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MISCONCEPTIONS OF CLIMATE CHANGE AMONG RUSSIAN-SPEAKING INSTAGRAM USERS

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Abstract

Skepticism can be a healthy phenomenon. However, with the influence of fossil fuel companies, conservative think tanks, and other parties whose agenda had been threatened by the gaining momentum of climate action, climate change skepticism became a serious issue. Once people start to doubt the causes and effects, they are less likely to do something about global warming. In times of climate emergency, passive actions are no longer an option; thus, effective climate change communication strategies are required.

In order to efficiently apply the misconception-based approach to social media communication, it is crucial to know which misconceptions are common within the targeted audience. This paper aimed to explore misconceptions concerning climate change amongst Russian-speaking users of Instagram and identify the most common misconceptions among those who actively follow environmentally-related accounts and mostly believe that climate change is occurring to some extent due to the anthropogenic force.

In this paper, quantitative research methods were used to gain knowledge of the current state of the public's perception. A significant sample size of the targeted audience was surveyed with closed-ended questions. After that, the results were analyzed with frequency counts, cross-tabulation, and Pearson's Chi-square test for contingency to observe the trends and find the differences between the groups with different beliefs in the cause of climate change.

The study showed some common misconceptions related to the understanding of climate change mechanisms (for example, greenhouse effect, ozone depletion, and the effect of waste pollution) and the assessment of possible efficient actions slowing down climate change. Besides, it was found that target group mostly included people who believe that climate change is happening not only due to human activities but due to nature itself. Thus, it is recommended to focus misconception-based communication strategy on aforementioned topics.

Keywords

climate change communication, misconception-based learning, skepticism, climate misconceptions, social media

IMPORTANT DEFINITIONS

Climate change skeptisism and denialism

The Random House Unabridged Dictionary defines «climate denialism» as:

> “A belief that climate change/global warming is not happening.”

According to Van Rensburg (2015) «climate skeptisism» refers to “doubts about certain ideas related to climate change.”

Different groups of scientists segment climate change skepticism into different categories, with the models of Capstick et al. (2016) and Rahmstorf (2004) being the most popular. Capstick divides climate skepticism into two categories: epistemic justification and "response" skepticism. Epistemic justification of climate denialism refers to the rationality of belief, while "response" skepticism is concerned with doubts about climate action's effectiveness. Meanwhile, Rahmstorf characterizes doubts about climate change into trend, attribution, and impact skepticism – concerning doubts that warming is not taking place at all, skepticism about an anthropogenic component, and those about the harmfulness of the impacts of climate change.

It should be noted that in this paper, the meaning of the term «skepticism» is not used in its original meaning as «an integral part of the scientific method». Instead, it is used in its alternative but frequently used sense as the doubt or rejection of climate science. O'Neill and Boykoff (2010) encourage appropriate use of this word in different contexts as "continued indiscriminate use of the terms will further polarize views on climate change [and] reduce media coverage to tit-for-tat finger-pointing." However, the various terms including «anti-science,» «doubt,» «dismissal,» and «contrarianism» continue to be used widely, as found by Bjornberg et al. (2017).

Naturalizing climate change

According to Tynkkynen (2018) «naturalization» is related to the argumentы that climate change is a completely natural phenomenon and all societies can do is to adapt.

Anthropogenic

According to IPCC (2018) «anthropogenic» is

> «Resulting from or produced by human activities..»

(Climate) misconceptions

Oxford Dictionaries states:

> «Misconception (about something) is a belief or an idea that is not based on correct information, or that is not understood by people.»

That suggess that «climate misconception» is related to the wrong idea/belief in regards to climate change.

CONTENTS

1 INTRODUCTION

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels (IPCC, 2018). With the increase in temperature, public and media attention have increased with «climate emergency» being the word of the year 2019 in Oxford Dictionary and one of the biggest online media outlets, The Guardian, changing its communication strategy on climate coverage in 2019 (Oxford Languages, 2019).

Climate change is not a scientific controversy per se, but a political and economic issue. For example, it has been widely studied that oil companies did not only know that burning fossil fuels would negatively influence global climate but continued to engage in the spread of climate change disinformation, «manufacturing doubt» in public for the benefit of their own corporations (for example, Hoggan & Littlemore, 2010; Oreskes & Conway, 2010). The aforementioned disinformation has resulted in the spread of misconceptions (Ranney & Clark, 2016) and polarization of opinions in public (Cook et al., 2017). People started to mistrust the scientific data and possible ways of mitigation and adaptations (van der Linden et al., 2018). Overall, encouraged mistrust and doubt are a serious phenomenon, being a part of the reason for inaction and a lack of effort to support climate initiatives (Nisbet & Myers 2007).

In order to decrease the gap between knowledge and action, education and communication should be improved. One effective way to teach and discuss climate change topics is misconception-based communication. Misconception- or anthology-based or refutational approach involves challenging the misconception while providing the scientific conceptions that replace the previous information. Twenty years of research have shown that refutational texts are among the most effective forms of reducing misconceptions (Tippett, 2010).

However, education and communication take place not only offline. Social media is a relatively new form of media, with Facebook, Instagram, Youtube, and Tiktok leading among the most used platforms (Statista, 2020). Social media became

more than just an entertainment platform; it is effectively substituting TV and newspapers, becoming a new platform for receiving and learning new information and news. Social media has become a threat and opportunity, causing the spread of misinformation and leaving people in echo-chambers where they are persuaded of their opinions' righteousness while also allowing people to engage, share, learn and challenge their views and ideas.

Many climate misconceptions are reinforced by media and spread easily in social media posts and stories. Since social media is an important tool for communication, it is paramount and urgent that we learn and understand how to communicate and what to communicate to effectively engage the public in climate action and support climate initiatives without the reinforcement of misconceptions.

As it will be demonstrated below, climate change communication in social media should evolve to engage - but not scare - the audience, to make them curious but not overwhelmed. The misconception-based approach was chosen for a communication strategy by the commissioner of this thesis to inoculate climate misconceptions and increase climate literacy efficiently. In order to successfully implement it, the commissioning party asked to make the first step by analyzing the target audiences' beliefs and attitudes concerning common misconceptions, providing further research and development. Thus, this paper aims to explore misconceptions of climate change amongst Russian-speaking users of Instagram with the primary purpose of improving climate change communication in social media of the commissioner of this thesis.

The fundamental motive for this research is to contribute to the greater framework of studies about climate change communication in social media (with Instagram as a case). Despite huge changes in the media landscape, many studies still focus on newspaper print and a lesser extent, on television and online media (Schäfer et al., 2016). Besides, Marianna Poberezhskaya (2016) claims that climate change communication in Russia remains largely under-researched, with the first overviews done only in 2016 focusing only on LiveJournal social

media. This thesis uses statistical analysis of the current, prevailing climate change-related misconceptions within a target group.

The thesis was commissioned by Zero Waste & Sustainability School, an online platform providing environmental education on climate change, sustainable development and eco-friendly living. Zero Waste & Sustainability School has a website, platform for teaching, and a social media account for marketing and communication. Zero Waste & Sustainability School has over 5000 followers on Instagram, 500 of whom are graduates of their program, while 300 are actively engaged in the activities headed by the Zero Waste & Sustainability School. The commissioner aims to use the research to improve climate science communication by developing a strategy for misconception-based communication in their Instagram account to stimulate recipients' awareness and behavioral change.

2 THEORETICAL BACKGROUND

2.1 Nature and drivers of climate change skepticism and denialism

2.1.1 Causes of climate change skepticism

The fundamental understanding of climate and weather physics has existed since the beginning of the 20th century. However, the concepts of climate change have become better studied and popularized through different forms of media only during the last 50 years (Le Treut et al., 2007). As a term, «climate change» has been used since 1956 to describe the past, present, or future shifts of climate with natural or anthropogenic forcing on global, regional, or local scales (Le Treut et al., 2007). Today, The UN Framework Convention on Climate Change (UNFCCC) uses the term «climate change» for human-caused change and «climate variability» for other changes. This is also true regarding public perception, as climate change is mainly referred to in mass media and social networks as «global warming with attributed consequences caused by human activities such as fossil fuel combustion, forest, land use, and other industrial processes» (Oxford Languages, 2019).

In the 1960s, the scientific exploration of the phenomenon started with the first calculations of the rise of global temperatures within the next century. The 1970s were marked by the rise of global activism, which helped climate change catch public attention and, eventually, even turn it into a public anxiety. Finally, by the late 1980s, an international meeting of scientists proposed a warning to start actively decarbonizing the industries. (Spencer R. Weart, 2008.)

The response of the industries was intense. In 1982, Exxon's inner group of scientists produced a report on the relationship between greenhouse gases and warming, causing the company's heads to choose wisely what message to communicate to the public. 80% of ExxonMobil's internal documents from 1977 to 1995 acknowledged that climate change was real and human-caused, while 80% of their public-facing statements from 1989 to 2004 expressed doubt. In the early 1990s, the fossil fuel company spent half a million dollars on a campaign to cast doubt on the consensus. (Oreskes, 2010.)

There was a radical increase in the number of misleading publications in the 1990s, which coincided with international efforts to reduce carbon emissions (McCright & Dunlap, 2000). Meanwhile, public skepticism about global warming increased, suggesting that the misinformation campaign had been effective (Nisbet & Myers, 2007).

Even though by 2001 Intergovernmental Panel on Climate Change (IPCC) managed to establish a scientific consensus, ExxonMobil as well as two other oil companies, Total Fina Elf and BP Amoco, had already greatly influenced the public perception of climate change, casting doubts which with the time have rooted into climate denialism and skepticism (Sybille van den Hove et al., 2002). Nevertheless, it was not only the oil companies that were involved in creating and sustaining the controversy. In a profound review of the climate change denial literature, Bjornberg et al. (2017) found a wide categorization of individuals and organizations contributing to and continuing to engage in denial of climate science.

This categorization can be presented as follows:
1) scientists;
2) governments;
3) political and religious organizations including think tanks, foundations, and institutes;
4) industry, often oil or coal extraction, also steel, mining, and car industries;
5) media, particularly those with right-wing affiliations;
6) the public, particularly politically conservative white males.

For example, since 1992, conservative think-tanks have published numerous environmentally-skeptical books (Jacques et al., 2008). Apart from this strategy, they also exploited the journalistic norm of balanced media coverage of political issues, which resulted in false-balance coverage of climate change (Painter & Ashe, 2012).

Oreskes and Conway (2010) reveal how corporations, conservative think tanks, and scientists on their payroll have worked to sustain controversy about the scientific consensus on climate change over the last 30 years using the same tactics as the tobacco industry. Overall, according to Boussalis & Coan (2018), the manufactured skepticism is sustained on three causes: doubt about the reality of climate change, doubt about the urgency and doubt about the credentials of climate scientists.

Moreover, susceptibility to misconceptions and even risk perceptions can be linked to cultural and political worldviews, as was found by Smith and Leiserowitz (2012). People tend to perceive a particular phenomenon based on the values of the group they represent or are part of. Studies by Kahan et al. (2012) have also observed that cultural worldviews are important determinants of climate change perceptions and misconceptions.

As social media tends to unite people of the same values, Williams et al. (2015) suggest that the climate change debate online might be susceptible to

misinformation diffusion. Research by Bhagwat et al. (2016) discusses that climate change can be viewed as a belief system, suggesting that social media users with particular ideologies, belief systems, and perceptions of social norms about climate change may be more susceptible to supporting misinformation and engaging with it.

Apart from fossil fuel corporations, media, and political parties, the public's climate confusion, in the example of the United States, is also fuelled by national and state science education curricula, which misrepresents basic climate science. After reviewing five decades of science education relating to climate, McCaffrey et al. (2008) found that students and teachers strongly hold key misconceptions about basic climate science.

To conclude, there has been lasting pushback from the industries dependent on fossil fuels and political parties which agendas could have been influenced by climate action. Apart from oil companies spreading misinformation, social media has also contributed to the fast dissemination of misinformation related to climate science. In addition to that, education systems did not have enough time or resources to adapt their teaching methodologies to address misinformation properly.

2.1.2 Dangers of climate change skepticism

Numerous negative effects have been observed by different researchers based on both quantitative and qualitative approaches. Authors of numerous papers on the topic of climate denial claim that mistrust and doubt are among the reasons for public confusion, which contributed to political inaction and rejection of mitigation policies (Brulle, 2018; Cook et al., 2018; Ding et al., 2011). Jolley & Douglas (2014) also found that misinformation impacts the intent to reduce one’s carbon footprint.

One experiment explored that media coverage with accurate climate science from a mainstream scientist alongside misinformation from a contrarian scientist

reduced acceptance of anthropogenic climate change (Cook, 2019). Lewandowsky et al. (2017) discuss that false facts make it harder for the public to believe in facts altogether, in addition to the low trust in the government and institutions.

Van der Linden et al. (2017) state that campaigns by think tanks and fossil fuel companies contributed to political polarization and undermined public understanding of the degree of scientific agreement, thus limiting deeper societal engagement with the issue. Besides, the broader research into the impacts of misinformation shows a high emotional response, including panic, suspicion, worry, and anger, that influence the decision-making process (Budak et al., 2011). Finally, misinformation about climate change has also been found to reduce climate literacy levels (McCright, 2016).

2.1.3 Current trend of climate change movement

One of the latest increases of climate change phenomenon’s popularity is coincided with mass protests organized by Extinction Rebellion in the spring of 2019 and later with Greta Thunberg's Fridays for Future school strikes. In 2019 alone, more than 7.6 million people were involved in protest movements of different kinds around the globe (Anadolu Agency, 2019).

This can also be tracked with Google Trends that show the distribution of popularity of a search for "climate change" in Google. As can be observed in Figure 1, the highest peak coincided with September 2019 climate strikes.

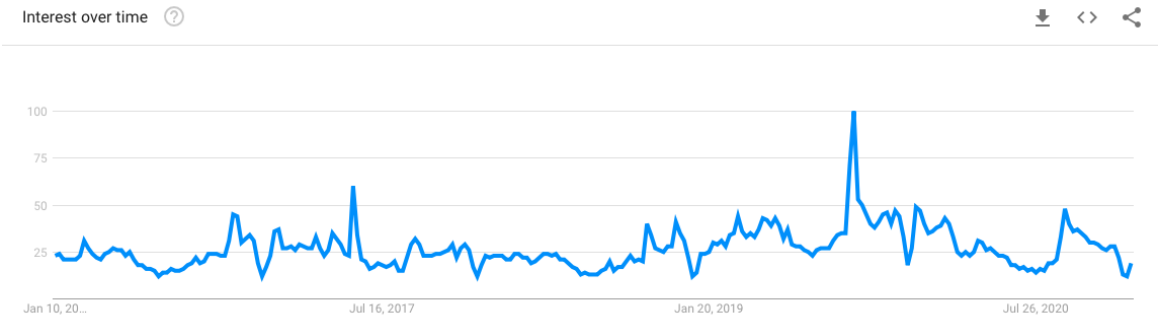


Figure 1. Google trends for "climate change" worldwide for the last 5 years. Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. A score of 0 means there was not enough data for this term.

Another significant change happened in the economic sector due to EU commitment to Paris Agreement (2015). The European Union is significantly cutting funds for oil, gas, and coal projects by the end of 2021 (BBC, 2019). Coal-fired power plants are also no longer getting investments. The number of coal-fired power plants under development worldwide has already plummeted (The Guardian, 2019).

Recently, climate change started to attract more attention amongst the public and industries to an extent where the term was changed to convey a more catastrophic and action-thirsting message: "climate emergency," which has become the Oxford Word of the Year 2019. It is defined as "a situation in which urgent action is required to reduce or halt climate change and avoid potentially irreversible environmental damage resulting from it" (Oxford Languages, 2019.)

Another example of public mood swing is that The Guardian has changed its reporting of environmental news. Instead of climate change, the newspaper stated that its preferred terms are "climate emergency, crisis, or breakdown" to describe climate change's broader impact. (Oxford Languages, 2019.)

To accept the urge and show the commitment, even governments like the European parliament declared a global climate and environmental emergency as it urged all the EU countries to commit to net-zero greenhouse gas emissions by 2050. The same was done by the other countries like the United Kingdom and Canada (Climate emergency declaration, 2020).

Overall, climate change has been on scientists' radar for a long time, but quite far from the general public's agenda until the latest decades when mass protests, broad media coverage, governmental actions, and consequences could not be ignored. As Moser (2016) states, we need to move beyond simply raising awareness and fostering fear in order to explore effective communication in a highly polarized and politicized medium.

2.2 Climate change skepticism in Russia

The position of Russian government on climate change matters on the international agenda since Russia remains one of the world's largest greenhouse gas emitters and is still dependent on oil and gas exportation. If all or most of Russia's fossil resources are extracted and burnt, the goal of limiting global warming to 2 C° compared with pre-industrial times will be impossible to reach. (Benjamin Beuerle, 2018.)

