Meteorology Can Be a Key to Enhance Environmental Wellness

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Abstract

The effects of Earth's warming are impacting all living beings because we all live in one big and connected global-climate system. While countries from all over the world are pledging to reverse climate change, they do not stand on the same level playing field.

At COP27, Global South managed to convince Global North to drop its opposition to a "loss and damage" fund to help developing countries that face some of the worst climate impacts. There is no doubt that financing is a key to helping level the playing field. But, funding is finite.

In this paper, I raised two points for consideration: One, all countries should work hard to combat climate change, to reach their 2050/2060 pledge. However, they should not lose sight of the need to deal with the increasingly frequent and severe climate threats we are currently experiencing. Two, certain nations have existing skills, experience, facilities, and systems that can accurately forecast weather and provide early warning so that the appropriate adaptive actions can be taken. The haves should help the currently have nots on the preventative front so that we can all build on existing experience for the entire world to become more climate resilient.

Meteorology - Study of the Atmosphere

Ancient Greeks invented the term "meteorology," the study of atmospheric disturbances. Aristotle is considered the founder of meteorology. Around 340 BC, Aristotle tried to explain the weather through the interaction of the four elements: earth, fire, air, and water. His student Theophrastus produced the first book on weather signs, listing observations used to forecast weather, many of which are still used to this day.[1]

In today's term, meteorology is a science that deals with the atmosphere and its phenomena. Such phenomena impact every bit of human lives and affect the ecology and survival of other living beings.

Weather is the conditions of the atmosphere over a short period of time, and climate is how the atmosphere behaves over relatively long periods of time.[2]

Climate Change

Meteorology is concerned with long-term trends in climate. Climate change is on the minds of many people and certainly on the agenda of most countries.

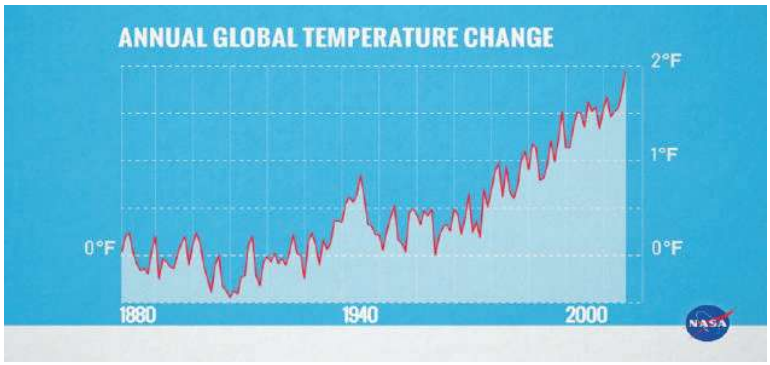
Climate change describes a change in the average conditions in a region over a long period of time. Global climate change refers to the average long-term changes over the entire Earth. These include warming temperatures and changes in precipitation, as well as the effects of Earth's warming, such as rising sea levels, shrinking mountain glaciers, ice melting at a faster rate than usual in Greenland, Antarctica, and the Arctic, and changes in blooming times of flowers and plants.[3]

Earth's climate has constantly been changing - even long before humans came into the picture. However, scientists have observed unusual changes recently. For example, Earth's average temperature has been increasing much more quickly over the past 150 years than they would expect.

Some parts of Earth are warming faster than others. But, on average, global air temperatures near Earth's surface have

gone up about 2°F (~1.1°C) in the past 100 years.

Figure 1: Change in Annual Global Temperatures, 1880-2016



Source: NASA's Goddard Space Flight Center, https://climatekids.nasa.gov/climate-change-meaning

Many people, including scientists, are concerned about this warming. Oceans, land, air, plants, animals, and energy from the Sun all have an affect on one another - Earth's climate functions like one big, connected system. As Earth's climate continues to warm, the intensity and amount of rainfall during storms such as hurricanes is expected to increase. Droughts and heat waves are also expected to become more intense as the climate warms.

When the whole Earth's temperature changes by one or two degrees, that change can have big impacts on the health of Earth's plants and animals, and, obviously, human beings.

Climate Pledges from Countries Around the World

Approximately 2.5 trillion tons of carbon dioxide equivalents (CO_2e) have been released into the atmosphere since humans started emitting carbon dioxide (CO_2). We continue to release 50 billion tons of CO_2e each year, a major cause of global warming.[4]

Climate change represents a pressing and potentially irreversible threat to human societies and the planet. In December 2015, 193 parties (192 countries plus the EU) adopted the Paris Climate Agreement. The long-term temperature goal of this international treaty is to strengthen the global response to the threat of climate change by "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."

