Saudi Arabia

Ministry of Education / Sabya

search title/

Problems and dangers of solar storms on planet Earth, their threat to human life and their relationship to climate.

Student's name/

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Abstract:

Solar storms are massive explosions on the surface of the Sun that release large amounts of energy and charged particles, which can affect Earth. They can disrupt communications and satellites, cause power outages, and pose a danger to astronauts and airplanes. Although the atmosphere protects us from radiation, their effects on modern technology require constant monitoring and preventive measures, and through my research I began to propose questions.

Questions:

- Do solar storms affect planet Earth and human life?
- Is there a relationship between solar storms and climate change?

Hypothesis:

1- Solar storms affect planet Earth and human life.

2- There is a relationship between solar storms and climate change.

Procedures:

I used the descriptive survey method and created a questionnaire, distributed it to a random sample, and then analyzed the results.

Conclusions:

The relationship between solar storms and planet Earth is directly proportional in effect, meaning that the more intense the solar storms, the greater their negative impact on Earth and its effect on the climate.

Terminology:

Solar storms : are disturbances resulting from strong emissions from the Sun

Earth: is the third planet in the solar system, and the only one known to have conditions that support life.

content list :

Summary:

Solar storms occur on the surface of the Sun, where it releases large amounts of energy that significantly impact Earth. These storms can cause disruptions in communications, satellites, and power outages, and pose a danger to astronauts and aircraft. Although these storms are rare, their effects on modern technologies can be substantial.

Research Questions:

- What are the effects of solar storms on Earth and human life?
- Is there a relationship between solar storms, planet Earth and climate change?

Hypotheses:

1. There is a planet that assists solar storms and is affected by them.

2- There is a relationship between solar storms and their impact on Earth and climate change.

Variables:

- **Independent variable**: Solar storms.
- **Dependent variable:** Earth and human life.

Research Objectives:

To study the potential effects on human health and Earth.

Learn about the relationship between solar storms and climate change.

Research Importance:

This research contributes to reducing the risks posed by solar storms, helping to protect modern technology and ensuring the safety of humans, both on Earth and in space.

Research Limitations:

Objective: Problems and dangers of solar storms on planet Earth, their threat to human life and their relationship to climate

Temporal: Year 2025.

Spatial: Planet Earth.(Al-Mattan School)

Research Terms:

• **Solar Storms**: Disturbances caused by powerful emissions from the Sun.

• **Human:** A rational living being characterized by the ability to think, learn, and adapt to the environment.

• **Planet Earth:** The third planet in the solar system, the only one known to have conditions that support life.

• **Aurora Borealis:** A natural light phenomenon that appears in the skies of polar regions, caused by the interaction of charged particles from solar winds with Earth's atmosphere, leading to colorful, moving lights in the sky.

Climate: is the description of the weather conditions over a long period.

Introduction:

The Sun plays a fundamental role in life on Earth, being the primary source of energy and light. However, solar activity is not limited to light and heat alone; it also includes powerful phenomena known as solar storms, which are massive emissions of charged particles and magnetic fields that can affect Earth in various ways.

Solar storms are significant astronomical phenomena, as they can cause disturbances in Earth's magnetic field, leading to widespread impacts, such as disruptions in communication systems, satellites, and effects on power grids and air navigation. They can also affect human health, particularly astronauts and airline passengers, due to increased exposure to cosmic radiation.

This research aims to study solar storms, their causes, and their effects on planet Earth, human health, and climate change, in addition to reviewing methods for predicting them and preventing their negative effects.
Solar storms have effects on climate, as they can affect the Earth's atmosphere and change temperatures and humidity. Here are some relationships between solar storms and climate:

Effects of solar storms on climate:
- Temperature changes: Solar storms can affect temperatures in the Earth's atmosphere, leading to changes in temperatures on the Earth's surface.
- Humidity changes: Solar storms can affect the humidity in the Earth's atmosphere, leading to changes in humidity on the Earth's surface.
- Atmospheric pressure changes: Solar storms can affect the atmospheric pressure in the Earth's atmosphere, leading to changes in the atmospheric pressure on the Earth's surface.
- Atmospheric current changes: Solar storms can affect the atmospheric currents in the Earth's atmosphere, leading to changes in the atmospheric currents on the Earth's surface.
Effects of solar storms on human activities:
- Effects on agriculture: Solar storms can affect agriculture, as they can lead to changes in temperature and humidity, which affects plant growth.
- Effects on air transport: Solar storms can affect air transport, as they can lead to changes in air currents and atmospheric pressure, which affects the safety of aircraft.
- Effects on electrical grids*: Solar storms can affect electrical grids, as they can lead to changes in electrical currents, which affects the integrity of the grids.