In terms of scientific exploration, climate change has been in Russian scientists' focus for the last 200 years, with significant achievements made during last 70 years. However, in terms of political action, Russia is often criticized for its extensively prolonged negotiations and lack of active climate action participation (Poberezhskaya, 2015). This can be explained by the fact that Russia's climate change policy has always been influenced by economic interests (Henry et al., 2010) and a close connection between the state and the energy sector (Buchner & Dall'Olio, 2005).

In Russia, a strong public discourse of climate change denial emerged simultaneously as academic consensus on climate change was finally reached (Kokorin & Korppoo, 2013). Even evidential events like the Siberian fires or the drought of 2010 did not convince the national media to portray climate change as a scientific fact (Kokorin & Korppoo, 2013). This can also be linked to the dependence of national media on the political agenda. As Gustafson's (2012) studies show, Putin's agenda rests not on the diversification of the Russian economy but on granting the hydrocarbon sector the leading role in shaping Russia's future.

Moreover, Russian President Putin himself has never publicly endorsed anthropogenic climate change. Despite the world's attention towards the climate change issue in 2019, Putin's words were: «And, surely, specialists from different fields are still trying to answer the question of the cause of climate change. There are different opinions… I personally think that even if we are a small part of it, we must do something to prevent negative consequences. Despite all scientific *uncertainties*, we will continue our fight» (NTV, 2019).

In short, Putin's agenda of diminishing climate change and fossil fuel use mitigation have given impetus to the strengthening of Russia's status as a 'hydrocarbon superpower' (Bouzarovski & Bassin 2011). Moreover, even though there is no open investigation on Russian oil companies, the random publications by Gazprom would show similar tactics for a spread of misinformation that was chosen by American companies (Paillard, 2007).

Tynkkynen et al. (2018) have performed a quantitative analysis of Russian mainstream media, searching for state TV programs and other types of content to reinforce any possible misconceptions. It was found that state media still contributes to the spread of climate doubt with the arguments from three categories:

1) denial of mainstream climate science,
2) naturalizing climate change,
3) perception of climate change as beneficial.

2.2.1 Denial of mainstream climate science

According to Poberezhskaya (2014) research, the Russian skeptical blogosphere is widely focused on criticizing or denying any climate change consensus. A typical criticism is devoted to the role of human activities and the benefits of global warming. The quote also demonstrated this by Putin in the previous chapter, emphasizing the uncertainties that climate science presumably has.

Another example of arguments from this category is that the observed temperature rise is of natural origin, as claimed by Rossiiskaya Gazeta article focused on future droughts in Kyrgyzstan and Central Asian countries caused by climate changeю The paper wrote: «According to scientists, humans, alas, cannot do anything to avoid such nightmarish forecasts from taking place» (Rossiiskaya Gazeta, 2012.) This claim became circulated in different media, the most popular being children's cartoon with 10 million views on YouTube (Barboskyni, 2017).

2.2.2 Naturalizing climate change

Arguments based on naturalizing climate change are optimistic about the positive outcomes of global warming for Russia. This can be understood as the intellectual legacy of the global cooling hypothesis elaborated by Soviet scholars during the 1950s–1970s. According to this hypothesis, the Earth's climate is facing a new glaciation period, and that this natural climatic fluctuation over intervals of several thousand years is a more real and pressing threat than global warming. Therefore, global warming is a positive development, as it postpones the beginning of a new glaciation. (Tynkkynen, 2019.)

One more argument is based on the climate cooling theory, which was popular in the Soviet era. It presents (for example, in the TV documentary Rossiya Nauka, Russian Science) as an equally possible scenario to global warming. The support of this misconception indicates that Russia's position as an energy superpower can even be framed as something positive: if Russia does not decreases GHG, they it would even save the world from a global winter. (Tynkkynen, 2019.)

2.2.3 Benefits of climate change

Skeptics usually see global temperature rises as a positive development: Arctic energy recourse, sea path, which eventually will further strengthen Russia's role as an energy giant and a territorial authority (Tynkkynen, 2019). This idea was also introduced in a Rossiiskaya Gazeta article: «Global warming and the

ongoing melting of the ice is turning the Arctic … into a giant international promising project of the twenty-first century, potentially into the largest investment platform of the current era.» The benefits of climate change were even included in Russia's climate doctrine (Climate Doctrine, 2009).

However, the situation is improving; regarding the overall range of opinions, blogging displays significantly more diverse debates than traditional media. Contrary to the popular discourse on climate being a disaster of the early 2000s (Tynkkynen, 2010), only seven out of 101 articles studied in 2015 were categorized as presenting climate change as beneficial for Russia. It is still argued if "the damage of misinformation can be undone," but the improving trend is the definite hope.

Despite the ambiguity in the political arena, Russia still participates in the negotiation process and insists on the "common but differentiated responsibilities" approach. After all, Russia participates in the UNFCCC climate process, ratified the Paris Agreement and the Kyoto Protocol. Since 2009, there have been several reports on Climate Change and its Consequences in the Russian Federation. (Shmeleva et al., 2012.)

With time, the public perception has also improved, by chance or by the spread of social media and independent sources, but currently, 66% of Russians believe that climate change is a real threat right now, and 69% link it with human activities. This is the highest level of acceptance for the last 50 years in this country. However, when asked about the precise cause, Russians, in 35% of cases, choose pollution and disbalance with nature as the primary causes, with only 31% choosing fossil fuels. Overall, 33% have had no idea about the precise mechanism of climate change (ROMIR, 2020).

2.3 Effective climate change communication in the era of social media

Nearly 50% of the world's population uses social media, that is over 3 billion users worldwide (Statista, 2020). Social media blogs have become a soft power

that influences daily agendas, distributes information, and fosters discussions. As one of the hottest issues of our time, climate change has also been widely discussed in the news and social media blogs. However, with wide public attention comes a much-unwanted phenomenon of misinformation.

2.3.1 Opportunity for misinformation

Unlike conventional media, social media blogs can be created by anyone worldwide and attract millions of people within hours. Social media is a platform where any user can contribute to online content by generating or by sharing content. Readers have a chance not only simply passively to consume but also to share and co-create. «However, the opportunity for authentic multi-party debate also opens the door to misleading, offensive, or inappropriate content» (Lewandowsky, S, 2019).

Social media does not only support scientific discussions; it also performs as a platform for open denial of scientific findings (Lewandowsky et al., 2013; Lewandowsky et al., 2015). It has been researched that the quality of information and its scientific accuracy have no influence on the amount of attention that information gets: Qiu et al. (2017) found that low-quality information received just as many Facebook shares as high-quality information.

Elgesem et al. (2015) analyzed climate change discourse in the blogosphere and found social media blogs to be a crucial outlet for climate change denialism. «Blogs, and in particular the comment sections of blogs, also play a major role in the dissemination of contrarian positions that question mainstream climate science. The effect of this content on people’s attitudes is not fully understood». (Lewandowsky et al., 2019.)

According to Jasny et al. (2015), social media blogs have also led to the development of echo-chambers, the phenomenon when people perceive that their opinions are widely shared by the public because they have been exposed only to the information supporting their views. Leviston et al. (2013) found that it

makes climate denialists resistant to changing their beliefs, and on the bigger scale, polarizes the views on climate change in public.

Williams et al. (2015), with their study on climate change debate on social media, emphasize that since «climate change is a belief system» (Bhagwat et al., 2016), social media users with particular ideologies, belief systems, and perceptions of social norms about climate change may be more susceptible to spreading, consuming, and accepting climate change misinformation. To conclude, social media makes it easier for the social phenomenon as misinformation to be created, disseminated, supported, and discussed.

To counter misinformation and improve climate action, Fernandez & Alani (2018) highlight four strategies to apply online:

- Inoculating against misinformation as an approach to combat misinformation;
- responding to misinformation with facts and correct information;
- early detection of malicious accounts; and the use of ranking,
- and selection mechanisms.

The first two strategies are also known as a misconception-based approach, which will be discussed later in chapter 2.4.

2.3.2 Opportunity for education

In short, numerous articles are discussing that Internet use is associated with greater knowledge about climate change. In general, social media is good at mobilizing climate change activists, providing a platform for discussions, and mostly help to deliver the seriousness of the phenomenon to society. (Anderson, 2017.)

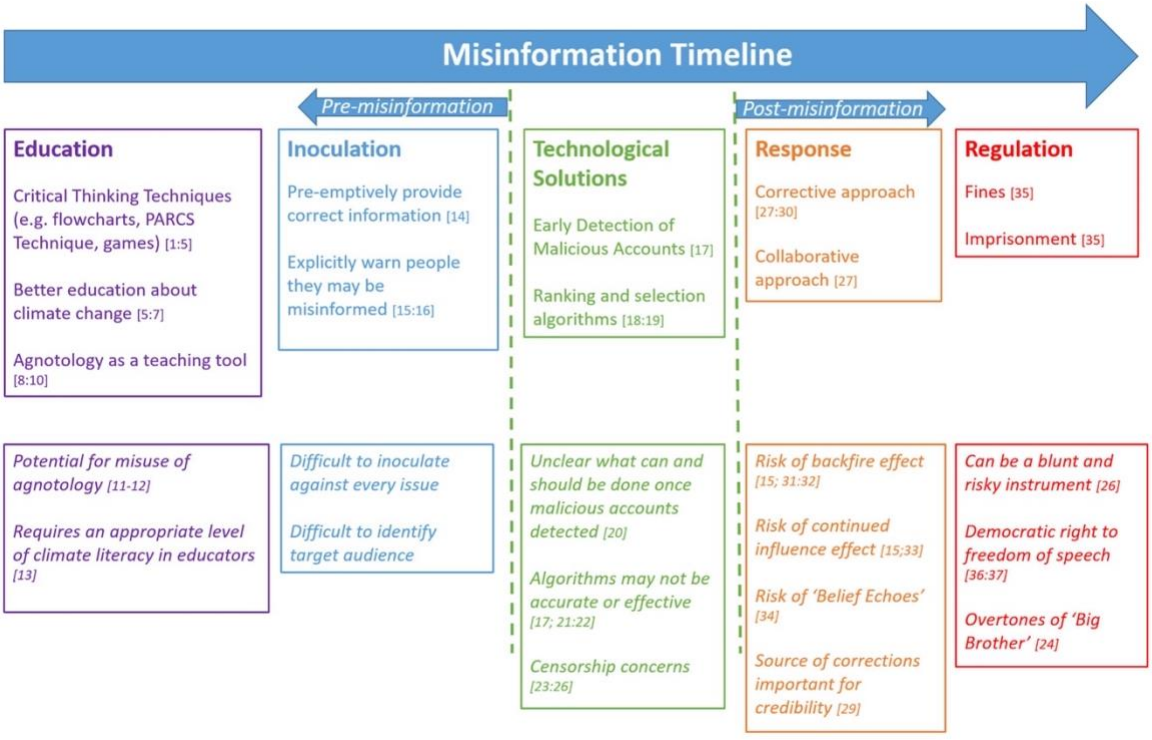
It has become popular for Internet users to create communities around certain topics, especially environmentally related. People unite together to discuss issues

that bother them, proactively solve local environmental problems, and exchange information worldwide. Williams et al. (2015) found that activists were more active communicators than skeptics, with a greater potential audience reach and effectiveness.

2.4 Misconception-based approach

Misconceptions can be categorized based on their property (preconceived, non-scientific, conceptual, vernacular, factual (Tekkaya, 2002) or based on the mechanism that caused them (cherry-picking, fake experts, conspiracy theory, etc.) (Cook, 2017). There have been also several approaches identified to fight misconceptions: from education to regulation. The main ones are presented in Table 1 below from Treen et al. (2020) study.

Table 1. A summary of the potential ways to counteract misinformation found in the literature, along with their criticisms and caveats.



As mentioned earlier, this research focuses on misconception-based communication, which can also be utilized in communication online. Misconception-based (refutation-based, inoculation, or agnotology-based)

instruction is the method that acknowledges and explains the falsities. The aim is to intervene and «vaccinate» against misconceptions either before receiving misinformation, pre-bunking (Cook et al., 2017), or after it has been settled, to debunk it and substitute it with the correct beliefs (Cook, Ecker, & Lewandowsky, 2014).

Pre-bunking has been found more effective than debunking in reducing the influence of misinformation. (Cook, 2016). With that, educating people in critical thinking techniques to identify misinformation has been highlighted to be the core for inoculating theory (Cook et al., 2018). As Jonathon Osborne, science education professor, claims: “Comprehending why ideas are wrong matters as much as understanding why other ideas might be right.”

The misconception-based approach is founded on research about how we learn (Arons, 1990). There are mental models related to any knowledge in the human mind. To learn a new concept, when there is already an alternative model that explains a phenomenon presently, the person should remove the false information and fill in the gap with the factual alternative. (Ecker et al., 2015).

However, it is important that the replacement fact is easy to understand and seems more plausible than the original message (Baadte & Dutke, 2010). The rule of thumb is best described as “fight sticky myths with stickier facts” (Heath & Heath, 2007). Another significant feature of the misconception-based approach is the misconception requirements to be identified before it can be corrected, and the target audience for potential misinformation to be studied to create a plausible alternative. Thus, to apply this method successfully in social media communication, one should clearly understand which misconceptions have been popularized and what audience will get one’s message to find the appropriate words, meaning, and values.

Inoculation theory was first tested in the context of climate change by Linden et al. (2017), who found that pre-emptively warning people about politically motivated attempts to spread misinformation helps to “promote and protect”

public attitudes about the scientific consensus on climate change and Cook et al. (2017), who found that pre-emptive inoculation is an appropriate method for “neutralizing” the adverse effects of misinformation about climate change.

This method outstandingly reduces the spread of climate misinformation. In the study by Muller et al. (2008), it was found that refutation techniques and their discussion greatly improved learning gains, suggesting that online multimedia can be greatly improved by adopting misconception-based learning. Another type of research showed that lessons that explicitly state and refute misconceptions produce significantly higher learning gains than lessons that explain the facts. Misconception-based teaching produces longer-lasting learning gains compared to traditional instruction. It also improves critical thinking and raises awareness. Inoculation has other benefits besides reducing the influence of misinformation. Ivanov et al. (2015) found that people exposed to an inoculating text were more likely to talk about climate change, thus breaking another significant factor for climate action, known as “climate silence.”

Overall, two decades of research have found that misconception-based learning is one of the most effective means of reducing inaccurate understanding (Cook, 2014).

3 RESEARCH METHODS

3.1 Research questions and objectives

This descriptive study aims to identify if Russian-speaking Instagram users who endorse anthropogenic factor as a cause of climate change hold many climate misconceptions.

Thus, the three objectives of this thesis were

1) to establish the most common misconceptions of climate change based on literature research,
2) to measure how prevalent climate change misconceptions are among Russian-speaking users of Instagram, and

3) to explore whether the difference in beliefs concerning the causes of climate change significantly impacts the prevalence of these misconceptions.

To meet these objectives, the following research questions should have been answered:

1) To what extent are the misconceptions about climate change prevalent among Russian-speaking users endorsing anthropogenic global warming?
2) Which misconceptions are the most common?
3) Do one's beliefs in the different causes of climate change affect the popularity of misconceptions?

3.2 Scope of the Research

The study focused on identifying and analyzing popular climate change misconceptions related to the causes and consequences of climate change, and actions that could be taken to mitigate carbon emissions and adapt to related consequences. It mainly provided the grasp into all misconceptions related to each of the topics mentioned above and did not include assessing behavior or values, only attitudes and beliefs. The chosen research method included limited information on the reason and development of the misconceptions within the target audience, and it mainly aimed at analyzing which of the chosen misconceptions are popular rather than studying misconceptions as a phenomenon.

3.3 Quantitative approach

The practical part of the work included the design and distribution of a questionnaire and collection and analysis of the gained preliminary data. The design process of questionnaire included a systemic literature and media review, and the quantitative method was chosen as the primary research method to gather numerical data and statistically analyze it to make a general conclusion about target group as a whole.

The survey's focus was to provide the data to study trends in holding misconceptions, define percentage of people who support each of the established statements, and whether that percentage changes depending on the variabilities. The quantitative data collection method was chosen, as it is cheap to use, easy to administer while covering a large geographic area, and eliminates personal bias (Walliman, 2011).

3.4 Literature and media review

Systematic and structured literature and media reviews were used to analyze, examine, and choose climate change misconceptions to design a research survey. Literature and media reviews were narrowed down to materials from 2013-2020 in order to focus on the latest trends and updated information.

The data sources included key published research in climate change communication and misconceptions, available statistics on the current public perception of climate change in Russia, and popular media review for spread misconceptions. The following keywords were used to search for literature: climate change communication, social media, science communication, Instagram, misconceptions, anthology-based, misconception-based, social media science communication, misinformation, denialism, skepticism, global warming, misconception-based learning.

