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CLIMATE CHANGE AND OUR FUTURE: ANTICIPATING TRENDS AND CHALLENGES USING MEDIA DATA

BASIC RESEARCH PROGRAM
WORKING PAPERS

SERIES: SCIENCE, TECHNOLOGY AND INNOVATION

WP BRP 65/STI/2016

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This paper proposes a multidisciplinary approach to understanding the future perspectives of climate change. First, it analyzes the possibilities of using the media as an information source for anticipating trends and challenges in this area through exploring the topics that have been actively discussed in the news in the recent 5 years. Second, qualitative and quantitative approaches are combined in this study in order to identify trends of different categories: social, technological, economic, environmental, political and values/culture. It allows integrating the results of trends monitoring obtained from qualitative and quantitative sources and create a complex map of trends. Qualitative approach is based on the literature review and consultations with the experts, while quantitative analysis includes collecting the news from Factiva database and processing it in Vantage Point software using bibliometric analysis, natural language processing, statistical analysis and principal component analysis. The results shown that 58% of trends were validated by the news and its contribution to the final trends list accounts for 25% on average, which means that the media can be considered as a useful additional data source for validating and updating trends. The results of this multidisciplinary study can be of interest to researchers, economists, business representatives and policy makers that are involved in the climate change related activities.

JEL Classification: O33.

Keywords: climate change, foresight, trends monitoring, news, quantitative methods.

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1. Introduction

Scientists from all over the world have been actively involved in investigating past and future climate development by using empirical data and theoretical models. For fully understanding the climate change phenomenon various aspects (social, technological, economic, environmental, political, cultural/values) must be taken into consideration. The way to realize what the humans can do about it is to see how the experts from diverse areas engage with this multidisciplinary issue. Additionally, it is important to appreciate how response to climate change depends upon the interplay between these different approaches. It is needed to both analyze the claims about the science itself and anticipate the responses that can be made by humanity at present and for the future, based on current scientific data and the predictions over the next decades. These objectives are reflected in the UN Development Program's sustainability development goal "Climate Action", which implies "taking urgent actions to combat climate change and its impact" (UNDP, 2016).

Sustainable development aiming to achieve a balance between the parallel demands for environmental protection, economic development and social justice, is essentially about reorienting the human development trajectory so that genuine societal progress can be sustained. Being a system of interactive relationships between the main components (atmosphere, hydrosphere, cryosphere, biosphere, lithosphere, anthroposphere), climate is influenced by various external forcing mechanisms. In addition to the environmental, economic and social dimensions, political and technological factors are noticeably important. The anthroposphere (also named as technosphere) has been modified by the humans using advanced technology, which may cause both positive and negative impacts on the climate system.

In this study a *trend* (social, economic, technological or other) is considered as a topical, cutting-edge, and quickly growing pattern, which have been existed for a certain time period in the past (usually about 5 years) and is expected to continue its growth and significantly affect the development of the economy, environment and society in the next 5-10 years or beyond.

In recent years there has been a number of environmental studies applying foresight methods for understanding future pathways for mitigation and adaption to climate change (Al-Saleh et al., 2012; Fazey et al., 2016; Kalafatis et al., 2015; Pahl-Wostl et al., 2013; Van Der Sluijs and Wardekker, 2015; Wickramasinghe and Gamage, 2013) and for anticipating

development in climate-related areas, e.g. transport planning (Lyons and Davidson, 2016), bioeconomy (Pätäri et al., 2016), land use (Huang and Lee, 2016), forest management (Nelson et al., 2016), urban planning (Eames et al., 2013; Eames et al., 2014; Edeholt, 2012; Prata et al., 2015), disaster risk management (Mokrech, 2012; Nair et al., 2014; Rautela, 2016), biodiversity conservation (Cook et al., 2014), migration (Heinonen, 2013), health care and social issues (Boschetti et al., 2015; Connolly, 2015). There have been also the attempts to integrate future-oriented technology analysis (FTA) and risk assessment methodologies (Koivisto et al., 2009). These studies are mostly based on qualitative methods (literature review, expert surveys, scenarios, etc.), but a number of them use quantitative techniques as well (such as integrated modeling, GIS-based multi-criteria analysis) to extend the set of methods and integrate new information sources in research.

