworthiness can be increased or decreased?

To answer the research questions of this thesis, a literature survey on previous research in the field of map trust was undertaken. Based on the results of this survey, hypotheses were formulated and an online user survey with questions designed to test these hypotheses was created. For this survey, three thematic maps, varying in their potential for controversy, were created. These allow to test the potential influence of the level of controversy on the trustworthiness of maps. The participants were presented with these maps in the survey both with and without additional information on the map's sources and mapmaking decisions and should then answer questions about the perceived trustworthiness of these maps. Additionally, they were tasked to identify factors they think are helpful or not necessary for increasing trustworthiness. After a sufficient number of people participated in the survey, the answers to the survey were evaluated.

This diploma thesis is divided into six chapters. Chapter 1 discussed the motivation, research objectives and research questions central to this thesis. In Chapter 2, existing research about trust in maps and related research is analysed and summarized. To achieve the research objectives, three thematic maps and an online survey were created. How these maps and the survey were designed is described in Chapter 3. After participants filled out the survey, the data was evaluated. The results of this are shown in Chapter 4. In Chapter 5, a critical reflection and discussion of the results takes place. Additionally, future research questions are posed. Finally,

conclusions arising from the work were made and are presented in Chapter 6. The appendices contain all survey questions as well as the survey results.

2 State of the art

In recent years, the topic of trust in maps has become increasingly important in cartographic research. The main reasons for this are the increased number of maps getting produced and circulating in the web, and the power of maps, and therefore, the responsibility that comes with creating maps. In the following, findings from previous research and articles regarding these topics are discussed and summarized.

2.1 Power and authority of maps

Maps have been an instrument of power for a very long time. Kitchin et al. (2011) points out the historical and political power of maps, apparent in the forming of nations, empires and colonies as well as in critical decisions in historical wars and trading routes. In a more modern aspect, he states that „maps are not neutral, value-free spatial representations of the world“ (Kitchin et al., 2011, p. 444). This implies that maps carry the interests of their creators or publishers and can be used to influence the opinions of their readers. As an example, he names maps commissioned by state agencies, which tend to communicate certain messages in the interest of stakeholders and „include all kinds of ‘silences’ about other information” (Kitchin et al., 2011, p. 444).

Griffin (2020) describes, that in recent years it seems that pressing global issues, where maps act as an important factor in decision making and showing facts to the wide public, have increased. She points out that when looking into the past, maps have been a trusted source of information and not much attention was given to the fact that maps might contain false information or be used to manipulate opinions. Also, Schiewe et al. (2013) highlights the importance of trust in maps in the field of risk management, as maps can enhance the effectiveness of communication and trust in experts in hazardous events.

Kent (2017) discusses the authority of maps, as people put faith in maps and in cartographers, because they believe in the information that is depicted in maps and that the cartographer communicates true facts. In the “post truth society”, defined by the Oxford University Press (2017) as "relating to and denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief", this undisputed faith in maps should no longer be presumed. Cartographers should take care that not only the visual appeal of a map and the number of likes it gets on social media is important, but also a robust critique about whether the map communicates the truth and is trusted by the audience. Kent

(2017) describes this as the problem of *acritical cartography*. He suggests that modern cartographers must be more transparent in their mapmaking process, which could be achieved by giving more detailed information about data sources or revealing certain decisions made in the mapmaking process to the audience.

Mode (2017) wrote a journal article about persuasive cartography and why it is important for academic research. He describes persuasive maps, as "maps whose primary intent or effect is to influence opinions or beliefs – to send or reinforce messages – rather than to communicate objective geographic information"[1]. As an answer to the question why especially maps are such an effective tool for persuasion, e.g., when compared to messages communicated by images, he states that maps are seen as an honest and objective source of information. Therefore Mode (2017), states that maps, as a persuasive tool, are advantageous for communicating all kinds of intended messages, e.g., in the fields of politics, military, commerce, or religion. According to Mode (2017), especially in the times of "alternative facts", it is important to critically analyse the motives and interests behind all maps.

Nelson (2020) created a website[2] for an online exhibition where he shows, by various examples of maps, how maps display and bend reality and how they even try to persuade or mislead the readers. In the introductory text on this website, he states that maps are a representation of reality, but they always implicate simplification and symbolization. As an example, he names the fact that in maps the Earth is compressed on a sheet of paper and other information, like places and statistics are shown as symbols, lines or cartograms. Although people can't see the Earth from above themselves, they believe and trust in maps. According to Nelson, this is because these maps have been reproduced many times by people and institutions that are trusted. Nelson (2020) further points out that just because maps don't exactly show the real picture of the world or a region, doesn't mean that there are bad intentions behind it and that maps can still be honest and accurate. However, he mentions that it is important to think about how information is visualized in a map and what the motivation behind this visualization is, as this motivation is critical to understand trust in maps (Nelson, 2020).

In a blog post Cheshire (2021) takes a more moderate view on the quote that maps always lie and never tell the whole truth and states that „maps are never perfect so we need to create and use them responsibly"[3]. He believes that this is particularly important in modern cartography,

[1] https://persuasivemaps.library.cornell.edu/about/ (last access 2025-02-06)
[2] https://www.leventhalmap.org/digital-exhibitions/bending-lines/intro/ (last access 2025-02-07)
[3] https://jcheshire.com/visualisation/mapstrust/, p. 1 (last access 2025-02-07)

as the high level of trust people have in maps may suffer under the consequences of maps getting easier to produce. He identifies the data that is used to create the maps as the factor with the most potential to change people's trust in maps. He makes a point that there are maps with certain topics that can have potentially harmful impact if they are misinterpreted by the readers or misused by certain groups. Therefore, he also suggests being transparent about how maps are created and if there is uncertainty in the displayed data to encourage the map's readers to be critical of maps (Cheshire, 2021).

Kang et al. (2023) mentions a more futuristic aspect of the power of maps, in terms of AI-generated maps and the impact they might have in the future. He conducted research on the ethics of AI-generated maps in cartography with the aim of contributing to the existing research on trustworthy maps. Kang et al. show the benefits and the potential of AI in generating useful and good-looking maps but also points out the ethical issues with AI-generated maps and the negative impacts of misleading maps. He investigates four potential concerns of AI-generated maps, which are i) inaccuracies, ii) misleading information, iii) unanticipated features and iv) irreproducibility, which must be considered when creating or using AI-generated maps. Furthermore he developed „an ethical examination system with deep learning" (Kang et al., 2023), which allows to identify whether a map was generated by humans or AI. Kang et al. also suggests, that in the future, cartographers should cooperate with AI developers, to enhance the quality of maps produced by AI and such that ethical concerns and negative impacts can be minimized.

Juergens (2020) points out the power that choropleth thematic maps – maps, which display "divided geographical areas or regions that are coloured, shaded or patterned in relation to a data variable"[4] – can have and discusses what variables are available to create trustworthy maps rather than misleading maps, focussing on mapmakers with no cartographic background. Choropleth maps are widely used, also by non-experts, in the media for communicating spatial data, as they are easy to understand for the wide public. However, when creating such maps, there are some cartographic map-making principles that must be taken in account, so that the displayed data is not misinterpreted. According to Juergens (2020) the most important factors that could lead to misleading information from thematic maps are the chosen projection, generalization, scale, classification method and map design itself. Juergens further points out, that the user of the map only sees the final product and not the design decisions and data processing steps that were taken during the map production. If the user gets more insights in

[4] https://datavizcatalogue.com/methods/choropleth.html (last access 2025-02-08)

the process of creating the map from the initial source data, this could help the user to judge whether the product is trustworthy or not. He concludes that mapmakers must be aware of the power of their maps, in positive and negative ways, as maps can be used to manipulate large audiences with misleading information.

2.2 Easier access to maps and mapping

Besides the power of maps, multiple researchers have mentioned that the wider access to mapping and the easier distribution of maps should be a focal point of future research, as this creates the danger of an increased number of not well produced and potentially misleading maps getting spread around the internet, with the potential to influence large amounts of people.

Already in 1991, Mark Monmonier commented on the technological advancements that allow amateur cartographers to create proper looking maps. While Monmonier criticizes that amateur cartographers can create proper looking maps without or with just minimal understanding of the data and cartographic principles, he still calls for attention on the positive effects of technological advancements, which allows for more openness and better understanding of maps and mapping (Monmonier, 1991).

Griffin and Fabrikant (2012) point out the relevance of spatial information in everyday life, as not only more and more people use maps for an increasing number of tasks, but also more people have access to creating maps serving these tasks. As additional factors for the increasing relevance of maps she mentions the distribution capabilities of the internet, easier collection of location data and the increasing number of devices that can make use of maps. According to Griffin and Fabrikant (2012) this increased use of maps, forms a set of challenges that cartographers must face, such as representing useful information for new use cases on new devices and how to get the knowledge about mapmaking to the widening field of mapmakers.

In 2014, Kenneth Field wrote a journal article, where he reflects on the state of modern cartography. He highlights the increasing demand of maps, that comes with open data initiatives, easier accessible mapping tools and the internet and social media as powerful publishing mechanisms for maps. According to Field (2014), this increased demand in maps has led to more and more people creating maps. He criticizes that this increase in people who create maps, causes a large number of not-well produced maps circulating in the internet visible for everyone. Field (2014) makes a distinction between the terms mapping and cartography: according to him, mapping is what everyone can do, and cartography is what some people with proper education can do. Field further draws attention to the fact that these ‘terrible’ maps

circulating in the web may lead to a decreased appreciation for the quality of maps in the wide public.

Griffin (2020) highlights that in reference to open data initiatives and advancements in mapmaking technologies, which has widened the field of people who can create proper looking maps, it can no longer be presumed that widely spread maps have been produced by professional cartographers. According to Griffin (2020) this fact, combined with the so called 'post truth society', might lead to decreased trust in maps, and therefore, cartographers should pay more attention on creating trustworthy maps.

Chilton and Kent (2016) also state that the creation of maps has become easier in recent years, as mapmaking tools and geospatial data are more easily accessible for the general public. He also points out that the widespread use of social media makes it possible to easily share maps with big audiences and get recommendation for them. Based on that, Chilton and Kent (2016) discuss what educated cartographers can learn from so-called *neocartographers*, who create maps without proper education on cartographic principles, based on the aesthetics of a map. He highlights that in the past some convenient and now widely used mapping principles (e.g. Metro/subway maps) have been developed by people who did not have any formal education in cartography. By interviewing two people that fit his definition of neocartographer, Chilton and Kent try to gain insights about what their principles in the mapmaking process are. He concludes that communicating information seems to be an important factor in their purpose of creating a map, and also distribution numbers, in social media for example, play an important role in the design decisions of the neocartographers. Furthermore, Chilton and Kent found out, that user-centered design seems to be an important factor for neocartographers and not only for formally educated cartographers, as neocartographers do care about whether the user can use and see the map as it is intended to be by the author. Chilton and Kent conclude that "there is a movement from an exclusive community" that knows about cartographic principles, "towards an inclusive and more open community" (Chilton and Kent, 2016), which benefits the mapmakers as well as the users, as professional cartographers and researchers can learn from the successful products of amateur cartographers and also profit form the increased interest in maps and cartography. In turn, amateur cartographers can profit from the more inclusive and open research about cartographic principles for everyday people.

In 2019, Anthony C. Robinson, conducted research on viral cartography and how viral maps can be characterized and identified. He defines viral maps as „maps that reach rapid popularity via social media dissemination" (Robinson, 2019). He states that the research is driven by the

fact that the increased simplicity of creating and distributing maps via social media allows maps and mapmaking to gain significant attention and engagement. Therefore, it is important for cartographers to understand why maps get viral and how they can be identified. He proposes a framework where he defines the elements of viral cartography, such as purpose, audience, format, message context, etc. Furthermore, he presents a series of future research questions, like how virality in mapping can be detected and if it is possible to intentionally produce viral maps.

Finally, Cheshire (2021) argues that the increasing number of people being able to create maps can be a good thing as long as the mapmakers are aware of the trustworthiness of maps and the responsibility associated with creating maps.

2.3 Existing research about trust in maps

The chapter above shows factors that might lead to a decrease in trustworthiness of maps, or - more specifically - show the importance of producing trustworthy maps and the influence maps can have in the society. Therefore, research on trust in maps has been a focal point in cartography in the recent years.

Schiewe et al. (2013) points out the importance of the phenomena *trust* as a pivotal aspect of user experience when using maps. Although, in his journal article he focuses more on maps for orientation purposes, there are some aspects of trust that are relevant for all kinds of maps. In context of maps Schiewe et al. mentions so called “trust cues” following Egger (2001), such as graphical design, the sources and the medium of the map (paper or screen). As main aspects for enhancing trust in maps he names the features of source, actuality, and cartographic design.

In disciplines other than cartography, Van der Bles et al. (2019) conducted research on how public trust in facts and numbers is affected by communicating uncertainty in verbal and numerical form. Uncertainty is often not shown to the reader and only known to the scientists that curated the information. Results show that communicating uncertainty never significantly increased trust to the readers, but rather communicating uncertainty, especially numerically, only resulted in a minor decrease of trust. Based on that finding, the question arises wether that also translates to the discipline of cartography and maps.

Griffin (2020) used COVID-19 maps to further describe the critical importance of trust in maps and states that uncertainty is not sufficiently presented in these maps, which might have a negative impact on decision making in the fight against the pandemic. Based on her findings,

she describes how information about uncertainty in the data could help the user to know how much trust they can put in the map, and hence the displayed data could be used more efficiently and accurately. Still, Griffin warns that showing uncertainty to certain groups of users, especially non-experts, might not be beneficial as uncertainty can cause doubts in trustworthiness. Griffin further points out the importance of showing transparency of how the map was created to prevent misinterpretations.

Using the example of the COVID-19 pandemic in an online newsletter article, Griffin (2020) argues that trustworthy maps are important, because they are relevant for government decisions, and the governments rely on citizens following their information and restrictions presented through maps. Griffin (2020) further presents three questions that everyone should ask themselves when reading maps, to clarify whether a map is trustworthy or not. The first question is „What information is being mapped?“, which means that the information presented in maps always has to be taken with due caution, as there might be uncertainties in the data which are not visible easily. The second question is „How is the information being mapped“, which is aimed at the design decisions being used for the data being mapped, like colours, sizes or fonts. Lastly, the third question is „Who made this map and why did they make it?“ (Griffin, 2020), which is about the author of the map, and what the intentions behind the map are, as maps can be used to inform but also to misinform.

Gartner (2022) presents a proposal on how trustworthiness of maps can be protected and enhanced. He points out that - in times where the easier access to mapmaking and the data required to make maps leads to an increased risk for misusing maps and the distribution of fake maps - it is important that fake maps can be distinguished from trustworthy maps. Therefore, he presents two concepts on how this can be achieved. The first one is the concept of “going deep”, which should allow the user to have a transparent view of the decisions the mapmaker has made in the process of creating the map. The second one is the concept of “going broad”, which suggests that the user gets presented alternative sources, maps or visualizations to allow the user to make a more profound judgement of the original map (Gartner, 2022).

Prestby (2023) reviewed empirical research in the field of cartography and similar disciplines about trust in maps. On the one hand he highlights the significant role of maps in accurately communicating scientific information, and on the other hand the increasing threat of maps being used to spread misinformation, due to the easier accessibility to mapping and advancements in AI mapping. Therefore, he collected findings from empirical studies and identified gaps in

research regarding the topic trust in cartography. Prestby summarized the findings in the following six major themes (Prestby, 2023, p. 14):

- „Maps by authoritative, unbiased sources may enhance trust“
- „Maps with metadata, especially about data sources, may boost trust“
- „Visualizing a comprehensive but not excessive amount of information may elevate trust“
- „Visualizing uncertainty may elevate trust if the level of uncertainty is low, but high levels of uncertainty may stifle trust“
- „Beautiful and professional-looking maps may foster the impression of trustworthiness“
- „Maps may not be more trustworthy than other modalities of information“

Based on his findings, he presents a research agenda to show how the challenges of empirically studying trust in maps can be dealt with; and furthermore, he displays multiple research questions regarding the empirical research on trust in maps.

In 2024, Prestby criticized that most research in the field of map trust have inconsistent and untested measures of map trust. He further points out that the latest advancements in generative artificial intelligence and the potential of viral maps to spread misinformation are the main driving factor for more research in the field of map trust. He also argues that trust in maps is more versatile than trust in other forms of media and information and so it is hard to carry over the findings from other fields of research in trust. Therefore, he developed a numerical rating scale, called ‘MAPTRUST Scale’, for measuring trust in maps. He empirically evaluated twelve adjectives as indicators for map trust, which can be rated by study participants. Based off this evaluation, he recommends using this scale for future studies in map trust, as map trust can be empirically evaluated with this scale and „improve the reproducibility and robustness of cartographic research in the long-term” (Prestby, 2024).

2.4 State of AI in cartography

Yonov (2024) analyzes the role of artificial intelligence in the field of cartography and the associated opportunities and concerns of using AI in cartography. According to him, the main applications of AI in cartography are i) data extraction, ii) automated feature mapping, iii) terrain analysis, iv) personalized map generation and v) predictive mapping. For creating maps there are different AI tools. On the one hand there are AI image generators (DALL·E 3, Leonardo.Ai, Adobe Firefly, Google Gemini), that can be used for generating maps, by giving a more or less detailed description of how the map should look and what information it should

contain. As an example for an AI-generated map, a map of Austria, which was generated by using DALL·E 3 - which is implemented in ChatGPT[5] - can be seen in Figure 1. At first glance when looking at the shape of the country, it looks like a proper map. But when looking at details, like the location of cities, provinces, or rivers, they hardly ever appear in the right place. Also, the names of cities and landmarks are mostly written wrong or are not even readable. These mistakes also can't get eliminated by giving more detailed instructions for generating the map. In general, it can be said that ChatGPT doesn't create useful maps at the time of writing[6], and they are still easily distinguishable from maps created by real cartographers. However, the current rapid advancements in AI technology make clear that this might change rather sooner than later.