Effects of solar storms on the environment:
- Effects on the atmosphere*: Solar storms can affect the Earth's atmosphere, as they can lead to changes in temperature and humidity.
- Effects on oceans*: Solar storms can affect oceans, causing changes in temperature and humidity.

- Effects on ecosystems*: Solar storms can affect ecosystems, causing changes in temperature and humidity, affecting plant and animal growth.

Impact of Solar Storms on Earth:

1. Disruption of Communications and Navigation: Solar storms can cause disruptions to GPS signals and radio communication.

2. Impact on Satellites: They can damage electronic devices or alter the orbits of satellites.

3. Power Outages: Solar storms can induce electric currents that lead to failures in power grids.

4. Aurora Borealis: The aurora may appear in unusual locations due to disturbances in the magnetic field.

Impact of Solar Storms on Humans:

Health Effects:

• Increased Radiation: Solar storms can raise radiation levels in the upper atmosphere, potentially affecting air travelers, especially on polar routes.

• Risk to Astronauts: Astronauts may be exposed to high levels of radiation, increasing the risk of diseases such as cancer or neurological disorders.

• Potential Impact on the Human Body: Some studies suggest that magnetic storms may affect blood pressure and mood in certain individuals, though this has not been scientifically proven conclusively.

Impact on Daily Life:

• Disruption of Communication and Navigation Systems: Solar storms can lead to the loss of GPS signals and wireless communications.

• Power Outages: They can affect power grids, causing disruptions to essential services such as hospitals, the internet, and transportation.

• Satellite Malfunctions: This could impact television broadcasting, internet services, and communications.

The Relationship Between Solar Storms and the Aurora Borealis:

1. Solar Storms Release Charged Particles: During solar storms, the Sun releases massive amounts of charged particles (electrons and protons) through solar winds. These particles interact with Earth's magnetic field, resulting in the aurora borealis.

3. Increased Aurora During Strong Storms: The stronger the solar storm, the wider the aurora borealis can reach, making it visible in areas far from the poles.

4. Interaction with the Atmosphere: The particles enter the upper atmosphere, where they interact with oxygen and nitrogen, leading to the emission of bright colors such as green, red, and purple, as shown in **(Figure 1).**

(Figure 1)

How can solar storms be predicted?

Solar activity is monitored using several methods:

1- Solar telescopes

It is used to monitor sunspots and solar flares to determine the likelihood of solar storms occurring.

2 satellites dedicated to observing the sun

SOHO (Solar and Heliospheric Observatory) like satellite

Which constantly monitors the sun and gives early warnings of any unusual solar activity.

3 - Computer models and space weather forecasts

Supercomputers are used to simulate changes in space weather and provide early warnings

Previous Studies:

Solar storms are astronomical phenomena that have received significant attention in scientific research due to their potential effects on Earth and human health. Below are some notable studies in this field:

1. The Impact of Solar Storms on Technical Infrastructure:

A study published on the “Al Jazeera” website indicated that strong solar storms could cause disruptions in power grids and communication networks, leading to significant economic losses. For example, these storms can affect Global Positioning Systems (GPS) and satellites, resulting in service interruptions.

2. The Potential Health Effects of Solar Storms:

According to an article published on the “UltraSawt” website, solar storms do not directly impact human health due to the Earth’s atmospheric protection. However, indirect risks may arise from power and communication outages, which could put people at risk in emergency situations.

3. Geomagnetic Storms and Heart Health:

A study published by the U.S. National Library of Medicine reported that disturbed geomagnetic activity could exacerbate certain health conditions, such as irregular heartbeats, cardiovascular diseases, increased blood pressure, and epileptic seizures.

4. The Impact of Solar Storms on Satellites:

According to an article on the Arabi Post website, geomagnetic storms can increase the drag on satellites, making their orbits more difficult to control. Additionally, satellite electronics may suffer damage due to the accumulation and discharge of static electric charges, which can affect their performance and functionality.

5. Solar storms.. How climate change increases their danger on Earth

The severity of the effects resulting from solar storms is closely and directly linked to the phenomenon of climate change.