In academic studies aiming to discover STEEPV trends, the most widely used data sources are scientific publications (Chen, 2006; Cobo et al., 2011; Guo et al., 2011; Upham and Small, 2010) and patents (Lee et al., 2011; Tseng et al., 2007; Wang et al., 2010). Nevertheless, much information can be found in additional sources (newspapers (Daim et al., 2006); business related press, such as Lexis-Nexis (Porter and Cunningham, 2005); data from venture capital funds and start-ups (Cozzens et al., 2010); data from specialized conferences (Porter and Cunningham, 2005); and others). Along with extensive use of expert procedures, automated and semi-automated methods for extracting trends are being increasingly popular. Nevertheless, in most studies devoted to anticipating trends in the climate change area novel sources of information (such as media resources, blogs, startups, business information) are underrepresented.

Therefore, the main purpose of this paper is to propose a complex multidisciplinary approach to understanding the future perspectives of climate change using the media (news) as a source for finding additional information for anticipating trends and challenges in this field. Playing a great role in shaping the sustainability debates, the news can serve as an important data source for monitoring trends. In addition, since climate change has no clear boundaries, it gives more opportunities for exploring the various aspects of this phenomenon (STEEPV trends).

The research objectives of this paper are:

In theory: To explore whether or not the media can serve as a valuable data source for validating and updating STEEPV trends related to climate change.

In practice: To create the complex map of STEEPV trends in the field of climate change based on the integration of qualitative and quantitative data.

Therefore, the research question of this paper is: *Can the media serve as a valuable additional information source for validating and updating the map of STEEPV trends in the area of climate change?*

The intended target group for this multidisciplinary study include policy makers (making decisions about how to address climate change by setting priorities in the particular sectors), business representatives (intending to understand the risks, weak signals and possible disruptions, which may take place in the markets for developing effective corporate strategies), and researchers (contributing to the multidisciplinary methodology for anticipating trends) involved in climate change related activities.

Following the introduction, Section 2 will provide the methodological approach of this study. Then, the analysis of the trends related to climate change will be presented in Section 3. Subsequently, the results will be discussed in Section 4. Section 5 will formulate an answer to the research question and draw a conclusion.

2. Methodology

The media providing an opportunity to monitor the news from business sites, specialized information portals, and news channels, might be successfully used for validating and updating trends in the area of climate change. First, taking into account the complexity and multidisciplinarity of this phenomenon, the media serves as a key information platform for discussing STEEPV aspects with participation of diverse stakeholders (governments, companies, scientific society, civil society). Second, the news is updated rapidly and includes the most recent information in the subject field, since the gap between an idea and its publication in less than, for example, in case of publications or patents. Third, it allows to understand the technology supply and demand dynamics in a wide range of disciplines, helping to identify the needs (market pull) and the possible solutions (technology push).

At the same time, the media as an information source has a number of limitations. The news records are not scientifically peer-reviewed and are not necessary adopted by the experts, and therefore the validity of this data can be questionable (noise problem). The media data is semi-structured data, and additional efforts are needed to process it (appropriate well-structured database currently does not exist). Taking into account these limitations, for our

study the media is not considered as an original source of information about the climate change trends, but as an additional one, which allows to validate these trends and gives extra ideas about new trends candidates. Thus, the quantitative results should be treated carefully, and in order to overcome the limitations discussion of the results with the experts is needed. A large database Factiva has been chosen for collecting data, as it provides an access to more than 2 000 newspapers (including "New York Times," "Wall Street Journal," "Financial Times," etc.), over 3 000 magazines (including "The Economist," "Time," and "Forbes"), and more than 500 news feeds (including "Dow Jones," "Reuters," and "The Associated Press"), which form the information base for our trends analysis. In this study while using the term "the media" we consider the news, which includes news publications in journals, web news and blogs.

The methodology of this study includes the following stages:

Stage 1. Creating a list of potential STEEPV trends using qualitative methods.

Stage 2. Creating a list of STEEPV trends based on quantitative data processing.

Stage 3. Integration (validating and updating) and analysis of the results, and creating a complex map of STEEPV trends.

The brief description of these three stages is presented below.

On the *Stage 1 (qualitative approach)*, the preliminary list of trends is constructed through literature review (reports and strategic documents of the international organizations, foresight studies, strategic documents of corporations, industry reports, available trends databases) and consultations with the experts (discussions in 3 iterations).