Important aspects for a successful literature review highlighted by Wouters, P. et al. (2015) were taken into account. These included relevance of the paper to the presented issue, how recently it was published, the number of citations it had (the impact factor or rating), types of publications (peer-reviewed paper were a priority), the authors and their field of expertise.

Climate misconceptions are categorized in different ways, as established earlier in this report. To identify the most common categories of the misconceptions, the Tynkkynen’s (2010) and McCright & Dunlap’s (2000) categorizations were taken

as a basis. The misconceptions were either directly adopted from the relevant studies or found in popular media and modified to fit the needs of the research. The full list of misconceptions with justifications for each question is presented in Appendix 1.

3.5 Questionnaire design

After the identification of the list of misconceptions, a 21-items questionnaire was designed with 2 questions establishing if the respondent was indeed a representative of a target audience, followed by 1 question establishing the belief in the cause of climate change, and, finally, 18 questions-statements to collect the data for the study.

An internet-mediated questionnaire was fully composed of closed-ended questions to ensure that all responses are standardized and contamination is avoided. It was important to make sure the data does not contain any errors or missing values. Therefore, for the respondent to submit their responses, it was constrained by the online survey tool that answers to all the questions had to be provided.

The part of a questionnaire with statements was designed to logically group the misconceptions and present them one by one in a logical order as the following categories: misconceptions related to the cause of climate change, to the science of climate change, of the scientific method, the current observations, consequences and effects, possible actions.

There were two or three related closed-ended questions for each group of the statements that the respondents were asked to assess. One-third of each group's statements were false, with the rest being correct. The answers were determined with a modified five-item Likert type scale (Vagias et al., 2006) with nominal options where: 1 – True, 2 – Probably True, 3 – Partly True and Partly False, 4 – Probably False, 5 – False. The answer value 3 aimed to provide the neutral ground for respondents to state their uncertainty about which side (True/False) to

choose. The answers with the value 3 were treated separately in the analysis and were not included in the True/ False group. The example page from the survey is presented in Appendix 2.

In this study, the state of holding a misconception was defined as an assessment of (Probably True/False or True/False) answers, i.e., Probably True and True were united to state the agreement with a statement. If the assessment was not following the current state of research, then it was analyzed that the respondent held a misconception.

3.6 Target group, sample size and survey distribution

The target group consisted of Russian-speaking users of Instagram who frequently engage in climate or other environmentally related discussions. Given the main goal of research for a commissioner's party, the similar audience was chosen to be convenient: people of the age 14-45, mostly women, comprehending Russian language, interested in climate change, zero waste, feminism, style, business, and social change, eco-startups, science, nature, traveling and studying. Besides, the target audience excludes people who are openly denying climate change.

The final sample size for the research was determined using the Survey Monkey calculator. To get 95% reliance on the results, and 3-5% margin error in a sample group, the survey needed to include around 1000 people. The number came from estimating how many people use Instagram in Russia (approximately 42 000 000) and excluding 19% of a population who believe that global warming is not happening (Romir, 2020).

The questionnaire was disseminated through Instagram stories of several bloggers similar to the commissioner's party Instagram account and Zero Waste & Sustainability School account itself without any preliminary information that can bias the audience. Participation was voluntary. The link to the survey was attached to the stories or/and bio of the accounts accompanied with the

instructions. The collection of data took place at the beginning of December 2020 by means of Google forms.

3.7 Reliability and limitations

To account for the limitations of the questionnaire and improve the reliability of results, the survey was rather short (3 minutes to fill in), user-friendly, and included a high number of respondents. The test group was organized before the survey's official release to receive feedback and reorganize the questionnaire. There were a couple of changes made to make questions clearer and more relatable.

The survey was susceptible to voluntary bias, which means that people who are already actively engaged in the topic might have filled it in, missing those of a less active position. At the end of November, there was a release of the «I am Greta» movie in Russia, which might have brought climate topic again to the surface and somehow affected the results. However, there was no other news that might have influenced the reliability of the answers.

To sum up, although there were some limitations, it should be noticed that an adequate amount of information was received, analyzed, and used for the suggestions and future improvements.

3.8 Analysis of data

The purpose of the analysis is to extract significant insights from the data and ensure valid and reliable findings to answer the research problem. (Malhotra et al. 2007.) In this paper, the quantitative data analysis is applied, and analysis was performed using Google Sheets, Google Sheets XLMiner Analysis ToolPak, and Chi-Square Calculator for 5 x 2 Contingency Table available at SocialStatistic.com/.

Firstly, in order to start with the analysis, a Google Excel sheet with all responses was created. After that, sorting was applied to leave out either corrupted

responses or not related to the research objective. The raw data was organized with color codes and sorted into two groups: responses from the group who chose human activities to be the primary reason for the climate change of the last 50 years (Group 1) and those who chose both human activities and natural reasons to be the primary cause for the observed phenomenon (Group 2). After that, all answers were coded into numeric alternatives to be processed further. The coding was done with the ifs-formula in Google Sheets. The legend is provided for each graph in the Results and Analysis.

Nominal data cannot perform many statistical computations, such as mean and standard deviation; however, for all relevant questions, median and frequency analyses were performed to conclude the answers for the first three questions of the research. The information was visually presented in the pie chart, bar charts, and table forms.

After that, the conclusions were drawn on either the misconceptions were at all popular or not. A misconception was defined as popular if more than 50% of respondents chose the wrong option of «Probably True/False» or «True/False» (depending on the statement). Wrong option was identified in accordance with the current state of research. If a particular misconception received more than 20% of answers with the value 3 (Partly True and Partly False), that misconception was marked as «not certain.» It was also calculated how many misconceptions each person holds using the ifs-formula and Sum through Google Sheets, which will be presented in the following chapter.

Lastly, nonparametric statistical tests, cross-tabulation with frequency counts, and Pearson's chi-square test for contingency were used to see if the difference between chosen misconceptions varies significantly between the two groups. The cross-tabulation results were visualized in the form of a table, and a chi-square test was performed on a cross-tabulation of nominal data.

Significance in χ^2 test means that interpretation of the cell frequencies is warranted. Non-significance means that any differences in cell frequencies can

be explained by chance. A contingency table was created for each statement by listing Group 1 and Group 2 as rows and answers from 1 to 5 as columns (True, Probably True, Partly True and Partly False, Probably False, False, respectively). Then cell frequency for each cell was calculated in Google Sheets.

The data from the contingency table was inserted into the calculator of χ^2 value. For each observed number in the table, the program found an "expected" one, providing data in the following order: the observed cell totals (the expected cell totals) and [the chi-square statistic for each cell].

χ^2 test was aimed at testing if numbers in each cell are proportionately the same in Group 1 as they are in Group 2, or in other words: if the way the statement was assessed in Group 1 significantly differs from the one in Group 2. The null hypothesis was phrased as: there is no significant difference between the two groups. An alternative hypothesis was that there is a significant difference between the two groups.

Alpha value, level of significance was chosen at .05. If the p-value (probability value) was < 0.05, the null hypothesis, assuming the insignificance of the difference between groups, was rejected. Consequently, if the p-value was > 0.05, it could be concluded that a difference between the results of the two groups was insignificant. (Kent State University, 2020.)

4 RESULTS AND ANALYSIS

A total of 1351 Russian-speaking users of Instagram participated in the study, with 42.4% and 44.3% of the age 18-24 and 25-34, respectively. There were 1057 were females, 287 were males, and 13 preferred not to state their gender. This was reflective of the required targeted audience.

Some answers were omitted: 4 responses stating that they think «climate change is not happening » and 8 responses «climate change is due to natural factors»,

since they were not representative of the target group. Thus, the overall number of analyzed responses was 1339.

4.1 Main findings

4.1.1 Extent to which the misconceptions about climate change are prevalent among Russian-speaking users endorsing anthropogenic global warming

Overall, from 18 chosen misconceptions, only 3 were significantly common (more than 70% of respondents' agreeing that a false statement was true or vice versa), 1 was common (51.2%), 1 was quite popular (40.6%) and 3 were questionable by the respondents (more than 18% of the respondents choose the option with the value 3) (Figure 2). Thus, there were only 28% prevalent misconceptions and 17% statements that were assessed with the value 3.

Statement	Group of misconception	Result
Global warming is not happening because there is still snow and cold weather in some places.	Trend	No
Volcanoes produce more CO2 (carbon dioxide) than human activity per year.	Attribution	No, but many respondents don't know the correct information
Solar activity over the past 50 years has influenced current climate change more than all human activity.	Attribution	No, but many respondents don't know the correct information
Greenhouse effect is caused by human activity.	Attribution	Yes, significantly
Ozone depletion significantly speeds up the rate of climate change.	Attribution	Yes, significantly
Waste pollution significantly speeds up the rate of climate change.	Attribution	Yes, significantly
Scientists mostly agree on the cause of climate change.	Consensus	No
Russians mostly agree on the cause of climate change.	Consensus	Quite popular, and many respondents don't know the correct information
The importance of climate change is greatly exaggerated by politicians.	Consensus	No
Global climate change is a long term effect that humans should not be concerned with.	Impact	No
Siberia will significantly benefit from climate change.	Impact	No
Russia, in general, will significantly win from climate change.	Impact	No
The frequency of extreme weather events is the same as it's always been.	Impact	No
The seriousness of sea level rise is exaggerated.	Impact	No
There is nothing we can do to slow down climate change.	Impact	No
Actions to slow down climate change will have a negative effect on the economy.	Impact	No, but many respondents don't know the correct information
Tree planting is an effective tool to slow down climate change.	Action	Yes
Reducing meat consumption is an effective tool to slow down climate change.	Action	No

Figure 2. The results of popularity assessment for all misconceptions studied in the thesis.

4.1.2 The most common misconceptions

Shortly, Table 2 presents the results for all 18 statements with frequency analysis, where assessments in coherence with the scientific community are marked as green, and assessments that represent misconceptions are represented in red. The last columns summarize how many percents of the responses were wrong and how many respondents are susceptible to the misconception.

The most common misconception was: « Ozone depletion significantly speeds up the rate of climate change», meanwhile the least common misconceptions was: «There is nothing we can do to slow down climate change». Besides, another quite spread misconceptions were related to greenhouse effect and waste pollution. The most confusing misconception appeared to be related to greenhouse effect.

Table 2. Summary table for all of the statements.

	Statement	N	TRUE (1)	Probably True (2)	Partly True and Partly False (3)	Probably False (4)	FALSE (5)	Median	Wrong answer	Amount of people holding misconception
1	Global warming is not happening because there is still snow and cold weather in some places.	1339	0.30%	2.50%	9.90%	17.80%	69.50%	5	2.80%	37
2	Volcanoes produce more CO2 (carbon dioxide) than human activity per year.	1339	3.40%	11.40%	18.20%	39.50%	27.50%	4	14.80%	198
3	Solar activity over the past 50 years has influenced current climate change more than all human activity.	1339	1.90%	6.20%	20.30%	38.80%	32.80%	4	8.10%	108
4	Greenhouse effect is caused by human activity.	1339	31.10%	31.30%	29.60%	2.40%	5.60%	2	62.40%	836
5	Ozone depletion significantly speeds up the rate of climate change.	1339	55.20%	31.70%	8.10%	4.00%	1.00%	1	86.90%	1164
6	Waste pollution significantly speeds up the rate of climate change.	1339	53.60%	25.30%	13.20%	6.00%	1.90%	1	78.90%	1056
7	Scientists mostly agree on the cause of climate change.	1339	43.60%	35.50%	17.60%	2.70%	0.60%	2	3.30%	44
8	Russians mostly agree on the cause of climate change.	1339	8.00%	22.70%	28.80%	32.50%	8.10%	3	40.60%	544
9	The importance of climate change is greatly exaggerated by politicians.	1339	1.40%	1.90%	7.50%	22.00%	67.20%	5	3.30%	44
10	Global climate change is a long term effect that humans should not be concerned with.	1339	1.70%	1.60%	7.00%	10.80%	78.90%	5	3.30%	44
11	Siberia will significantly benefit from climate change.	1339	2.50%	4.60%	14.00%	30.40%	48.50%	4	7.10%	95
12	Russia, in general, will significantly win from climate change.	1339	1.30%	3.70%	11.10%	28.30%	55.60%	5	5.00%	67
13	The frequency of extreme weather events is the same as it's always been.	1339	2.40%	6.80%	12.50%	32.90%	45.50%	4	9.20%	123
14	The seriousness of sea level rise is exaggerated.	1339	0.90%	1.80%	6.00%	18.00%	73.30%	5	2.70%	36
15	There is nothing we can do to slow down climate change.	1339	0.30%	1.50%	11.60%	17.10%	69.50%	5	1.80%	24
16	Actions to slow down climate change will have a negative effect on the economy.	1339	5.30%	11.40%	31.10%	24.60%	27.60%	4	16.70%	224
17	Tree planting is an effective tool to slow down climate change.	1339	18.20%	33.00%	37.10%	8.40%	3.30%	2	51.20%	686
18	Reducing meat consumption is an effective tool to slow down climate change.	1339	44.20%	23.10%	17.20%	9.20%	6.30%	2	15.50%	208

4.1.3 The impact of one's beliefs in the different causes of climate change on the popularity of misconceptions

To fulfill the last research objective, the responses were separated into two Groups: responses from the group who chose human activities to be the primary reason for the climate change of the last 50 years (Group 1) and those who chose both human activities and natural reasons to be the primary cause for the observed phenomenon (Group 2). There were more people in Group 2 (N2=746 respondents) than in Group 1 (N1=593 respondents) (Figure 3).

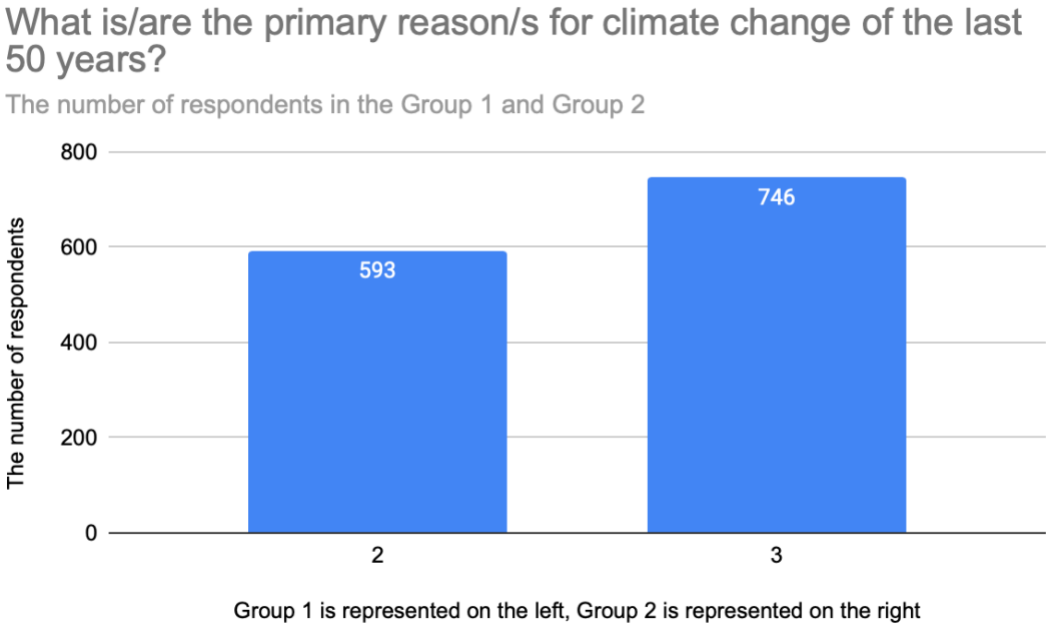


Figure 3. The proportion of respondents in Group 1 and Group 2

The summary of all Chi-square tests run for each statement is presented in Table 2. As it can be seen, for the majority of statements, the assessment of statements significantly differed between Group 1 and Group 2, suggesting that the belief in different causes of climate change affects the perception of climate mechanisms, consequences, and action. The only questions with no significant difference are related to a consensus within the Russian public, the effect of actions on the economy, and tree planting as an effective tool. That suggests that the

misconceptions about false consensus and tree planting are universal for both groups; meanwhile, both groups do not support the misconception about the negative effects of climate action on the economy.

Table 2. Summary of Chi-square test for all of the statements: the difference between Group 1 and Group 2.