[5] https://chatgpt.com/
[6] The Thesis was written in early 2025

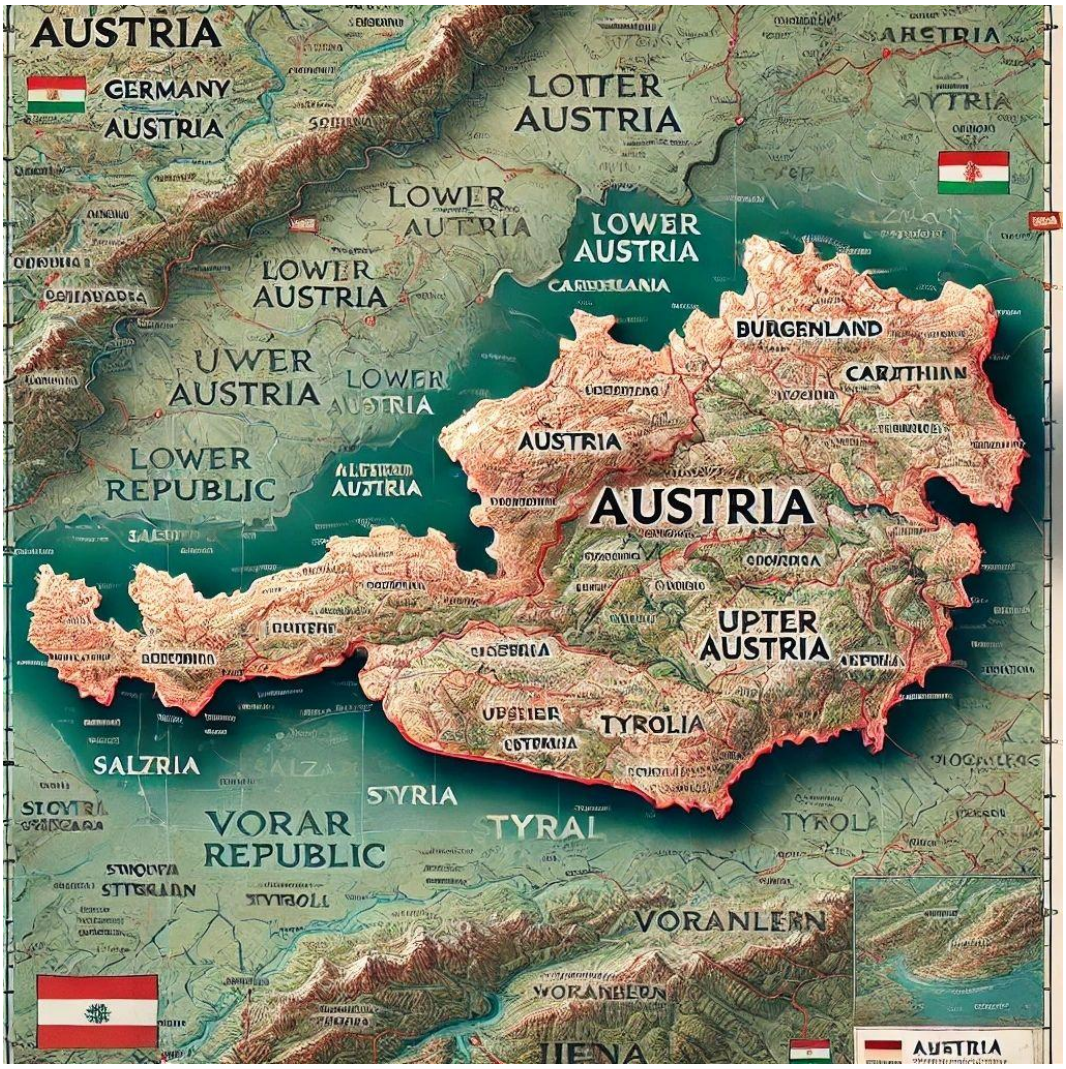

Figure 1: *Map generated with ChatGPT, using the prompt "Generate a map of Austria".*

In contrast to general purpose image generation like DALL·E 3, there are also AI tools specialized on creating maps, like MapsGPT[7] or Bettermaps[8]. With these tools, simple maps can be generated, although they are limited in terms of creativity and editability. Still, this is advantageous in terms of reliability of the map, as there are not as many elements that get generated by the AI and are therefore more trustworthy.

Another use of AI in cartography is GeoAI, which is „the integration of artificial intelligence (AI) with spatial data, science, and geospatial technology to increase understanding and solve spatial problems." (Yonov, 2024, p. 497). According to Yonov (2024), GeoAI is already being

[7] https://www.mapsgpt.com/
[8] https://app.bettermaps.ai/

successfully used for various use cases like flood prediction, deforestation detection and city heat mapping.

In terms of using AI for generating maps, Yonov (2024) identified the current main challenges and limitations. Apart from ethical considerations, which were also mentioned by Kang et al. (2023), he names data quality and availability, model interpretability and explainability, and technical limitations. All these limitations have to be solved or at least addressed, to ensure a responsible and trustworthy use of AI in cartography.

As possible future uses of AI in cartography Yonov (2024) suggests real-time updates for maps, personalized interactive maps and the combination of AI with augmented reality.

3 Methodology

To evaluate the impact of adding information about sources and mapmaking decisions on the trustworthiness of the map users an online survey was conducted. Therefore, three different thematic maps were created, with the intention that the map topics vary in controversial potential, from less controversial to more controversial.

3.1 Map design

All three maps were created with the vector design software Adobe Illustrator. To use a source of trustworthy information, the data for the base map with administrative boundaries was retrieved from the website ec.eurostat.eu, which is an official website of the European Union and acts as the statistical office of the European Union. The data forming this basemap itself was collected by EuroGeographics, which is an international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities[9]. This basemap was used for all three maps and was only changed a little in map extent and scale.

For the first map the forest coverage of countries in the EU has been chosen as a mostly non-controversial topic. Therefore, a simple choropleth map has been created in Adobe Illustrator, where the countries were filled with colours corresponding to their forest coverage (see Figure 2). As a thematic data source for this map, the website[10] of the Food and Agriculture Organization (FAO) has been used, which is a specialized agency of the United Nations that leads international efforts to defeat hunger. In detail, the data used for this map is provided by the Global Forest Resources Assessment (FRA), an initiative by the FAO, which monitors the world's forest resources through assessments.

[9] https://eurogeographics.org
[10] https://www.fao.org/home/en/

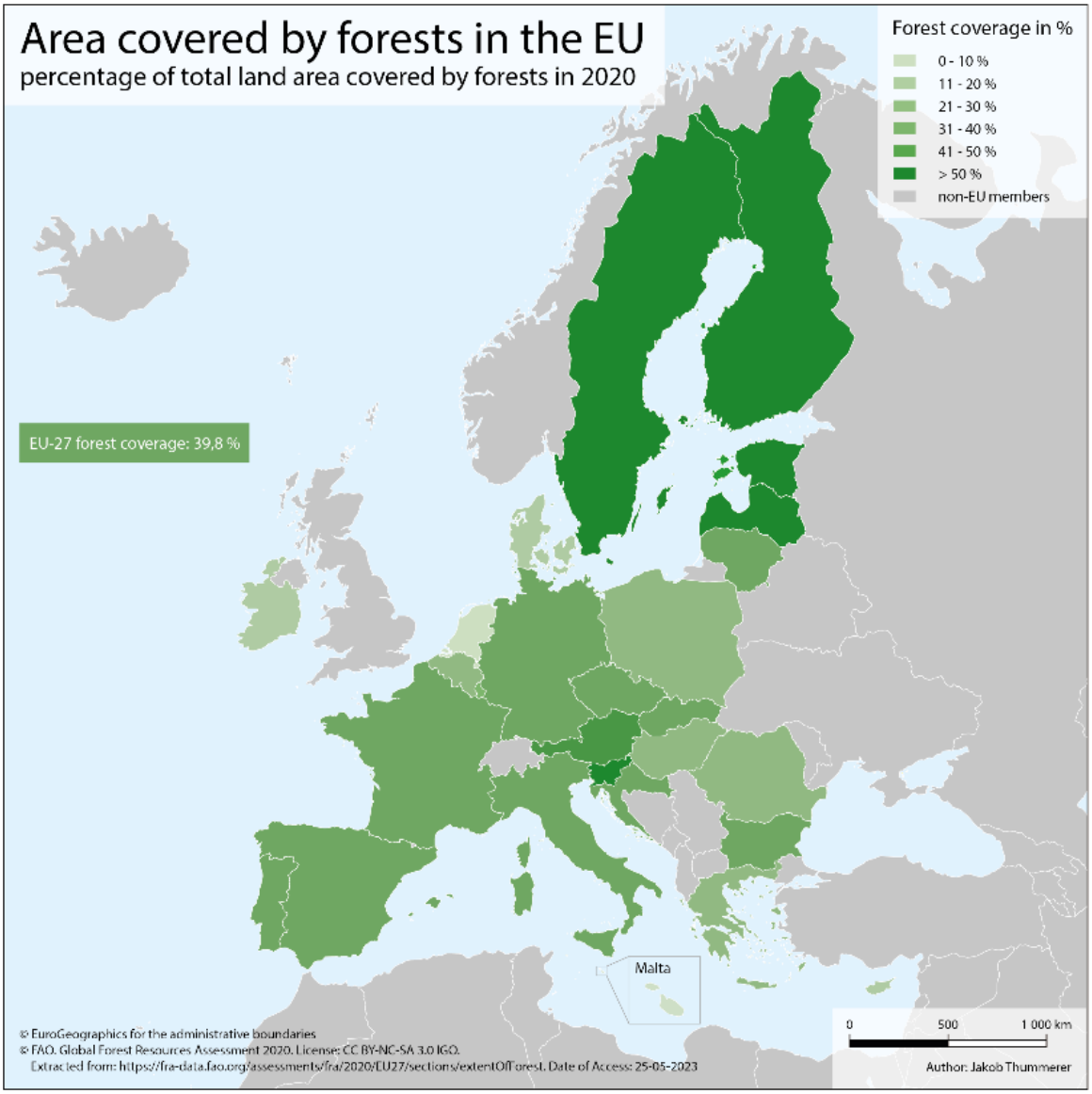

Figure 2: *Map about the forest coverage per country in the EU*

The second map was designed to have an intermediate level of controversy. It shows the energy imports of Austria as a graduated symbol map, divided into energy types and their countries of origin (see Figure 3). Additionally, an infographic with a detailed comparison of energy imported into and exported out of Austria has been added, to give the reader an idea of the energy dependency of Austria. The thematic data for this map was retrieved from the Austrian federal ministry for climate action, environment, energy, mobility, innovation and technology (BMK)[11]. The BMK annually publishes a brochure called 'Energie in Österreich', which gives an overview about the different energy sectors in Austria for the previous calendar year. The

[11] https://www.bmk.gv.at/themen/energie/publikationen/zahlen.html

data for the brochure was gathered by the BMK itself, Statistik Austria, which is Austria's Federal Statistical Office, responsible for collecting and publishing official statistics related to Austria, and E-Control Austria, which is the governmental department responsible for regulating the electricity and gas market in Austria.

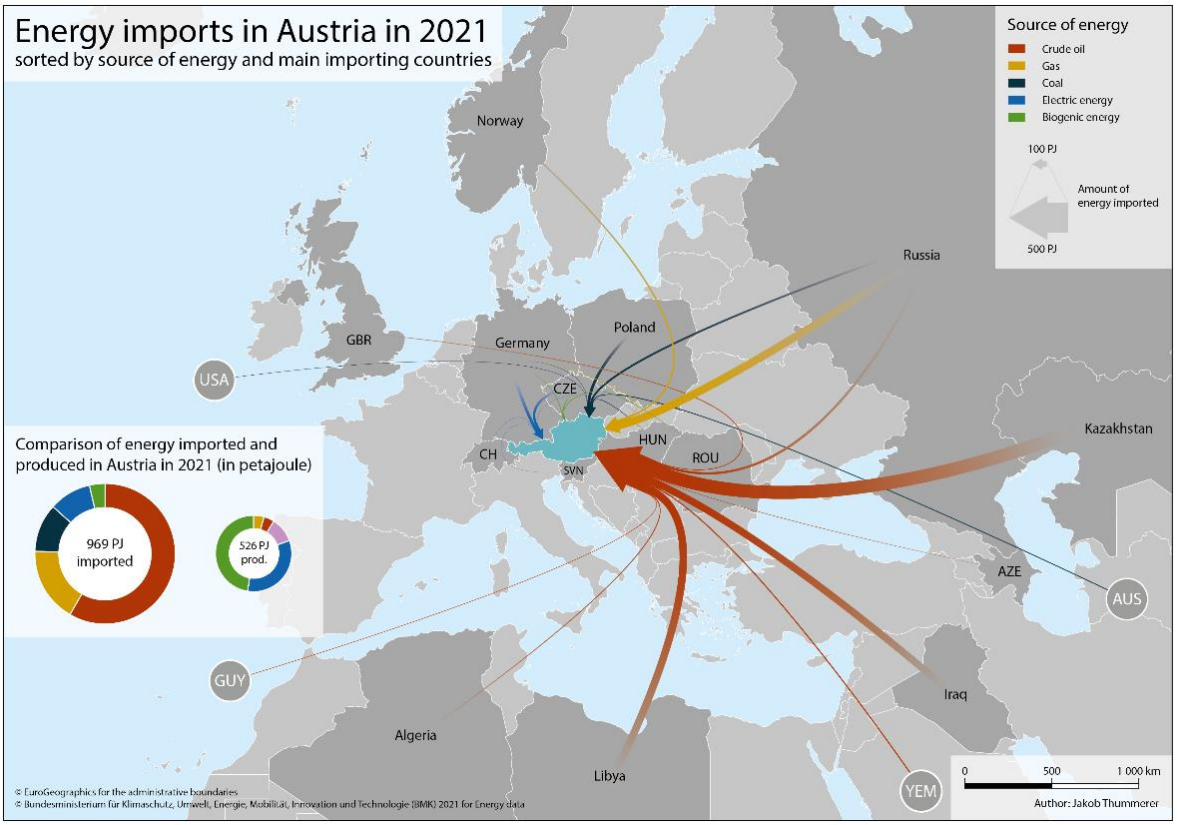

Figure 3: *Map about Energy imports in Austria*

Finally, as a more controversial topic, a graduated symbol map about the refugee movement forced by the Russian invasion of the Ukraine was created (see Figure 4). To use a trustworthy source, the data for the refugee numbers was downloaded from the Operational Data Portal (ODP) of the UNHCR, the United Nations Refugee Agency, which was initially created, to provide an information source and data sharing platform to enable coordination of refugee emergencies. The data and statistics on the site are updated weekly and are collected by the UNHCR through governments and authorities. For this map data from May 22nd, 2023, were used. In the map a small note regarding the refugee numbers recorded in Russia has been added as these are shown differently in the map, and it is important to not misinterpret the map and think that most refugees voluntarily relocated to Russia.

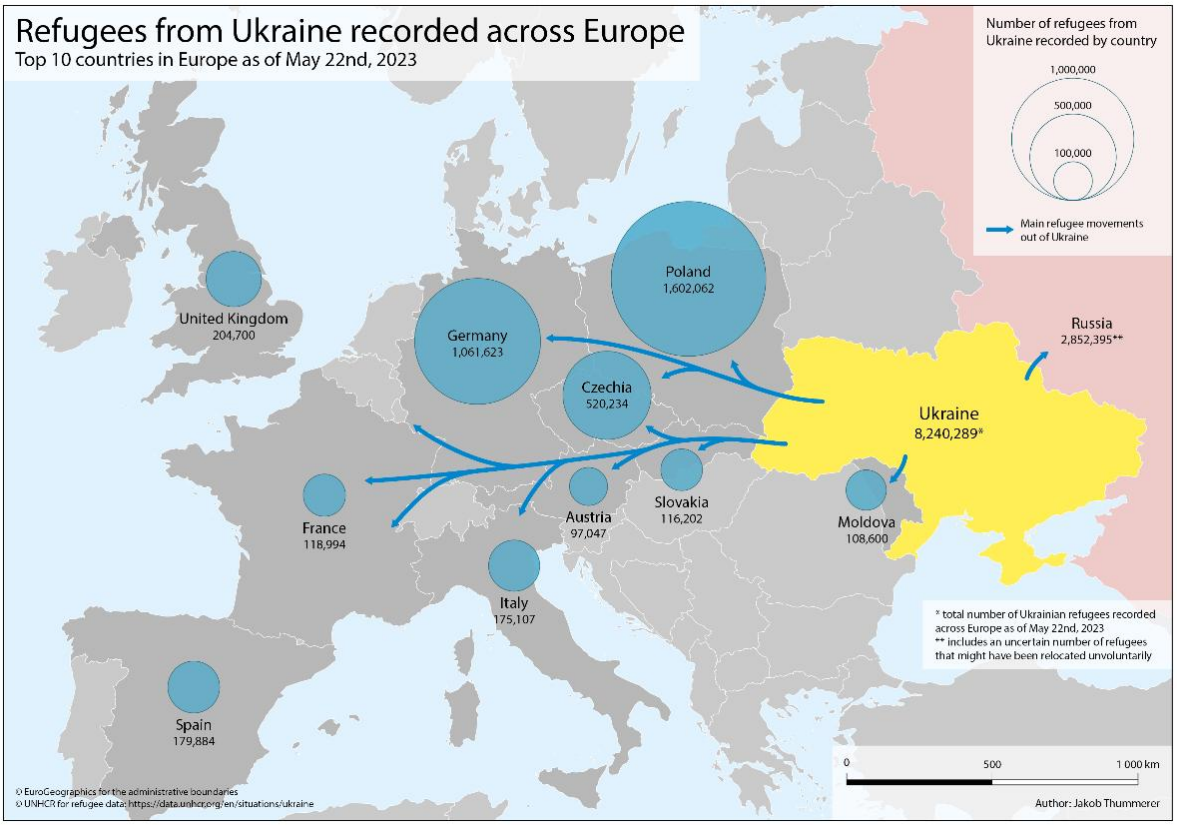

Figure 4: *Map about refugee movements from Ukraine*

Additionally, for all three maps standard map elements like title, legend, scale, author and sources have been added. To keep the maps comparable in terms of controversial potential, it was made sure that the maps don't vary too much in style or complexity, so that the results of the online survey for the different map topics would not be introduced by other factors than their potential of controversy. Furthermore, it was taken care that all the decisions in the mapmaking process were noted so they could be described later in the online survey.

3.2 Study design

For the online survey a mixed design approach was chosen, with quantitative questions carried out on a rating scale, to get data about the differences in trustworthiness, and open questions, to get more detailed feedback on the impact about certain design decisions. As a platform for the survey, the free-to-use web app LimeSurvey (2023)[12] has been chosen. It took about 30

[12] https://www.limesurvey.org/de-ch

minutes to participate in the survey, and it was created in English language. The survey was segmented in the following parts:

- **Introduction:** The participants got a short introduction about why the survey is conducted and a rough overview about the topic of the research. Additionally, the participants were given an approximate timeframe needed for completing the survey and they had to agree to the data policy before continuing with the next part.

- **Sociodemographic Questions:** Before the different thematic maps were shown to the participants, they had to answer three sociodemographic questions like age, gender and home country. Furthermore, the participants were asked about their experience in map reading and their expertise in cartographic principles on a 5-point unipolar rating scale. Figure 5 shows an example how the participants got presented these questions.