On the *Stage 2 (quantitative approach)*, quantitative analysis of the trends comprises three main steps proposed by Mikova and Sokolova (2014): data collecting, data processing, and data mapping. *Step 1 (data collecting)* includes gathering the news from Factiva database in order to be used as a base for compiling the data collection. *Step 2 (data processing)* implies data collection, uploading and processing in Vantage Point software (Search Technology, 2014) through the following procedures: 1) importing data into Vantage Point; 2) pre-preparing data; and 3) clustering keywords (Mikova and Sokolova, 2014). *Step 3 (data clustering/mapping)* includes creating a visual map of STEEPV trends, showing the groups of clusters and the connections between the selected keywords.

On the *Stage 3 (integration)*, the qualitative and quantitative lists of trends are analyzed and integrated into the final list of trends with a help of the experts in the subject area. This stage is needed to construct a complex map of STEEPV trends related to climate change, taking into account the interrelations and overlapping between these two lists.

More detailed description of how this methodology has been applied for climate change area is presented in the next section.

3. Analysis of the trends related to climate change

3.1. Stage 1 (Qualitative approach)

To provide the input for the analysis, the literature review was conducted using the following information sources: reports and strategic documents of the international organizations (UN, EU, OECD, etc.), foresight studies (RAND, NISTEP, HorizonScan 2050, etc.), strategic documents of the major corporations (Shell, Chevron, BP, etc.), industry reports (IEA, UNFCCC, European Water Association, etc.), available trends databases (Battelle, TechCast, Shaping Tomorrow, Z-Punkt, etc.). Based on a total of 33 documents, the integrated table of trends was created. The experts from the areas related to climate change (energy efficiency, biodiversity, water management, sustainable production and consumption, etc.) participated in the discussions. With a help of the experts these trends were divided into STEEPV categories. As a result, a preliminary (qualitative) list including 36 trends groups was created as a base for further analysis.

3.2. Stage 2 (Quantitative approach)

3.2.1 Step 1 (data collecting)

While collecting data, 297 575 news records that have been actively discussed in the last 5 years (2011-2015) were downloaded from Factiva database. While gathering them, a broad query "(climate change) AND future" was used for retrieving the English-language documents. Taking into account the time limitations of the study, the news record were sorted "by relevance" (with a help of embedded tool in Factiva which uses a set of keywords around the query to show the result which includes only these keywords). As a result, a total collection of 10 000 the most actively discussed news in *.html format was created. The semi-structured data from the titles and abstracts was converted into *.smartXML format for further processing in Vantage Point.

3.2.2 Step 2 (data processing)

The next step was uploading the news collection into Vantage Point in order to be processed (cleaned and grouped), analyzed (based on the keywords co-occurrence) and visualized. The analysis was conducted in 3 iterations through discussions with experts.

First, the collection of 10 000 news (5 *.smartXML-files for 5 years) was *imported* into Vantage Point. Next, at the stage of *pre-preparing data*, the duplicated records were eliminated using the function "Remove duplicates", which allows to work only with unique documents. Next, the *linguistic tools* were applied in order to analyze keywords phrases, and *stemming instruments*[2] were used to simplify data processing. In addition, the function "Further processing" allowed to remove prepositions, conjunctions, punctuations and other words (universal words, linguistic patterns, names, topic area terms, etc.) that are not informative, in order to obtain clean data without significant noise.

3.2.3 Step 3 (data mapping)

The function "Factor map" was used in Vantage Point for data visualization (identifying clusters, trends and patterns). In this software the co-occurrence of keywords in the documents' texts was used as a main parameter for data clustering (for instance, if two key phrases occur together in a large volume of documents, they are added to the same cluster).

As a result, the collection was divided in Vantage Point into 40 clusters groups using principal component analysis (PCA), and for each of STEEPV categories the results were visualized as a cluster map. During processing PCA allowed to present only the main factors on the map. Fig. 1 presents the example of a map for the category "Technology trends".

[2] Many words have the same base (stem), but carry out different semantic functions (for instance, "computation" and "computing"). The process of stemming helps find the stem of several similar words.