Materials and Method (Procedures):

Tools:

GLOBE devices (GPS – thermometer – hygrometer – pen – paper – computer – barometer – cloud chart) GLOBE Environmental Website.

Image of the tools used (2)

❖ Questionnaire.

A. Preparing the study tool: The research questionnaire was built, and in its final form it consisted of (10) paragraphs, and the questionnaire was distributed to a random sample.

B. Validity of the research tool: The researcher presented the questionnaire to a random sample to express an opinion on this test in terms of: its suitability to the research topic, its comprehensiveness, and the sufficiency of the number of elements to enrich the research. The researcher obtained some constructive opinions and comments, in light of which she modified some paragraphs and approved them, so that it became in its final form.

C. Stability of the research tool: The stability of the research tool (questionnaire) was confirmed and high stability rates were observed for all areas of the questionnaire, and the research tool enjoyed stable results if it was reapplied to the research sample again, which confirms its suitability for field application.

Steps:

ϖ The descriptive survey method was used.

• The questionnaire was used.

Display of results:

Statistical methods:

To achieve the research objectives and analyze the data collected, the arithmetic mean was used to determine the trends of the responses of the research sample members.

Ratios and frequencies: One of the important steps in preparing scientific research is determining the research sample. The researchers chose the sample randomly, as its number reached (60) from the study community and a random sample of (50) was taken from it, representing a percentage of (83%)

Analysis and results:

From the table and statistical chart, we notice the percentage of the impact of solar storms on the questionnaire study tool.

Table No. 1

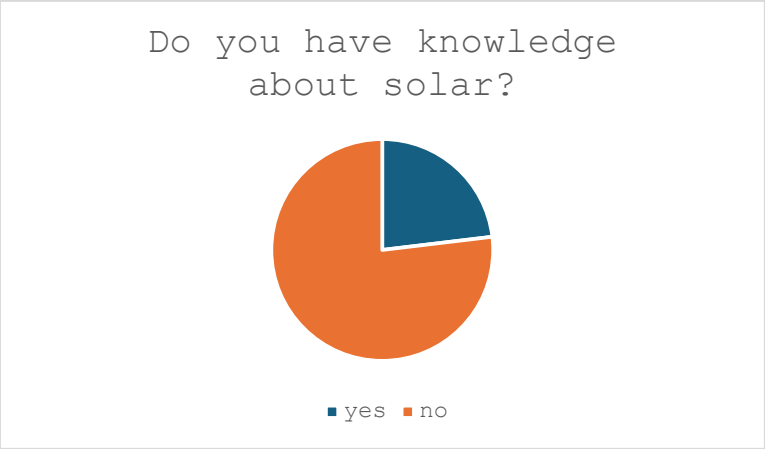
	Paragraphs	**DESCENT**				**TOTAL**
1	Do you have knowledge about solar storms?	Yes 23.1%	No 76.9%	_	_	**100%**
2	Where did you get your information about solar storms?	Internet 46.2%	Books 21.2%	TV 9.6%	Other sources 23%	**100%**
3	How do solar storms affect communication systems and satellites?	44.2% Strong	Average 21.2%	Weak 1.9%	I don't know 32.7%	**100%**
4	Do you think solar storms can affect power grids?	Yes 59.6%	No 28.8%	Not sure 11.5%		**100%**
5	How concerned are you about the impact of solar storms on daily life?	Very worried 28.8%	Anxiety 40.4%	Low anxiety 17.3%	Not worried 13.5%	**100%**
6	Do you think solar storms can affect human health?	Yes 63.5%	NO 15.4%	Not sure 21.2%		**100%**
7	In your opinion, what are the most likely health effects of solar storms?	Effect on the heart 31.4%	Sleep disturbances 25.6	Increased headache 31.4%	No effect 11.7%	**100%**
8	Have you ever felt strange health symptoms that coincided with strong solar activity?	Yes 75.4%	No 24.6%			**100%**
9	Do you think there is enough awareness about solar storms and their impact?	Yes 25%	No 46.2%	Somewhat 28.8%		**100%**
10	Do you think solar storms have an effect on astronauts?	Yes 53.8%	No 11.5%	Maybe 34.6%		**100%**

Discussion and explanation of reasons:

From the table and graph, we conclude that

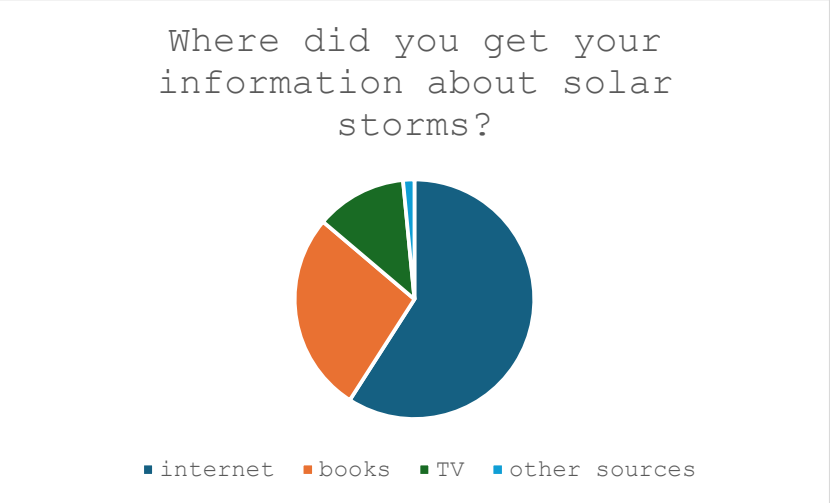
The percentage of answers and opinions for the first paragraph: Do you have sufficient knowledge about solar storms

(Figure 3)



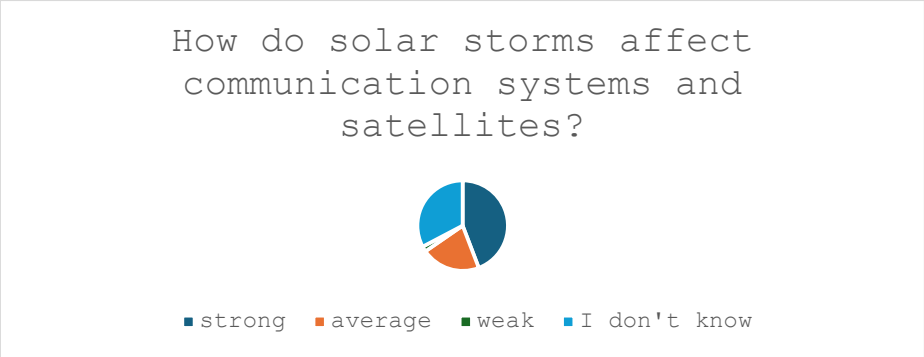
The percentage of answers and opinions for the second paragraph: Where did you get your information about storms?

(Figure 4)



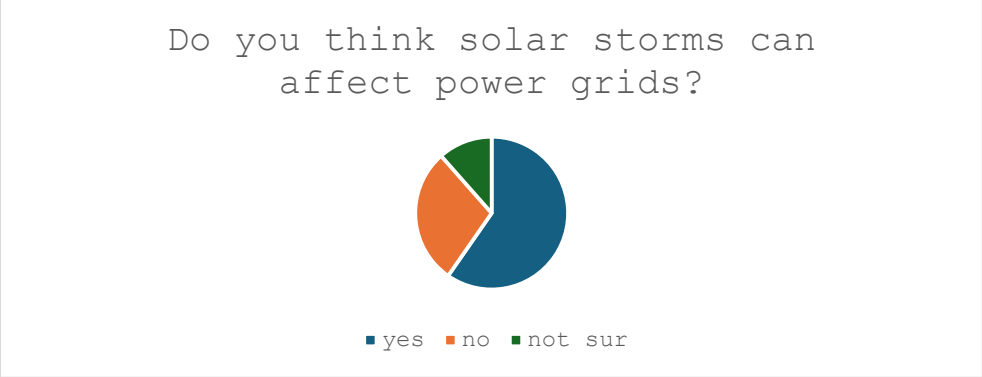
Percentage of answers and opinions for the third paragraph: What is the extent of the impact of solar storms on communication systems and satellites?