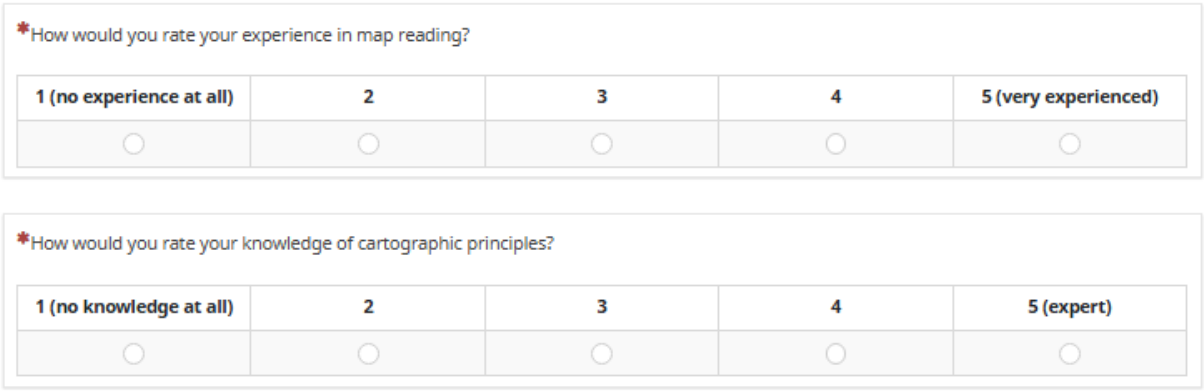

Figure 5: *Questions about experience in map reading (top) and cartographic expertise (bottom)*

- **Questions about the map:** The participants were presented with the thematic map, an instruction about the map, and the questions. After reading the map, the participants had to rate the controversial potential and trustworthiness of the map on a unipolar rating scale from 1 to 5. The topic of trustworthiness was divided into three separate questions about i) trustworthiness of information and numbers, ii) trustworthiness of sources and iii) trustworthiness of the cartographic competence of the mapmaker (see Figure 6). Additionally, the participants were asked if they believe it's possible to manipulate someone's opinion about the topic the way the information is shown in the map, with the option to add additional thoughts in a text box.

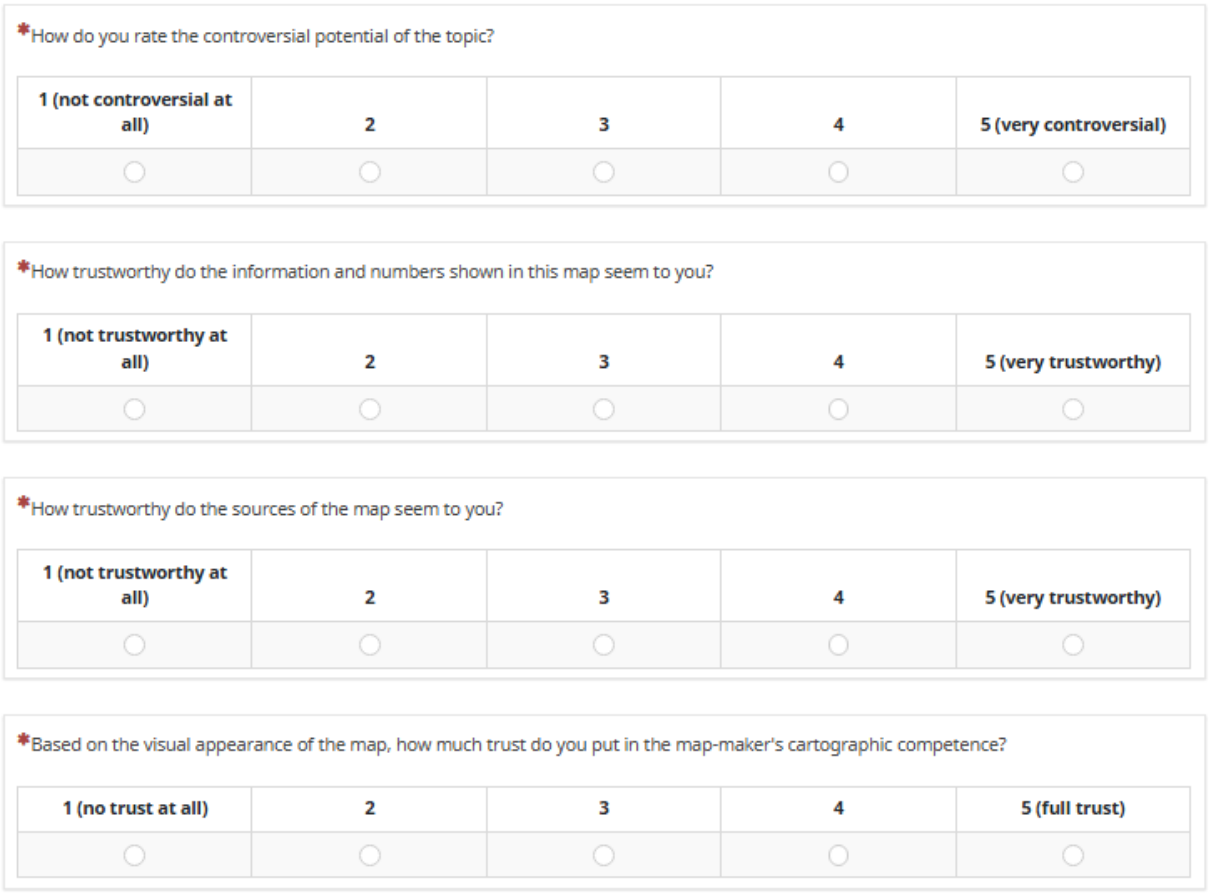

Figure 6: *Questions about the map without receiving additional information*

- **Additional information:** After the questions about the map, the participants got presented with the same map again, but this time with additional information in form of a text below the map. The additional information was divided in information about sources and information about map-making decisions. The information about the sources was further divided into sources for the base map and sources for the thematic data. The user was provided with more detailed information about the institutions that collected the data, and how or where these institutions collected the data. The information about the map-making decisions was further divided into four to five subsections - depending on the map - where the reasons for certain mapmaking decisions, for example colour choice, certain map symbols or elements, and map specific decisions were shortly explained. Figure 7 shows how the participants were presented with the additional information and the map. After reading all the additional information, the participants were again asked, using a unipolar rating scale from 1 (decreased) to 5 (increased), whether the trustworthiness had changed. This rating was also divided into the three categories: i) change of trustworthiness of information and numbers, ii) change of trustworthiness of sources, and iii) change of trustworthiness of

the cartographer's competence. Additionally, there were three open questions in which the participants could name parts of the additional information which they believed not to be relevant for increasing trustworthiness, parts where they would like to receive more information and parts which were especially helpful for increasing trustworthiness. Figure 8 shows how the open questions of these chapter were structured. After this survey page with additional information and questions, the user was presented the next map topic and the previous two sections were repeated for the other two maps.

Sources

- Base map

Data for the base map with administrative boundaries is retrieved from the website ec.eurostat.eu, which is an official website of the European Union and acts as the statistical office of the European Union. The data itself was collected by EuroGeographics, which is an international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities (https://eurogeographics.org). The data can be used for free on the condition that it is not used for commercial purposes and that the source is acknowledged by a copyright notice in the form of "© EuroGeographics for the administrative boundaries".

- Thematic data

Energy data is retrieved from the BMK which is the Austrian federal ministry for climate action, environment, energy, mobility, innovation and technology. The BMK annually publishes a brochure called 'Energie in Österreich', which gives an overview about the different energy sectors in Austria for the previous calendar year. The brochure can be downloaded on the website of the BMK (https://www.bmk.gv.at/themen/energie/publikationen/zahlen.html), but is only available in German language.

The annual coal and biogenic data are gathered by Statistik Austria, which is Austria's Federal Statistical Office, responsible for collecting and publishing official statistics related to Austria. The oil data is gathered by the BMK itself and the electricity and gas data by E-Control Austria, which is the governmental department, responsible for regulating the electricity and gas market in Austria.

According to the copyright notice of the BMK, reproduction of the data is allowed, provided the source is acknowledged.

Map-making Decisions

- Why arrows and lines for energy data?

As illustration method for the energy sources, arrows with branching curved lines originating in the associated importing country have been chosen. This gives the map a more dynamic character, indicating the flow of energy to Austria. The width of the arrowheads and lines are proportional to the amount of energy imported and allows to roughly compare the different energy values of the different sources and countries.

- Why these colours?

The colour choice for each source of energy has been done mostly intuitively, although it is hard to find an intuitive colour for each source. So, another factor was that the colours can be separated easily and energy sources like oil, gas and coal got some darker colour shades which corresponds well with fossil energy sources. Austria is highlighted in turquoise colour, as it is the central country of the topic and also no other meaning is associated with that colour in this map topic. The main importing countries are highlighted in darker grey colour, so they can be visually separated from the other countries.

Figure 7: *Presentation of additional information in the online survey*

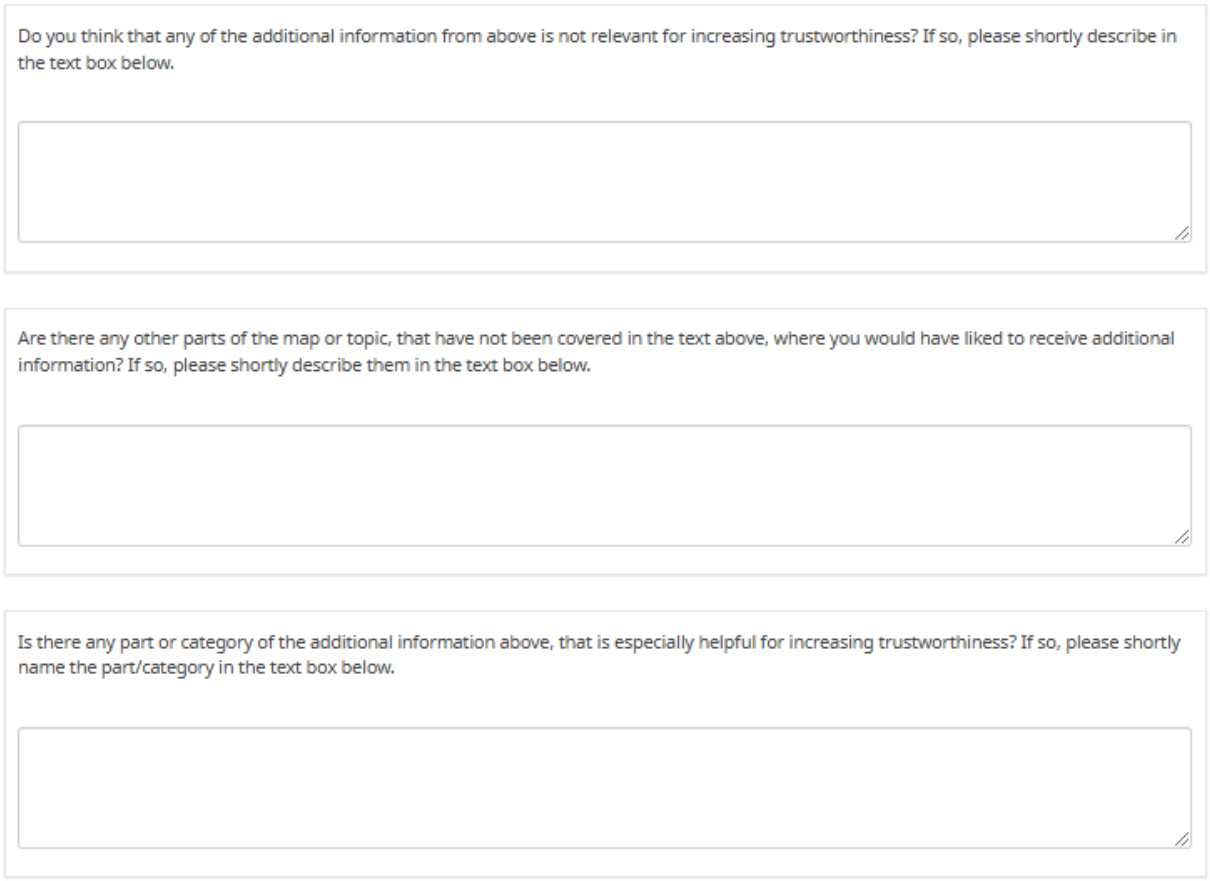

Figure 8: *Questions about the additional information the users get*

- **Final question:** In the end, participants were asked a more rhetorical question: whether the trustworthiness of the map would change if the map had been created by means of artificial intelligence. The expected answer for this question was 'Yes', as it can be assumed that most people doubt that artificial intelligence can create proper looking maps. Still this question was asked, to raise the awareness of the participants about AI generated maps and make them think about if maps have been created by AI.

3.3 Participants

There was no focus group for this survey and there were no limitations for who can participate, except for being fluent in English. The participants were recruited in the author's personal environment and were therefore not representative for a broad society or a certain focus group.

4 Results

In the following, the three map topics will be referred to as *forest map* for the map about 'Forest coverage in the EU' (Figure 2), *energy map* for the 'Energy imports in Austria in 2021' map (Figure 3), and *refugee map* for the 'Refugees from Ukraine recorded across Europe' map (Figure 4). The results of the survey have been evaluated with the free to use data and analysis software PSPP.

4.1 Participants

In total 46 participants completed the survey, of which 24 identified as female and 22 identified as male. Nearly all participants came from Austria (40 Austria, 5 Canada, 1 Turkey) and therefore the home country was not further used for the evaluation of the survey. The age of the participants was asked in intervals of ten years, and later these were aggregated into two groups of 40 and older (26 participants) and younger than 40 (20 participants), as it is hard to make a clear statement from the results with only a few participants per age group. The cut at 40 years was made with the assumption that people above 40 might have a different perception of maps as they grew up with analogue maps, compared to people under the age of 40, who already grew up with digital maps and are more used to maps in social media.

Most of the participants specified their experience in map reading to be moderate to very high (30.4% moderate, 34.8% high, 19.6% very high), whereas the knowledge of cartographic principles was more evenly distributed and in general lower than the experience in map reading (19.6% very low, 15.2% low, 28.3% moderate, 28.3% high, 8.7% very high). The histograms showing the answers for these questions are displayed in Figure 9 and Figure **10**.

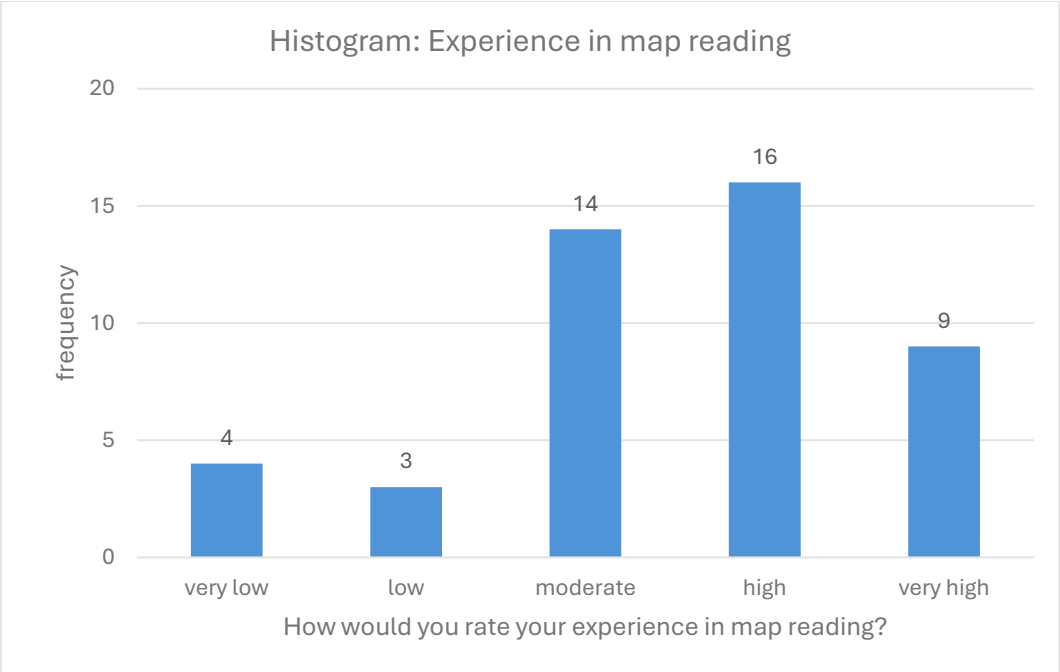

Figure 9: *Histogram of the participants' experience in map reading*

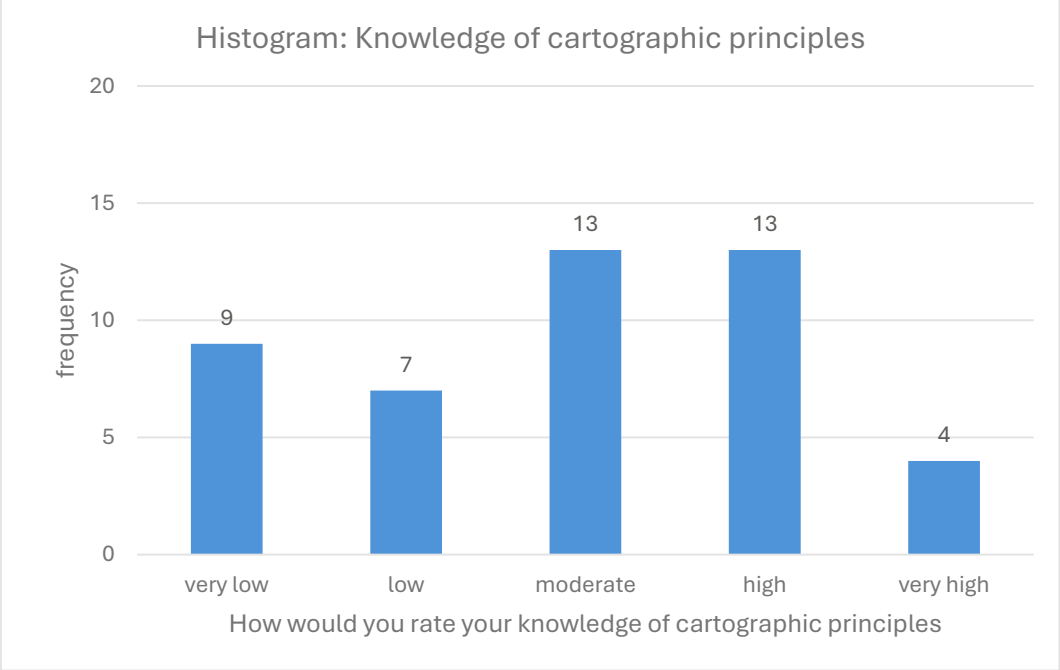

Figure 10: *Histogram of the participants' knowledge of cartographic principles*

4.2 Controversial potential

After reading the map, the participants had to rate the map on a unipolar rating scale from 1 (not controversial at all) to 5 (very controversial). The results for each map are shown in Figure 11. For all the maps, a statistical hypothesis testing was performed. The null hypothesis was 'There is no significant difference in controversial potential between the map topics.', and

testing was pairwise. Therefore, the Wilcoxon signed-rank test was used, as the data is not normally distributed, as confirmed by the Shapiro-Wilk test. The samples of the maps are matched as they were tested on the same participants. A value of 0.05 was chosen as level of significance. It is clearly visible that the forest map with a mean value of 2.13 was significantly less controversial than the energy map with a mean value of 3.11 and the refugee map with a mean value of 3.48, which was also confirmed by the test. However, the difference in controversial potential between the energy map and refugee map did not turn out to be significant.

