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► To cite this version:

Prabhsimran Singh, Surleen Kaur, Yogesh K. Dwivedi, Sandeep Sharma, Ravinder Singh Sawhney. #SDG13: Understanding Citizens Perspective Regarding Climate Change on Twitter. 20th Conference on e-Business, e-Services and e-Society (I3E), Sep 2021, Galway, Ireland. pp.723-733, 10.1007/978-3-030-85447-8_60. hal-03648111

HAL Id: hal-03648111

<https://inria.hal.science/hal-03648111v1>

Submitted on 21 Apr 2022

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#SDG13: Understanding Citizens Perspective Regarding Climate Change on Twitter

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Abstract. Earth, today is facing numerous environment related problems which have put a big question on the survival of the entire existence of humankind. Climate change is one of the most significant problems that are needed to be addressed by the present generation in order to safe guard the existence of our future generations. This research work explores the use of social media by the people across the world on discussions regarding the factors driving the climate change. The statistical analysis tools were applied on the collected data to get useful insights for our research objectives. The results obtained are indicative of the concerns raised by the people belonging to different strata of society from across the continents related to the causes of climate change on social media. Further, this research work confirms the fact that social media can be efficiently used to question the governmental policies on climate control by the citizens of any country and thus raising their voice against any climate related activity while leading to increased public participation towards policy making.

Keywords: Climate Action, Climate Change, SDG13, Public Participation, Sustainable Development, Twitter Analytics.

1 Introduction

Ever since the start of this millennium, due to the pressure exerted by the environmental agencies, the governments of many countries realized that the mankind in pursuit for industrial growth has already depleted a huge chunk of the natural forest resources available on this planet. This depletion has caused an immense harm to our environment thus endangering the life on the Earth while putting a big question on the survival for our future generations. More than 170 countries came together at the Earth-Summit in 1992 and raised a common consent to construct a concrete plan of action to continue with global socio-economic development but not at the cost of harm to climate and the term “sustainable development” was first coined (Parson et al., 1992). According to Brundtland Commission, sustainable development can be

defined as a process of development which fulfils the requirements of the present keeping in check the necessities and demands of the future generations (Robert et al., 2005). Henceforth, the governments and environmental agencies of both developed as well as developing nations have been actively working hand-in-hand to accomplish UN's post-2015 Sustainable Development Goals (SDGs) for the greater good (UNDP, 2021).

In total, there are 17 Sustainable Development Goals (SDGs) namely **SDG1**: End poverty in all its forms everywhere; **SDG2**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture; **SDG3**: Ensure healthy lives and promote well-being for all at all ages; **SDG4**: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; **SDG5**: Achieve gender equality and empower all women and girls; **SDG6**: Ensure availability and sustainable management of water and sanitation for all; **SDG7**: Ensure access to affordable, reliable, sustainable and modern energy for all; **SDG8**: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; **SDG9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation; **SDG10**: Reduce inequality within and among countries; **SDG11**: Make cities and human settlements inclusive, safe, resilient and sustainable; **SDG12**: Ensure sustainable consumption and production patterns; **SDG13**: Take urgent action to combat climate change and its impacts; **SDG14**: Conserve and sustainably use the oceans, seas and marine resources for sustainable development; **SDG15**: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; **SDG16**: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; **SDG17**: Strengthen the means of implementation and revitalize the global partnership for sustainable development (UNDP, 2021).

Out of these 17 SDGs, **SDG13** is one of the most talked and discussed goal (United Nations, 2021). Climate change is indubitably the biggest threat to our planet Earth and to our goal of sustainable development (UNFCCC, 2021). Ever since industrialization, globalization, urbanization gained pace, directly or indirectly it has proved extremely harmful for the global climate. As per United Nations, the previous decade i.e., 2010-2019 has been reported as the warmest decade ever with the year 2019 being recorded as the warmest year till date (UN, 2021). Despite the endless efforts towards climate change mitigation, the levels of greenhouse gases, especially CO₂ were at record high in 2019. However, the year 2020 witnessed a fall in the levels but that was due to the worldwide economic slowdown as a result of ongoing COVID-19 pandemic. With the situation getting back to normal, once again a rise in the levels of greenhouse gases is expected. Already the average global temperature is over 1°C more than that in the 19th century and the collective worldwide emissions of CO₂ have increased by 50% after 1990 (United Nations India, 2021). Without any stringent actions, the global temperature will have risen above 3°C by the end of 21st century (United Nations India, 2021). This rapid climate change has already caused irreversible damage and is continuing to disrupt lives on Earth. Drastic changes in

weather conditions, heat waves, natural disasters like floods, cyclones and draughts, loss of biodiversity, scarcity of water and food, rising sea levels, melting of glaciers, polluted air for breathing are some of the most alarming issues we are facing today (IAEA, 2021; IISD, 2021).