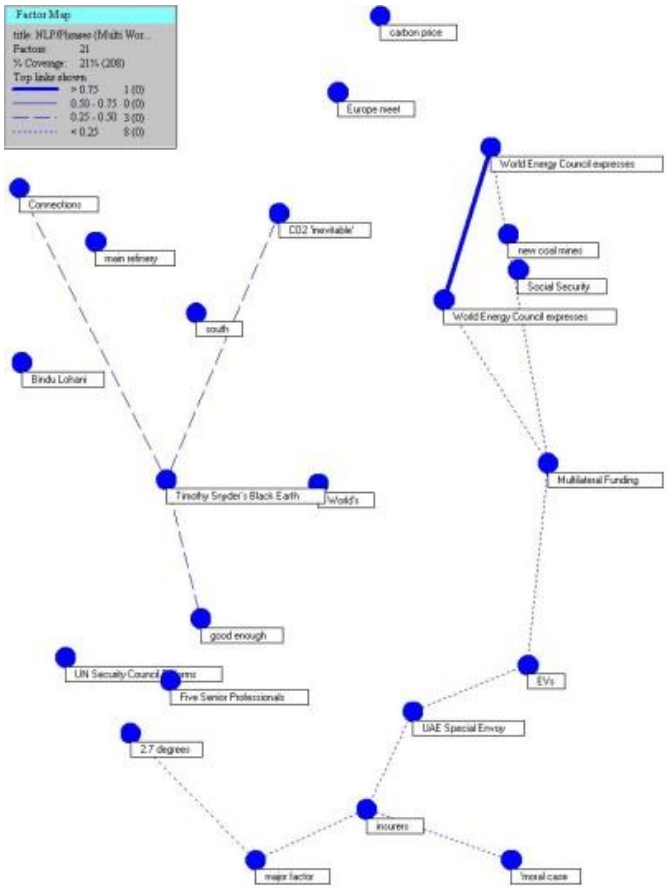

Fig. 1. The Vantage Point map of technology trends groups

Some clusters on these maps were interrelated and others were isolated. Each cluster included a set of key phrases (descriptors), which were listed in receding order according to the frequency in which they occur. These descriptors were needed to understand the core idea of each cluster, based on studying their content.

3.2. Stage 3 (Integration)

At this stage the final (integrated) list of trends was created in order to collate and integrate qualitative and quantitative lists, identify matches and mismatches between them and study in detail the trends that are different.

Tab. 1 presents the examples of technology trends for each of the trends groups.

Tab. 1. Examples of technology trends

Trends group	Example
Energy	Carbon capture and storage (CCS) Thin film solar cells
Rational use of nature	Vertical farming Agricultural drones

Transport	Smart roads Electric aircrafts
Information and communications technology (ICT)	Small satellites for monitoring forest fires Smart grids
Nanotechnology	Membranes for fuel cells Graphene for solar cells
Biotechnology	Biodiesel from microalgae Waste recycling

Source: National Research University Higher School of Economics

Further, discussions with the experts in the area of climate change were conducted in order to analyze the resulting clusters. Fig. 2 shows the integrated map of the trends groups obtained for each STEEPV category. Due to the space limitations and data confidentiality, only the main trends groups are presented on the map. The groups of trends, which were complemented by the trends from the news, are highlighted in green.