Statement	There is a difference between Group 1 and Group 2	The results of Chi-square test	Reporting number
Volcanoes produce more CO2 (carbon dioxide) than human activity per year.	Yes	The chi-square statistic is 61.8665. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 61.8665, p < .001
Solar activity over the past 50 years has influenced current climate change more than all human activity.	Yes	*The chi-square statistic is 88.105. The p-value is < 0.00001. The result is significant at p < .05.*	χ^2 (4, N = 1339) = 88.105, p < .001
Greenhouse effect is caused by human activity.	Yes	*The chi-square statistic is 122.6669. The p-value is < 0.00001. The result is significant at p < .05.*	χ^2 (4, N = 1339) = 122.6669, p < .001
Ozone depletion significantly speeds up the rate of climate change.	Yes	The chi-square statistic is 17.6847. The p-value is .001422. The result is significant at p < .05.	χ^2 (4, N = 1339) = 17.7, p < .001
Waste pollution significantly speeds up the rate of climate change.	Yes	The chi-square statistic is 38.7024. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 38.7, p < .001
Scientists mostly agree on the cause of climate change.	Yes	The chi-square statistic is 79.0082. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 79.0, p < .001
Russians mostly agree on the cause of climate change.	No	The chi-square statistic is 4.4361. The p-value is .350198. The result is not significant at p < .05.	χ^2 (4, N = 1339) = 4.44, p = .350
The importance of climate change is greatly exaggerated by politicians.	Yes	The chi-square statistic is 37.8804. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 37.9, p < .001
Global climate change is a long term effect that humans should not be concerned with.	Yes	The chi-square statistic is 26.5198. The p-value is .000025. The result is significant at p < .05.	χ^2 (4, N = 1339) = 26.5, p < .001
Siberia will significantly benefit from climate change.	Yes	The chi-square statistic is 30.7058. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 30.8, p < .001
Russia, in general, will significantly win from climate change.	Yes	The chi-square statistic is 18.4922. The p-value is .000989. The result is significant at p < .05.	χ^2 (4, N = 1339) = 18.5, p < .001
The frequency of extreme weather events is the same as it's always been.	Yes	The chi-square statistic is 49.1288. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 49.1, p < .001
The seriousness of sea level rise is exaggerated.	Yes	The chi-square statistic is 54.8731. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 54.9, p < .003
There is nothing we can do to slow down climate change.	Yes	The chi-square statistic is 33.2697. The p-value is < 0.00001. The result is significant at p < .05.	χ^2 (4, N = 1339) = 33.3, p < .004
Actions to slow down climate change will have a negative effect on the economy.	No	The chi-square statistic is 9.1996. The p-value is .0563. The result is not significant at p < .05.	χ^2 (4, N = 1339) = 9.2, p = .056
Tree planting is an effective tool to slow down climate change.	No	The chi-square statistic is 7.1052. The p-value is .130434. The result is not significant at p < .05.	χ^2 (4, N = 1339) = 7.1, p = .130
Reducing meat consumption is an effective tool to slow down climate change.	Yes	The chi-square statistic is 25.4077. The p-value is .000042. The result is significant at p < .05.	χ^2 (4, N = 1339) = 25.4, p < .001

4.2 Detailed results and analysis

4.2.1 To what extent are the misconceptions about climate change prevalent within Russian-speaking users endorsing anthropogenic global warming?

Overall, as it is seen in the Figure 4, majority of respondents hold 3-5 of 18 chosen misconceptions.

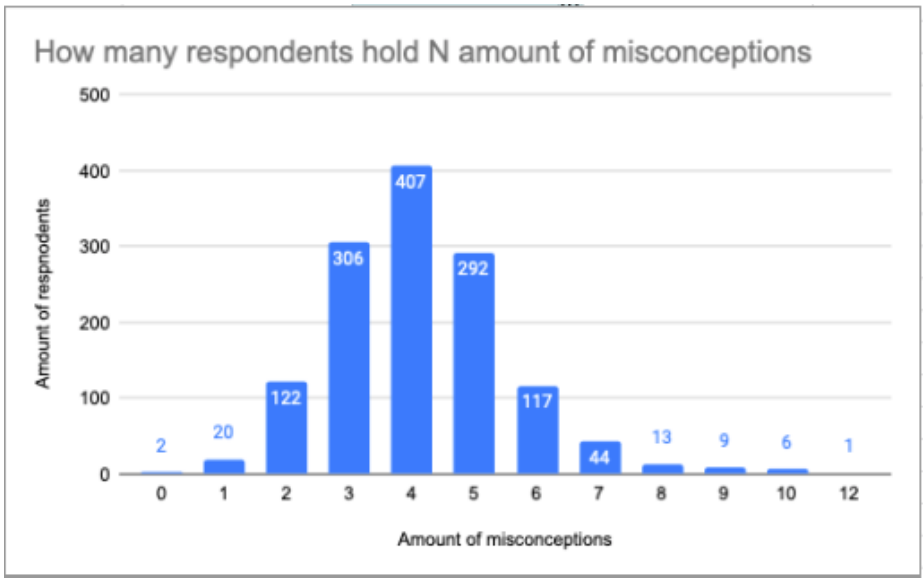


Figure 4. Proportion of respondents holding different number of misconceptions.

However, as stated in Methods, option 3 was not included in the judgment of misconception popularity and was counted separately (Figure 5). The results were as follows: most people assessed «Partly True and Partly False» 1-4 statements out of 18.

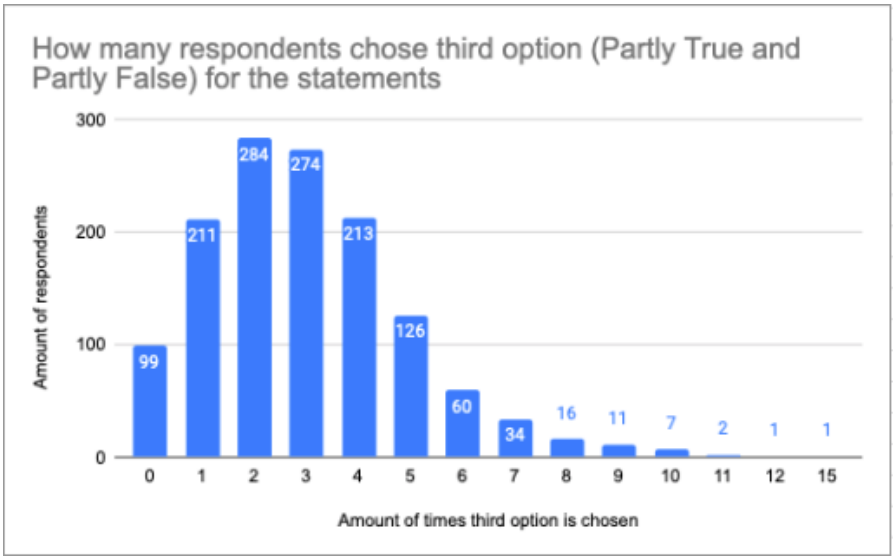


Figure 5. Proportion of respondents choosing the option 3 for different number of misconceptions.

4.2.2 Which misconceptions are the most popular? Do these beliefs in the different causes of climate change affect the popularity of these misconceptions?

Unfortunately, it was impossible to estimate all levels of agreement on the cause of climate change, and the study was limited only by two groups: people who believe that humans are the primary driver for climate change and those who think that apart from people, nature is the cause. However, that was also a significant finding, showing that there are two primary opinions in the respondents' sample of the targeted audience.

To make sure, that there is a consistency in answers, a statement related to whether people think global warming is not happening due to snow and cold weather or not was analyzed: there were 38 responses claiming it to be «True» (4) or «Probably True» (34) (Figure 8). Since they represent only 2.8% of all

responses, it is an insignificant incongruency, thus, those answers did not affect the whole picture.

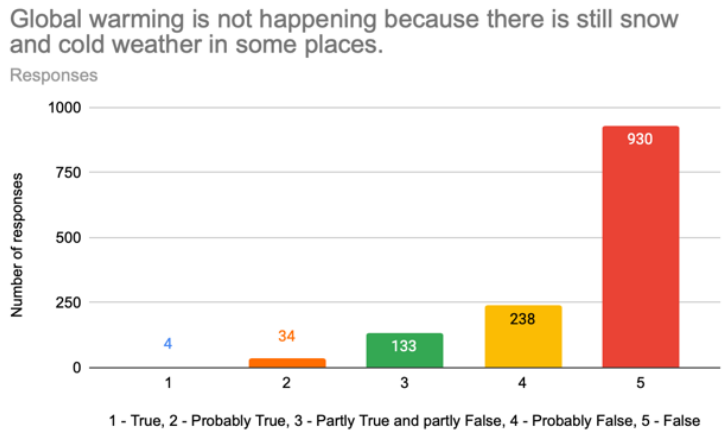


Figure 6. Distribution of answers to a given statement.

The detailed Figures and Tables for each statement's statistical analysis can be found in Appendix 3.

Assessment of understanding of the cause of climate change

In general, the misconceptions related to the cause of climate change were rather popular, however, not because respondents believe in some natural cause for climate change, but because they choose as significant contributor waste pollution and ozone depletion.

Regarding the respondents' opinion on volcanoes and Sun activities' contribution, a minority of people chose related false statements to be true (14.8% and 8.1%, respectively). However, nearly 20% of respondents showed doubt, choosing the 3 option. 13.7% of respondents chose both volcanoes and Sun activities as

significant contributors, with more choices of false conceptions in Group 2 (431 response versus 214 responses).

As for the volcano statement, most respondents chose the assessment «Probably False» rather than «False»: 529 against 368. However, both of those answers still were more frequent than the wrong ones (Figure 7).

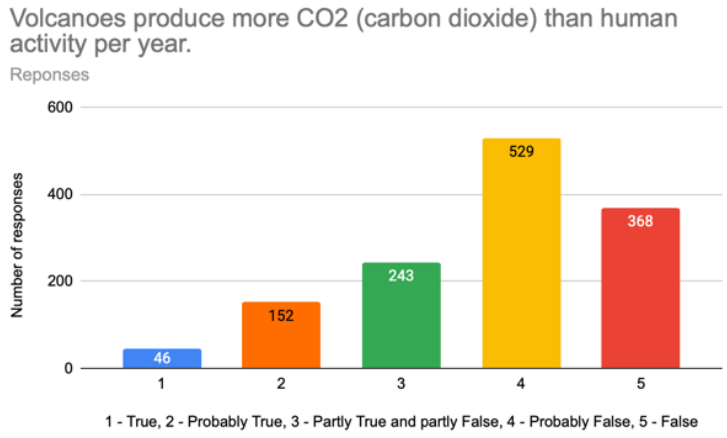


Figure 7. Distribution of answers to a given statement: Volcanoes produce more CO2 (carbon dioxide) than human activity per year.

Statistical analysis showed that the assessments in Group 2 significantly differed from Group 1, χ^2 (4, N = 1339) = 61.9, p < .001. More people in Group 2 assessed the statement about the influence of volcanoes as «Probably True» or «Partly True and Partly False,» suggesting there are more doubts and incorrect perceptions.

The solar activity showed similar trends as volcanoes, with a more frequent answer being «Probably False.» However, respondents chose «False» more frequently and «True» less frequently compared to volcanoes' question,

suggesting that volcanoes' influence doubt people more than the Sun's activity (Figure 8).

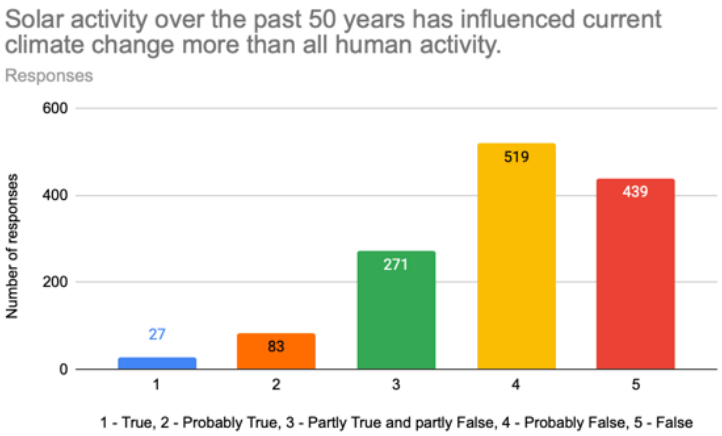


Figure 8. Distribution of answers to a given statement: Solar activity over the past 50 years has influenced current climate change more than all human activity.

Statistical test for «Solar activity over the past 50 years has influenced current climate change more than all human activity» showed a significant difference between the groups, χ^2 (4, N = 1339) = 88.1, $p < .001$. Group 1 more often assessed the statement correctly; meanwhile, Group 2 showed rather a law confidence in the right answer.

Overall, only 77 answers out of 1339 were inconsistent, where the respondent chose human activity as a primary reason, but later on, chose either Sun or/and volcanoes as a more significant contributor: 54 being about volcanoes, 23 about Sun, and 2 of them were from the same respondents.

Regarding the answers related to the greenhouse effect, 62.4% of respondents chose human activity as the main cause for this effect, with 29.6% showing doubt. The majority of answers were divided between «Partly True and Partly False,» «Probably True» and «True,» which suggests the popularity of given misconceptions (Figure 9). Only 75 people confidently assessed the misconception as wrong.

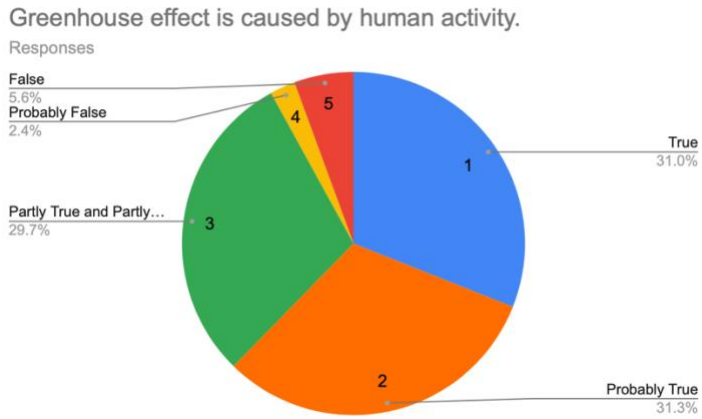


Figure 9. Proportions of assessments of a given statement: Greenhouse effect is cause by human activity.

The results of the statistical test rejected the null hypothesis, meaning the groups had a statistically significant difference in answers, χ^2 (4, N = 1339) = 122.7, p < .001. With further analysis, those who chose anthropogenic factor as a reason for climate change significantly more believe that the greenhouse effect is created by human activity; meanwhile, those with a choice of both human and natural factors significantly showed more doubt assessing it as «Partly True and Partly False,» giving the right answer more often, than the Group 1.

With the impacts of ozone depletion and waste pollution, the results showed similar trends and were as follows: 86.9% and 78.9% of respondents chose them to be a significant contributor with only 5% and 7.9% of those who chose it to be misconceptions, respectively. The results for these questions are presented in Figures 10 and 11. These were, by far, the most popular misconceptions that are studied in this research.

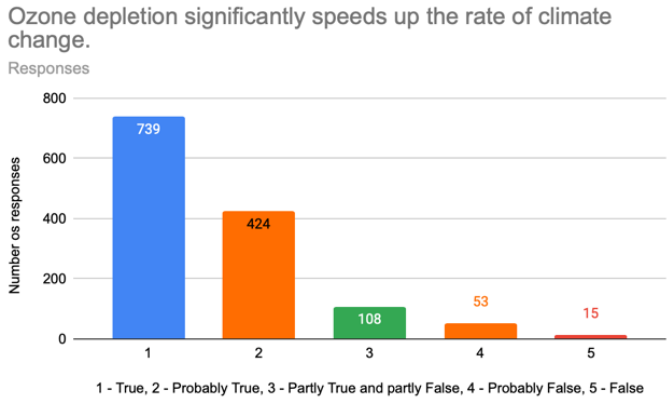


Figure 10. Distribution of answers to a given statement: Ozone depletion significantly speeds up the rate of climate change.

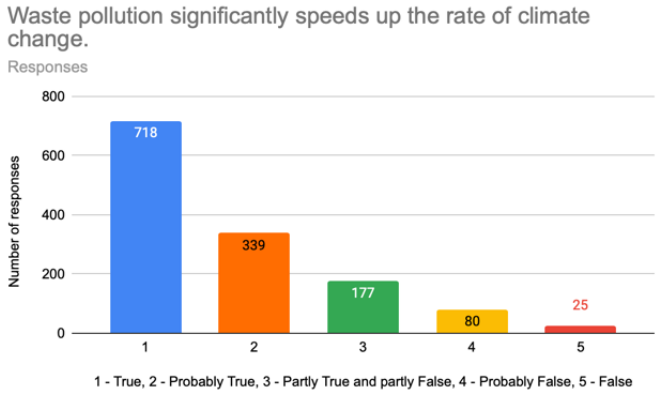


Figure 11. Distribution of answers to a given statement: Waste pollution significantly speeds up the rate of climate change.

