How Drones are Used to Measure Climate Change

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Small unmanned aircraft systems, most commonly referred to as drones, are used for a variety of purposes ranging from leisure, business, military operations, transportation, and agriculture to cartography. Drones reflect the achievement of human innovations in technology. During an age of human development when advancements are taking a toll on the earth, drones reveal intimidating but significant images of the effects of climate change. Many researchers have commissioned the usage of drones to measure factors of climate change such as the melting of icebergs and glaciers, rising sea levels, and the effects of drought. These three areas will be the focus.

Climate Change

In addition to understanding the purpose of drones in measuring climate change, one must be aware of what climate change is alone. Climate change is a collective term referring to changes in long-term temperatures and weather patterns. Throughout Earth's history, the planet has experienced many periods of warming and cooling and changes in precipitation from region to region. The Industrial Revolution marked advancement in human civilization and development during the early nineteenth century, but this milestone caused consequences: an increase in global temperature (What is Climate Change? n.d.).

Melting of Icebergs and Glaciers

As global temperatures increase, the melting of icebergs and glaciers accelerate. Ice holds most of the world's freshwater. Climate change will cause interruptions in Earth's natural circulation (Airborne Drones, 2021) and contamination of freshwater.

Many people would be interested in how soon all ice will melt. This can be predicted by calculating the rate at which icebergs and glaciers are melting. Drones can provide remote sensing to measure the mass of a given iceberg or glacier. Icebergs, which are located on water, are challenging to measure as most of their mass is submerged below water surface. With remote sensing used in combination with multibeam sonar and GPS units, geometric measurements can be calculated. A minimum of two drones are used for the sole purpose of remote sensing: one at low altitude and one at high altitude. Multiple GPS units are placed on the iceberg itself. The GPS units and drones measure the geometric shape of the iceberg above the surface. These two systems calculate roughly a shape of a cone. The multibeam sonar is placed at surface level to measure the iceberg below the surface. In contrast with the drones and GPS units, this system calculates roughly a cylindrical shape (Airborne Drones, 2021). This operation can be performed regularly to compare the size of a given iceberg throughout time.

The University of Alberta conducted research in Antarctica, where ice is melting at a rate of 150 billion tons annually (Ice Sheets, n.d.), with drones equipped with advanced cameras and lasers. This technology was able to collect information regarding contour, crevasses, and thickness (Frackiewicz, 2023).

Rising Sea Levels

The effects of climate change are well interconnected. Concerning the melting of icebergs and glaciers, sea levels are rising. It is believed the sea level will rise by seven feet in the San Francisco Bay Area by 2100. Stanford University has used ice-penetrating radar from the drone ‘Peregrine’ to measure activity inside the ice, thus

making predictions on rising sea levels. This method has challenges, however. This is costly and the penetration of ice may exacerbate melting as shards melt faster and the internal portion of ice would be exposed to warmer temperatures (Christian, 2022).

Despite climate change being a global concern, there are methods used at local scales to monitor and make predictions about the phenomenon. The University of Exeter in the United Kingdom has created 3-D images taken from drones with the assistance of GPS satellites. The drones take photographs, which can be converted into measurements. The University of Exeter uses the term *photogrammetry* to refer to the extraction of measurements from photographs. This method is generally affordable. The university conducted research in Cyprus using local loggerhead turtles. Loggerhead turtles build their nests in beach areas. GPS satellites locate their nests. Images have revealed their nests have been moving inland (University of Exeter, 2018).

Using the model employed by the University of Exeter, sea level rise can be measured. Fixed objects in coastal areas—or objects that will not be normally moved—can be located by GPS. Regular images should be taken by drones during the same form of tide periodically. Using photogrammetry, measurements should be taken between a given fixed object and seawater. Images will reveal sea levels are rising and mobilizing inland as overlaying photographs will not match perfectly (Wawryzn, 2022).

Effects of Droughts

Climate change has altered the amount of precipitation. Some regions are experiencing an increase, while others are experiencing a decrease. Drones used in California have revealed alarming images as a result of droughts. As a part of the Southwest, California has seen a decrease in precipitation. Images taken from drones

can easily be interpreted by the public to understand the effects of climate change. Images from drones do not always necessarily differ from images taken from other devices. The situation in California will be used as a prime example of drought.

Brian van der Brug from the Los Angeles Times reported that drone images taken in the Sacramento area revealed disturbing low levels of water in reservoirs and lakes. Lake Shasta, the largest reservoir in California, was only at 34% of its capacity in 2021. Boats docked on the lake were a few hundred feet lower in altitude than usual. Lakebeds of Lake Folsom were exposed. Boat decks appeared to be on land as opposed to water. A peninsula was formed on Lake Trinity due to its water level only at 47% capacity. Boats sailing on Lake Oroville appeared to be physically closer than usual because of the capacity at only 33%. The sponge of the lake was completely dry (Van der Brug, 2021). All these simple images were taken from drones, revealing the difference in water capacity.

The simplest tool can serve as the most effective tool. There is a misconception that drones *only* take images beyond the human spectrum. While drones may take infrared or X-ray images, photographs comparable to ordinary cameras or smartphones can also be taken. Images revealing the effects of droughts should be an effective tool to promote climate change awareness. The usage of drones alone is fuel efficient and will not defeat the purpose compared to full-sized vehicles. On average, drones use 90% less energy and emit 84% less carbon (Jacquemain, 2022). Citizen science is a well-appreciated concept. Anyone, regardless of profession, can contribute to the measurements of climate change using civilian drones. The National Park Service describes the concept as voluntary involvement from the public to collect data, analyze

results, and solve problems (What is Citizen Science? 2021). Drone images can be taken regularly from a specific body of water during the same season annually. These images should be compared, not only yearly, but over decades. Other effects of climate change can be revealed by simple drone images, such as deforestation, the intensity of wildfires, or the depletion of biodiversity.

Conclusion

The effects of climate change have been measured and monitored using a variety of methods. With the grace of drones, many aspects of climate change have been researched. While drones serve as civilian, government, and business tools, they will continue to aid climate and environmental challenges during a crucial century when the worst is to come.

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