(Figure5)



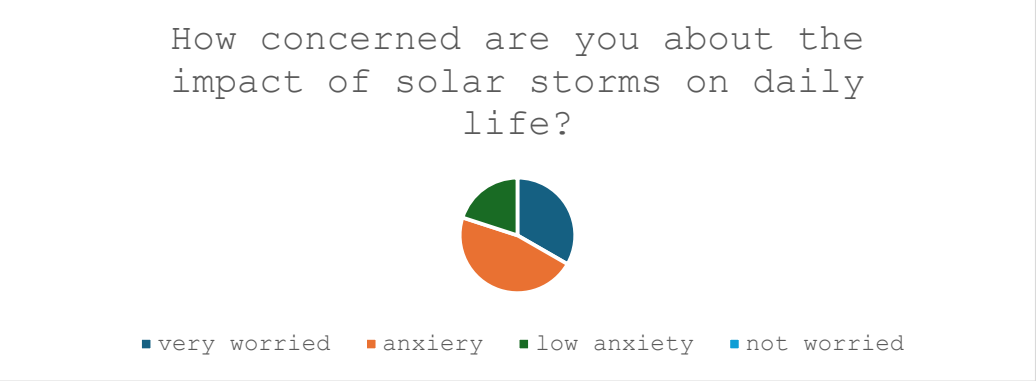
Percentage of answers and opinions for the fourth paragraph: Do you think that solar storms can affect electricity networks?

(Figure 6)



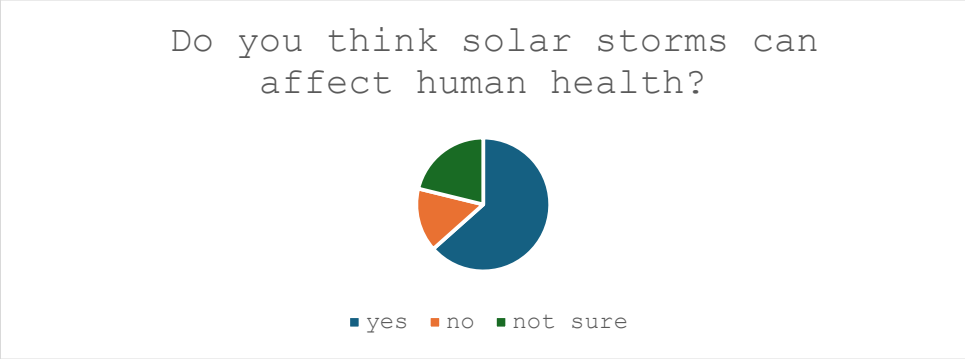
Percentage of answers and opinions for the fifth paragraph: How concerned are you about the impact of solar storms on daily life?

(Figure 7)



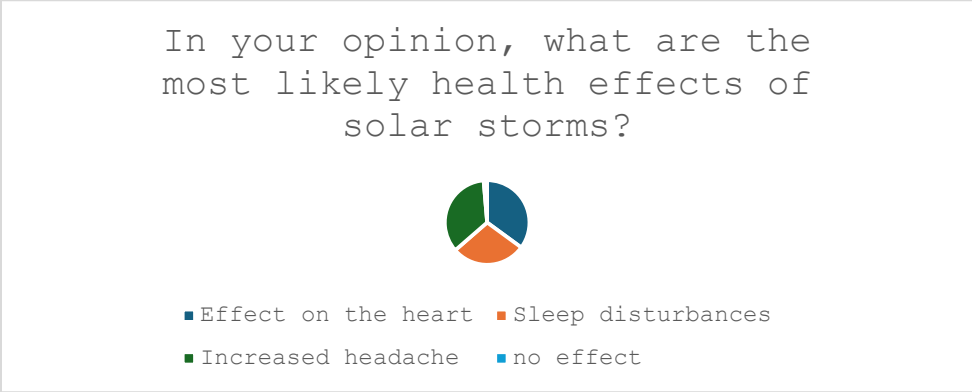
Percentage of answers and opinions for the sixth paragraph: Do you think that solar storms can affect human health?

(Figure 8)



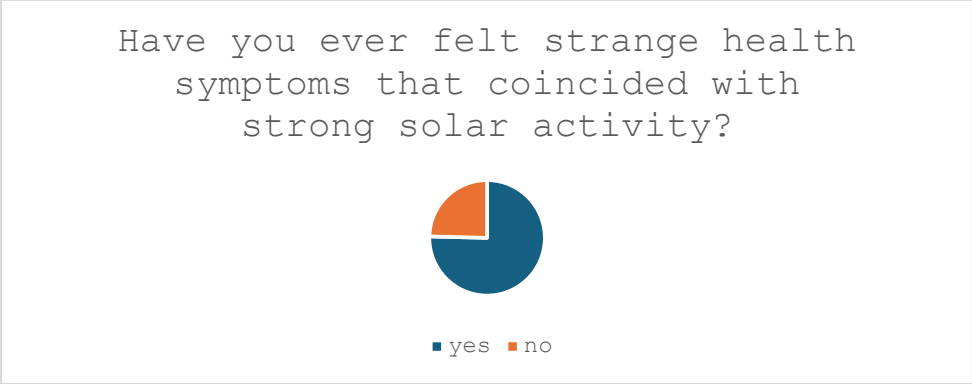
Percentage of answers and opinions for the seventh paragraph: In your opinion, what are the most likely health effects of solar storms?