The statistical test on «ozone depletion» statement found the difference between the answers of Group 1 and Group 2, χ^2 (4, N = 1339) = 17.7, p < .001. As cross-tabulation revealed, Group 1 assessed the statement with more confidence than Group 2. In terms of waste pollution and its impact on climate, Group 1 and Group 2 also differed in their assessment, χ^2 (4, N = 1339) = 38.7, p < .001. Although both groups in majority cases made an incorrect assumption, Group 1 again was significantly more confident assessing the misconception as a fact.

Overall, this section's results showed that respondents are mainly doubtful about the impact of natural factors as volcanoes and the Sun, have little knowledge of the greenhouse effect mechanisms and believe that ozone hole and waste

pollution are significant contributors to climate change. A significant difference was observed between the two groups for all questions of this sector.

Assessment of understanding of scientific and societal consensus

Most of the respondents (79.1%) rated scientific consensus on the cause of climate change as a «True» or «Probably True» phenomenon, meanwhile 17.6% remained doubtful, and only 3.3% showed the answer that contradicts the current scientific research. However, there were quite many answers favoring 2 rather than 1, which indicates a certain degree of doubt (Figure 12).

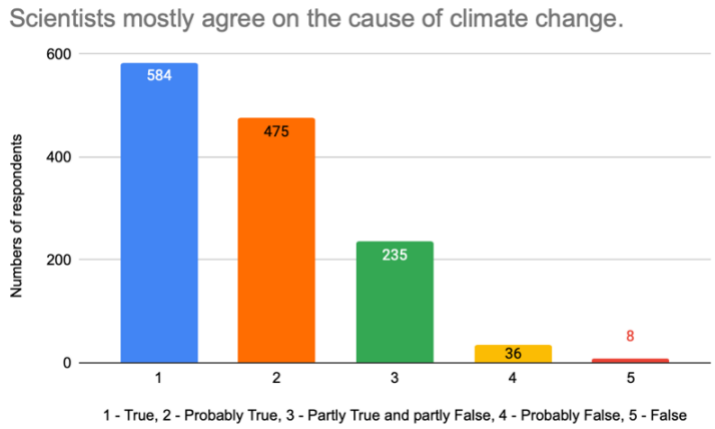


Figure 12. Distribution of answers to a given statement: Scientists mostly agree on the cause of climate change.

Chi-square test results (Table 3) and cross-tabulation analysis results (Table 4) show that there was a significant difference between the two groups, χ^2 (4, N = 1339) = 79.0, $p < .001$, with respondents from Group 1 choosing 1 answer more often (54.3%) than those from Group 2 (35.3%). The second group also chose 3 options more often, which indicates a higher level of doubt in Group 2.

Table 3. The results of χ^2 test for a given statement: Scientists mostly agree on the cause of climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	322 (259.08) [15.28]	205 (210.36) [0.14]	61 (104.07) [17.83]	4 (15.94) [8.95]	1 (3.54) [1.83]	593
Group 2	263 (325.92) [12.15]	270 (264.64) [0.11]	174 (130.93) [14.17]	32 (20.06) [7.11]	7 (4.46) [1.45]	746
Column Totals	585	475	235	36	8	**1339 (Grand Total)**

Table 4. The frequency table for assessments of a given statement: Scientists mostly agree on the cause of climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	54.30	34.57	10.29	0.67	0.17
Group 2	35.25	36.19	23.32	4.29	0.94

Opposite to these results, Russians' societal consensus was rated rather low, with 40.6% of respondents assessing the right statement as a wrong fact (Figure 13). Moreover, almost a third of respondents preferred to choose the middle option to state their doubt or inclination to both extremes to be true at the same time.

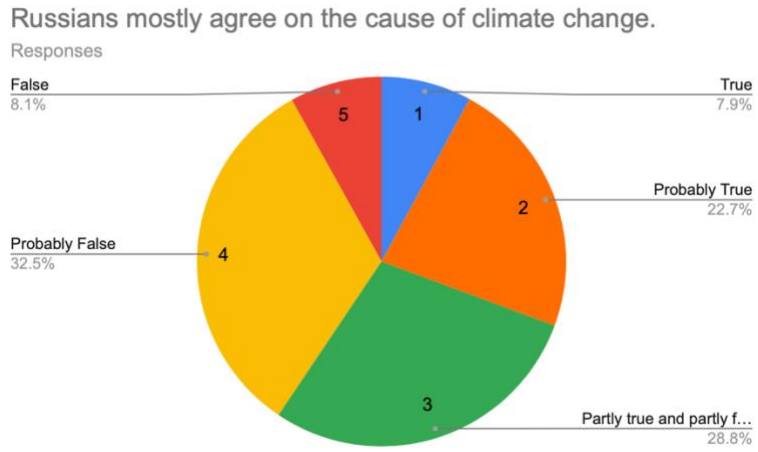


Figure 13. Proportions of assessments of a given statement: Russians mostly agree on the cause of climate change.

Statistical test showed no significant difference between the groups, χ^2 (4, N = 1339) = 4.44, p = .350 (Table 5). Thus, this misconception was quite common for both of the groups.

Table 5. The results of χ^2 test for a given statement: Russians mostly agree on the cause of climate change.

	Results					
	1	2	3	4	5	***Row Totals***
Group 1	48 (47.39) [0.01]	121 (134.63) [1.38]	184 (170.50) [1.07]	193 (192.65) [0.00]	47 (47.83) [0.01]	593
Group 2	59 (59.61) [0.01]	183 (169.37) [1.10]	201 (214.50) [0.85]	242 (242.35) [0.00]	61 (60.17) [0.01]	746
Column Totals	107	304	385	435	108	**1339 (Grand Total)**

In terms of climate change is politically exaggerated, the respondents mostly chose it to be «Probably False» (22%) or «False» (67.2%). Only 7.5% of respondents assessed it as «Partly True and Partly False» (Figure 14).

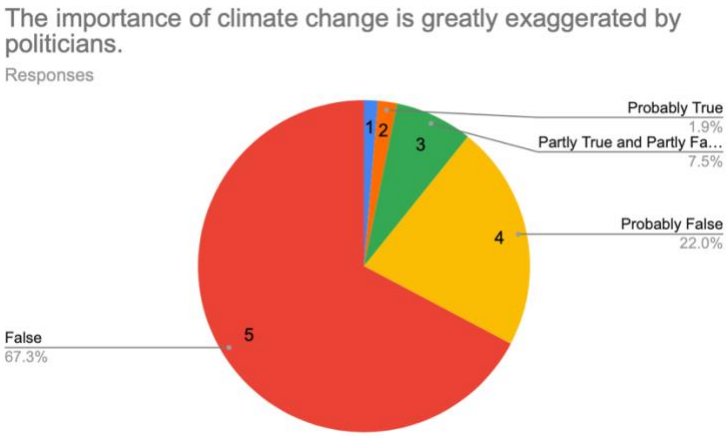


Figure 14. Proportions of assessments of a given statement: The importance of climate change is greatly exaggerated by politicians.

There was a statistical significance between two groups according to chi-square test, χ^2 (4, N = 1339) = 37.9, p < .001. As cross-tabulation (Table 6) revealed, there were fewer right assessments and more uncertainty from Group 2.

The same trend was observed for this section's last question, which was related to humans' not being concerned about climate change due to its long-term effect: only 3.3% chose the wrong answer, and 7% chose «Partly True Partly False»

(Figure 15). The frequency of the option «False» for this statement was the highest, concluding that it is one of the least common misconceptions.

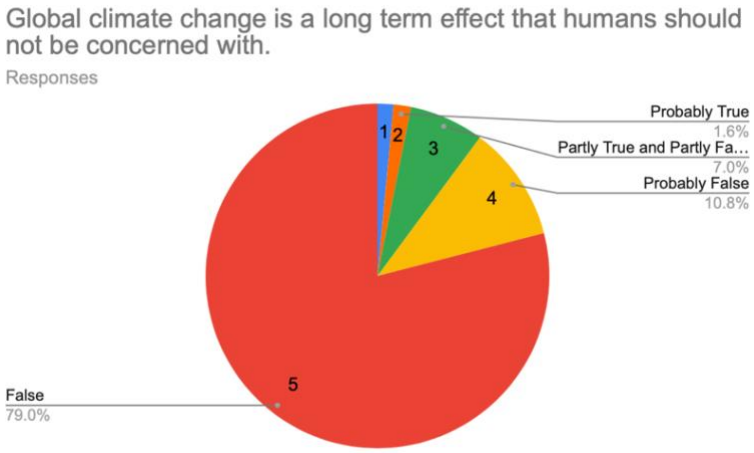


Figure 15. Proportions of assessments of a given statement: Global climate change is a long-term effect that humans should not be concerned with.

As for answers from the two groups, there were again statistically different, and the null hypothesis was rejected, χ^2 (4, N = 1339) = 26.5, p < .001. The distribution of answers in Group 2 followed a familiar trend to the previous question, with respondents being more uncertain.

To conclude, even though there was a rather high endorsement of scientific consensus, there was a high percentage of doubt in either other Russians agree on the cause of climate change. As for political involvement, the respondents showed a low inclination to believe in such misconceptions and the idea that humans should not bother with climate change at all. However, there were differences in degrees of uncertainty between the two groups.

Assessment of understanding of benefits of climate change

The following statement related to the effect of climate change in Siberia was not a common misconception: only 7.1% of respondents chose the wrong answer. The majority of respondents' answers were distributed between 3, 4, and 5 options, with 5 being the most common choice (Figure 16).

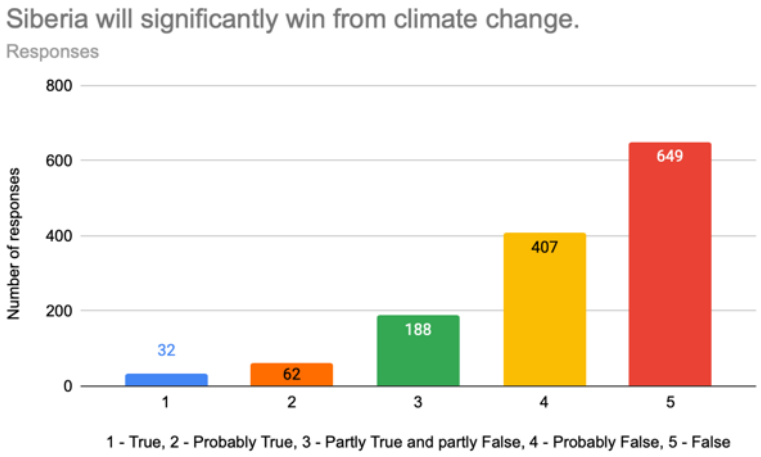


Figure 16. Distribution of answers to a given statement: Siberia will significantly benefit from climate change.

Statistical analysis showed that there is a significant difference between the answers of the two groups, χ^2 (4, N = 1339) = 30.8, p < .001. Group 2 showed more uncertainty about the answer, choosing 3 and 4 over 5, compared to Group 1.

Similar results were acquired for the statement related to the benefits of climate change to Russia: only 5% (67) of respondents assessed the misconception as a fact (Figures 17). The vast majority of people, 55.7%, confirmed that the

statement is a misconception, and only 11.1% chose «Partly True and Partly False» as an option.

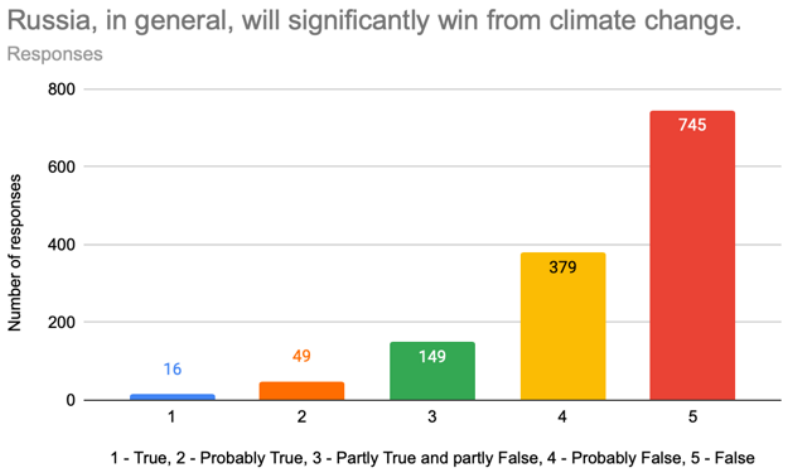


Figure 17. Distribution of answers to a given statement: Russia, in general, will significantly benefit from climate change.

The null hypothesis was rejected for a statistical test run for the results of the assessment of this statement, χ^2 (4, N = 1339) = 18.5, p < .001. In other words, there was a significant difference between how Group 1 answered, comparing to Group 2. Similar to the previous trends, Group 1 was overall more confident, assessing the misconception as «False,» comparing to Group 2, in which respondents more often chose «Probably False».

To sum up, misconceptions from this section were rather uncommon, with only less than 10% wrong answers for each statement. As a trend, Group 2 was more hesitant to choose «True,» which is indicative of a certain degree of doubt.

Understanding of consequences of climate change

Misconceptions regarding the frequency of extreme weather and sea-level rise showed quite unpopular within the target group, with just 9.2% and 2.7% wrong answers. The majority of respondents did not choose the 3 answers, suggesting they were quite comfortable choosing between True/False (Figure 18).

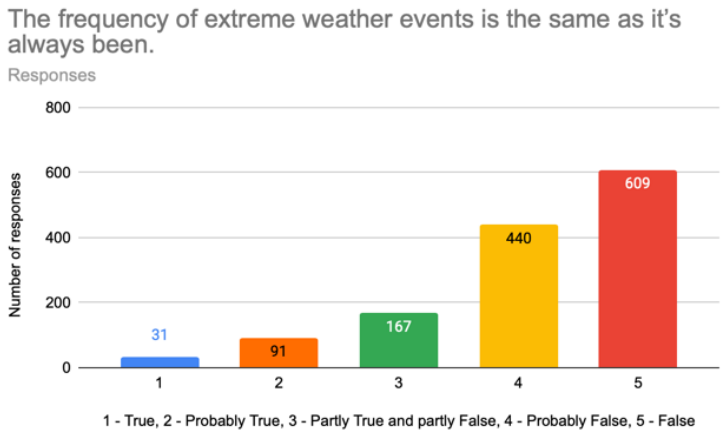


Figure 18. Distribution of answers to a given statement: The frequency of extreme weather events is the same as it's always been.

The null hypothesis was rejected with χ^2 (4, N = 1339) = 49.1, p < .001. The difference was statistically significant, and, according to cross-tabulation presented in Table 24, Group 1 showed the highest frequency for the option «False,» meanwhile Group 2 more often rated the statement to be «Probably True,» «Partly True and Partly False,» «Probably False,» suggesting that Group differed in the level of certainty.

Overall, the misconception related to sea level rise was not common, with only 2.7% of respondents assessing it as a fact and 6% showing uncertainty (Figure 19). Figure 30 shows that the frequency of the option «False» for this statement is rather high, concluding that it is one of the least common misconceptions.

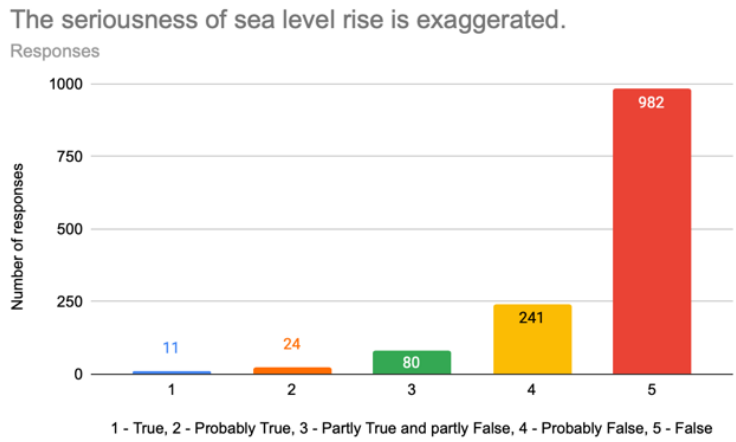


Figure 19. Distribution of answers to a given statement: The seriousness of sea level rise is exaggerated.

The Chi-square test rejected the null hypothesis, concluding that there is a difference between the opinions of the groups, χ^2 (4, N = 1339) = 54.9, p < .003. The option «False» was more common within Group 1, who were more intentional in assessing the statement as a misconception. Group 2 doubted that the seriousness of sea level is not exaggerated.

This section's misconceptions were not common since there were more than 70% of the right answers. The respondents were less certain about the frequency of extreme weather events than the exaggeration of sea-level rise. The difference between the groups indicated the link between knowing the cause of climate change and being certain about the consequences of climate change.

Actions to combat climate change

There was a high level of optimism found regarding question 16. The vast majority (69.5%) ranked the statement as «False,» and more than a quarter of respondents assessed it as «Probably False». Only 1.8% (23) of people indicated this misconception's susceptibility, which resulted in this misconception being the most uncommon within a sample group (Figure 20).