According to a United Nations report issued on October 26, 2022, countries around the world are failing to live up to their commitments to fight climate change, pointing Earth toward a future marked by more intense flooding, wildfires, drought, heat waves, and species extinction.[5]

Without drastic reductions in greenhouse gas emissions, the report said, the planet is on track to warm up by an average of 2.1-2.9°C, compared with pre-industrial levels, by 2100. That is far higher than the goal of 1.5°C set by the landmark Paris Agreement in 2015, and it crosses the threshold beyond which scientists say the likelihood of catastrophic climate impacts significantly increases.

Expand Use of Meteorological Data to Enhance Environmental Wellness

While climate change is a worldwide issue that demands immediate and concerted actions, we need to pay attention to

and deal with weather conditions that the world is currently facing.

Record-breaking storms, forest fires, droughts, heat waves, and floods are resulting phenomena of climate change, which prompted countries to pledge efforts and embark on a long and challenging journey to reverse. We, however, should not lose sight of the present, on how we should adapt the appropriate steps and put forward solutions to handle effects of climate change - something happening right now, in increasingly frequent intervals, and negatively impacting people's life around the world.

Modern weather prediction works when meteorologists gather large amounts of data from accurate sensing devices on Earth and in space about past and current weather and use complex computer programs to estimate future weather.[6]

I, like the majority of the population, use weather forecast to determine if I should bring an umbrella or wear a pair of sunglasses when going outdoor, put on layers of clothes or what not. In a larger sense, accurate weather forecast has much bigger implications. Accurate weather forecast beyond a week, for example, as pointed out by a Brookings report, "matters a lot to a farmer who has to decide on optimal timing for planting, harvesting, and irrigation; or an electric utility manager who needs to plan for the expected supply of solar or wind energy to the grid. It matters to airport, train, and truck operators who worry about major weather events impeding their functions; to those engaged in preparation for and prevention of weather-related disasters; and to insurers who need accurate historical and projected weather and climate data to assess price risks.[7]

Accurate weather forecast is needed to develop appropriate measures to control and mitigate weather-related disasters, protect people's lives and properties, and keep economic loss to the possible minimal. In fact, meteorology, if applied appropriately in different facets of society, not only can reduce climate change's negative impact in our society but can possibly increase positive impact.

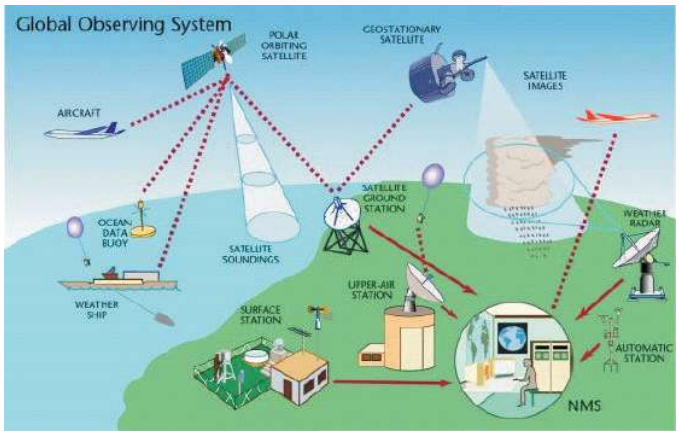
Improving Weather Forecast is Key

As asserted by the Brookings report, improve weather forecasts to reach the highest possible prediction accuracy for future trends in global, regional, and local climate change depends on the quality of the "value chain." This can lead to better weather forecasts, early warnings, and climate services. The chain starts with weather data collected in many locations around the globe. These data are shared and uploaded into global weather prediction models that are used for all global, regional, and local weather and climate predictions. These predictions are disseminated to commercial and government users as well as potentially affected populations, all of whom benefit in terms of improved economic production, disaster preparedness, and risk mitigation.

Weather stations collect data on land and sea. Weather balloons, satellites, and radar collect data in the atmosphere.