(Figure 9)



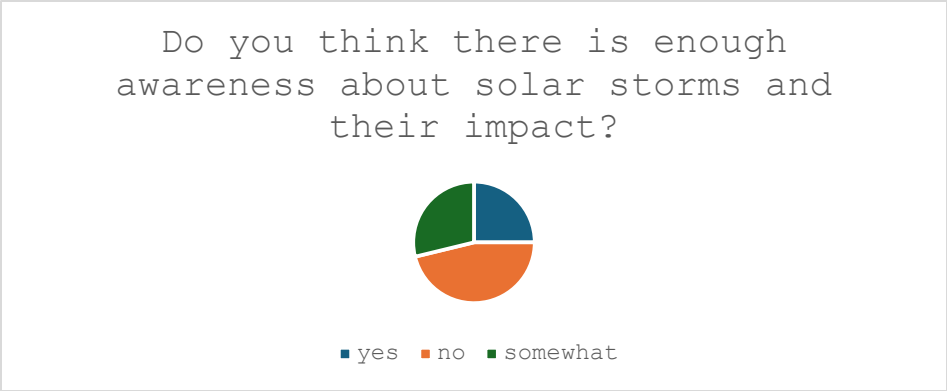
Percentage of answers and opinions for the eighth paragraph: Have you ever felt strange health symptoms that coincided with strong solar activity?

(Figure 10)



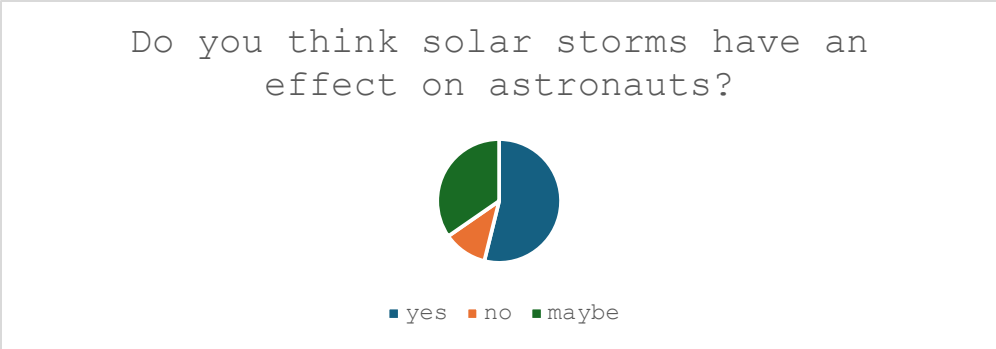
Percentage of answers and opinions for the ninth paragraph: Do you think there is awareness about solar storms and their impact?

(Figure 11)



Percentage of answers and opinions for the tenth paragraph: Do you think that solar storms have an effect on astronauts?

(Figure 12)



Key Findings from the Statistical Analysis:

1. Awareness of Solar Storms:

• 76.9% of participants have no knowledge of solar storms, while only 23.1% are aware of them.

2. Sources of Information on Solar Storms:

• 46.2% of participants obtained their information from the internet, 21.2% from books, 9.6% from television, and 23% from other sources.

3. Impact of Solar Storms on Communication Systems & Satellites:

• 44.2% believe the impact is strong, 21.2% consider it moderate, 1.9% think it is weak, while 32.7% are unsure.

4. Effect on Electrical Grids:

• 59.6% believe solar storms can affect electricity, 28.8% disagree, and 11.5% are uncertain.

5. Concern About the Impact on Daily Life:

• 28.8% are highly concerned, 40.4% are somewhat concerned, 17.3% have slight concerns, and 13.5% are not worried.

6. Impact on Human Health:

• 63.5% believe solar storms affect health, 15.4% disagree, and 21.2% are uncertain.