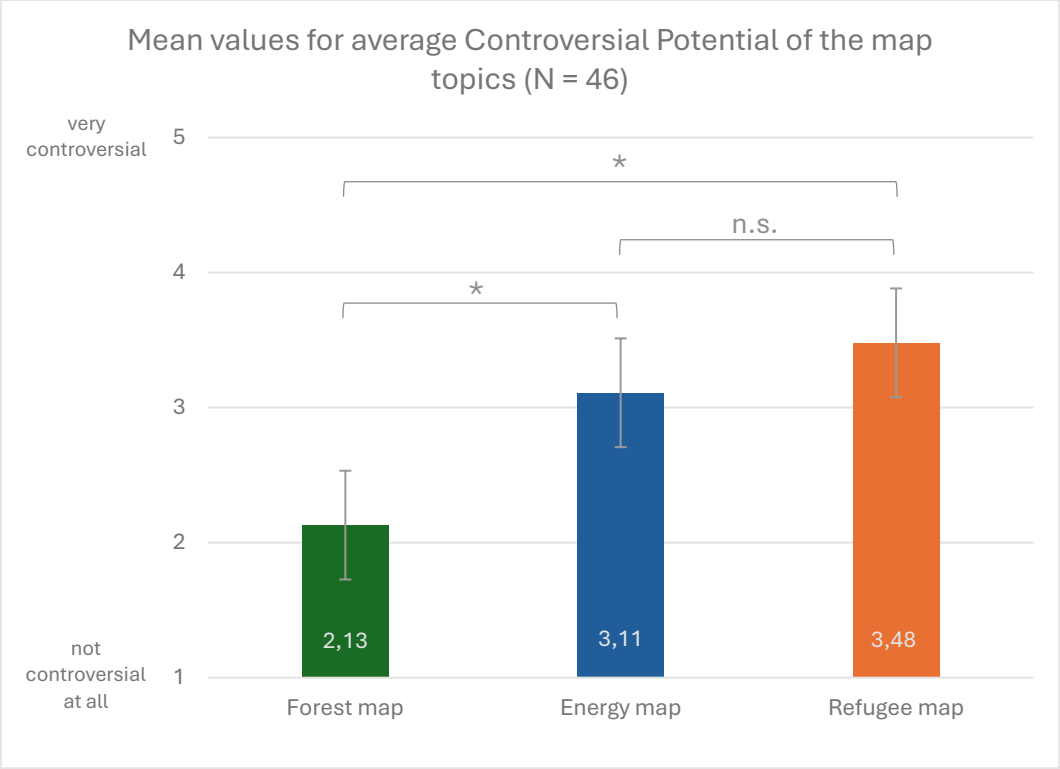

Figure 11: *Mean values (N = 46) for controversial potential of the different maps. Error bars showing the standard error and brackets indicating the statistical significance (Symbol meaning: * → $P \leq 0.05$; n.s. → $P > 0.05$)*

4.3 Map questions about trustworthiness

For the questions about trustworthiness, the same statistical testing as above was performed, although with adjusted null hypotheses. First, the Shapiro-Wilk test confirmed that the data exhibited no normal distributions for any of the questions about trustworthiness. As all the questions, that were compared to each other, were answered by the same participants, the samples of the maps are again matched, thus the Wilcoxon signed-rank test was used. Additionally, the Pearson's correlation coefficient as a measure for the effect size was

calculated for each pair of questions. For all the questions appropriate null hypotheses were phrased to test whether there is a significant difference between the map topics. The results can be seen in Table 1.

Trustworthiness of information and numbers			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	0.201	0.143	0.960
r (effect size)	0.19	0.21	0.01

Trustworthiness of the sources			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	0.732	0.350	0.453
r (effect size)	0.05	0.14	0.11

Trustworthiness of mapmaker's cartographic competence			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	**0.031**	0.302	0.090
r (effect size)	0.32	0.15	0.25

Table 1: *Results for statistical testing, on the difference in trustworthiness between the map topics. Significant values ($p \leq 0.05$) are highlighted in* ***bold****.*

Table 1 shows that there are hardly any significant differences between the map topics on the questions about trustworthiness before getting additional information, as the p-values are – except for one – all above the significance level of 0.05, in which case the effect size is irrelevant. This is also clear when looking at the mean values for each map topic and question in Figure 12. The only significant difference appears to be between the energy map and forest map for the question about trust in the mapmaker's cartographic competence. By looking at the mean values of the response to this question for the maps it can be stated that the trust in the cartographic competence of the mapmaker is significantly higher for the forest map than the energy map, but only with a medium effect size of r = 0.32.

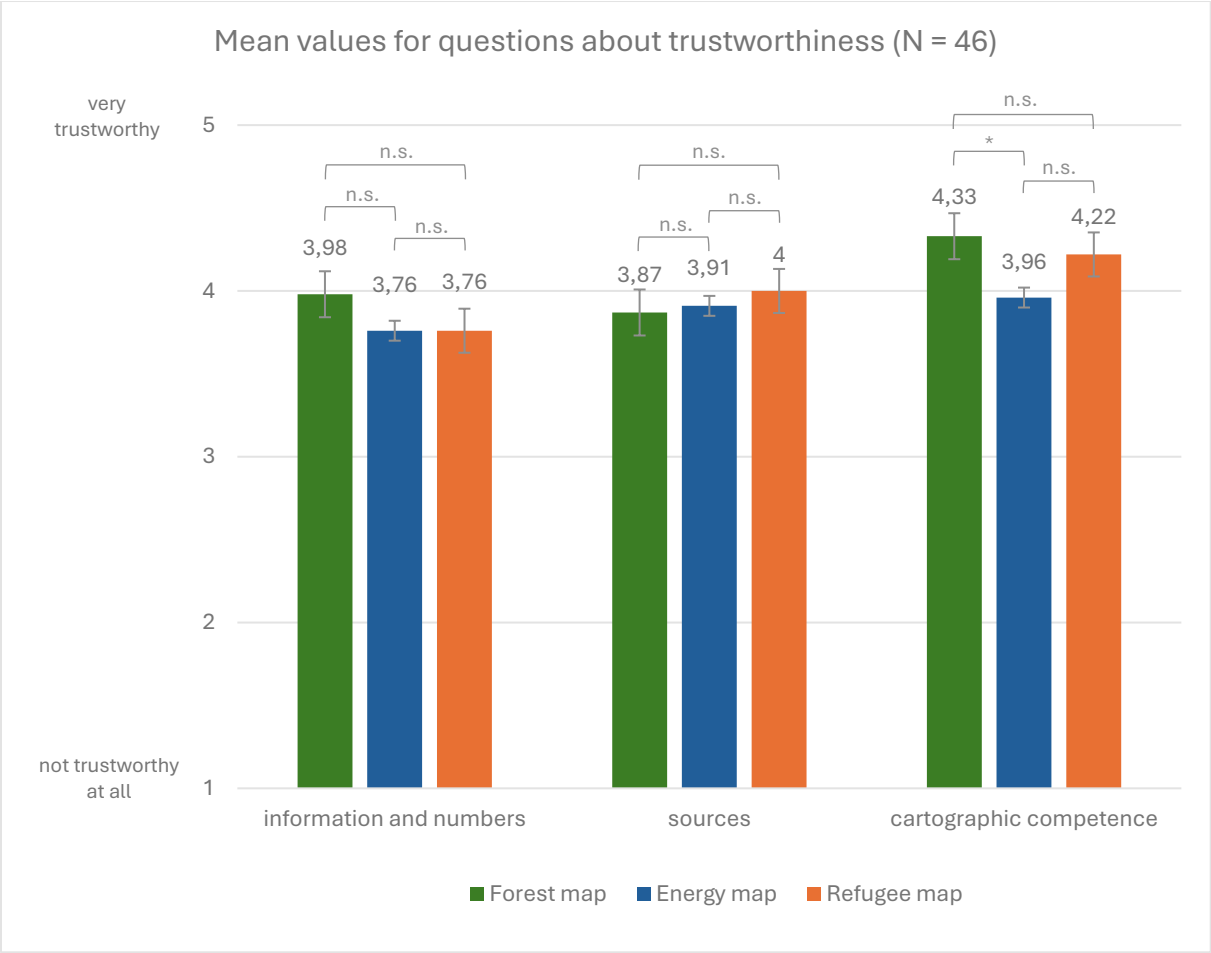

Figure 12: *Mean trustworthiness ratings (N=46) for the different map topics. Left: 'How trustworthy do the information and numbers shown in this map seem to you?'; Middle: 'How trustworthy do the sources of the map seem to you?'; Right: 'Based on the visual appearance of the map, how much trust do you put in the mapmaker's cartographic competence?'. Error bars showing the standard error and brackets indicating the statistical significance (Symbol meaning: * → $P \leq 0.05$; n.s. → $P > 0.05$)*

4.4 Questions about the change of trustworthiness

When testing the questions about the change of trustworthiness after additional information, a few more significant differences between the map topics can be observed, which is already visible when looking at the mean values in Figure 13. The increase in trustworthiness in all three categories is significantly higher in the energy map than in the refugee map. Also, the increase in trustworthiness about the information and numbers, and the cartographer's competence is significantly higher in the energy map than in the forest map. Still, for all these significant differences, the effect size is medium with values between 0.3 and 0.4, as it can be seen in Table 2.

Change of trustworthiness of information and numbers			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	0.068	0.349	**0.007**
r (effect size)	0.27	0.14	0.40

Change of trustworthiness of the sources			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	**0.040**	0.243	**0.004**
r (effect size)	0.30	0.17	0.42

Change of trustworthiness of mapmaker's cartographic competence			
	Forest map ↔ Energy map	**Forest map ↔ Refugee map**	**Energy map ↔ Refugee map**
p-value	**0.010**	0.674	**0.010**
r (effect size)	0.38	0.05	0.38

Table 2: *Results for statistical testing, if the change of trustworthiness is significantly different between the map topics. Significant values ($p < 0.05$) are highlighted in* ***bold****.*

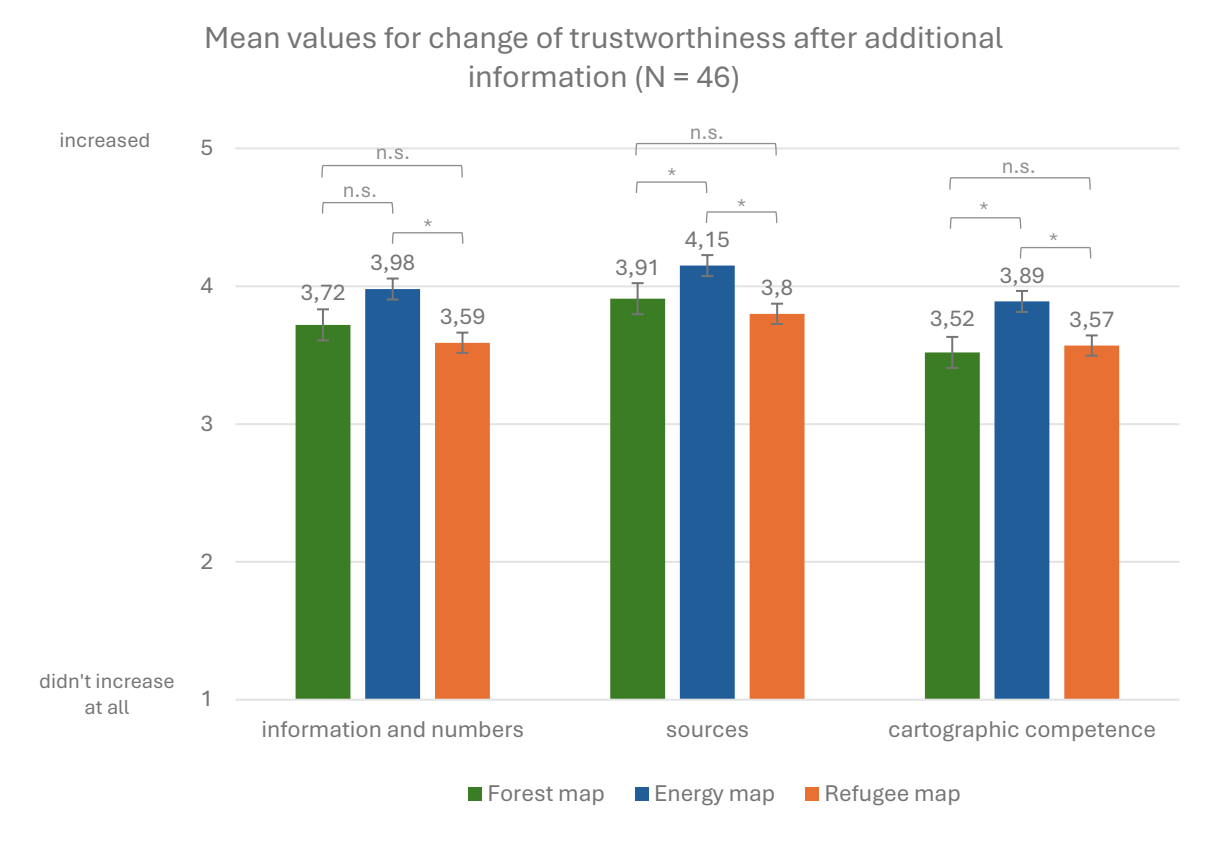

Figure 13: *Mean change of trustworthiness ratings (N=46) for the different map topics. Left: 'After reading the additional information, did the trustworthiness of information and numbers change?'; Middle: 'After reading the additional information, did the trustworthiness of the sources change?'; Right: 'After reading the additional information, did the level of trust you put in the mapmaker's cartographic competence change?'. Error bars showing the standard error and brackets indicating the statistical significance (Symbol meaning: * → $P \leq 0.05$; n.s. → $P > 0.05$)*

After testing for differences between the maps, the questions about the change of trustworthiness were tested against the median of 3 (trustworthiness didn't change at all), to find out if the trustworthiness changes after the participants get additional information. Here, the one-sample Wilcoxon signed-rank test was used, as the samples are – as stated above not – normally distributed. They were tested directionally for a value bigger than 3, as it was expected that the trustworthiness was increasing (values 4 and 5) rather than decreasing (values 1 and 2), and therefore the null hypothesis formulated for this test was 'The trustworthiness does not increase after the user gets additional information about the sources and map-making background.' Again, a significance level of 0.05 was chosen. The results of this test can be seen in Table 3.

Change of trustworthiness about information and numbers			
	Forest map	**Energy map**	**Refugee map**
p-value	**0.000**	**0.000**	**0.000**
r (effect size)	0.62	0.78	0.59

Change of trustworthiness about sources of the map			
	Forest map	**Energy map**	**Refugee map**
p-value	**0.000**	**0.000**	**0.000**
r (effect size)	0.73	0.80	0.65

Change of trustworthiness of the mapmakers cartographic competence			
	Forest map	**Energy map**	**Refugee map**
p-value	**0.001**	**0.000**	**0.000**
r (effect size)	0.50	0.67	0.60

Table 3: *Results for statistical testing, if the trustworthiness changes after receiving additional information. Significant values ($p < 0.05$) are highlighted in* ***bold****.*

As it can be clearly seen in the results of this test, for all of the maps and questions the p-values are within the significance level. Therefore, the null hypothesis can be rejected and the alternative hypothesis 'The trustworthiness increases with additional information about sources and the map-making background' can be accepted, for all maps and questions. While for each of the three questions the energy map had the largest effect size, the increase in trustworthiness about sources had the largest effect size over all the three maps, compared to the increase in trustworthiness about information and numbers and increase in trustworthiness about the mapmaker's cartographic competence.

4.5 Open questions

Finally, also the following optional open questions were evaluated:

- Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map?
- Do you think that any of the additional information from above is not relevant for increasing trustworthiness?
- Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information?
- Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness?

The questions had between 10 and 20 responses each, although in a few cases some responses had to be excluded or associated to one of the other open questions as they didn't answer the respective question. These responses were then summarized to categories for certain key words and key elements of the maps, for example colour choice, symbol size, and sources.

For the first question about the manipulative potential of the map, the colour choice and size of certain symbols and elements were the most mentioned factors of influence. There were single mentions for the placement and directivity of the arrows in both the energy map and the refugee map as potential factors of influence. For the forest map, the lack of controversy was mentioned as a factor that makes it harder to manipulate someone's opinion. The results to the yes or no question on this topic are shown in Figure 14.

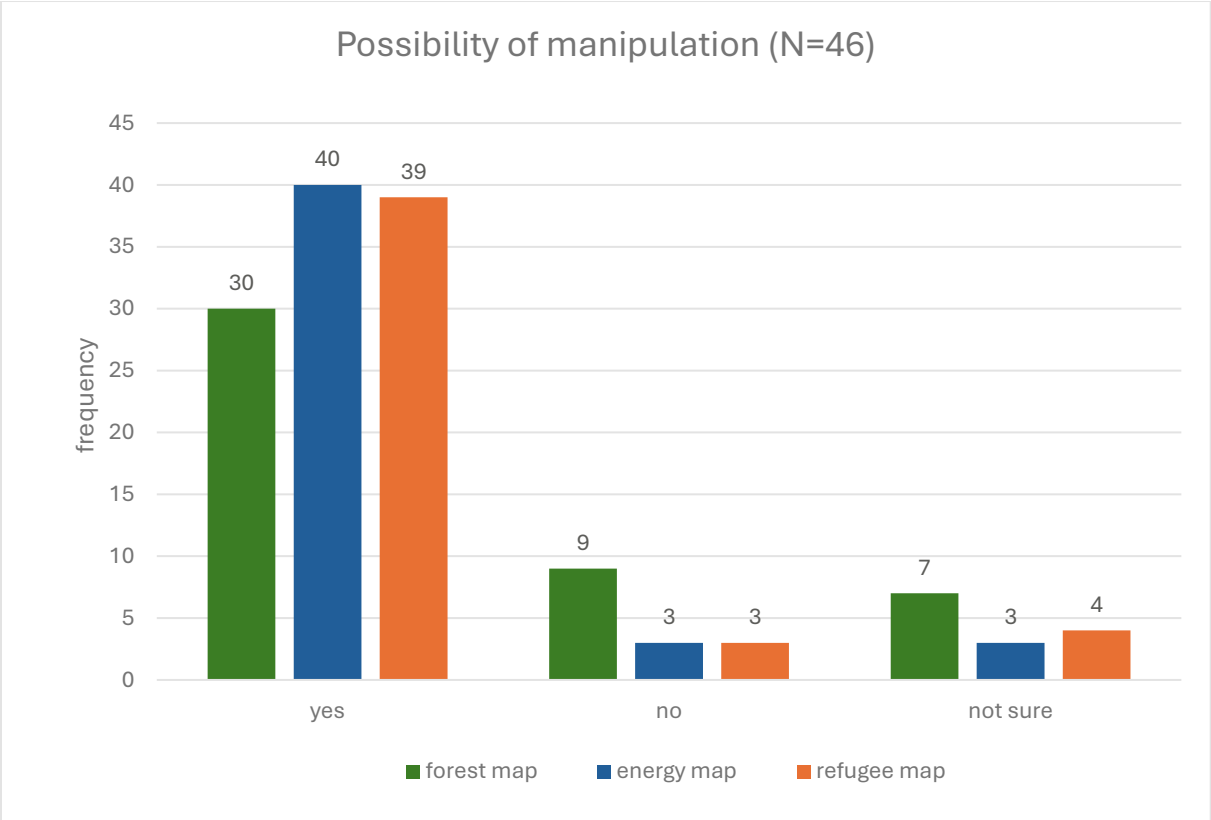

Figure 14: *Histogram of the answers to the question "Do you think it is possible to manipulate someone's opinion by how the information is visualized in the maps?"*

The responses for the question which additional information is not relevant for increasing trustworthiness in all 3 maps were mostly related to information about map-making decisions, like colour choice or the size of certain map elements.