Drawing motivation from the above statements, this paper explores how people globally are discussing climate change (SDG13) on Twitter. The main objective of this research is to draw valuable insights from online discussions done by people with regards to climate change on Twitter. Rest of the paper is organized as following: Section 2 discusses a brief literature review along with hypothesis development. Section 3 provides in depth into the research methodology followed. Section 4 provides finding and results, followed by discussions in Section 4. Finally, we make concluding remarks in Section 5.

2 Literature Review and Hypothesis Development

This Section is divided into two sub-sections (a) Literature Review and (b) Hypothesis Development. The first sub-section presents a brief literature review regarding social media. In second sub-section, we discuss the hypothesis which forms the foundation of our research work.

2.1 Social Media

Social media especially Twitter has seen an exponential growth in last decade. Social media have become an integral part of our everyday life, as it enables us to discuss on wide range of topics ranging from elections (Grover et al., 2019; Singh et al., 2017), public policies (Harris et al., 2014; La et al., 2020), warning for natural disasters (Chatfield et al., 2013; Singh et al., 2019), social tensions (Burnap et al., 2015), diseases/pandemics (Singh et al., 2020c) etc. Social media provide us a virtual platform where people can share their view point with like-minded people globally, without any geographical barrier, that too free of cost (Kapoor et al., 2018; Singh et al., 2020a; Singh et al., 2020b).

Recently, people started using social media to create awareness among people on topics related to planet Earth like sustainable development goals including climate change (Cody et al., 2015; Williams et al., 2015; Pearce et al., 2019). However, most of the studies, focused upon applying text mining approaches particularly focusing upon sentiment analysis. Though, these studies were instrumental in providing textual information being discussed on social media. However, these studies failed to provide valuable insights regarding the discussions taking place on social media.

2.2 Hypothesis Testing

Our research focuses on four research questions (RQ) and we try to explore how Climate Change “#SDG13” and “SDG-13” is being used on Twitter, in order to get

valuable insights regarding the discussions taking place on Twitter. Further, to statistically validate our RQ, we propose four hypothesis.

In RQ1, we explore that how SDG13 (climate change) is being discussed as compared to other SDGs on Twitter. To statistically validate RQ1, we propose the hypothesis H1.

RQ1: *How “#SDG13” and “#SDG-13” is being discussed on Twitter?*

H1: *The mean discussion on SDG13 and other SDGs is same on Twitter.*

There has been a lot of conversation on climate change among people on Twitter. However, the question remains, whether there is equal discussion on the problems arising from climate change and the possible solutions for climate change mitigation, which we try to examine through RQ2. To statistically validate RQ2, we propose the hypothesis H2.

RQ2: *Are people discussing the problems as well as their potential solutions regarding climate change on Twitter?*

H2: *The mean discussion on the problems and their potential solutions regarding climate change is same on Twitter.*

Climate action, in today’s time, is no more a cause of concern only for the environmentalists and world organizations, it is affecting each and every being on Earth. Thus, in RQ3 we compare the discussions among people belong to different sections of society on Twitter. To statistically validate RQ3, we propose the hypothesis H3.

RQ3: *Which all sections of society are discussing “#SDG13” and “#SDG-13” on Twitter?*

H3: *The mean discussion involving different sections of our society is same on Twitter.*

In RQ4, we try to investigate whether the people from developed countries & developing countries are equally aware and how deeply invested they are in the discussion regarding the climate change on Twitter. To statistically validate RQ4, we propose the hypothesis H4.

RQ4: *Were the people globally discussing regarding “#SDG13” and “#SDG-13” on Twitter?*

H4: *The mean discussion on SDG13 from developed and developing countries is same on Twitter.*

Figure 1 presents pictorial representation of the conceptual concept being investigated in the study. Hashtag usage is given on one side (SDG13, SDG-13, ClimateAction, ClimateChange). While, on the other side measures like hashtag frequency, word frequency, user-type and geo-location is given. The proposed hypothesis, H1, H2, H3 and H4 explores the relationship between the two sides.