7. Most Common Health Effects of Solar Storms:

• 31.4% associate solar storms with increased fatigue, 31.4% with sleep disturbances, 25.6% with exhaustion, and 11.7% believe there is no impact.

8. Experiencing Physical Symptoms During Solar Storms:

• 75.4% have felt physical symptoms associated with solar storms, while 24.6% have not noticed any.

9. Sufficiency of Awareness Regarding Solar Storms & Their Impact:

• Only 25% believe awareness efforts are sufficient, 46.2% think they are insufficient, and 28.8% believe awareness is limited.

10. Effect of Solar Storms on Astronauts in Space:

• 53.8% believe the impact is significant, 11.5% disagree, and 34.6% are uncertain.

Conclusions:

This study found that there is a general lack of knowledge about solar storms and their effects. A significant percentage of participants are unaware of their dangers, despite expressing concern about their impact on electricity, health, and communication networks. Additionally, public awareness of the issue remains limited, highlighting the need for increased education and awareness.Scientific research plays a crucial role in understanding the effects of solar storms, developing solutions, and emphasizing the importance of studies that contribute to mitigating their risks on Earth and human health.

Discussion:

Many studies confirm the harmful effects of solar storms on Earth and human health, aligning with the findings of this research. However, the current study focuses on developing solutions and stressing the importance of protection and preparedness measures to reduce the risks of solar storms on Earth and in space.

Protection and Preparedness for Solar Storms:

Securing Electrical Grids:

• Some countries are developing protection systems for power grids to prevent damage caused by solar storms, such as installing backup transformers and shielding power stations.

Protecting Satellites:

• Precautionary measures are taken, such as placing satellites in “safe mode” during strong solar storms to reduce their exposure to radiation.

Raising Awareness:

• Governments and scientific institutions should work to increase public awareness about solar storms, their effects, and the necessary preventive measures.

Monitoring Space Weather:

• Space agencies such as NASA, ESA (European Space Agency), and NOAA (National Oceanic and Atmospheric Administration) provide regular forecasts on solar activity. These reports help organizations take necessary precautions in case of solar storms.

Is There a Real Threat from Solar Storms?

• Strong solar storms are rare, but when they occur, they can have catastrophic effects on modern technology, especially if there are no prepared contingency plans.

• The last powerful solar storm, known as the Carrington Event (1859), caused severe disruptions to communication systems and led to visible auroras in unusual locations. If a similar storm occurred today, it could cause major disturbances and disrupt modern technology.

• Solar storms are natural phenomena that cannot be prevented, but their impact can be minimized through prior planning, the development of protective systems, and public awareness. It is crucial to follow news updates and scientific reports to prepare for such events in the future.

How to Reduce the Effects of Solar Storms:

Although solar storms cannot be prevented, precautionary measures can be taken to minimize their impact on infrastructure and technology. These include:

1. Protecting Electrical Grids

• Installing backup transformers

• Using geomagnetic storm protection devices (GIC) to prevent excessive electrical currents that could damage main transformers.

• Implementing circuit breakers to shield the grid from unnatural current surges.

• Enhancing electrical grid resilience

• Upgrading electrical infrastructure and developing new materials that can withstand magnetic fluctuations caused by solar storms.

• Storing backup energy by relying on batteries and solar energy to reduce dependence on power grids during outages.

2. Protecting Communication Systems and Satellites

• Designing more resilient satellites

• Using radiation-resistant materials in satellite construction.

• Switching satellites to “safe mode” during high solar activity.

• Improving ground-based communication systems

• Strengthening ground communication networks to reduce reliance on satellites during strong solar storms.

• Providing alternative communication methods.

• Developing systems that do not depend on electronic communication in emergencies, especially for aviation and maritime sectors.

3. Personal Protection and Reducing Health Effects

Raising Awareness of Possible Health Effects:

• Spreading awareness about how solar storms affect sleep and mood, and ways to cope with them, such as reducing exposure to intense magnetic fields.

Protecting Astronauts and Pilots:

• Reducing air travel in polar regions during strong solar storms, as radiation exposure is higher.

• Using radiation shielding in spacecraft to protect astronauts from exposure.

4. Early Warning and Emergency Planning

Monitoring Space and Atmospheric Phenomena:

• Space agencies such as NASA and the National Oceanic and Atmospheric Administration (NOAA) provide early forecasts of solar storms, helping to take precautionary measures in time.