For the question about whether the participants would like to receive more information for increasing trustworthiness, the most mentioned key factors were more detailed information about data collection in the energy map and forest map, and for all three maps more detailed information about numbers in general, like certain thresholds or trends over time were mentioned a few times.

Finally, by far the most responses for the question about which parts are especially helpful for increasing trustworthiness in all three maps, were about the sources and especially about the thematic sources of the map. There were also some individual mentions about the description of colour choice, scaling of symbols, classification and data collection.

4.6 Gender, age and experience difference

All the questions about trustworthiness before and after receiving additional information were evaluated for difference between sex, age and experience groups. For these tests the Mann-Whitney-U-Test was selected, which is suitable for independent samples when the requirements for a t-test – like normal distribution – are not given. The results to these tests can be found in the appendix.

When testing for a difference between genders, no significant differences between women and men could be identified. All p-values are well above the significance level and therefore the null hypothesis, that there is no significant difference, cannot be disregarded.

The participant's age was condensed into two groups, one below 40 years and one for 40 years and above. The intention of this division was that people at age 40 and above might have a different approach to how they read and understand maps, as they most likely grew up and were educated with maps on paper and non-online maps. When looking at the significance levels of the Mann-Whitney-U-Test, there are significant differences especially in the refugee map, where the increase in trustworthiness in all three categories is significantly higher for participants aged under 40. Also, the controversial potential of the refugee map, seems to be significantly higher for participants aged under 40.

When testing for a difference between participants with low and high experience in map reading and low and high knowledge of cartographic principles, no significant difference between these groups could have been observed for any of the questions.

4.7 Question on artificial intelligence

For the final question about artificial intelligence, 74 % of the participants answered that it would decrease the trustworthiness of the map, if the map was created by an artificial intelligence, 26 % answered that it wouldn't change trustworthiness at all and none of the participants answered that it would increase trustworthiness (see Figure 15).

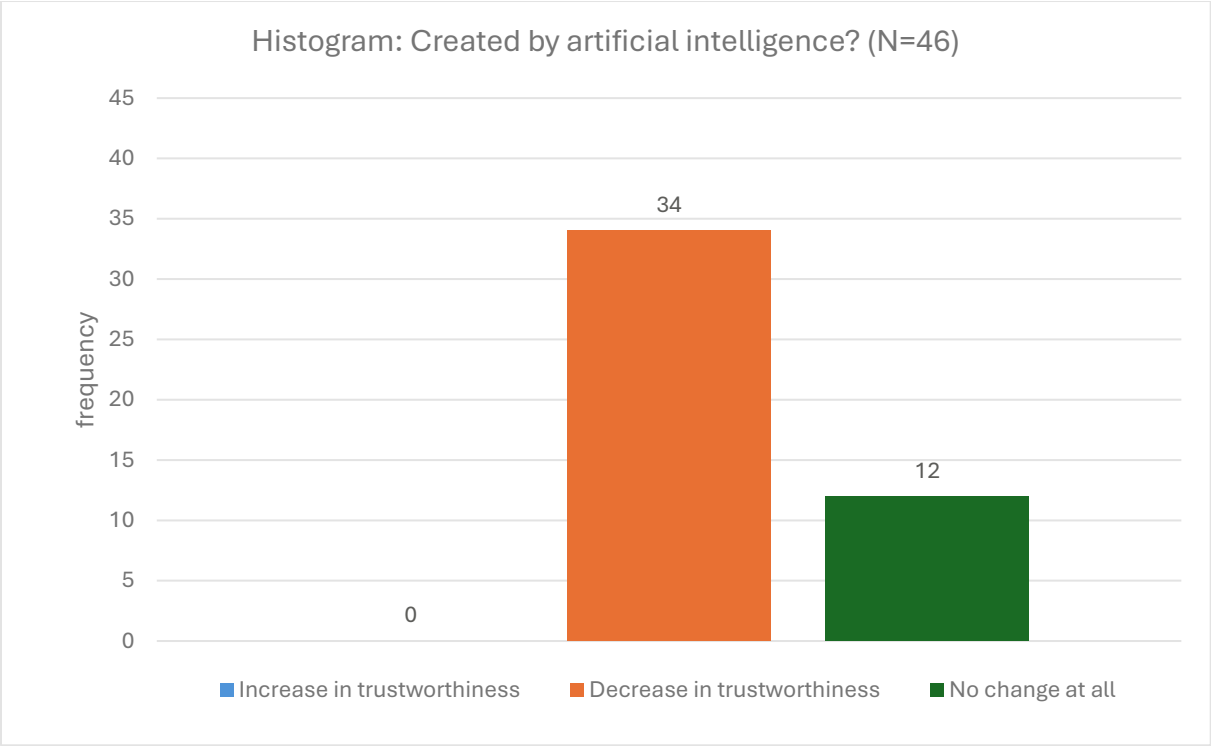

Figure 15: *Histogram of the answers to the question 'If the maps, you've seen in the sections before, would have been created by an artificial intelligence, would this affect the trustworthiness of the maps for you?'*

5 Discussion

When looking at the results of the survey, some significant results and differences between groups of questions could be observed. First of all, there is a significant difference in controversial potential between the forest map and the other two maps, respectively. This showed that the participants acknowledged the intended difference in controversial potential and the questions on these maps could be further analysed. The missing significant difference in controversial potential between the energy map and refugee map will be addressed in Chapter 5.2.

The significant difference in trust in cartographic competence between the forest map and the energy map could be explained by the fact that the forest map was easier to interpret and read, and this might have had the effect that the participants put more trust in the mapmaker's cartographic competence for the forest map. However, in general, there were less differences than expected between the varying controversial maps in terms of trustworthiness.

The results for the questions about the increase of trustworthiness after receiving additional information clearly showed that the additional information led to an increase in trustworthiness across all maps. This was expected for the more controversial topics, as it helps the map reader to verify information in the map, which he might be doubtful about. But the results also show that the increase in trustworthiness was similarly high in the less controversial forest map, which indicates that this additional information is also helpful in less controversial topics.

The question about the possible manipulation of someone's opinion about the map topics, showed that for all three maps, the participants think that manipulation is possible. But the higher number of 'yes' answers for the refugee map and energy map than for the forest map, show similar results as the controversial potential for the map topics, which indicates a correlation between the controversial potential and the possibility of manipulation. Hence, a higher controversial potential of the map topic might result in a higher perceived risk of manipulation of the map reader.

The open questions about which additional information people wish to receive more information about, showed that the participants are more interested in how the data was collected and want more information about the displayed numbers in general. This might also be caused by the fact that there was a higher number of participants with academic background and more expertise in scientific topics, who might not represent the broad society or general map audience.

The results for age groups above and under the age of 40, respectively, only showed differences in controversial potential and the increase of trustworthiness for the refugee map, where participants below 40 rated the controversial potential and the increase of trustworthiness significantly higher than participants above 40. This indicates that younger people are more sensitive to controversial topics and give more weight to additional information in these topics.

5.1 Comparison with existing work

The results of this survey confirm one of the findings from previous research of Prestby (2023), where he stated that metadata, especially about data sources, might increase trustworthiness. This was confirmed by the results presented in this thesis, where the participants' trustworthiness significantly increased after getting additional information on data sources and mapmaking background. Furthermore, the increase in trustworthiness about sources was higher compared to increase in trustworthiness of the information and numbers and the mapmaker's competence. Also, the answers to the qualitative questions showed that sources – especially thematic data sources – were mentioned the most for being especially helpful with increasing trustworthiness.

With the general increase in trustworthiness after getting additional information, the suggestion by Kent (2017), to restore faith in cartography by being transparent about the mapmaking process, is underlined.

The answers to the question whether the participants think if it is possible to manipulate someone's opinion about the map topic, by how the information is visualized in the map, shows that the majority of the participants at least acknowledges the risk of getting manipulated by maps. However, it must be taken in account that in this scenario the participants already were made aware of the danger of getting manipulated simply by reading the question, and it cannot be assumed that they would consider this fact while reading a real map in a newspaper or on social media. Still, by looking at the answers to the open question on this topic, some of the participants focus on relevant features of the map, as they mentioned colour choice and symbol size as potentially misleading factors in the maps. This proves the mentioned danger of manipulation by maps mentioned by multiple researchers, such as Griffin (2020) or Cheshire (2021).

The claim by previous publications, that maps are seen as a trustworthy source of information gets at least partly approved, as the ratings for trustworthiness in all three categories and maps are generally high, even without receiving additional information about the sources or the

mapmaking background. However, it cannot be proven that the general trustworthiness of maps might decrease, as this only shows the results of this one study at a certain time. To find out if – in general – trustworthiness of maps is decreasing or staying the same must be studied over longer periods of time.

The results from the open questions about especially useful information partly confirm some of the factors Jurgens (2020) mentioned, like map design or source data. This also confirms Jurgens' assumption that more insights in the process of creating the map from the initial source data could help the user to judge whether the product is trustworthy or not.

Schiewe et al. (2013) mentioned the features source, actuality and cartographic design as main aspects for enhancing trust in maps. This is comparable to the results of the open questions, where the participants mentioned the additional information to sources as the most useful information for increasing trustworthiness. Furthermore, map design elements like colour choice or size of certain map elements were mentioned by the participants.

Compared to Kang et al. (2023), the results of the last question, where the participants were asked if the use of artificial intelligence in the mapmaking process would affect trustworthiness, shows that nearly all participants are sceptical of AI produced maps and would doubt their trustworthiness. It must however be taken in account that this only applies if the reader already knows that the map was produced by an AI, and not when the reader mistakes the map for being produced by a real cartographer.

The general results of this study which show increased trustworthiness after receiving additional information about the mapmaking process, prove the positive effect of the concept of "going deep" by Gartner (2022), which should allow the user to have a transparent view of the decisions the mapmaker has made in the process of creating the map.

5.2 Limitations and future improvements

The study proved some assumptions previously presented by different researchers and confirmed results from other previous studies about similar topics. Still, some of the results must be treated with caution. One of the main reasons is that the participants are not representative for the broad society and were only recruited from a closer personal environment. For example, the percentage of people with knowledge in cartography and general scientific education is likely higher in this study than it would be with a representative group of the broad society. So, after evaluating the survey and looking at the results it can be said that a higher

number of participants and a more heterogenous group of participants would be recommended to get more precise and representative answers to the research questions.

The differences in controversial potential between the energy map and forest map is not significant and smaller than expected. Therefore, it would have been more useful for getting clearer results on the difference in controversial potential, to only use two maps with a larger difference in controversial potential, like here for example only the forest map and refugee map. This could lead to more significant results related to difference in controversial potential, as it is now harder to distinguish between the maps since the participants didn't rate the controversial potential of the refugee map much higher than the energy map. In future studies it should be taken care of that there is a larger difference in controversial potential, so that significant differences in that results of the survey can be assigned more clearly to the difference in controversial potential.

The trustworthiness in sources did not differ significantly between the map topics, which can be related to the fact that when creating the map, it was taken care of that for all of the three maps, reliable and widely accepted sources were chosen. However, the fact that the trustworthiness in information and numbers also showed no significant differences between the map topics, is more surprising, as it could be argued that with more controversial topics people would tend to be more doubtful of the visualized information. An explanation for this could be that even in this category participants still related to the sources, which seemed reliable to them and as they already seemed to be similarly trustworthy for all three maps, they also rated the numbers and information in the map as similarly trustworthy.

There are only small differences between the results for the maps varying in differing controversial potential. These small differences in trustworthiness and change of trustworthiness should not only be referred to the controversial potential of the maps, as they can also be caused by small variations of complexity in the maps, although it was taken care of that the maps don't vary too much in complexity. For example, the forest map had the highest increase in trustworthiness about the mapmaker's cartographic competence, which was unexpected, as the expectation was that the more controversial topics would increase more in trustworthiness after receiving additional information. This result could be related to the fact that the forest map had less information in form of text on the map than the energy and the refugee maps. This increases the potential for misinformation and therefore the map reader might have felt more need to receive additional information on the map topic. As a result, in

future studies there should be more focus on the complexity and amount of information displayed in the maps which are compared.

When looking at the results of the open questions, it must be taken in account that the number of participants was not very high, as the open questions were not mandatory to answer. Therefore, these questions only had 10 to 20 answers. While these results should be taken with care, they can still show a trend what additional information might be beneficial in future studies or maps. The feature *colour choice* was mentioned in the answers to both questions, if it is unnecessary information and especially helpful information, but here it can be related to the fact that these answers came from participants with different knowledge of cartographic principles. Participants with less knowledge of cartographic principles had the intention that information about colour choice was not necessary information, while participants with a higher knowledge of cartographic principles assigned it as helpful information. But, as these features were not mentioned by a larger number of participants, this cannot be used as a general statement for people with less or more cartographic knowledge. For future studies about the topic of trust in maps, open questions should be asked more precise and structured, so that it is possible to make more general applicable statements and comparisons.

In terms of controversial potential, trustworthiness and increase in trustworthiness there were no relevant differences between participants with different levels of cartographic knowledge and experience in map reading. This might be caused by the fact that the participants were not evenly distributed in these categories, and therefore it is suggested to research this in another study where the participants are more representative for the general public, or at least more evenly distributed in map reading experience and cartographic knowledge.

Further, there were no significant results in any of the categories for differing genders, which came as no surprise, as the number of participants was low and for significant gender specific differences, larger amounts of participants would be necessary.

In general, the survey results show an overview about the important factors that might be helpful for increasing trustworthiness in maps. To make a reliable statement on certain questions and information to ask, further studies specialized in subtopics of this survey with more detailed questions and more representative user groups should be conducted. For example, a study about which and how much additional information without the factor of controversial potential, with an expanded and more representative user group might be helpful for future mapmaking to decide which additional information should be displayed in real maps.

The rapid advancements and the current potential in the technology of artificial intelligence, as discussed in Chapter 2.4, show that artificial intelligence should be a more discussed topic in studies about trust. It also needs to be taken into account that because of these rapid advancements in AI, emphasis has to be put on the current state of the art of AI during the planning and execution of the survey and therefore, the results of studies about trust and AI have to interpreted with care.

As this study was carried out in 2023, the suggestions from Prestby (2024) about research in the field of map trust, were not implemented in this study. For future studies about the above-mentioned subtopics, the suggestions and the 'MAPTRUST Scale' from Prestby (2024) would be suitable to make these studies intercomparable.

6 Conclusion

The results of this online survey delivered a broad overview on how trustworthiness of thematic maps can be improved. Although not all sections in the survey led to clear statements and suggestions valid for the general public, many results can be used to further investigate certain subsections of this survey with more detail.

The general results of survey confirm the first research question, as it was clearly shown that after receiving additional information, the large majority of participants showed increased trustworthiness in the maps. In detail the results show that the additional information on data sources and data collection, had the largest impact on the increase of trustworthiness for participants. The impact of additional information about mapmaking decisions has to be taken with care, as there were differing mentions of certain decision points which are helpful or not necessary. This can be associated to the fact that the user group was not representative, and it would be recommended to further investigate the influence of mapmaking decisions in a separate study focused only on this subject with focus groups or representative groups for larger parts of the society.

The answers to open questions about which information is helpful, not necessary or missing, gave an overview about which information could be included in maps to help map readers increase their trustworthiness in maps in the future. However, to make a confident list of key elements necessary to increase trustworthiness, additional research and studies with more participants should be conducted, which are specialized on these influence factors and the respective intended audience of the maps.

The second research question – Does the level of controversy of the topic presented in a map affect how trustworthiness can be increased or decreased? – cannot be answered confidently as not all of the results of the survey can be related to the difference in controversial potential. The different increase in trustworthiness between the map topics, might rather be an effect of the different complexity in the map topics. In future studies there should be put more caution on the complexity of the map and the selection of the map topics, and it might be useful to only use two different maps with a large difference in controversial potential rather than three, as this removes more potential influence factors that make it harder to relate the results to the controversial potential of the map topic.

With questions about the manipulative potential of maps and influence of AI generated maps, the participants were made aware of current and future challenges in mapmaking and map

reading. The results to these questions showed that the users are already aware of the potential of being misled by maps and that maps created by AI cannot be automatically trusted. However, it was not tested if map readers would recognize whether maps were intentionally misleading, or AI generated. Therefore, it would be useful to conduct a separate survey and research on this topic, to find out to which degree people can identify misleading and AI generated maps and how we can further help people to identify these maps to avoid getting influenced by manipulative or intentionally misleading maps.

In conclusion, the overall results of the survey and this thesis confirm the effectiveness of suggestions from previous researchers, of using background information about sources and mapmaking decisions to improve the trustworthiness of maps. However, the results of individual questions asked in the survey show that more specific and detailed research is required. However, this work gives a good overview about which subsections in the field of trust in maps need additional attention. Additionally, this work should help in the process of finding out how to create more trustworthy maps, and how they can be distinguished more easily from potentially misleading maps and AI generated maps.

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Appendices

Appendix A: Printed online survey

Appendix B: Survey data

Appendix A

User Study: Map Transparency and Trustworthiness

Thank you for your interest in taking part in this online survey about Map Transparency and Trustworthiness, which is part of my diploma thesis at the TU Wien.

Maps have been an important part of our society for a long time and nearly everyone uses maps for decision making or reads maps in the news. Over the last couple of years, the amount of people, who can produce maps for the public, has increased. On the one hand because of map making tools and open data initiatives that are available through the web for everyone. On the other hand, the use of social media makes it easy to distribute maps to larger amounts of people. This leads to the problem that maps may no longer be seen as a trusted source of information, as it is easier to spread misinformation to a wide audience through maps. Also, in modern times there seem to be more and more global problems, like climate change, pandemic disease, refugee crisis, which often demand to communicate important data through maps. Therefore, this user study aims to find out how trustworthiness of thematic maps is affected by showing transparency about certain map making decisions and giving a more detailed description of the used sources.