The huge amounts of data collected constantly by a vast array of weather devices all over the world make weather forecast models as accurate as they are now. Today, thousands of instruments all over the world, as well as in space, are constantly recording and transmitting data to scores of weather networks. National Weather Service (NWS) of the United States noted that weather satellites are an important observational tool for all scales of its forecasting operations - satellite data provides a global view, and is complemented by land-based systems such as radiosondes, weather radars, and surface-observing systems.[9]

Figure 2: Global Observing System



Source: Climate Currents, https://climatecurrents.org/ways-and-scope-of-measuring-weather

The United States Dominates the Field of Meteorology

There are different meteorology institutions around the world, and most of them are government agencies. Of the 54 government agencies listed on Wikipedia, nine are U.S. agencies.[10]

In addition to these nine government agencies, the National Aeronautics and Space Administration (NASA), an independent agency of the U.S. Federal Government, is a strong contributor to the national weather-forecasting goals, primarily through the development and use of data from space-based sensors. Rose Croshier, Policy Fellow at Center for Global Development (CGD), affirmed that space-based services make up a growing slice of the data mosaic necessary to build a strong forecast. They tend to specialize in large weather patterns and can cover gaps left by a deficit of radar and other surface and air-based sensors.[12]

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Further, of the best universities for meteorology and atmospheric science in the world - listed by EduRank - based on their research performance in these disciplines, 13 of the Top 15 are located in the U.S., and only one each in the U.K. and Japan.[13]

Satellites Orbiting Earth [14]

As of September 1, 2021, Earth has 4,550 satellites in orbit. They are grouped in four categories:

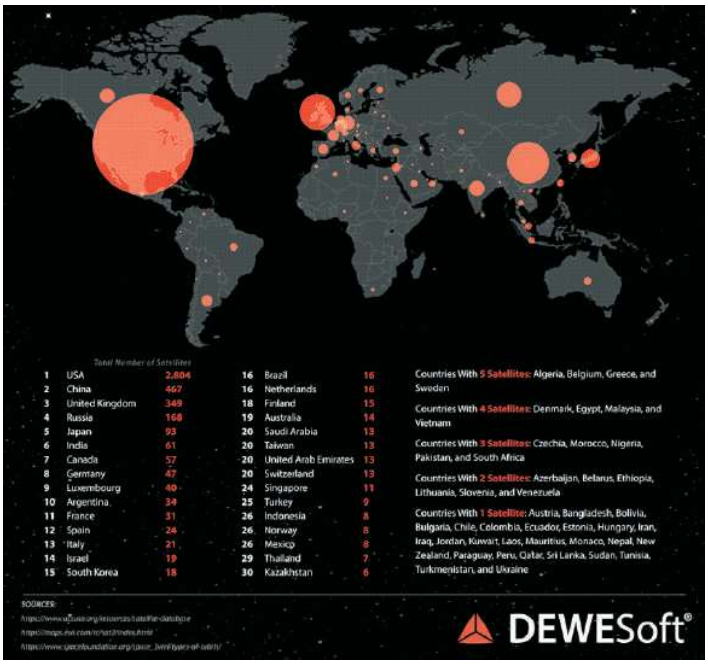
- Low Earth Orbit (LEO)
- Medium Earth Orbit (MEO)
- High Elliptical Orbit (HEO)
- Geosynchronous Orbit (GSO) / Geostationary Orbit (GEO)
  The second biggest of these four categories is GSO/GEO - 565 - with orbital speeds that match Earth's rotation. They are used for telecommunications and Earth observation.

These 4,550 satellites serve eight main purposes: Communications (63.0%), Earth observation (22.1%), Technology development (7.8%), Navigation / Global positioning (3.6%), Technology demonstration (0.77%), Earth science (0.44%), Space observation (0.22%), and Space science (2.3%).

The top five countries with the most satellites orbiting Earth are: U.S. (2,804), China (467), U.K. (349), Russia (168),

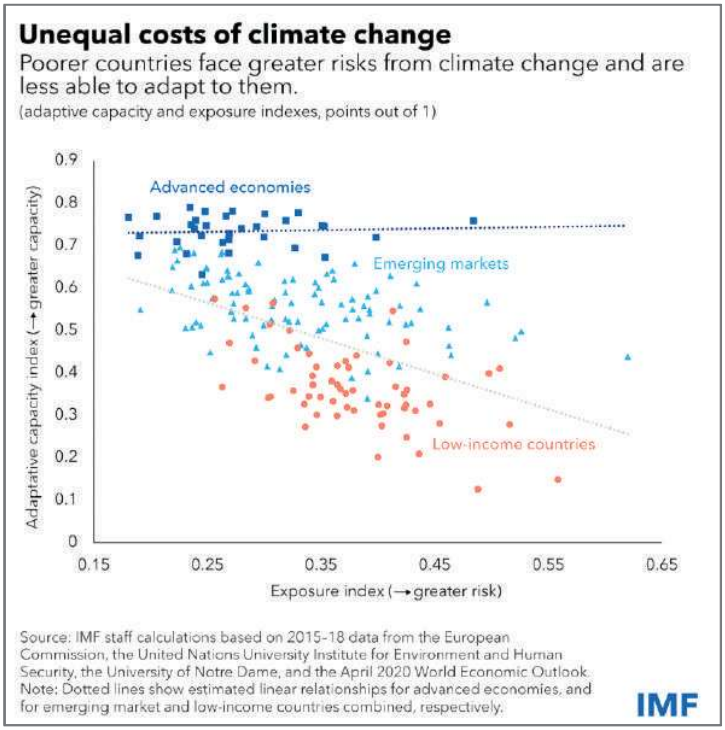
and Japan (93). They collectively own 3,881 of the satellites orbiting Earth, amounting to over 85 percent of the total.