Developing National Emergency Plans:

• Governments can develop emergency plans, including protective measures for power grids, communication networks, and aviation to mitigate the impact of solar storms.

Increasing Research and Studies:

• Investing in space science and technology to improve solar monitoring accuracy and detect solar storms well in advance**.**

Challenges:

1. Lack of Equipment and Data in Polar Research Programs.

2. Rarity of Direct and Modern Data: Strong solar storms are rare, making it difficult to collect detailed information on their long-term effects.

3. Complexity of the Phenomenon: Understanding solar storms requires knowledge of astrophysics, geomagnetic physics, and space weather, making research difficult for non-specialists.

4. Impact on Multiple Fields: Solar storms affect various sectors such as electricity, communications, and health, complicating research efforts.

5. Limited and Inconsistent Sources of Information.

6. Need for Specialized Satellite Monitoring: Studying solar storms requires data from dedicated satellites, which are not always available for future monitoring.

7. Continuous Changes in Solar Activity: The Sun follows an 11-year activity cycle, meaning solar storm effects vary over time, requiring continuous updates to research.

Acknowledgment:

I would like to extend my sincere thanks and appreciation to my dear family, who have always been my first supporter, and each member of them has had a great impact on my career, especially my dear father, who is the one who came up with the idea and the greatest motivation for me to continue and progress, so I have all my love and appreciation for his valuable support and guidance. I would also like to thank Ms. Faiza Bahri, the environmental globe teacher, specializing in BA in Geography, who provided me with all sincerity in following up on my research, and she was a support for me in every step, so she has all my respect and appreciation. I would also like to thank my school, which provided me with knowledge and education in a stimulating and supportive environment. I conclude with thanks and loyalty to my beloved country, which I am proud to belong to, and I ask God to keep it safe and prosperous forever. I would like to thank the activity supervisor in the Sabya Education Department, teacher Najla Khawaji, and the science teachers at the school, teacher Ashwaq Al-Subaie, specializing in physics, teacher Awali Attia, specializing in biology, and teacher Reem Al-Rashidi, specializing in computer science.

References:

1. Scientific studies and research articles:

• "The Solar-Terrestrial Environment and Space Weather"

This study, published in the Geophysical Research Letters journal, examines the effects of solar storms on Earth, including their impact on Earth's magnetic field and the changes that result from these storms.

• "Space Weather: Its Effects on Earth and Human Activities"

In this study, researchers discuss the effects of solar storms on communication technologies and power grids, as well as their environmental impact on living organisms.

• "Impact of Solar Storms on Earth's Magnetosphere"

An academic article published in the Astronomical Journal about the effects of solar storms on Earth's magnetic field, especially during periods of high solar activity.

2. Specialized Books:

• "Space Weather: The Physics Behind a Slogan"

This book, authored by Heidi L. Stenborg, provides a detailed explanation of space weather science, including solar storms and their interactions with Earth. The book covers topics scientifically, supported by studies and modern data.

• "Introduction to Space Weather"

Written by Mark Moldwin, this book explains the fundamentals of space weather and the effects of solar storms on Earth, including their impact on artificial satellites and power grids.

3. Scientific Journals and Periodicals:

• Journal of Geophysical Research: Space Physics

A peer-reviewed scientific journal that publishes research articles on topics related to solar storms and their impact on Earth's system. It includes recent articles and reviews of previous studies.

• Space Weather: The International Journal of Research and Applications

This journal focuses on studying space weather and the effects of solar storms on Earth. It publishes numerous studies related to the development of solar storm prediction model

4. Research published by space agencies: NASA:

NASA provides many researches and studies on solar storms on its official website. You can find scientific reports and articles explaining the effects of solar flares and coronal mass ejections on Earth.

NASA website link: NASA Space Weather

European Space Agency (ESA)

The European Space Agency publishes studies and research on the effects of solar activity on Earth and space objects.

ESA: ESA Space Weather

This is a study from the German Aerospace Center (DLR) that focuses on how solar activity affects the Earth in terms of magnetic changes and radiation effects on the environment.

Sunspot count chart at LSES Solar Cycle for the Last Yearshttps://www.swpc.noaa.gov/products/solar-cycle-progression

a poster

https://drive.google.com/file/d/1VI69lEOWnxOXmRIZLVM0EnujDVpJn4fr/view?usp=drive_link

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