The survey will take about 30 minutes and you can take your time for answering the questions.

There are 42 questions in this survey.

Introduction

The following questions are about some of your personal data and how you rate yourself in using maps. This data will only be used for evaluating the results of the study and will not be shared or used for any other purposes.

What is your age? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ 18-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ 70-79

I am (Gender) *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ a woman
- ◯ a man
- ◯ non-binary
- ◯ rather not say
- ◯ Other

I am from (country) *

Choose one of the following answers
Please choose **only one** of the following:

◯ country

How would you rate your experience in map reading? *

Please choose the appropriate response for each item:

	1 (no experience at all)	2	3	4	5 (very experienced)
	◯	◯	◯	◯	◯

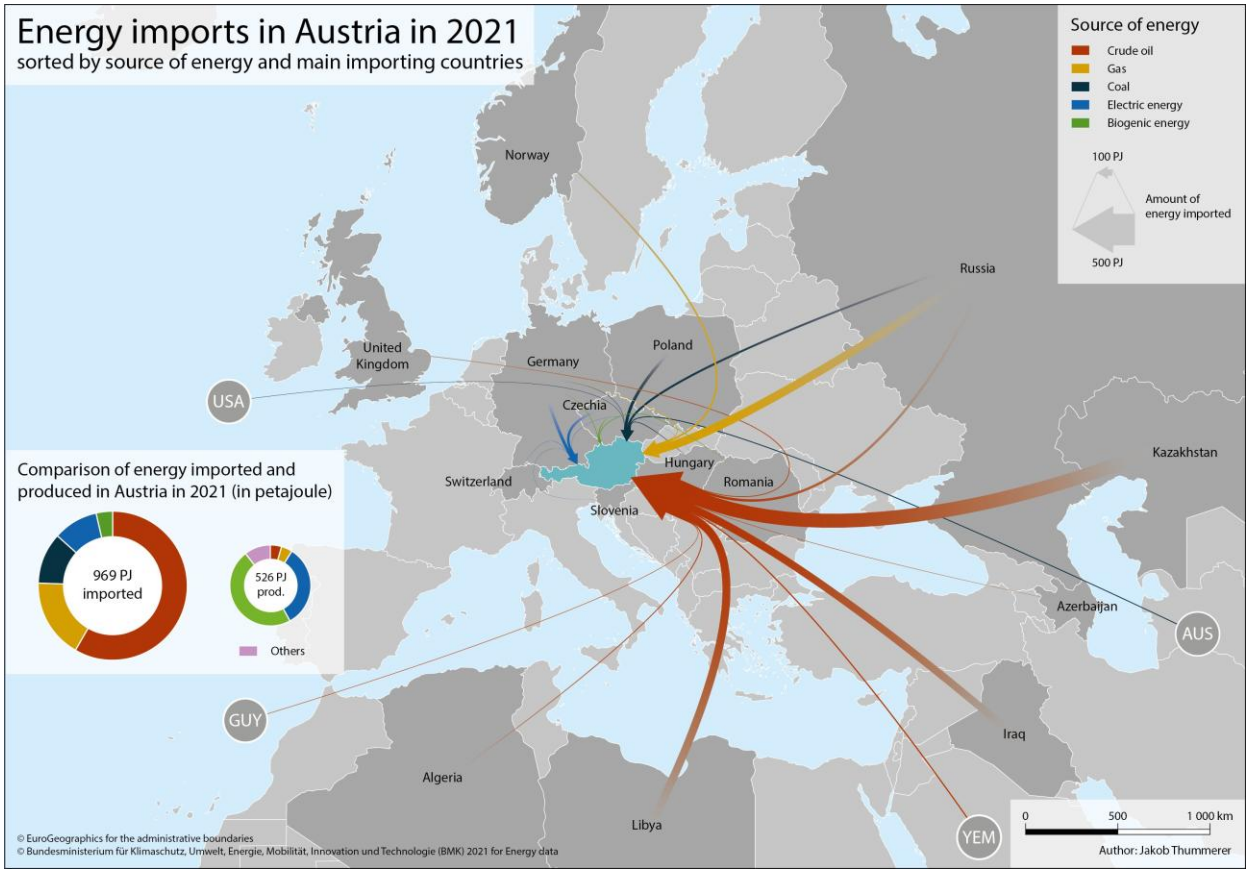
How would you rate your knowledge of cartographic principles? *

Please choose the appropriate response for each item:

	1 (no knowledge at all)	2	3	4	5 (expert)
	◯	◯	◯	◯	◯

Map 1

Please read the following map carefully and try to understand the thematic content of the map. After reading the map please scroll down and answer the following questions. You can always scroll back up and take another look at the map, there is no time pressure.



How do you rate the controversial potential of the topic? *

Please choose the appropriate response for each item:

1 (not controversial at all)	2	3	4	5 (very controversial)
○	○	○	○	○

How trustworthy do the information and numbers shown in this map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
○	○	○	○	○

How trustworthy do the sources of the map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
◯	◯	◯	◯	◯

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence? *

Please choose the appropriate response for each item:

1 (no trust at all)	2	3	4	5 (full trust)
◯	◯	◯	◯	◯

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right. *

Choose one of the following answers

Please choose **only one** of the following:

◯ Yes

◯ No

◯ Not sure

Make a comment on your choice here:

Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you? *

Choose one of the following answers

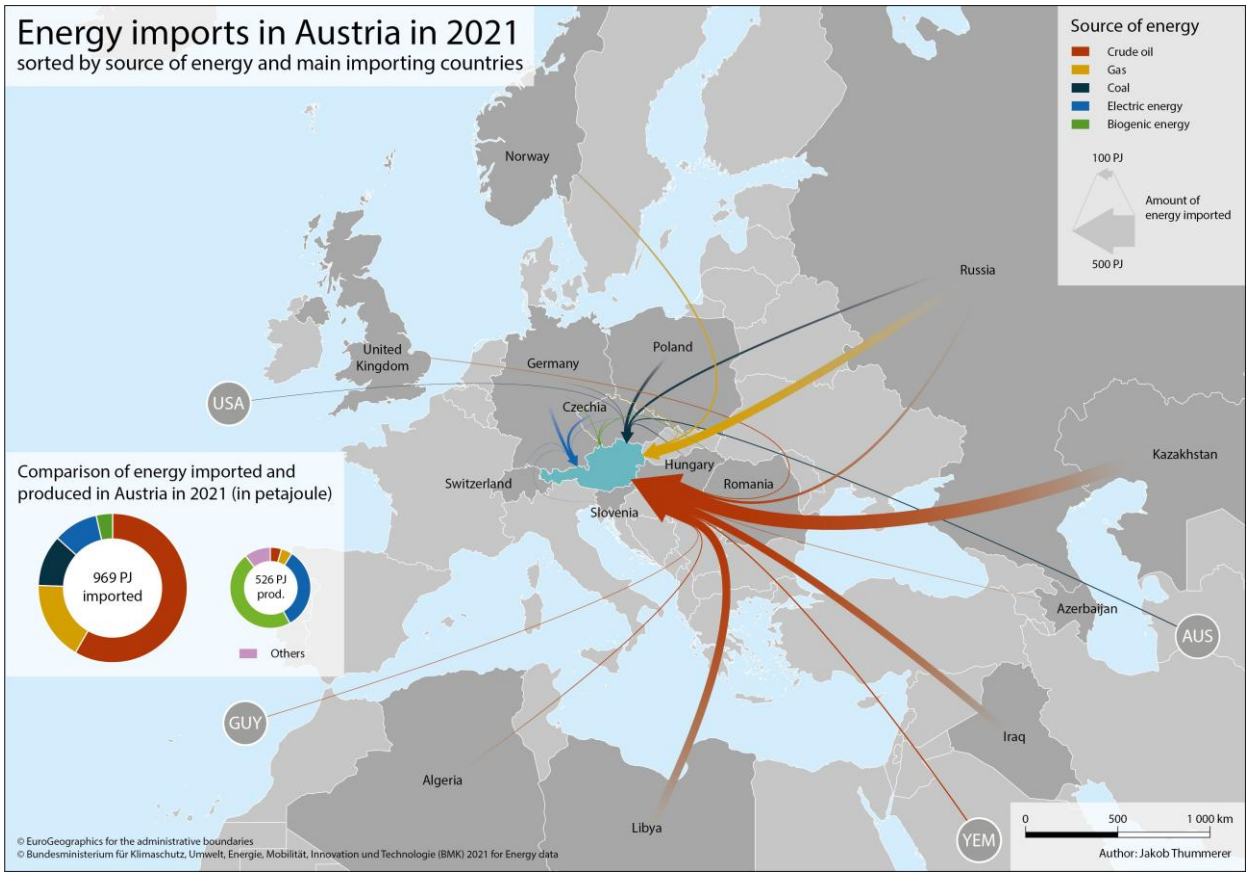
Please choose **only one** of the following:

◯ Yes

◯ No

Map 1 additional information

In this section you will get additional information about the sources of the map and about decisions that were made in the map-making process. Please read the information carefully and answer the questions below.



Sources

- Base map

Data for the base map with administrative boundaries is retrieved from the website ec.eurostat.eu, which is an official website of the European Union and acts as the statistical office of the European Union. The data itself was collected by EuroGeographics, which is an international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities (https://eurogeographics.org). The data can be used for free on the condition that it is not used for commercial purposes and that the source is acknowledged by a copyright notice in the form of "© EuroGeographics for the administrative boundaries".

- Thematic data

Energy data is retrieved from the BMK which is the Austrian federal ministry for climate action, environment, energy, mobility, innovation and technology. The BMK annually publishes a brochure called 'Energie in Österreich', which gives an overview about the different energy sectors in Austria for the previous calendar year. The brochure can be downloaded on the website of the BMK (https://www.bmk.gv.at/themen/energie/publikationen/zahlen.html), but is only available in German language.

The annual coal and biogenic data are gathered by Statistik Austria, which is Austria's Federal Statistical Office, responsible for collecting and publishing official statistics related to Austria. The oil data is gathered by the BMK itself and the electricity and gas data by E-Control Austria, which is the governmental department, responsible for regulating the electricity and gas market in Austria.

According to the copyright notice of the BMK, reproduction of the data is allowed, provided the source is acknowledged.

Map-making Decisions

- Why arrows and lines for energy data?

As illustration method for the energy sources, arrows with branching curved lines originating in the associated importing country have been chosen. This gives the map a more dynamic character, indicating the flow of energy to Austria. The width of the arrowheads and lines are proportional to the amount of energy imported and allows to roughly compare the different energy values of the different sources and countries.

- Why these colours?

The colour choice for each source of energy has been done mostly intuitively, although it is hard to find an intuitive colour for each source. So, another factor was that the colours can be separated easily and energy sources like oil, gas and coal got some darker colour shades which corresponds well with fossil energy sources. Austria is highlighted in turquoise colour, as it is the central country of the topic and also no other meaning is associated with that colour in this map topic. The main importing countries are highlighted in darker grey colour, so they can be visually separated from the other countries.

- Why this map scale and extent?

Some main importing countries are visualised by grey circles with their name in it. This doesn't mean that these countries are less important, it just allows to limit the map extent to Europe and closer regions, which makes the map better readable than a whole world map.

- Why an additional infographic?

Besides the map an infographic has been added that targets to further illustrate Austria's energy dependency on other countries, as the difference of energy imported and produced is shown in the size of the circles and by exact numbers.

After reading the additional information about the sources, did the trustworthiness about the sources of the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information about the sources and mapmaking background, did the trustworthiness about the information and numbers shown in the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Please write your answer here:

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

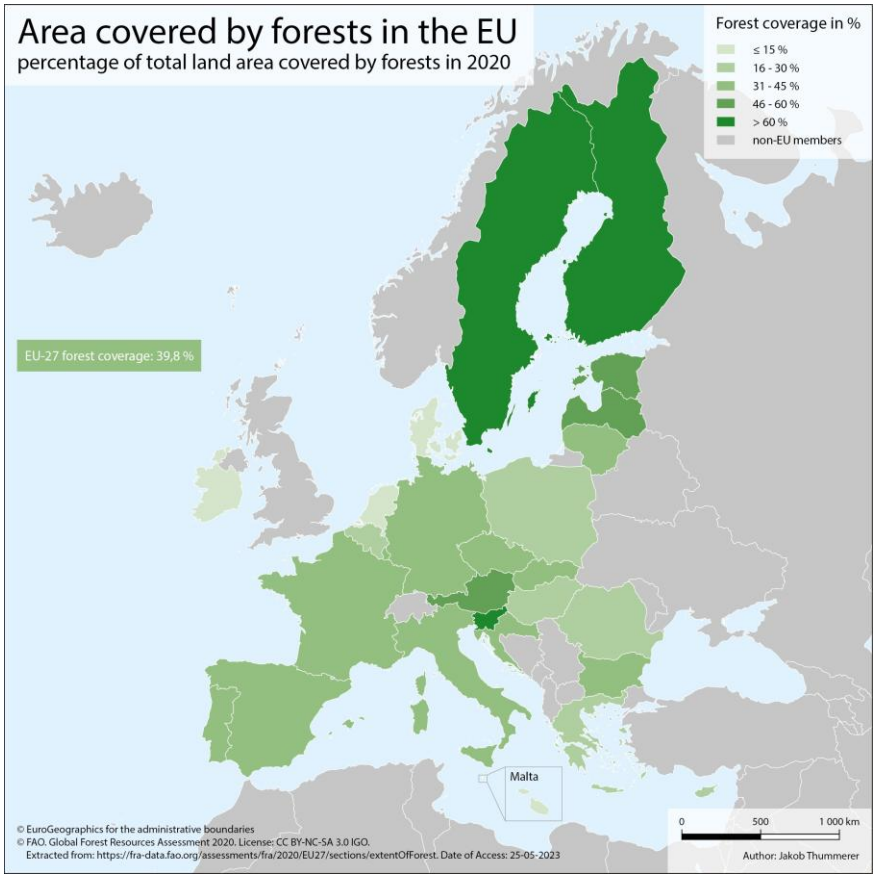
Please write your answer here:

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Please write your answer here:

Map 2

Please read the following map carefully and try to understand the thematic content of the map. After reading the map please scroll down and answer the following questions. You can always scroll back up and take another look at the map, there is no time pressure.



How do you rate the controversial potential of the topic? *

Please choose the appropriate response for each item:

1 (not controversial at all)	2	3	4	5 (very controversial)
◯	◯	◯	◯	◯

How trustworthy do the information and numbers shown in this map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
◯	◯	◯	◯	◯

How trustworthy do the sources of the map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
◯	◯	◯	◯	◯

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence? *

Please choose the appropriate response for each item:

1 (no trust at all)	2	3	4	5 (full trust)
◯	◯	◯	◯	◯

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right. *

Choose one of the following answers

Please choose **only one** of the following:

◯ Yes

◯ No

◯ Not sure

Make a comment on your choice here:

Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you? *

Choose one of the following answers

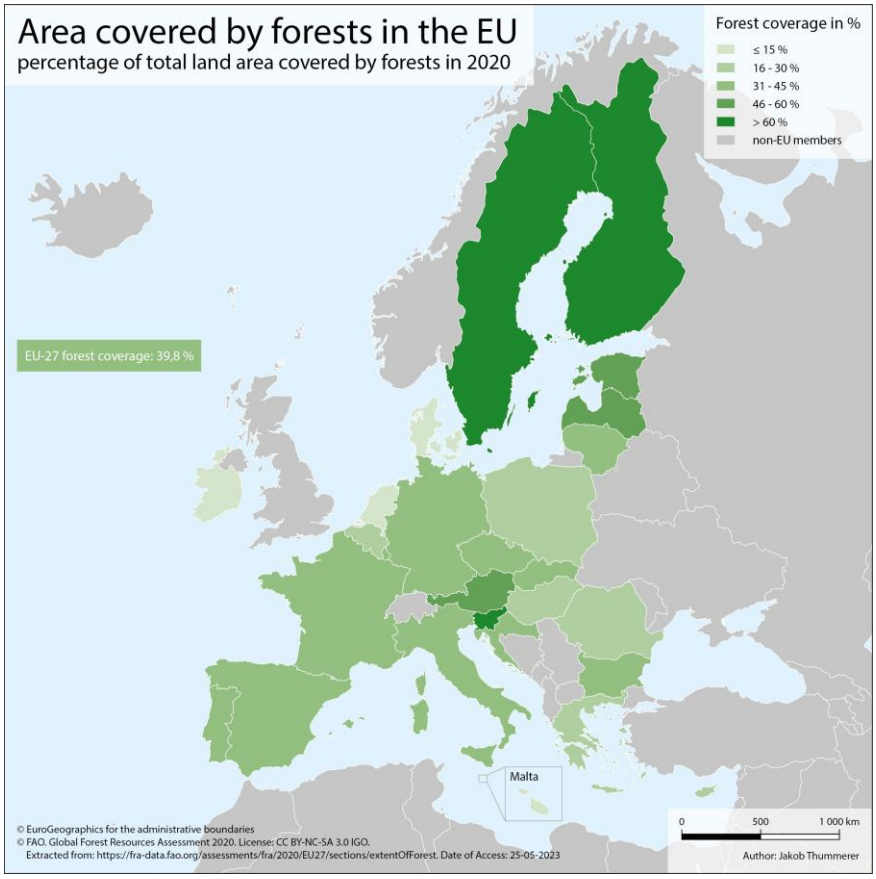
Please choose **only one** of the following:

◯ Yes

◯ No

Map 2 additional information

In this section you will get additional information about the sources of the map and about decisions that were made in the map-making process. Please read the information carefully and answer the questions below.



Sources

- Base map

Data for the base map with administrative boundaries is retrieved from the website ec.eurostat.eu, which is an official website of the European Union and acts as the statistical office of the European Union. The data itself was collected by EuroGeographics, which is an international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities (https://eurogeographics.org). The data can be used for free on the condition that it is not used for commercial purposes and that the source is acknowledged by a copyright notice in the form of "© EuroGeographics for the administrative boundaries".

- Thematic data

The data for the forest coverage was retrieved from the website (https://www.fao.org/home/en/) of the Food and Agriculture Organization (FAO) which is a specialized agency of the United Nations. In detail the data used for this map is provided by the Global Forest Resources Assessment (FRA), an initiative by the FAO, which monitors the world's forest resources through assessments which are done every 5 years in cooperation with its member countries. The assessments are based on analysis of country sources supported by expert judgements, remote sensing and statistical analysis.

The data of the FRA which includes the forest area in 1000 hectares for nearly all countries of the world can be downloaded via the dashboard of the FAO (https://fra-data.fao.org/assessments/fra/2020/). In preparation for displaying the data, the forest area was converted from hectares to percentage of total land area.