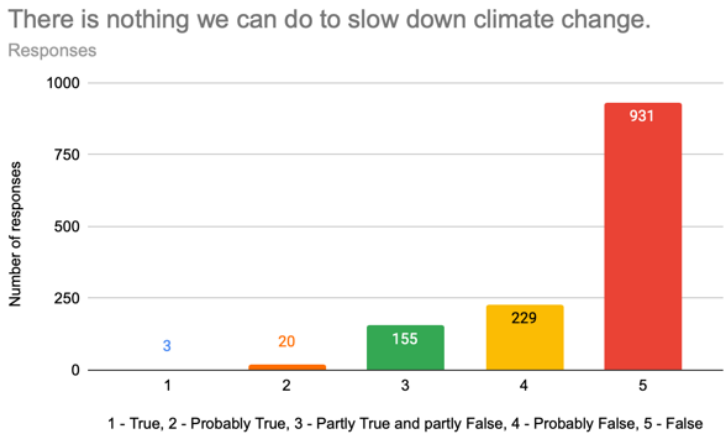


Figure 20. Distribution of answers to a given statement: There is nothing we can do to slow down climate change.

The difference between the groups was significant, χ^2 (4, N = 1339) = 33.3, p < .004, with Group 2 being less optimistic about the possibility to act on climate change. They more often preferred to assess the statement as «Partly True and Partly False». Besides, there chose «Probably True» by a bit more than 1.5% more often than the respondents from Group 1.

In terms of the influence of actions on the economy, the results were not so simple. More people (31.2%) chose option 3 compared to the 4 and 5 ones, suggesting a rather low level of susceptibility for this misconception and a low level of knowledge of the related topic (Figure 21).

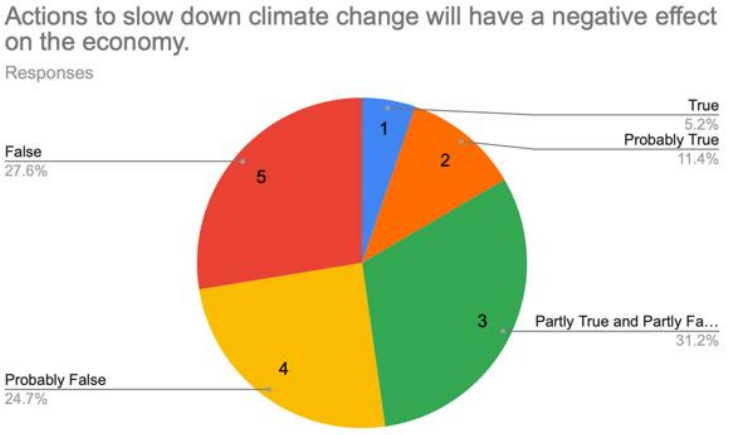


Figure 21. Proportions of assessments of a given statement: Actions to slow down climate change will have a negative effect on the economy.

The statistical test did not reject a null hypothesis, χ^2 (4, N = 1339) = 9.2, p = .056, suggesting that there is not really much difference between the level of certainty of respondents from two groups.

The next question's results showed the obvious inclination towards this statement being a fact, although there were considerably more uncertain answers compared to any other states. More than two-thirds of respondents chose «Probably True» or «Partly True and Partly False,» which is indicative of the statement to be an arguable topic (Figure 22).

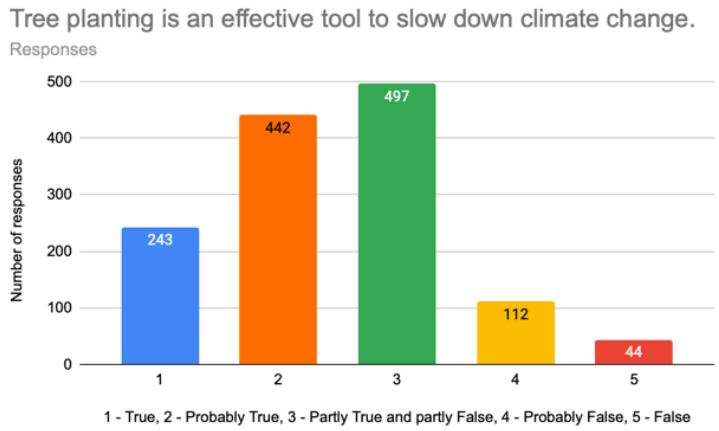


Figure 22. Distribution of answers to a given statement: Tree planting is an effective tool to slow down climate change.

Chi-square test did not show significant difference between the groups, suggesting that the frequencies of choices were proportional, χ^2 (4, N = 1339) = 7.1, p = .130. Concluding both results, both groups were rather uncertain about the either tree planting is indeed an efficient tool, but more often were inclined towards positive assessment.

The reduction of meat in the diet was assessed mostly as an effective solution to slow down climate change; only 208 respondents (15.6%) reported it to be a false fact (Figure 23). However, the results were not that simple; there were still quite significant proportions of those who assessed the statement as «Probably True» (23.1%) and «Partly True and Partly False» (17.2%).

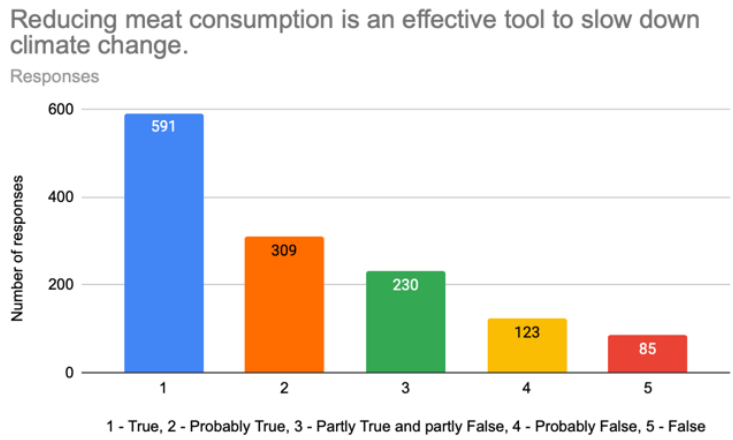


Figure 23. Distribution of answers to a given statement: Reducing meat consumption is an effective tool to slow down climate change.

The difference was significant according to the statistical test with χ^2 (4, N = 1339) = 25.4, p < .001. More people in Group 1 were intentional with assessing the statement as a misconception, compared to Group 2, where the respondents were less certain and ranked the fact as «Probably True» more often or even «False» in some cases.

Optimistically, the section with possible actions to slow down climate change showed rather high support for the idea of improving the situation, with high literacy levels on the reduction of meat in the diet and quite uncertain results in terms of tree planting. In terms of economic impact, most people agreed that it does not significantly damage the economy, which is also a sign of supportive of climate action motives.

5 DISCUSSION

The target audience showed a low inclination towards the chosen misconceptions, which is surely good news for Russia's climate communicators. If people are engaged with social media accounts on environmentally related topics, they are quite aware of climate change issues and their cause. It is in line with the latest polling of the general population in Russia by ROMIR (2020), where the majority of people showed rather high levels of climate literacy for the

shortlist of chosen questions. It is also supported by studies of Tynkkynen (2010), who emphasizes that social media blogging displays significantly more diverse debates than those in the traditional state media in Russia.

It is important to note that respondents' low misconception susceptibility should also be considered in future communications. Mentioning and highlighting misconceptions can lead to people believing that many people doubt climate science; meanwhile, the actual public support is quite high. This can also be noticed from the answers to the question related to the Russian population's consensus: most respondents did not actually think that others are not as skeptical as they are portrayed in media. This is a significant thing to consider because of the false consensus effect, a tendency to overestimate how common the opinion is within a public. According to Leviston et al. (2013), people with high false consensus bias are less likely to change their opinions, and according to Videras et al. (2012), the knowledge that «neighbors are doing something» has been proven to improve the intent of respondents to act.

There were only two major Groups defined by the belief in the cause of climate change; however, that was also a relevant finding, showing that there are two primary opinions in the respondents' sample of the targeted audience.
The number of respondents in Group 2 (who chose both human activities and natural reasons to be the primary cause for climate change of the last 50 years) was surprisingly bigger than in Group 1 (who chose human activities to be the primary reason for the climate change), meaning that people still believe that natural forces can take account for a significant percentage of warming. This knowledge can help improve how the carbon cycle and the greenhouse effect are explained during online lectures and media content production.

Another explanation for the increased number of respondents in Group 2 can be the question's meaning, asked to determine their position. Perhaps, respondents cannot separate natural factors from the phenomenon even though nature changes because of human activities. However, that was not claimed by the

people in the focus pre-survey group, so a closer look in future studies is recommended.

The most interesting finding was that most people think that the greenhouse effect is caused by humans, especially in Group 1, which might be explained by thy fact that respondents from Group 1 are more biased to blame human activity for anything unusual. The same explanation can be used for the statements related to ozone depletion and waste pollution being a significant reason for speeding up climate change. People confuse the ozone hole topic and climate change, thanks to education and popular media articles. This finding was in line with the ROMIR (2020) survey, where 31% of respondents explained climate change with pollution.

As for misconceptions related to volcanoes and the Sun, they might not be as popular because the facts behind them are the core reason why these people are engaged with climate and sustainable agendas. However, climate action options are still raising some questions, which should be addressed with proper climate communication. This was in line with the theoretical background presented by this research. Overall, Group 1 showed rather high levels of optimism in terms of action; meanwhile, Group 2 represented less optimism about the possibility of acting on climate change. Again, this can be explained through the core difference between these views – if nature is the partial cause, then, perhaps, it is less likely that we can resolve the issue.

Statistical tests showed a link between the belief in what exactly causing climate change with other misconceptions supported by the person. The respondents from Group 2 generally indicated more uncertainty regarding different statements; meanwhile, people representing Group 1 were more biased to blame all types of human activity for climate change. In the study by Poortinga et al. (2011), it was found that people who, for example, were doubtful about the extent of human activity on climate change were more likely to be skeptical about other aspects of climate change. In this research, there was insufficient data to support that claim confidently, but the same pattern was observed to a certain degree.

As for the commissioning party, it is going to use the material of this research to create a better strategy for communication in Instagram, namely include posts that would target and explain the most popular misconceptions revealed by this study with the help of memes, scientific facts, quick videos, and graphs. The target audience's portrait will be updated following the results to include which questions made respondents doubtful. Later on, the commissioning party will use the derived data in a book focused on explaining climate change doubts and misconceptions for the general public in the Russian-speaking countries.

According to the limitations and scope of this research, recommendations for future research include studying and analyzing different respondents' groups, different sets of misconceptions (related not only to beliefs but also behavioral groups), and different methodology with more in-depth interviews. The methodology from "climate imaginaries" (Levy & Spicer, 2013) or work on the "Six Americas" of climate change (Maibach et al., 2009) can be adopted for the Russian context.

For the Commissioning party, it is recommended to perform focus group-based surveys to study the effect of different media types on climate misconceptions. Besides, interviews can be helpful in further improving the target audience's portrait.

Possible questions for future research include:

- How misconceptions affect the behavioral shift in Russians?
- Which misconceptions are still popularized through state TV programs and/or popular Youtube blogs?
- Does the misconception perception differ between age and gender groups?
- Which type of media content can significantly improve climate literacy?

6 CONCLUSION

Skepticism can be a healthy phenomenon. However, with help from fossil fuel companies, conservative think tanks, and other parties whose agendas are threatened by gaining momentum climate action, climate change skepticism became a serious issue. Once people doubt the causes and effects, they are less likely to do something about global warming. In times of climate emergency, this cannot be the case, and thus effective climate change communication strategies are required.

Since people are spending several hours edutaining themselves on social media, it is important to find a workable solution for online science communication that would educate but not confuse. Misconception-based communication has been studied to eradicate climate misinformation efficiently.

However, before misconceptions are pre-bunked or debunked, it is crucial to know which misconceptions are popular and which audience is targeted. Thus, this research was devoted to outlining the current popular misconceptions within Russian-speaking Instagram users who already support climate agendas and, to a certain degree, engage with climate action.

The research included polling of Russian-speaking Instagram users who actively follow environmentally-related accounts and mostly believe that climate change is happening due to a certain degree of anthropogenic force.

As the research showed, some common misconceptions are found related to the exact mechanisms of climate change (such as greenhouse effect and ozone holes) and possible, efficient actions. Besides, the Commissioning party's target audience is mostly sure that climate change is happening not only due to human activities but due to nature itself. Thus, misconception-based communication is recommended to be focused on those topics.

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LIST OF FIGURES

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Appendix 1

THE SUMMARY OF CHOSEN MISCONCEPTIONS WITH JUSTIFICATION

Statement	**False/ True**	**Scientific fact and source**	**Source for misconception**
Global warming is not happening because there is still snow and cold weather in some places.	False	*Despite the fact that some place still experience snow and cold weather, global warming makes hot days more likely and cold days less likely*. NASA, What's the Difference Between Weather and Climate? 2005. Article. Available at: https://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html [Accessed 1 January 2021]	Bentley, Petcovic, & Cassidy. 2016. Development and validation of the anthropogenic climate change dissenter inventory. Environmental Education Research, vol 5.
Volcanoes produce more CO2 (carbon dioxide) than human activity per year.	False	*Overall, volcanoes release less than 2% of the equivalent amount of CO2 released by human activities*. NASA, What do volcanoes have to do with climate change? 2020. Article. Available at: https://climate.nasa.gov/faq/42/what-do-volcanoes-have-to-do-with-climate-change/ [Accessed 1 January 2021]	*Australian Senate: «Over the past 250 years, humans have added just one part of CO2 in 10,000 to the atmosphere. One volcanic cough can do this in a day».* ABC. 2009. New report. Available at: https://www.abc.net.au/news/2009-08-13/29320 [Accessed 1 January 2021]
Solar activity over the past 50 years has influenced current climate change more than all human activity.	False	*The output of energy from the sun has been monitored by satellites for thirty years and has not increased during this period of rapid global warming.* WMO. The Sun and Climate change. 2017. Article. Available at: https://public.wmo.int/en/sun-and-climate-change [Accessed 1 January 2021]	Lambert, J. L., & Bleicher, R. E. 2014. Improving Climate Change Communication Starting with Environmental Educators. Journal of Geoscience Education, 62(3), 388–401.
Greenhouse effect is cause by human activity.		*Greenhouse gases arise naturally and are part of the make-up of our atmosphere. In the last century or so, humans have been interfering with the energy balance of the planet, mainly through the burning of fossil fuels that give off additional carbon dioxide into the air.* NASA. What is greenhouse effect? 2017. Article. Available at: https://climate.nasa.gov/faq/19/what-is-the-greenhouse-effect/ [Accessed 1 January 2021]	Ranney & Clark. 2016. Climate Change Conceptual Change: Scientific Information Can Transform Attitudes. Future Global Change and Cognition.