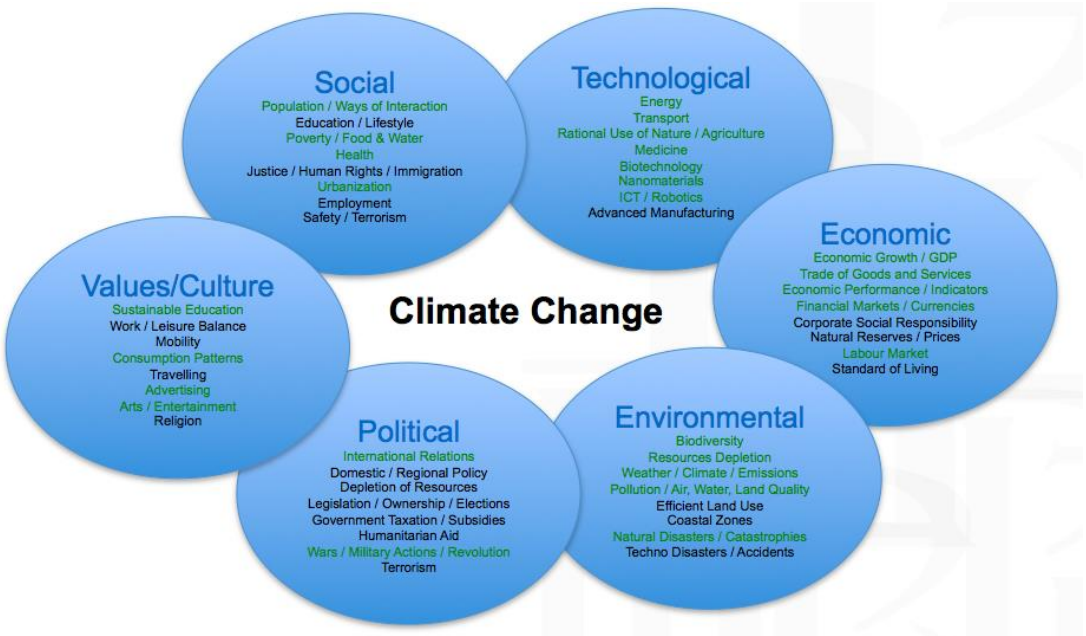

Fig. 2. The integrated map of STEEPV trends related to climate change
source: National Research University Higher School of Economics

Considering the results of analysis of the trends related to climate change, the possibilities and limitations of this study, as well as the controversial issues and the lessons learned are discussed in the next section.

4. Discussion

Studying the qualitative and quantitative lists shed light on the groups of trends related to climate change, which may influence the development of the society, the environment and the economy in the long run.

Tab. 2 shows the integrated results of the analysis of the trends groups obtained. It includes the following statistics for each of STEEPV categories: the number of trends groups received from the qualitative and quantitative lists, the percentage of validated and new added (value added) trends groups from Factiva.

Tab. 2. The results of integration of trends groups from qualitative and quantitative lists

STEEPV category	Qualitative list of trends groups	Quantitative list of trends groups	Overlapping trends groups (validated by Factiva) (%)	New (non-overlapping) clusters added from Factiva (%)	Integrated number of clusters groups
Social	6	7	4 4/8=50%	3 3/8=37.5% (high)	8
Technological	7	8	7 7/8=87.5%	1 1/8=12.5% (low)	8
Economic	6	7	5 4/8=62.5%	2 2/8=25% (medium)	8
Environmental	6	7	5 4/8=62.5%	2 2/8=25% (medium)	8
Political	4	7	3 3/8=37.5%	3 3/8=37.5% (high)	8
Values/Culture	7	5	4 4/8=50%	1 1/8=12.5% (low)	8
Total average (groups):	36	41	28 (58%)	12 (25%)	48

Source: National Research University Higher School of Economics

As can be seen from Tab. 2, there is a significant overlapping between these trends lists, which means that more than a half of the qualitative trends (58%) have been validated by the news data (Factiva). The highest degree of overlapping refers to technological category, where seven trends groups out of eight were validated. The average percentage of the Factiva trends (value added), added to the final integrated trends list accounts for 25%. This percentage is high (37.5%) for social and political categories; medium (25%) – for economic and environmental category; and low (12.5%) – for values/culture category.

4.1 Social trends

The high value added to social category can be explained by the social orientation of the discussions about climate change in the media. This dimension of sustainability is very important, and the participants are primarily interested in how climate change may affect the development of society, what challenges and risks does it evolve, and what behavioral changes does it require. Four trends groups (population; education and lifestyle; poverty, food and water; and health) were validated by the Factiva data. New trends connected with education and lifestyle, justice and human rights, and safety from natural disasters, were added from the news. The most popular trends discussed in the media are related to energy (77 265 news), agriculture (19 449 news), and transport sector (15 562 news).

4.2 Technological trends

The technological category received low value added, but the highest validation level (87.5%), which means that the news may be successfully used as an additional information source of for validating trends and getting more detailed description of them. Technological breakthroughs are not the first priority in the media discussions, and the news serves mostly for identifying socio-economic and environmental problems and challenges. Seven trends groups (energy; transport; rational use of nature; medicine; biotechnology; nanotechnology; and ICT) were validated by quantitative data, and only one trends group (advanced manufacturing) was added from the quantitative list.

4.3 Economic trends

The economic dimension of sustainability refers to “prosperity” and touches the problems, where climate change can be considered as a threat to economic growth. Rising prices for food, water and energy may be caused by falling crop yields, disruptions in supply chains and competition for scarce resources including water. Climate change influences may be extended to all economic sectors and it will affect both companies and their employees. The contribution of the trends from the news to this category is medium (25%). Five groups of trends (economic growth; trade of goods and services; economic performance and indicators; international finance; and labour market) were validated by the quantitative data, with two trends groups added (corporate social responsibility and standard of living).