Map-making Decisions

- Why square format?

For the map extent a square format centered around the EU has been chosen, as this covers all of the EU-countries and not too much irrelevant areas are shown.

- Why a choropleth map?

As a visualization method for displaying the forest area per country a choropleth map has been chosen, as this is an easy interpretable way of displaying a feature that varies across a geographical area.

- Why this classification?

The data has been classified in 5 15 % equal interval classes, as this gives a good overview about the approximate values of the countries forest areas. Too many classes would have made it difficult to distinguish the colours and fewer classes would have generalized the data too much. The 5th class above 60 % is open, as there are only 3 countries with values above 60 % and the maximum is Finland with 66 %.

- Why these colours?

For the colouring of the top class above 50 % a saturated green colour has been chosen, as this is an intuitive choice for forest area. The classes below have less saturation in descending order, which indicates a lower forest coverage.

- Why a separate box for the EU?

The forest area for the entire EU region has been added in text, highlighted with the corresponding class colour, so the individual countries can be compared to the total EU coverage.

- Why is Malta shown in a zoomed-in box?

The country of Malta is shown in a zoomed in box, as it would not be interpretable in the normal map scale.

After reading the additional information about the sources, did the trustworthiness about the sources of the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information, did the trustworthiness about the information and numbers depicted in the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Please write your answer here:

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

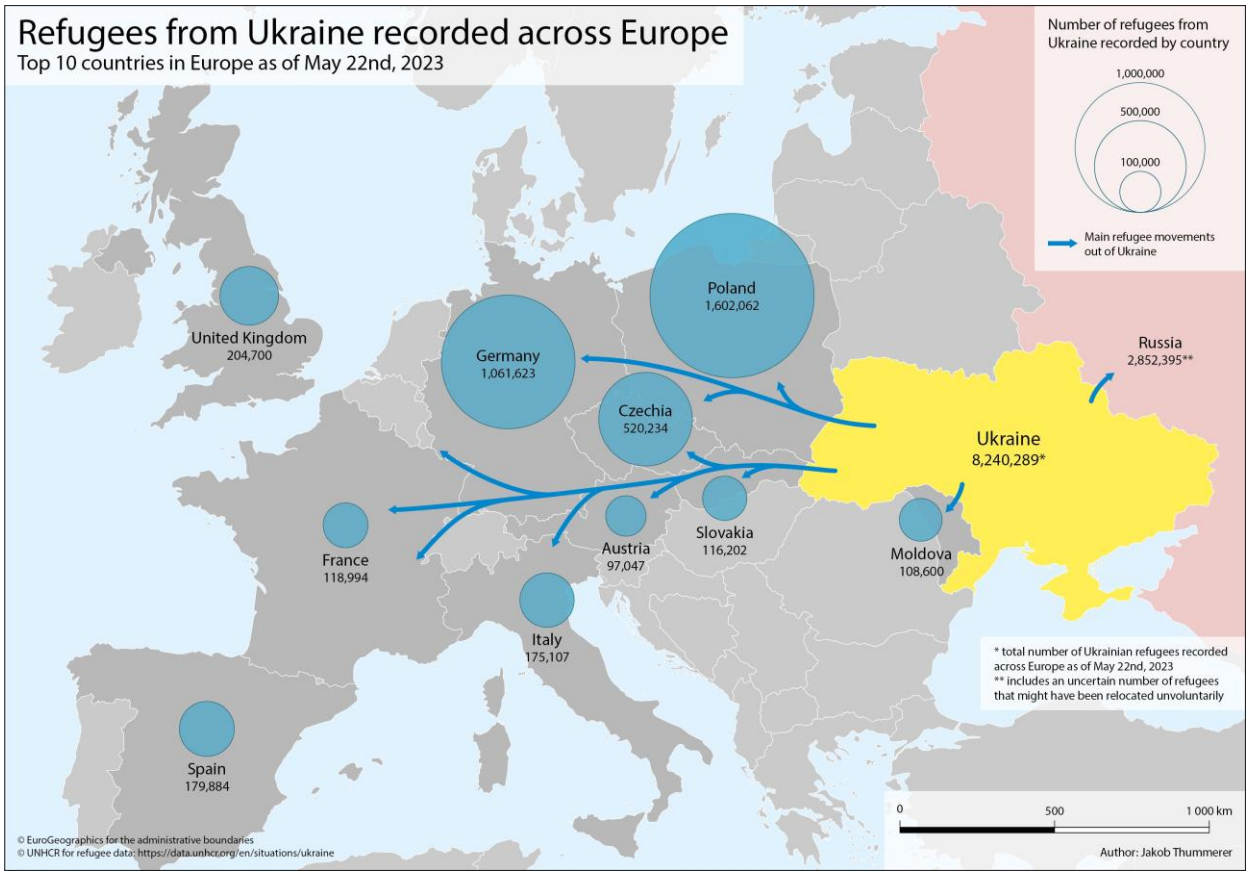
Please write your answer here:

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Please write your answer here:

Map 3

Please read the following map carefully and try to understand the thematic content of the map. After reading the map please scroll down and answer the following questions. You can always scroll back up and take another look at the map, there is no time pressure.



How do you rate the controversial potential of the topic? *

Please choose the appropriate response for each item:

1 (not controversial at all)	2	3	4	5 (very controversial)
○	○	○	○	○

How trustworthy do the information and numbers shown in this map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
◯	◯	◯	◯	◯

How trustworthy do the sources of the map seem to you? *

Please choose the appropriate response for each item:

1 (not trustworthy at all)	2	3	4	5 (very trustworthy)
◯	◯	◯	◯	◯

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence? *

Please choose the appropriate response for each item:

1 (no trust at all)	2	3	4	5 (full trust)
◯	◯	◯	◯	◯

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right. *

Choose one of the following answers

Please choose **only one** of the following:

◯ Yes

◯ No

◯ Not sure

Make a comment on your choice here:

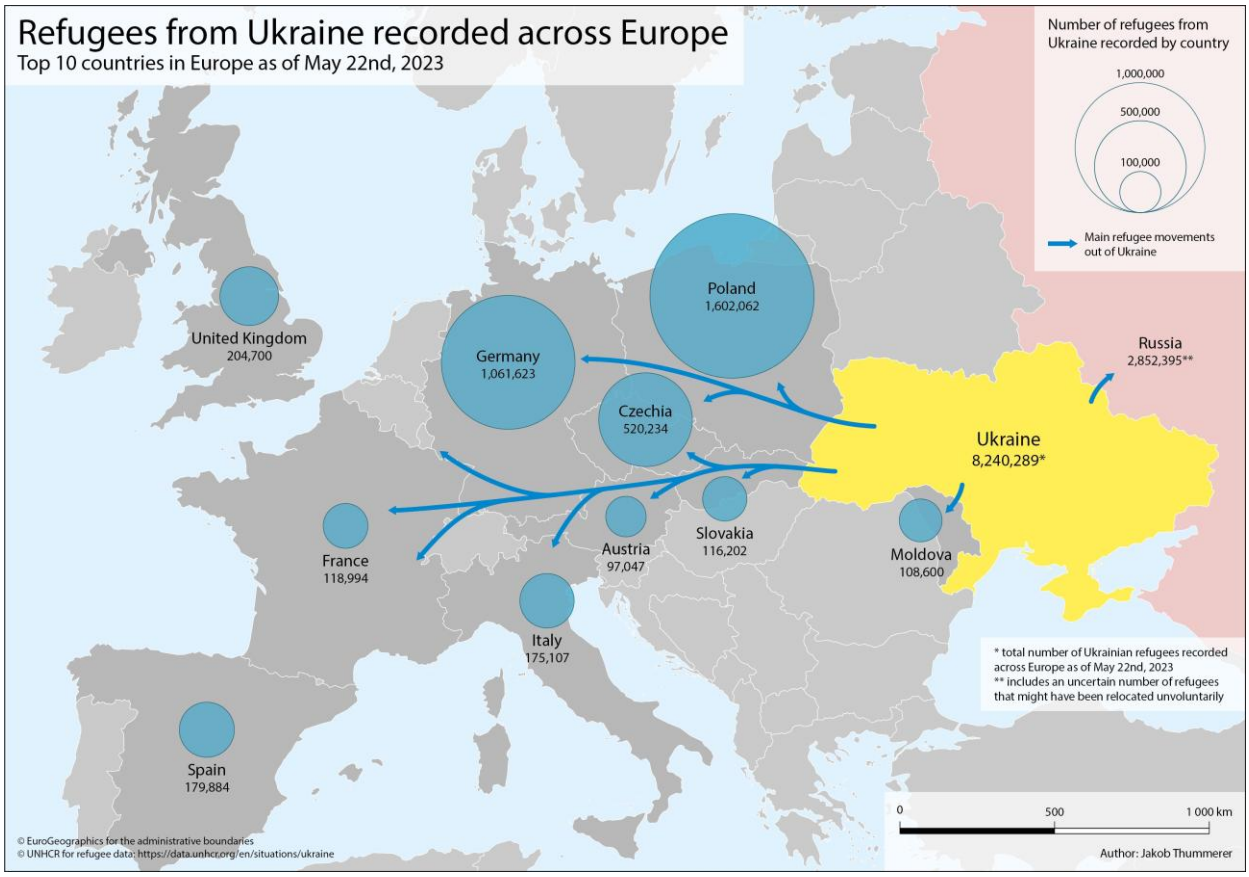
Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you? *

Choose one of the following answers
Please choose **only one** of the following:

◯ Yes
◯ No

Map 3 additional information

In this section you will get additional information about the sources of the map and about decisions that were made in the map-making process. Please read the information carefully and answer the questions below.



Sources

- Base map

Data for the base map with administrative boundaries is retrieved from the website ec.eurostat.eu, which is an official website of the European Union and acts as the statistical office of the European Union. The data itself was collected by EuroGeographics, which is an international not-for-profit organisation representing Europe's National Mapping, Cadastral and Land Registration Authorities (https://eurogeographics.org). The data can be used for free on the condition that it is not used for commercial purposes and that the source is acknowledged by a copyright notice in the form of "© EuroGeographics for the administrative boundaries".

- Thematic data

The data for the refugee numbers was downloaded from the Operational Data Portal (ODP) of the UNHCR, the United Nations Refugee Agency, which was initially created, to provide an information source and data sharing platform to enable coordination of refugee emergencies.

The ODP contains an overview about all refugee situations around the world as well as detailed information about individual countries that are affected by refugee situations. For this map the data was retrieved from the subsection of the Ukraine Refugee Situation. The data and statistics on the site get updated weekly and are collected by the UNHCR through governments and authorities.

The map uses the numbers of Refugees from Ukraine recorded across Europe, which reflects the estimated number of individual refugees that are currently present in European countries. If there is no official estimate available UNHCR uses the sum of numbers from registration for Temporary Protection or other national protection schemes and numbers of asylum applications from Ukrainian refugees.

Map-making Decisions

- Why only show top 10 countries?

In preparation the countries were sorted by the number of recorded refugees and decided that only the top 10 would be displayed in the map, as the main target of the map is to give an overview about the main refugee movement from Ukraine and more countries would decrease the readability of the map. But of course, it must be taken in account that refugees haven't only fled to the shown countries and is also dependent on the population of the country.

- Why is Russia visualized different?

The refugee numbers to Russia have also been included as it is such a high number, but as already stated in the map, it must be taken in account that an uncertain number of refugees have been relocated involuntarily and therefore it is not displayed the same way as the other countries.

- Why circles for refugee data?

For all the other countries in this map, circles that are scaled by area to the number of refugees, have been used as a visualization method, as circles scaled by area are a good representation for quantities.

- Why refugee routes?

Between the circles branched arrows have been added, that should indicate the main refugee movements out of Ukraine. It must be noted that these arrows don't show exact refugee movements or any exact proportions and there are of course more than just the indicated routes.

- Why these colours?

The arrows and circles are in a light blue colour, as it is not intended to associate refugees with danger or negative feelings. Ukraine has been highlighted in a yellow colour, as this is the focal point of the topic and corresponds with the national colours of the flag. Russia however has been filled with a very light red colour, as the attack from Russia is the reason for the refugee movement, and therefor the impression of danger is intended here. Additionally, the top 10 countries have been coloured in slightly darker grey colour, so that the area where most of the refugees are fleeing to is slightly highlighted.

After reading the additional information about the sources, did the trustworthiness about the sources of the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information, did the trustworthiness about the information and numbers depicted in the map change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change? *

Choose one of the following answers
Please choose **only one** of the following:

- ◯ decreased
- ◯ slightly decreased
- ◯ didn't change at all
- ◯ slightly increased
- ◯ increased

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Please write your answer here:

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

Please write your answer here:

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Please write your answer here:

One final question

If the maps, you've seen in the sections before, would have been created by an artificial intelligence, would this affect the trustworthiness of the maps for you? *

Choose one of the following answers

Please choose **only one** of the following:

- ◯ Yes, it would increase trustworthiness.
- ◯ Yes, it would decrease trustworthiness.
- ◯ No, it wouldn't change anything.

Thank you very much for participating in this survey!

If you have any questions, you can contact me:

Jakob Thummerer, BSc

e01327244@student.tuwien.ac.at

Submit your survey.

Thank you for completing this survey.

Appendix B

Zusammenfassung für G01Q01

What is your age?

Antwort	Anzahl	Prozent
18-29 (AO01)	14	30.43%
30-39 (AO02)	6	13.04%
40-49 (AO03)	6	13.04%
50-59 (AO04)	15	32.61%
60-69 (AO05)	5	10.87%
70-79 (AO06)	0	0.00%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G01Q02

I am (Gender)

Antwort	Anzahl	Prozent
a woman (AO01)	24	52.17%
a man (AO02)	22	47.83%
non-binary (AO03)	0	0.00%
rather not say (AO04)	0	0.00%
Sonstiges	0	0.00%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G01Q03

I am from (country)

Antwort	Anzahl	Prozent
Austria (AO15)	40	86.96%
Canada (AO41)	5	10.87%
Turkey (AO228)	1	2.17%

Zusammenfassung für G01Q04

How would you rate your experience in map reading?

Antwort	Anzahl	Prozent
1 (no experience at all) (AO01)	4	8.70%
2 (AO02)	3	6.52%
3 (AO03)	14	30.43%
4 (AO04)	16	34.78%
5 (very experienced) (AO05)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G01Q05

How would you rate your knowledge of cartographic principles?

Antwort	Anzahl	Prozent
1 (no knowledge at all) (AO01)	9	19.57%
2 (AO02)	7	15.22%
3 (AO03)	13	28.26%
4 (AO04)	13	28.26%
5 (expert) (AO05)	4	8.70%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G02Q06

How do you rate the controversial potential of the topic?

Antwort	Anzahl	Prozent
1 (not controversial at all) (AO01)	6	13.04%
2 (AO02)	6	13.04%
3 (AO03)	13	28.26%
4 (AO04)	19	41.30%
5 (very controversial) (AO05)	2	4.35%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G02Q07

How trustworthy do the information and numbers shown in this map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	2	4.35%
2 (AO02)	3	6.52%
3 (AO03)	9	19.57%
4 (AO04)	22	47.83%
5 (very trustworthy) (AO05)	10	21.74%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G02Q08

How trustworthy do the sources of the map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	1	2.17%
2 (AO02)	1	2.17%
3 (AO03)	13	28.26%
4 (AO04)	17	36.96%
5 (very trustworthy) (AO05)	14	30.43%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G02Q09

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence?

Antwort	Anzahl	Prozent
1 (no trust at all) (AO01)	2	4.35%
2 (AO05)	2	4.35%
3 (AO04)	8	17.39%
4 (AO03)	18	39.13%
5 (full trust) (AO02)	16	34.78%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G02Q10

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right.

Antwort	Anzahl	Prozent
Yes (AO01)	40	86.96%
No (AO02)	3	6.52%
Not sure (AO03)	3	6.52%
Kommentar	12	26.09%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Yes, depending on colour scheme, text size of place you can make different parts of the map stand out as more positive or negative
12	I think the red arrow is very large, maybe even more than proportional to the amount of oil imported.
14	Color and thickness of the arrows, size of the circles, which countries are labelled dark grey
28	cartographers should be aware of the responsibility to keep (own) opinions out of the mapmaking process and stay as objective as possible
30	A different directivity and placement of the arrows could lead to misinterpretation or gives a different picture, when only taking a quick look at the map; Non-linear sizing of symbols, e.g. many smaller imports are less pronounced than bigger imports
36	Different colors for the arrows, Arrows not coming from nowhere, but pipelines actually depicted with flow numbers for oil + gas, train lines for coal. Roads/ships for biogenic from USA? Is that soy? Or wood?
37	color choice, scaling of the arrows
53	e.g. the color could indicate which is "good" energy (green) and which is "bad" energy (red), e.g. the scale of the arrows (linear, logarithmic) could give a wrong feeling about the real amount
62	Choice of colours for respective kinds of energy imports are influencial, as are different shades of grey colouring for respective countries.
70	Manipulation through the form of how information is presented is a fact in my opinion. This gets amplified obviously when political hot-spots are included like as an example Russia's war in the Ukraine - makes the energy dependence Austria and other countries have to some extent from Russia more critical. In general using honest information which can be checked but presenting it in a certain way is a significant tool to influence the opinion of people. And maps looks innocent in that matter, but it is relatively easy to form the opinion / opposition during the form of presentation.
71	Every information is manipulative ...
73	The selection of scales and colours can influence the first impression!

Zusammenfassung für G02Q11

Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you?