Figure 4: Satellites Owned by Countries



Source: https://dewesoft.com/daq/every-satellite-orbiting-earth-and-who-owns-them

Figure 5: Unequal Costs of Climate Change



Source: https://www.weforum.org/agenda/2022/11/carbon-neutral-climate-resilient-developing-countries-cop27

Resources Should be Allocated Equitably To Assure Optimal Climate Outcome

The mildest contributors to planet-heating emissions suffer the same consequence as heavy contributors because we all live in one big and connected global-climate system. In fact, poorer nations are bearing the brunt of the harm caused by rising temperatures as a result of emitted pollution by industrialized nations heating the Earth.

A key focus of COP27 held in Egypt in November 2022 is about finding ways for the developed world to help the developing world to become climate resilient. At the Conference, low-incoming countries asked for "loss and damage" to be added to climate financing while some rich countries favored using the new Global Shield Against Climate Risks Initiative - a social-protection and insurance-based finance mechanism for the loss and damage outside the United Nations Framework Convention on Climate Change (UNFCCC) process.

Whether it is "loss and damage" or insurance-based finance, they are "after the fact" actions. Why not take preventative measures to reduce the loss and damage?
Green Climate Fund (GCF) executive director Yannick Glemarec stated in a November 17, 2022, interview that the Fund was already using about 30 percent of the roughly US$11 billion in resources it has deployed so far for activities that fall under efforts to avoid and minimize "loss and damage." They include projects to strengthen early warning systems and build infrastructure such as roads and embankments that can better withstand climate shocks and stresses, as well as provide weather insurance for farmers.

Rich nations pledged, in 2009, US$100 billion a year by 2020 to help developing countries manage the impacts of climate change and become climate resilient. They have not reached this target in any year since and the need is only growing. The United Nations now estimates that US$300 billion a year is needed to support climate action in developing countries. Should some of this money be used in preventative actions to avoid and minimize loss and damage?

Hydromet

In a December 1, 2017, World Bank brief, it noted that hydromet (hydrological and meteorological) hazards are responsible for 90 percent of total disaster losses worldwide. Hydromet services provide real-time weather, water, early warning, and climate information products to end users, based on weather, water, and climate data.

The Alliance for Hydromet Development was created in December 2019 at COP25 to close the capacity gap on high-quality weather forecasts, early warning systems, and climate information.

The First Hydromet Gap Report by the Alliance for Hydromet Development, released on July 8, 2021, estimated that 23,000 lives per year could be saved and potential annual benefits of at least US$162 billion could be realized by improving weather forecasts, early warning systems, and climate information. It highlighted how investments in multi-hazard early warning systems create benefits worth at least 10 times their costs and are vital to build resilience to extreme weather. And, yet, only 40 percent of countries currently have effective warning systems in place, and large gaps remain in the vital underpinning observations-data upon which these services depend, particularly in Least Developed Countries and Small Island Developing States.

Takeaway

Doing all we could to reverse climate change is important as it can help ensure a livable Earth for the many future

generations to come. However, we also need to take care of all of us who are now living on Earth and constantly living under the threat of more frequent and more severe climate disasters.

Professor Petteri Taalas, Secretary General of World Meteorological Organization, noted in a forward to the First Hydromet Gap Report, "Science-based, data-driven weather and climate services are the foundation for effective adaptation measures."

Prevention is better than cure. No one is out of the climate-disaster woods until everyone is out. Financial help is certainly a route, but not the only route to go. Countries with applicable expertise should work with countries that lack it - and help them become climate resilient. Think hydrology, think meteorology, think satellites orbiting Earth.

Endnotes

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