4.4 Environmental trends

The medium value added (25%) from the news to environmental category may be explained by the fact that the media is used to increase awareness of environmental problems among the companies and the civil society. Five groups of trends were validated by the quantitative data (biodiversity; resource depletion; weather, climate, and emissions; pollution; and natural disasters and catastrophes), and two additional trends groups (coastal zones; technogenic disasters and accidents) were obtained from the Factiva news.

4.5 Political trends

Climate change is one of the major challenges for humankind that has to be taken up on all levels of policy making. Numerous actors need to be involved in effective international policy in this field, ranging from states to intergovernmental organizations, business corporations, civil society representatives (e.g. NGOs), and networks of scientists. The high value added of the news (37.5%) to this category can be explained by the relevance of the media as a platform for discussions and climate change debates. Three groups of trends (international relations; wars and military actions; and terrorism) were validated by Factiva data (50%), and three additional trends groups (domestic and regional policy; legislation and ownership; governmental taxation and subsidies; and humanitarian aid) were extracted from the news.

4.6 Values/culture trends

Values/culture trends are closely connected with social issues with the emphasis on the future shift in the values in the society, related to climate change problems. Through psychological research, it can be known that there is a long distance between the theoretical concept of climate change and people's everyday lives. In order to actively involve the civil society into addressing climate change it is crucial to influence and change the existing values. In our research, a half of the trends from values/culture category (sustainable education; consumption patterns; advertising; arts and entertainment) were validated by the news data, and only one trend (religion) was added from Factiva.

Discussing the results obtained, some limitations of this research need to be presented. First, due to the time constraints, in this pilot study a limited number of the experts participated in the integration and analysis the trends. The problem was also to ensure that all areas related to climate change (energy, water management, agriculture, sustainable production and consumption, etc.) are covered by the experts and there is no a significant shift towards one of them. Second, during creating a quantitative list of trends a broad query

"(climate change) AND future" was used, as the goal of this research was to create a holistic map of issues related to climate change. For more detailed analysis of trends, using a list of keyword would be more beneficial for data collection. Third, in this research the analysis was conducted mostly on the level of trends groups in order to provide the insights about the main components of this phenomenon. More detailed analysis of the trends themselves is needed for understanding their specific characteristics and interrelations. Fourth, a trend can be considered from two perspectives: as a result of climate change or/and its cause. More comprehensive framework is needed to delineate these two types and investigate the interconnections between them. Finally, more detailed analysis of the trends groups is needed in order to identify the gaps between them and divide them into demand-side and supply-side trends. In addition, is highly beneficial to use the news in combination with the other information sources (conferences, social networks, blogs, etc.) and integrate this methodology with the analysis of weak signals of future trends.

Based on the analysis of the possibilities and limitations of this study, some conclusions are made in the next section on the benefits that this approach brings to the technology monitoring.

5. Conclusion

This study proposes a multidisciplinary approach to anticipating the future trends and challenges related to climate change using the media (news) as an information source. A complex map of trends for all STEEPV categories was presented. Through applying qualitative and quantitative methods the possibilities of using the news as a data source for trends monitoring were analyzed. The results shown that the news can serve as a valuable data source for anticipating STEEPV trends: in terms of validation and complementation of expert list. The results indicated that 58% of trends from the qualitative list were validated by the news (with the highest degree of overlapping refers to technological category (87.5%)), and 25% of trends were added. The value added of Factiva was high (37.5%) for social and political categories; medium (25%) – for economic and environmental categories; and low (12.5%) – for values/cultural category. Nevertheless, the news must not be considered as an independent data source for anticipating trends related to climate change, but it could serve as complementary source for validating expert results and giving additional thoughts. Taking into consideration the multidisciplinarity of the subject area, the systemic analysis of the trends groups obtained from qualitative and quantitative sources with their interrelations, as well as more detailed investigation of the trends themselves, are needed for more deep

understanding of the future of climate change. Moreover, identifying multidisciplinary trends, which emerge at the intersection of several aspects (social, economic, environmental, etc.) and disciplines (f.e., ICT, nano, and medicine) is an open room for further research.

Acknowledgements

The article was prepared within the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) and supported within the framework of the subsidy granted to the HSE by the Government of the Russian Federation for the implementation of the Global Competitiveness Program.

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