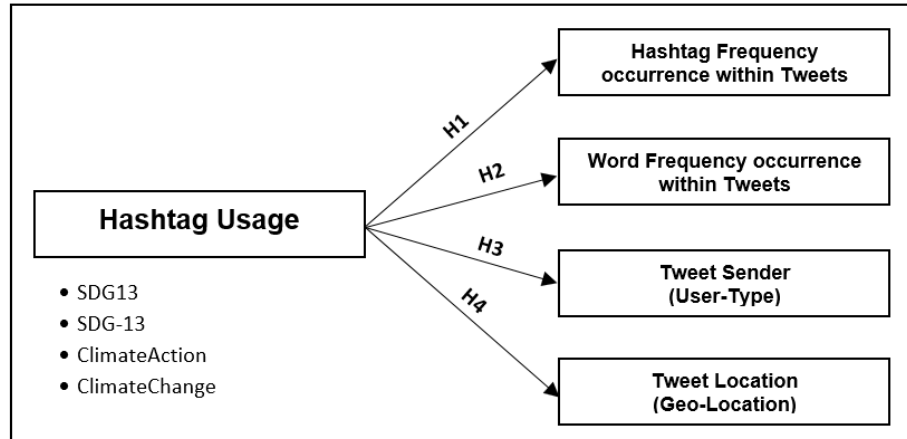


Figure 1: Conceptual Concept and Investigated in the Study

3 Research Methodology

To fulfil our research objectives, the entire process was divided three phases (data collection, data cleaning and data analysis). Phase-1, deals with data collection from Twitter, which was collected in an authenticated manner using Twitter API. For tweet collection, hashtags “#SDG13”, “#SDG-13”, “#ClimateAction” and “#ClimateChange” were used as search terms. Using these hashtags, a total of 45,874 tweets were collected from 32,715 unique senders over a period of five days (Feb 7, 2021 to Feb 11, 2021). Only the original/unique tweets were collected for analysis, and no retweet was considered for analysis. In phase-2, task of data cleaning was performed. Data cleaning is important in order to avoid any ambiguity in results (Naseem et al., 2020; Singh et al., 2018a). Finally, once data is cleaned, phase-3 comes into fray. In phase-3, statistical testing is performed in order to answer our research questions.

4 Findings and Results

In RQ1, we investigate how “#SDG13” and “#SDG-13” is being discussed on Twitter as compared to other SDGs? Hence, in this we compare the tweets associated with hashtag “#SDG13” with tweets associated with hashtags of all other SDGs. To answer RQ1, hypothesis H1 is formulated.

H1: *The mean discussion on SDG13 and other SDGs is same on Twitter.*

For H1, we apply one-way ANOVA on Tweets associated to 17 different SDGs. The results of ANOVA at 95% confidence, is F-Value=7.37 and P=1.47e-09. According to decision rule since, the value of $P < 0.05$, hence, H1 is rejected. This means that there exists significant difference between the one or more group (SDGs) in regards to discussion on Twitter.

Inference: As mentioned earlier, all SDGs are not discussed equally on social media. Some are discussed more, while some are discussed in association with others. Since, climate change is utmost important owing to extreme changes in weather conditions, heat waves, natural disasters like floods, cyclones and draughts, loss of biodiversity, scarcity of water and food, rising sea levels, melting of glaciers etc. Therefore, it is discussed more as compared to other SDGs, as found in our study. Further, Moreover, as we move towards sustainable development, SDG13 (climate action) cannot be regarded as a standalone goal, it is tightly coupled with various other goals namely SDG15 (life on land), SDG14 (life below water), SDG3 (good health & well-being), SDG7 (affordable and clean energy), SDG11 (sustainable cities and communities), SDG8 (decent work and economic growth), SDG1 (no poverty), SDG4 (Quality Education) where the developments of one largely impacts the progress of the others (IISD, 2021).

Since, there has been a lot of conversation on climate change among people on Twitter. Hence, in RQ2 we examine, whether there is equal discussion on the problems arising from climate change and the possible solutions for climate change. To answer RQ2, hypothesis H2 is formulated.

H2: *The mean discussion on the problems and their potential solutions regarding climate change is same on Twitter.*

For H2, two-tail independent t-test was applied to the tweets. The results of two-tail independent t-test at 95% confidence, is T-Value=-0.31304 and P=0.7593. According to decision rule since, the value of $P > 0.05$, hence, H3 is accepted. This means that there exists no significant difference between the discussion on the problems arising from climate change and the possible solutions for climate change.