Ozone depletion significantly speeds up the rate of climate change.	False	*Global warming is caused by increased greenhouse gases in the atmosphere. These gases include carbon dioxide and water vapor, which trap infrared radiation from the warmed surface of the Earth. The ozone layer protects the planet from the sun's harmful radiation. A depletion of ozone allows more UV light to reach the surface,but is not an important factor leading to increased temperature on Earth. Heat-trapping gases contribute to creating the cooling conditions in the atmosphere that lead to ozone depletion.* Union of Concerned Scientists. Is There a Connection Between the Ozone Hole and Global Warming? 2017. Article. Available at: https://www.ucsusa.org/resources/ozone-hole-and-global-warming [Accessed 1 January 2021]	Bell, A. 1994. Media (mis)communication on the science of climate change. Public Understanding of Science, 3(3), 259–275.
Waste pollution significantly speeds up the rate of climate change.	False	*Wastewater (1.3%): organic matter and residues from animals, plants, humans and their waste products can collect in wastewater systems. When this organic matter decomposes it produces methane and nitrous oxide. Landfills (1.9%): landfills are often low-oxygen environments. In these environments, organic matter is converted to methane when it decomposes.* Our World in Data. 2016. Sector by sector: where do global greenhouse gas emissions come from? Report. Available at: https://ourworldindata.org/ghg-emissions-by-sector [Accessed 1 January 2021]	*30% of respondents in Russia claim that pollution is a cause for climate change.* Romir. 2020. ПРОБЛЕМЫ ОКРУЖАЮЩЕЙ СРЕДЫ. Report. Available at: https://www.levada.ru/2020/01/23/problemy-okruzhayushhej-sredy/ [Accessed 1 January 2021]
Scientists mostly agree on the cause of climate change.	True	*A synthesis of consensus studies found that among published climate scientists, the level of agreement on human-caused global warming ranged from 90 to 100% with multiple studies converging around 97%.* Cook et al. 2016. Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. School of Psychological Science.	Lewandowsky, Stephan & Gignac, Gilles & Vaughan, Samuel. (2013). The pivotal role of perceived scientific consensus in acceptance of science. Nature Climate Change.
Russians mostly agree on the cause of climate change.	False	Romir. 2020. ПРОБЛЕМЫ ОКРУЖАЮЩЕЙ СРЕДЫ. Report. Available at: https://www.levada.ru/2020/01/23/problemy-okruzhayushhej-sredy/ [Accessed 1 January 2021]	Treen, K.M, Williams, H.T.P, O'Neill, S. (2020) Online misinformation about climate change. WIREs: Climate Change, 11:e665.
The importance of climate change is greatly exaggerated by politicians.	False	IPCC, 2018: Summary for Policymakers. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the	*During this period, but especially in the most recent decade, about a third to almost half of the public believes that the seriousness of global warming is generally exaggerated.*

		global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp.	Rookings. 2019. The challenging politics of climate change. Report. Available at: https://www.brookings.edu/research/the-challenging-politics-of-climate-change/ [Accessed 1 January 2021]
Global climate change is a long term effect that humans should not be concerned with.	False	*Global mean sea level rise (GMSLR) is projected to be around 0.1 m (0.04 – 0.16 m) less by the end of the 21st century in a 1.5°C warmer world compared to a 2°C warmer world (medium confidence). Risks of local species losses and, consequently, risks of extinction are much less in a 1.5°C versus a 2°C warmer world (high confidence).* IPCC, 2018: Summary for Policymakers. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp.	Citations from Illarionov, presidents's economic advisor Gazeta. Climate change. 2009. Article. Available at: https://www.gazeta.ru/science/2009/12/05_a_3294962.shtml [Accessed 1 January 2021]
Siberia will significantly benefit from climate change.	False	*Natural science also shows that the negative consequences of climate change, such as droughts and heat waves in the southern regions of Russia, will eventually cancel out the potential increase of agricultural production in the central and northern regions*. Dronin, Nikolai & Kirilenko, Andrei. 2011. Climate change, food stress, and security in Russia. Regional Environmental Change. 11. 167-178.	The document, published on the government's website on Saturday, outlines a plan of action and acknowledges changes to the climate are having a "prominent and increasing effect" on socioeconomic development, people's lives, health and industry. Possible "positive" effects are decreased energy use in cold regions, expanding agricultural areas and navigational opportunities in the Arctic Ocean The Guardian. Russia announces plan to 'use the advantages' of climate change. 2020. Article. Available at: https://www.theguardian.com/world/2020/jan/05/russia-announces-plan-to-use-the-advantages-of-climate-change [Accessed 1 January 2021]
Russia, in general, will significantly win from climate change.	False	*Russia is one of the most vulnerable countries to climate change, with vast Arctic regions and infrastructure built over permafrost. Recent floods and wildfires have been among the planet's worst climate-related disasters.* Dronin, Nikolai & Kirilenko, Andrei. 2011. Climate change, food stress, and security in Russia. Regional Environmental Change. 11. 167-178.	Citations from Illarionov, presidents's economic advisor Gazeta. Climate change. 2009. Article. Available at: https://www.gazeta.ru/science/2009/12/05_a_3294962.shtml [Accessed 1 January 2021]

The frequency of extreme weather events is the same as it's always been.	False	*Trends in intensity and frequency of some climate and weather extremes have been detected over time spans during which about 0.5°C of global warming occurred (medium confidence).* IPCC, 2018: Summary for Policymakers. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp.	Citations from Illarionov, presidents's economic advisor Gazeta. Climate change. 2009. Article. Available at: https://www.gazeta.ru/science/2009/12/05_a_3294962.shtml [Accessed 1 January 2021]
The seriousness of sea level rise is exaggerated.	False	*Global mean sea level rise (GMSLR) is projected to be around 0.1 m (0.04 – 0.16 m) less by the end of the 21st century in a 1.5°C warmer world compared to a 2°C warmer world (medium confidence).* IPCC, 2018: Summary for Policymakers. Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland, 32 pp.	Citations from Illarionov, presidents's economic advisor Gazeta. Climate change. 2009. Article. Available at: https://www.gazeta.ru/science/2009/12/05_a_3294962.shtml [Accessed 1 January 2021]
There is nothing we can do to slow down climate change.	False	*Future risks at 1.5°C of global warming will depend on the mitigation pathway and on the possible occurrence of a transient overshoot (high confidence).* IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Work- ing Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.	Ding, Ding & Maibach, Edward & Zhao, Xiaoquan & Roser-Renouf, Connie & Leiserowitz, Anthony. 2011. Support for climate policy and societal action are linked to perceptions of scientific agreement. Nature Climate Change.
Actions to slow down climate change will have a negative effect on the economy.	False	*Integrating measures to tackle climate change into regular economic policy will have a positive impact on economic growth over the medium and long term.*	Bedford, D. (2010). Agnotology as a Teaching Tool: Learning Climate Science by Studying Misinformation. Journal of Geography, 109(4), 159–165.

		OECD. Taking action on climate change will boost economic growth. 2017. Report. Available at: https://www.oecd.org/environment/taking-action-on-climate-change-will-boost-economic-growth.htm [Accessed 1 January 2021]	
Tree planting is an effective tool to slow down climate change.	False	For instance, much of the land Crowther described as “available” for tree planting already has plants growing on it, all of them storing carbon, many of which would have to be removed. Planting trees in snowy regions near the poles is likely to cause a net warming, while planting them in temperate climates – like that of the UK, much of Europe and parts of the US – may have no net effect on climate. BBC. 2020. Planting trees doesn’t always help with climate change. Available at: https://www.bbc.com/future/article/20200521-planting-trees-doesnt-always-help-with-climate-change [Accessed 1 January 2021]	The program by National Geographic. National Geographic. 2019. Триллион деревьев: новый план по спасению мира. Article. Available at: https://nat-geo.ru/nature/trillion-derevev-novyy-plan-po-spaseniyu-mira/ [Accessed 1 January 2021]
Reducing meat consumption is an effective tool to slow down climate change.	True	Poore, Joseph & Nemecek, Thomas. (2018). Reducing food's environmental impacts through producers and consumers. Science (New York, N.Y.).	Bjorn Lomborg. Don't let vegetarian environmentalists shame you for eating meat. Science is on your side. 2019. Article. Available at: https://eu.usatoday.com/story/opinion/voices/2019/07/25/vegetarianism-climate-change-meat-vegan-livestock-column/1804090001/ [Accessed 1 January 2021]

SAMPLE OF THE SURVEY (IN RUSSIAN)

Из-за чего происходит изменение климата последние 50 лет? *

- ◯ Из-за естественных причин
- ◯ Из-за деятельности человека
- ◯ И из-за естественных причин, и из-за деятельности человека
- ◯ Изменение климата не происходит

Часть 2/5

Оцените верность следующих высказываний по заданной шкале

Глобальное потепление не происходит, потому что в некоторых местах все еще наблюдается снег и холодная погода. *

- ◯ Это верно
- ◯ Скорее всего, верно
- ◯ Частично верно и частично ложно
- ◯ Скорее всего, ложно
- ◯ Это ложно

THE DETAILED RESULTS OF STATISTICAL ANALYSIS

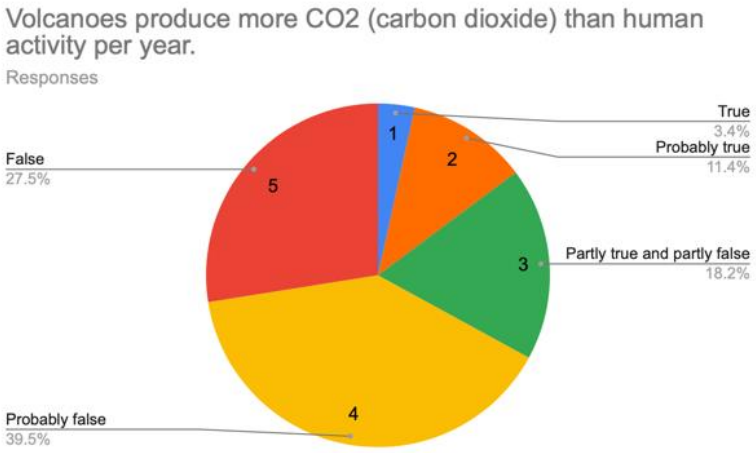

Figure 24. Proportions of assessments of a given statement: Volcanoes produce more CO2 (carbon dioxide) than human activity per year.

Table 6. The results of χ^2 test for a given statement: Volcanoes produce more CO2 (carbon dioxide) than human activity per year.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	12 (20.81) [3.73]	42 (67.32) [9.52]	87 (107.62) [3.95]	236 (234.28) [0.01]	216 (162.98) [17.25]	593
Group 2	35 (26.19) [2.97]	110 (84.68) [7.57]	156 (135.38) [3.14]	293 (294.72) [0.01]	152 (205.02) [13.71]	746
Column Totals	47	152	243	529	368	**1339 (Grand Total)**

Table 7. The frequency table for assessments of a given statement: Volcanoes produce more CO2 (carbon dioxide) than human activity per year (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	2.02	7.08	14.67	39.80	36.42
Group 2	4.69	14.75	20.91	39.28	20.38

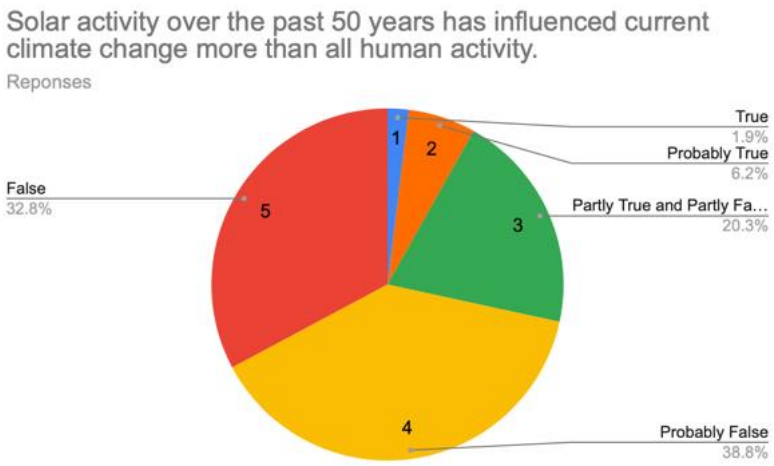

Figure 25. Proportions of assessments of a given statement: Solar activity over the past 50 years has influenced current climate change more than all human activity.

Table 8. The results of χ^2 test for a given statement: Solar activity over the past 50 years has influenced current climate change more than all human activity.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	6 (11.96) [2.97]	17 (36.76) [10.62]	91 (120.02) [7.02]	212 (229.85) [1.39]	267 (194.42) [27.10]	593
Group 2	21 (15.04) [2.36]	66 (46.24) [8.44]	180 (150.98) [5.58]	307 (289.15) [1.10]	172 (244.58) [21.54]	746
Column Totals	27	83	271	519	439	**1339 (Grand Total)**

Table 9. The frequency table for assessments of a given statement: Solar activity over the past 50 years has influenced current climate change more than all human activity (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	1.01	2.87	15.35	35.75	45.03
Group 2	2.82	8.85	24.13	41.15	23.06

Table 10. The results of χ^2 test for a given statement: Greenhouse effect is cause by human activity.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	268 (184.23) [38.09]	182 (185.56) [0.07]	109 (175.82) [25.39]	7 (14.17) [3.63]	27 (33.22) [1.16]	593
Group 2	148 (231.77) [30.28]	237 (233.44) [0.05]	288 (221.18) [20.19]	25 (17.83) [2.88]	48 (41.78) [0.92]	746
Column Totals	416	419	397	32	75	**1339 (Grand Total)**

Table 11. The frequency table for assessments of a given statement: Greenhouse effect is cause by human activity (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	45.19	30.69	18.38	1.18	4.55
Group 2	19.84	31.77	38.61	3.35	6.43

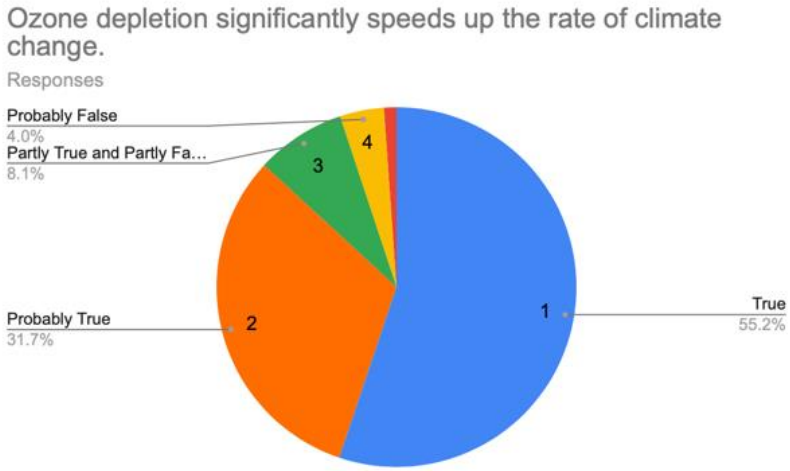

Figure 26. Proportions of assessments of a given statement: Ozone depletion significantly speeds up the rate of climate change.

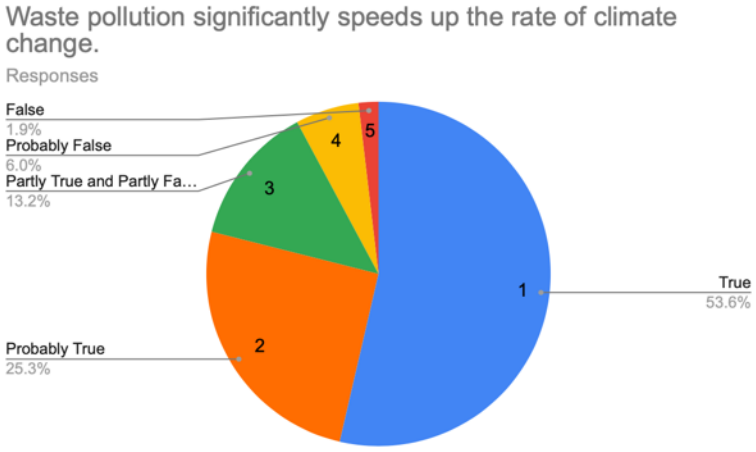

Figure 27. Proportions of assessments of a given statement: Waste pollution significantly speeds up the rate of climate change.

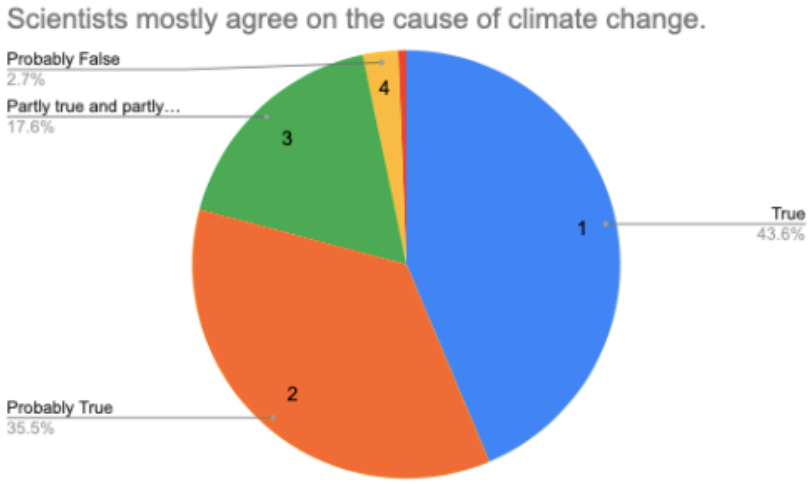

Figure 28. Proportions of assessments of a given statement: Scientists mostly agree on the cause of climate change.