Antwort	Anzahl	Prozent
Yes (AO01)	37	80.43%
No (AO02)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G03Q12

After reading the additional information about the sources, did the trustworthiness about the sources of the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	0	0.00%
didn't change at all (AO03)	4	8.70%
slightly increased (AO04)	27	58.70%
increased (AO05)	14	30.43%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G03Q13

After reading the additional information about the sources and mapmaking background, did the trustworthiness about the information and numbers shown in the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	0	0.00%
slightly decreased (AO02)	1	2.17%
didn't change at all (AO03)	10	21.74%
slightly increased (AO04)	24	52.17%
increased (AO05)	11	23.91%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G03Q14

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	0	0.00%
didn't change at all (AO03)	15	32.61%
slightly increased (AO04)	17	36.96%
increased (AO05)	13	28.26%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G03Q15

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Antwort	Anzahl	Prozent
Antwort	17	36.96%
Keine Antwort	29	63.04%
Nicht gezeigt	0	0.00%

ID	Antwort
10	I don't think I really needed to know the arrows for visualization, those seemed but pretty intuitive (but I am also a grad student who looks at maps all day) so maybe they would less so for some people.
12	I guess I would now trust more that the size of the arrows is actually proportional and not exaggerated
13	Some information, like 'the importing countries which are visualised by grey circles with their name in it' is obvious to me and therefor do not increase the trustworthiness for me personally, because it has no additional value in my eyes. It makes it just more difficult to find the usefull information. But of course there might be people for whom it is not obivous and where the information helps. I think it is quite difficult to give information in an amount fitting for most people.
14	The answer to: Why this map scale and extent?
15	Die Hinweise zur Farbwahl könnten entfallen, da diese ja den Farben der Kreisdiagramme aus den Energieberichten des Ministeriums entsprechen. In einer guten kartographischen Darstellung muss mE die Farbwahl nicht explizit erklärt werden.
27	the description of the process of choosing colours seems less important for me
30	Explaining how the copyright notice of each source works is not necessary as long as it is attributed correctly;
36	I already gathered who is behind it from the first map. Had I NOT known the trustworthiness of the sources, the additional information would have convinced me of the trustworthiness of the map. But I read the info already in the first map.
51	No
53	The BMK was already mentioned as source in the first map. I trusted that they use solid data sources. So the additional description confirmed my assumption (and therefore didn't significantly increase the already high trustworthiness).
55	No
59	also the additional informations could be manipulated
63	for people with less map-reading experience it may provide additional infos to increase trustworthiness
69	I think detailed information about the sources are important. Bout the map making decisions not so much. In the whole it is a lot of text that people wouldn't read.
70	Information and source is well presented. Maps with such or similar information should have an index-link to a web-site to allow a viewer to see the sources. A link is fine. I don't see the need to list the sources, even if just the key points on the map itself.
71	Either you trust the ministry as a reliable source or you don't ..
73	The diagram showing the relative amount of petajoule for each category could be complemented by exact numbers in form of a attached table, so that the interested person may better compare. A reference to an accompanying text where this information is represented could also be sufficient.

Zusammenfassung für G03Q16

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

Antwort	Anzahl	Prozent
Antwort	12	26.09%
Keine Antwort	34	73.91%
Nicht gezeigt	0	0.00%

ID	Antwort
10	You mentioned the data is from BMK, the Austrian federal ministry for climate action, environment, energy, mobility, innovation and technology, which definitely increased credibility for me but there is no mention of how they collect this data. I am not Austrian, so I don't necessarily know the generally view of credibility this ministry has, I assume they are credible. But for instance in Canada the government has some investment in oil and gas and might put out statistics trying to make that industry seem for beneficial, so I might be a little skeptical of a Canadian version of a figure like this... So I guess understanding a bit more on how the ministry collected the data would be helpful for credibility for me.
11	uncertainty in the measures or variation over the years (how significant is 2021?)
13	If there is no line/arrow does this mean that there is no import at all? If not, what is the threshold?
15	Eventuell konkrete Zahlen zu den einzelnen importierten Energieträgern, bzw in der Karte die Beschriftung der Pfeile mit Werten.
36	I am fine with the info.
37	Was there a threshold for energy imports shown in the map?
38	maybe a better explanation of the energy sources, for example biogenic energy
51	No
62	For a layman‘s better understanding of actual energy quantities, an indication in metric tons may be helpful.
69	No
70	The explanation of the line/arrow thickness is explained - but the colour in light grey is too light. I darker hue of grey would have been better - and maybe more line thickness option to further explain (like the small scale conversion typical on a map). Some short reference comparing Austria to some of it's surrounding countries would have been nice also (e.g. like how Germany, Italy, Switzerland, Slovenia have similar or not so similar dependencies
71	No

Zusammenfassung für G03Q17

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Antwort	Anzahl	Prozent
Antwort	21	45.65%
Keine Antwort	25	54.35%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Understanding where the data came from (BMK) and the cartographers choices on map scale and colours it was nice to know the thought but into these choices and that the cartographer was not trying to fool me with some choice.
12	the information about where the data comes from
13	Base map and Thematic data
14	References
15	Thematik data
19	explaining the sources
27	information about the sources
30	Explanation of the chosen metrics and how they relate to the chosen symbols; Stating the exact sources together with links to find additional/background information; I did not put too much attention on the colouring, which could be indeed a source of misinterpretation. So the explanation was very helpful to point out the meaning of the colours/thinking process behind it;
36	Perhaps links to the original data - where they can be downloaded might have helped.
37	description of the sources
38	thematic data sources
51	The thematic data/additional information on the sources used.
53	The data source is most important (BMK in a first level, further levels like Statistik Austria etc. add trustworthiness).
54	Thematische Daten
55	Informationen should be given directly.
58	thematic data
69	The sources of the used data.
70	As mentioned above - for example Switzerland being geographically relative close, it would be nice to know/see their energy basket and sources for comparison. Electric energy is too general. There should be at least 3 categories for electric import (and self-production) - like hydro derived, nuclear derived and fossil fuel and source not known as 3rd. It's less "disturbing" importing nuclear electricity from France than e.g. fossil fuel generated electricity from Czechia. Biogenic is too general. I would rather call it renewable and explain that this includes wind, solar, biogas and similar.
71	No
72	The fact of having added the sources & background info
73	To increase the trustworthiness it would be better to reference an underlying scientific institution and not a governmental entity.

Zusammenfassung für G04Q18

How do you rate the controversial potential of the topic?

Antwort	Anzahl	Prozent
1 (not controversial at all) (AO01)	13	28.26%
2 (AO02)	20	43.48%
3 (AO03)	8	17.39%
4 (AO04)	4	8.70%
5 (very controversial) (AO05)	1	2.17%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G04Q19

How trustworthy do the information and numbers shown in this map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	0	0.00%
2 (AO02)	2	4.35%
3 (AO03)	11	23.91%
4 (AO04)	19	41.30%
5 (very trustworthy) (AO05)	14	30.43%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G04Q20

How trustworthy do the sources of the map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	1	2.17%
2 (AO02)	1	2.17%
3 (AO03)	14	30.43%
4 (AO04)	17	36.96%
5 (very trustworthy) (AO05)	13	28.26%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G04Q21

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence?

Antwort	Anzahl	Prozent
1 (no trust at all) (AO01)	0	0.00%
2 (AO02)	2	4.35%
3 (AO03)	7	15.22%
4 (AO04)	11	23.91%
5 (full trust) (AO05)	26	56.52%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G04Q22

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right.

Antwort	Anzahl	Prozent
Yes (AO01)	30	65.22%
No (AO02)	9	19.57%
Not sure (AO03)	7	15.22%
Kommentar	8	17.39%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Yes, you can make a phenomenon look more or less extreme on a map which can influence people's feelings around it.
12	There's nothing about the map that seems like it would influence people... sure the overall topic might be controversial regarding loss of forest areas, but the map doesn't seem very sensational or controversial, and doesn't seem to exaggerate
30	The chosen projection can lead to misinterpretations. The size of country might visually interfere with the actual quantity being visualised, e.g. its hard to compare Sweden and Finnland with other countries; If the colourbar would be inverted, then the perception would be completely different; If the colourbar would have no adjusted limits, i.e. 0 and 100%, then it would be way harder to spot differences among the other medium forested countries;
36	by changing the color scheme to different densities of dots (60% coverage with dots. .....), one might get manipulative.
59	political pressure could be the reason for manipulation(especially because of financial interests-industry)
70	Similar to energy - form of presentation can and will form opinions although forest cover is less of an issue than where energy comes from.
72	Making countries bigger, distorted images
73	The green shadings are in the middle range not clearly discernible at first glance and could lead to misinterpretation at least at first glance

Zusammenfassung für G04Q23

Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you?

Antwort	Anzahl	Prozent
Yes (AO01)	35	76.09%
No (AO02)	11	23.91%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G05Q24

After reading the additional information about the sources, did the trustworthiness about the sources of the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	1	2.17%
didn't change at all (AO03)	8	17.39%
slightly increased (AO04)	27	58.70%
increased (AO05)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G05Q25

After reading the additional information, did the trustworthiness about the information and numbers depicted in the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	1	2.17%
didn't change at all (AO03)	16	34.78%
slightly increased (AO04)	20	43.48%
increased (AO05)	8	17.39%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G05Q26

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	0	0.00%
didn't change at all (AO03)	26	56.52%
slightly increased (AO04)	12	26.09%
increased (AO05)	7	15.22%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G05Q27

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Antwort	Anzahl	Prozent
Antwort	15	32.61%
Keine Antwort	31	67.39%
Nicht gezeigt	0	0.00%

ID	Antwort
10	The colours of classes where a bit hard to distinguish from each other
12	things like color green, square format for the map, and the explanation for why malta is shown the way it is all seem irrelevant to me
13	same as before: some of the map-making decisions are obvious to me and give no extra value
15	Infos betr. Darstellungen Malta und EU sind verzichtbar, ebenfalls die Begründung für die Wahl der Darstellung macht keinen Unterschied und muss nicht erklärt werden.
19	choosing of colours
27	colours, shape of the map
30	explanation of attribution; centering of the map (projection is more important)
33	I think that the map is very easy to interpret and therefore additional information does not increase trustworthiness
36	all info is relevant.
37	Square format Malta in a zoomed-in box
38	not all of the information about the map making decisions is needed for me, for example square format and colours
51	No - all relevant
53	The map looks professional, the map making decisions are more design criteria than content related, so the map making decisions do not add to trustworthiness of the topic and add just little to trustworthiness of the map maker's competence. The reason for the chosen cluster of 15% and the maximum (Finalnd 66%) are relevant informations.
69	I think the sourecrs are very important.
70	All what is mentioned adds value. A little bit more info (not less) would be interesting (see comment below)

Zusammenfassung für G05Q28

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

Antwort	Anzahl	Prozent
Antwort	11	23.91%
Keine Antwort	35	76.09%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Lat and lon lines,
15	No
30	Chosen projection
36	When I fist looked at the map, I did not see Malta nor the overall average box, as my screen is very bright. I needed the text to figure out these details. I would recommend the average box not to swim in the ocean and make it visually more prominent.
38	a bit more information on the thematic data source, for example how the data is collected
51	No
53	What is the minimum coverage (amount and country)? Min and max could be stated along with the EU average. The shading gives relative information (brighter or darker) but it is hard to determine the exact category. An additional pattern could help. Alternatively the exact percentage could be printed as text inside the boundaries of the countries - this would add accuracy and give better orientation beyond the 15% clusters.
59	information about growing of forrests(or becoming less)
69	No
70	I think the additional info is nice. Showing the split between agri-cultural utilized and forest cover would be nice. Also to show areas where the vegetation is low due to geographic reasons would be nice (trees don't grow on high mountains or way north in Sweden and Finland (more tundra like then)
71	No

Zusammenfassung für G05Q29

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Antwort	Anzahl	Prozent
Antwort	14	30.43%
Keine Antwort	32	69.57%
Nicht gezeigt	0	0.00%

ID	Antwort
10	It seem like there where a lot of countries in the 21-30%, it would be nice to see how these different. I wonder why the cartographer chose to do straight breaks in classes, based on the data. More information would be helpful in this category.
13	Base map and Thematic data
19	sources, calssification
27	sources, thematic data
30	Explanation of colouring scheme; links to sources; explanation of the details (malta and separate box)
36	I am not a great believer in FAO statistics, as the FAO has had the mission to increase yields with not much regard for nature for many decades. The info about the link to the data as being based on FRA, helped me trust the data.
37	sources for thematic data
51	Thematic data/sources
54	Thematische Daten
58	Thematic data
69	The sources
70	5 categories to classify is a bit low, but on the other hand easier to read. I would add the percentage in each country. I assume Slovenia has slightly less forest cover than Finland for example.
71	Source
72	Classification

Zusammenfassung für G06Q30

How do you rate the controversial potential of the topic?

Antwort	Anzahl	Prozent
1 (not controversial at all) (AO01)	5	10.87%
2 (AO02)	5	10.87%
3 (AO03)	9	19.57%
4 (AO04)	17	36.96%
5 (very controversial) (AO05)	10	21.74%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G06Q31

How trustworthy do the information and numbers shown in this map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	1	2.17%
2 (AO02)	2	4.35%
3 (AO03)	13	28.26%
4 (AO04)	21	45.65%
5 (very trustworthy) (AO05)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G06Q32

How trustworthy do the sources of the map seem to you?

Antwort	Anzahl	Prozent
1 (not trustworthy at all) (AO01)	0	0.00%
2 (AO02)	1	2.17%
3 (AO03)	13	28.26%
4 (AO04)	17	36.96%
5 (very trustworthy) (AO05)	15	32.61%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G06Q33

Based on the visual appearance of the map, how much trust do you put in the map-maker's cartographic competence?

Antwort	Anzahl	Prozent
1 (no trust at all) (AO01)	0	0.00%
2 (AO02)	0	0.00%
3 (AO03)	8	17.39%
4 (AO04)	20	43.48%
5 (full trust) (AO05)	18	39.13%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G06Q34

Do you think it is possible to manipulate someone's opinion about the given topic, by how the information is visualized in the map? You can add additional thoughts in the text box on the right.

Antwort	Anzahl	Prozent
Yes (AO01)	39	84.78%
No (AO02)	3	6.52%
Not sure (AO03)	4	8.70%
Kommentar	10	21.74%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

ID	Antwort
14	Circle size
28	Manipulation possible for example by color selection, line width of the arrows . . .
30	The arrows showing the main refugee movement leave a lot of room for (mis-)interpretation; What is "main", what is the share? Where do the arrows end, e.g., have refugees only come the Germany via Poland?
36	E.g. by RED arrows. The map is manipulative, as it gives NO blue circle for Russia, which would be much bigger than that of Poland. It could give the size of the circle as a dotted line, if the involuntary movements are to be depicted differently.
37	color choice, defintion/interpretation of uncertain refugee numbers, size of arrows
59	political interests
62	Colours
69	At first sight it seems that the most refugees went to Russia what is not true.
70	Similar as before - form of presentation does influence how information is received and digested.
73	Adding a proportionality index in relation to the inhabitants of each country would enhance the information given!

Zusammenfassung für G06Q35

Do you think additional information about sources and decisions in the map-making process could increase the trustworthiness of the map for you?

Antwort	Anzahl	Prozent
Yes (AO01)	37	80.43%
No (AO02)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G07Q36

After reading the additional information about the sources, did the trustworthiness about the sources of the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	1	2.17%
slightly decreased (AO02)	3	6.52%
didn't change at all (AO03)	9	19.57%
slightly increased (AO04)	24	52.17%
increased (AO05)	9	19.57%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G07Q37

After reading the additional information, did the trustworthiness about the information and numbers depicted in the map change?

Antwort	Anzahl	Prozent
decreased (AO01)	0	0.00%
slightly decreased (AO02)	5	10.87%
didn't change at all (AO03)	13	28.26%
slightly increased (AO04)	24	52.17%
increased (AO05)	4	8.70%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G07Q38

After reading the additional information about the sources and mapmaking background, did the level of trust you put in the map-maker's cartographic competence change?

Antwort	Anzahl	Prozent
decreased (AO01)	0	0.00%
slightly decreased (AO02)	2	4.35%
didn't change at all (AO03)	21	45.65%
slightly increased (AO04)	18	39.13%
increased (AO05)	5	10.87%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%

Zusammenfassung für G07Q39

Do you think that any of the additional information from above is not relevant for increasing trustworthiness? If so, please shortly describe in the text box below.

Antwort	Anzahl	Prozent
Antwort	13	28.26%
Keine Antwort	33	71.74%
Nicht gezeigt	0	0.00%

ID	Antwort
10	I thought the colours where pretty intuitive and didn't need to be explained.
15	Farbwahl würd ich nicht begründen, auch Begründung für die Kreisdarstellung nicht unbedingt notwendig.
27	colours
30	explanation of attribution
33	I mean, the choice of colors doesn't need to be explained because the colors don't really influence the information on the map
36	I think all info is relevant.
37	sources base map,
38	The base map sources are not that relevant for me, because I think that doesn't really affect my trustworthiness of the topic itself or the cartographer (for all 3 maps)
51	No
53	why use circles: circles are a common method, any other shape (e.g. squares, bars) would work also. The decision for circles is good from an design aspect but not relevant for trustworthiness.
55	No
69	No
73	A reference that the numbers are estimates would help to interpret the information!

Zusammenfassung für G07Q40

Are there any other parts of the map or topic, that have not been covered in the text above, where you would have liked to receive additional information? If so, please shortly describe them in the text box below.

Antwort	Anzahl	Prozent
Antwort	9	19.57%
Keine Antwort	37	80.43%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Thematic map- It might be helpful to know the start state of when people where considered refugees, not immigrants coming from Ukraine. Was it the very start of the war?
11	why are the numbers so exact? I would have expected more rounded numbers (e.g. 100,000 for Austria)
36	I am fine with the info. It alerted me to the one choice of the mapmaker, where he is manipulative: The red color of Russia. I also think a circle depicting refugees to "all other" countries worldwide might put things into perspective. But that only dawned on me after reading the additional information.
37	More detailled explanation of the numbers in Russia, and maybe explanation of how uncertain these numbers are
38	maybe somehow indicate that the numbers are still changing, and maybe how much they are rising over time
51	No
53	The remaining part (= total - sum of top 10) should be mentioned explicitly and indicated in the map to give a better feeling about the significance of top 10 related to the rest. Range of uncertainty of the numbers (how good are the estimations?).
55	No
70	Refugees into the Nordic countries (Sweden and Finland) and the Baltic states is missing.

Zusammenfassung für G07Q41

Is there any part or category of the additional information above, that is especially helpful for increasing trustworthiness? If so, please shortly name the part/category in the text box below.

Antwort	Anzahl	Prozent
Antwort	16	34.78%
Keine Antwort	30	65.22%
Nicht gezeigt	0	0.00%

ID	Antwort
10	Yes, the thematic map explaining where the data was from.
13	Base map, Thematic data and this time also Map-making Decisions since it was not that obvious and I questioned some of the design choices before
15	Quellenbeschreibung, Begründung für Wahl von 10 Ländern
19	sources
27	sources, thematic data,
30	explaining the thinking process behind the refugee movement routes
36	I very much trust in the UNHCR, but explaining that THEY use different sources actually helped me understand the potential difficulty they face in providing these numbers.
37	color choice
38	explanation of the refugee numbers
51	Thematic data and the additional information on Russia (possible involuntary relocation being visualized differently)
53	description of the UNHCR and how the data is collected
54	Flüchtlingsrouten, j
55	Each extra information helps to increase! But I think those who don‘t trust, can‘t be convinced with more information
58	thematic data
70	See above. Would also be interesting seeing a note how many Ukrainians left outside the EU (like Canada, US, etc.)
71	Information about Ukranians that went to Russia ..

Zusammenfassung für G08Q42

If the maps, you've seen in the sections before, would have been created by an artificial intelligence, would this affect the trustworthiness of the maps for you?

Antwort	Anzahl	Prozent
Yes, it would increase trustworthiness. (AO01)	0	0.00%
Yes, it would decrease trustworthiness. (AO02)	34	73.91%
No, it wouldn't change anything. (AO03)	12	26.09%
Keine Antwort	0	0.00%
Nicht gezeigt	0	0.00%