Inference: People are discussing a lot of problems arising due to climate change on Twitter. These problems include rising temperature, food shortages, water scarcity, loss of biodiversity, extreme weather conditions, air pollution, rising sea levels, melting glaciers etc. But parallelly, groups of people are also discussing about the potential solutions of the climate change, that can not only help us but also our future generations. These solutions include renewable energy, internet of things (IoT), artificial intelligence (AI), improve education, awareness, green economy, cooperation among nations, capacity building, strengthening resilience etc (Fathi et al., 2020; Sinha et al., 2019). These discussions highlight an important point that people are not only raising alarms by sharing problems associated with climate change but also providing potential changes that one should adapt to have a sustainable future.

Climate change is affecting each and every being on Earth. Therefore, in RQ3 we examine which all sections of our society are taking part in discussion regarding climate change. To answer RQ3, hypothesis H3 is formulated.

H3: *The mean discussion involving different sections of our society is same on Twitter.*

For H3, we apply one-way ANOVA on Tweets generated by different groups of our society. For ease of experimentation, we have bundled up these groups into following groups namely organizations (NGOs, government offices, non-profit organizations, societies), eminent personalities (politicians, ambassadors, UN-representatives, diplomats, bureaucrats, special envoys), activists (climate change activists, environmentalists, ecologists, social activists), journalists (media houses, news agencies, journalists, climate journalists), celebrities (actors, actress, singers) and general public.

The results of ANOVA at 95% confidence, is F-Value=108 and $P=1.2e-15$. According to decision rule since, the value of $P < 0.05$, hence, H3 is rejected. This means that there exists significant difference between the discussion done by various section of our society on climate change.

Inference: Though, climate change is affecting almost every section of our society and many groups are raising its voice on social media regarding climate change. However, the mean discussion of various groups varies, and its mainly general public which are the major contributor in Twitter discussion. Talking about various groups, many prominent personalities and organization are taking healthy participation in Twitter discussions. These includes organizations like UN Sustainable Development Group, International Institute for Sustainable development, United Nations Industrial Development Organization. Eminent personalities like Justin Trudeau, Manuel Pulgar Vidal and Malcolm Turnbull all raised their voice regarding climate change. Similarly, activists like Great Thunberg, Leah Namugerwa, Trisha Shetty, John Paul, Luisa Neubauer, Jake Horowitz and Holly Gillibrand were also part of Twitter discussion.

In RQ4, we try to investigate whether the people from developed countries & developing countries are equally participating in the discussion regarding the climate change on Twitter. To answer RQ4, hypothesis H4 is formulated.

H4: *The mean discussion on SDG13 from developed and developing countries is same on Twitter.*

For H4, two-tail independent t-test was applied to the tweets. The results of two-tail independent t-test at 95% confidence, is T-Value=1.9864 and $P=0.05127$. According to decision rule since, the value of $P > 0.05$, hence, H4 is accepted. This means that there exists no significant difference between the discussion involving developed and developing countries.

Inference: Given the importance of climate change, the entire world is facing problems that are affecting both developed as well as developing countries. Hence, people from both developed as well as developing countries are taking healthy part Twitter discussion on climate change in order to highlight the importance and immediate action need to be taken to combat it. Figure 2 shows the result of geo-location analysis (Singh et al., 2018b; Singh et al., 2019).