Table 12. The results of χ^2 test for a given statement: Ozone depletion significantly speeds up the rate of climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	364 (327.04) [4.18]	157 (187.64) [5.00]	43 (48.24) [0.57]	22 (23.45) [0.09]	7 (6.64) [0.02]	593
Group 2	375 (411.96) [3.32]	267 (236.36) [3.97]	66 (60.76) [0.45]	31 (29.55) [0.07]	8 (8.36) [0.02]	747
Column Totals	739	424	109	53	15	**1340 (Grand Total)**

Table 13. The frequency table for assessments of a given statement: Ozone depletion significantly speeds up the rate of climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	61.38	26.48	7.25	3.71	1.18
Group 2	50.27	35.79	8.85	4.16	1.07

Table 14. The results of χ^2 test for a given statement: Waste pollution significantly speeds up the rate of climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	363 (317.98) [6.37]	141 (150.13) [0.56]	67 (78.39) [1.65]	16 (35.43) [10.66]	6 (11.07) [2.32]	593
Group 2	355 (400.02) [5.07]	198 (188.87) [0.44]	110 (98.61) [1.32]	64 (44.57) [8.47]	19 (13.93) [1.85]	746
Column Totals	718	339	177	80	25	**1339 (Grand Total)**

Table 15. The frequency table for assessments of a given statement: Waste pollution significantly speeds up the rate of climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	61.21	23.78	11.30	2.70	1.01
Group 2	47.59	26.54	14.75	8.58	2.55

Table 16. The results of χ^2 test for a given statement: The importance of climate change is greatly exaggerated by politicians.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	5 (8.41) [1.39]	4 (11.07) [4.52]	25 (44.73) [8.70]	116 (130.20) [1.55]	443 (398.58) [4.95]	593
Group 2	14 (10.59) [1.10]	21 (13.93) [3.59]	76 (56.27) [6.92]	178 (163.80) [1.23]	457 (501.42) [3.93]	746
Column Totals	19	25	101	294	900	**1339 (Grand Total)**

Table 17. The results of χ^2 test for a given statement: Global climate change is a long-term effect that humans should not be concerned with.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	8 (9.30) [0.18]	6 (9.74) [1.44]	25 (41.63) [6.64]	49 (64.22) [3.61]	505 (468.11) [2.91]	593
Group 2	13 (11.70) [0.14]	16 (12.26) [1.14]	69 (52.37) [5.28]	96 (80.78) [2.87]	552 (588.89) [2.31]	746
Column Totals	21	22	94	145	1057	**1339 (Grand Total)**

Table 18. The results of χ^2 test for a given statement: Siberia will significantly benefit from climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	13 (14.61) [0.18]	25 (27.46) [0.22]	73 (83.26) [1.26]	145 (180.25) [6.89]	337 (287.42) [8.55]	593
Group 2	20 (18.39) [0.14]	37 (34.54) [0.17]	115 (104.74) [1.00]	262 (226.75) [5.48]	312 (361.58) [6.80]	746
Column Totals	33	62	188	407	649	**1339 (Grand Total)**

Table 19. The frequency table for assessments of a given statement: Siberia will significantly benefit from climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	2.19	4.22	12.31	24.45	56.83
Group 2	2.68	4.96	15.42	35.12	41.82

Table 20. The frequency table for assessments of a given statement: The importance of climate change is greatly exaggerated by politicians (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	0.84	0.67	4.22	19.56	74.70
Group 2	1.88	2.82	10.19	23.86	61.26

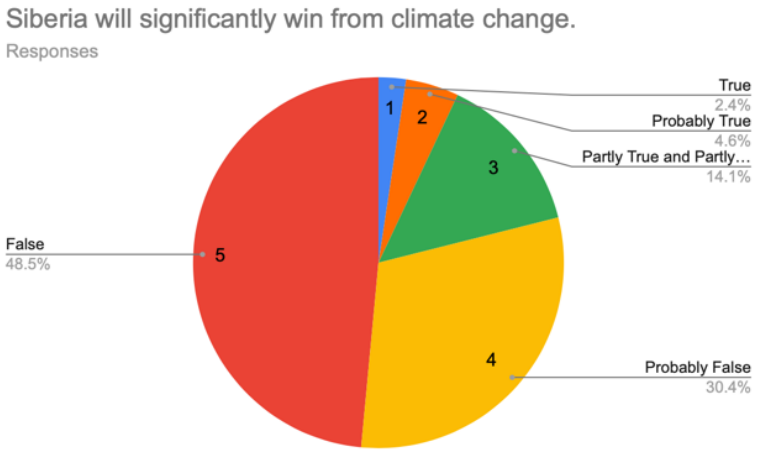

Figure 29. Proportions of assessments of a given statement: Siberia will significantly benefit from climate change.

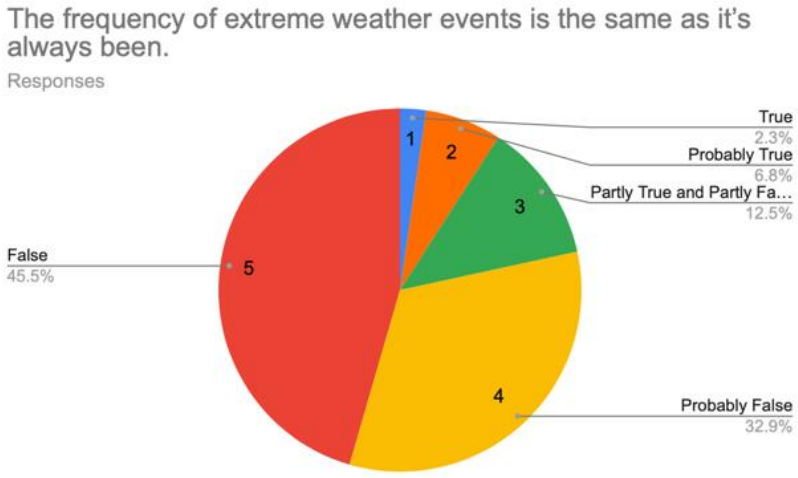

Figure 30. Proportions of assessments of a given statement: The frequency of extreme weather events is the same as it's always been.

Table 21. The frequency table for assessments of a given statement: Global climate change is a long-term effect that humans should not be concerned with (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	1.35	1.01	4.22	8.26	85.16
Group 2	1.74	2.14	9.25	12.87	73.99

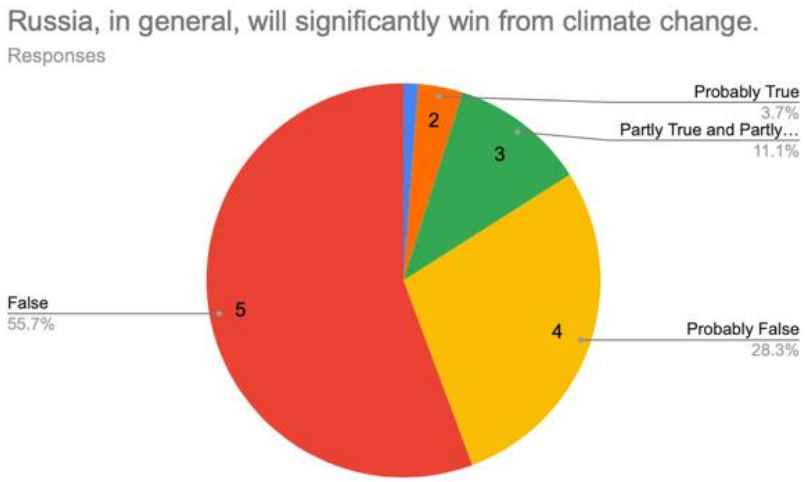

Figure 31. Proportions of assessments of a given statement: Russia, in general, benefit significantly win from climate change.

Table 22. The results of χ^2 test for a given statement: Russia, in general, will significantly benefit from climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	7 (7.53) [0.04]	11 (21.70) [5.28]	61 (65.99) [0.38]	152 (167.85) [1.50]	362 (329.94) [3.12]	593
Group 2	10 (9.47) [0.03]	38 (27.30) [4.19]	88 (83.01) [0.30]	227 (211.15) [1.19]	383 (415.06) [2.48]	746
Column Totals	17	49	149	379	745	**1339 (Grand Total)**

Table 23. The frequency table for assessments of a given statement: Russia, in general, will significantly benefit from climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	1.18	1.85	10.29	25.63	61.05
Group 2	1.34	5.09	11.80	30.43	51.34

Table 24. The results of χ^2 test for a given statement: The frequency of extreme weather events is the same as it's always been.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	6 (14.17) [4.71]	27 (40.30) [4.39]	54 (73.96) [5.39]	180 (194.86) [1.13]	326 (269.71) [11.75]	593
Group 2	26 (17.83) [3.75]	64 (50.70) [3.49]	113 (93.04) [4.28]	260 (245.14) [0.90]	283 (339.29) [9.34]	746
Column Totals	32	91	167	440	609	**1339 (Grand Total)**

Table 25. The frequency table for assessments of a given statement: The frequency of extreme weather events is the same as it's always been (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	1.01	4.55	9.11	30.35	54.97
Group 2	3.49	8.58	15.15	34.85	37.94

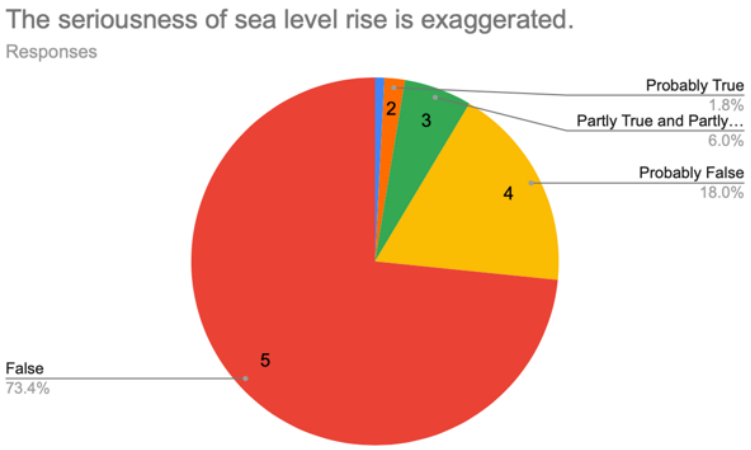

Figure 32. Proportions of assessments of a given statement: The seriousness of sea level rise is exaggerated.

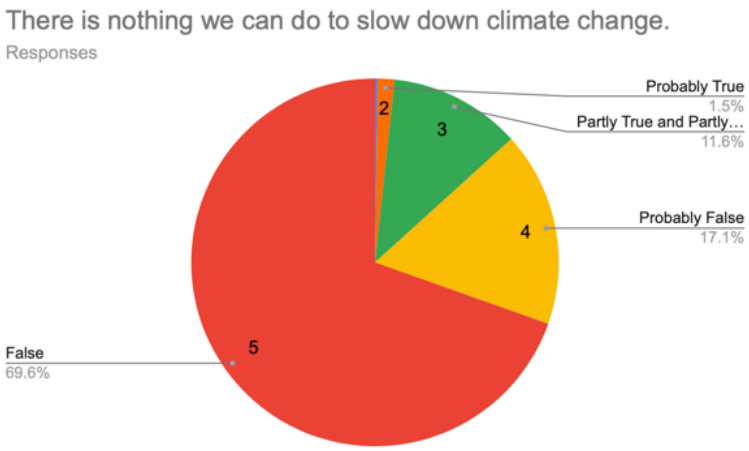

Figure 33. Proportions of assessments of a given statement: There is nothing we can do to slow down climate change.

Table 26. The results of χ^2 test for a given statement: The seriousness of sea level rise is exaggerated.

	Results					
	1	2	3	4	5	***Row Totals***
Group 1	1 (5.31) [3.50]	2 (10.63) [7.01]	21 (35.43) [5.88]	79 (106.73) [7.21]	490 (434.90) [6.98]	593
Group 2	11 (6.69) [2.78]	22 (13.37) [5.57]	59 (44.57) [4.67]	162 (134.27) [5.73]	492 (547.10) [5.55]	746
Column Totals	12	24	80	241	982	**1339 (Grand Total)**

Table 27. The frequency table for assessments of a given statement: The seriousness of sea level rise is exaggerated (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	0.17	0.34	3.54	13.32	82.63
Group 2	1.47	2.95	7.91	21.72	65.95

Table 28. The results of χ^2 test for a given statement: There is nothing we can do to slow down climate change.

	Results					
	1	2	3	4	5	***Row Totals***
Group 1	1 (1.77) [0.34]	3 (8.86) [3.87]	47 (68.64) [6.82]	85 (101.42) [2.66]	457 (412.31) [4.84]	593
Group 2	3 (2.23) [0.27]	17 (11.14) [3.08]	108 (86.36) [5.43]	144 (127.58) [2.11]	474 (518.69) [3.85]	746
Column Totals	4	20	155	229	931	**1339 (Grand Total)**

Table 29. The frequency table for assessments of a given statement: There is nothing we can do to slow down climate change. (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	0.17	0.51	7.93	14.33	77.07
Group 2	0.40	2.28	14.48	19.30	63.54

Table 30. The results of χ^2 test for a given statement: Actions to slow down climate change will have a negative effect on the economy.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	23 (31.44) [2.27]	70 (67.32) [0.11]	171 (184.68) [1.01]	149 (146.15) [0.06]	180 (163.42) [1.68]	593
Group 2	48 (39.56) [1.80]	82 (84.68) [0.09]	246 (232.32) [0.81]	181 (183.85) [0.04]	189 (205.58) [1.34]	746
Column Totals	71	152	417	330	369	**1339 (Grand Total)**

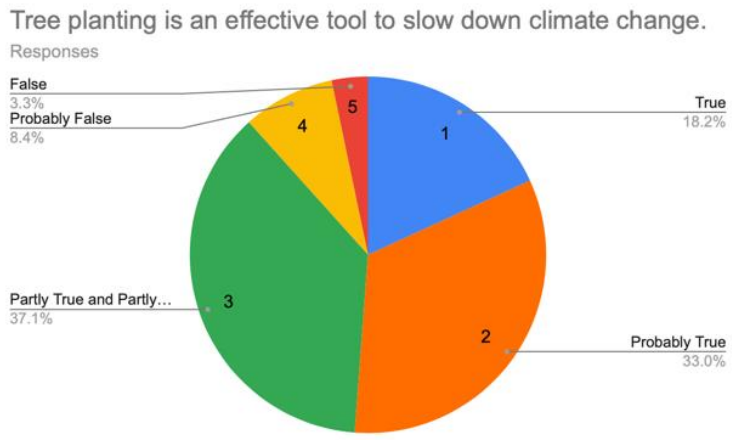

Figure 34. Proportions of assessments of a given statement: Tree planting is an effective tool to slow down climate change.

Table 31. The results of χ^2 test for a given statement: Tree planting is an effective tool to slow down climate change.

Results						
	1	2	3	4	5	***Row Totals***
Group 1	121 (108.06) [1.55]	178 (195.75) [1.61]	229 (220.11) [0.36]	45 (49.60) [0.43]	20 (19.49) [0.01]	593
Group 2	123 (135.94) [1.23]	264 (246.25) [1.28]	268 (276.89) [0.29]	67 (62.40) [0.34]	24 (24.51) [0.01]	746
Column Totals	244	442	497	112	44	**1339 (Grand Total)**

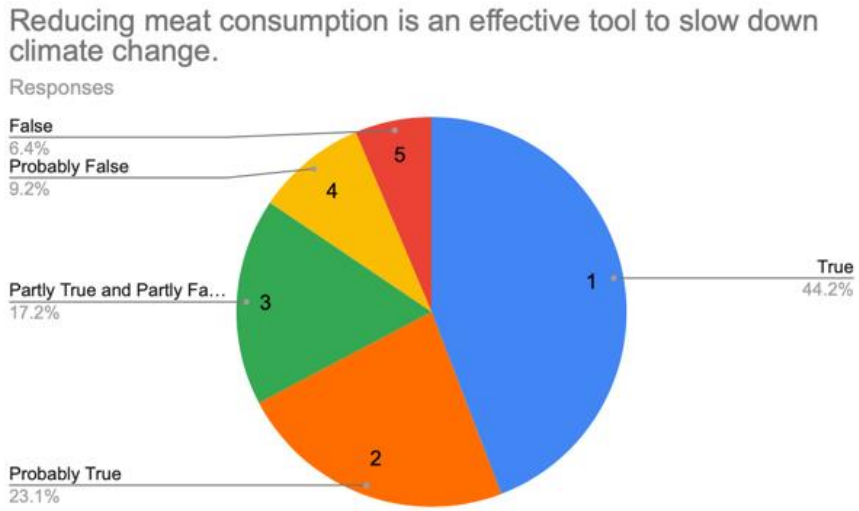

Figure 35. Proportions of assessments of a given statement: Reducing meat consumption is an effective tool to slow down climate change.

Table 32. The results of χ^2 test for a given statement: Reducing meat consumption is an effective tool to slow down climate change.

	Results					
	1	2	3	4	5	***Row Totals***
Group 1	303 (262.18) [6.36]	116 (136.85) [3.18]	96 (101.86) [0.34]	53 (54.47) [0.04]	25 (37.64) [4.25]	593
Group 2	289 (329.82) [5.05]	193 (172.15) [2.52]	134 (128.14) [0.27]	70 (68.53) [0.03]	60 (47.36) [3.38]	746
Column Totals	592	309	230	123	85	**1339 (Grand Total)**

Table 33. The frequency table for assessments of a given statement: Reducing meat consumption is an effective tool to slow down climate change (in %).

	TRUE	Probably True	Partly True and Partly False	Probably False	FALSE
	1	2	3	4	5
Group 1	51.10	19.56	16.19	8.94	4.22
Group 2	38.74	25.87	17.96	9.38	8.04