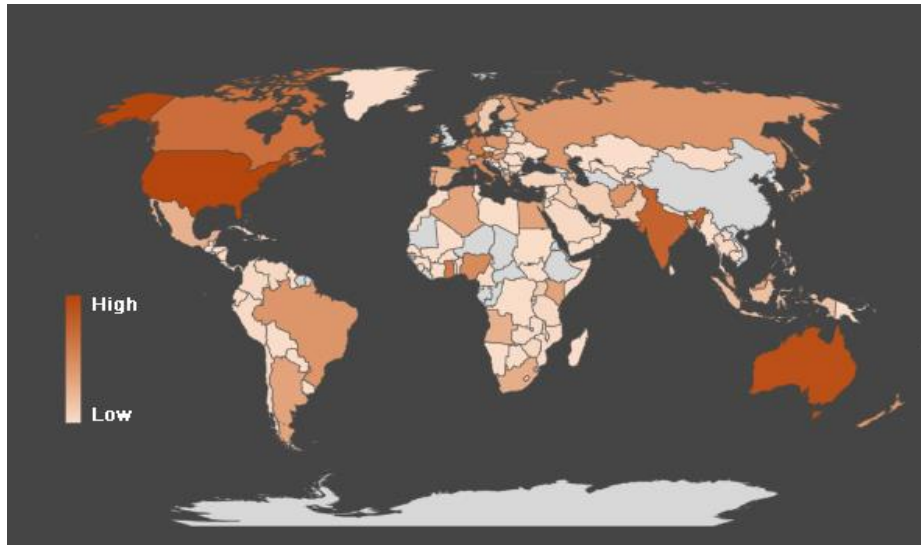


Figure 2: Result of Geo-location Analysis

5 Discussion

Ever since environment activists started realizing the importance of climate change (SDG13) and all the dangers which may bring the current as well as future generations on the verge of doubts about their survival, various protocols and treaties have been agreed upon by the member countries of the United Nations Framework Convention on Climate Change (UNFCCC) for the collective good of our planet (Climate-Change-News, 2019). This research work investigates how people globally are discussing climate change (SDG13) on Twitter and their reactions to the respective policies of their governments. Our results confirm that more and more public is becoming aware of climate deterioration and there is a continuous healthy discussion going on Twitter on climate change as well as the government policies on this issue. Further, when we discuss about SDG13, we need to be sure that it cannot be regarded as a standalone goal and it is tightly coupled with various other goals SDGs. Therefore, an integrated global action is required to increase awareness among people in this regard and both national as well as international policies, innovative strategies need to be implemented to achieve these goals (UNEP, 2021).

5.1 Implications for Practice

The implication of the study for practice can be divided into two sub-sections (a) Government (b) Citizens and Activists. These sub-sections are discussed briefly below:

- (a) Government:** Any policy or project related to environment is issued by ministry of environment, forest and climate on behalf of the government. Though, governments of both developed as well as developing countries nowadays consider the recommendations of various bodies appointed to do proper feasibility study, the cost of project should not burden climate and environment. Still, most of the times some real issues are ignored that may lead to public resentment leading to agitations by the local population and thus leading to confrontation with the government. Hence, governments can take additional measures and invite people to vote in terms of their opinions either in favor or against these projects on social media platform. In this way government can utilize the public outlook before implementation of any project or policy that might affect the local climate in particular and national environment in general (Aladwani and Dwivedi, 2018; Alryalat et al., 2017; Kar and Dwivedi, 2020).
- (b) Citizens and Activists:** In this digital era, the social media have emerged as an important platform for the people to create awareness among the unknowns and raise a collected voice of the people on topics related to climate changes on the planet Earth. Whenever the people or the activists realized that certain activity or project would severely affect the local as well as national climate and could put human lives in danger, they had raised the banner of revolt and social media have assisted their cause (Rana et al., 2020). They may start a protest trend on the social media, which can soon be strengthened by many other like-minded people and non-government organizations, ultimately raising alarms for the government to rethink about the activity or project.

6 Conclusions

In this paper, we try to highlight the importance of sustainable development and analyze the overall perception of the people all around the world in this regard using Twitter data. Out of the seventeen sustainable development goals, goal number 13, which concerns the climate action (SDG13) has been observed to be of utmost importance and the most discussed goal among the masses throughout the world on Twitter. Our planet has suffered from environment deterioration and some unprecedented challenges in the past few decades and the people now are facing the direct impacts of these man-made catastrophes and hence it warrants for urgent climate action. The main aim of this research work to examine whether this climate change discussion is only limited to the people of some developed nations and a certain section of societies or it is equally discussed globally. It is clearly inferred from the results that not only the developed nations like Sweden, France, Germany,

England, United States, Norway and Canada are working towards desired climate action; even the developing nations like India, Malaysia, African countries are equally participating. People from all over the world and from different backgrounds have become quite aware of the issues arising due to climate change and are raising their voices for resolving their concerns. There has been a constant debate and dialogue among nations regarding the climate problems that are being currently faced and will continue to face due to climate change; however, we have a long way to go before we have this issue well under control. Moreover, the accomplishment of various other sustainable development goals largely depends on climate action. Innovative solutions, national strategies, global cooperation among nations, stringent rules, awareness-drives, capacity-building are a few preliminary measures need to be implemented to achieve the set targets. The governments are shifting from use of fossil fuels to greener means like electric vehicle to cut down carbon emission and earn more carbon credits. In addition to these, the role of ICT is indispensable as we progress towards sustainability. Inclusion of technologies like internet of things and artificial intelligence can prove highly beneficial in achieving these goals in long run.

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