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Cloud Server's Impact: The Environment and Supply Chain

Jeremy Silvis
University of San Diego, jsilvis@sandiego.edu

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Jeremy William Silvis

Sustainable Global Supply Chain Management

Simon Croom

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Introduction

Our current society produces and consumes data more than any previous generation. It is estimated that we produce 328.77 million terabytes of data every single day[1]. For reference, my laptop has half a terabyte of storage and the world would fill up my laptop about 7500 times every second! Files keep growing and growing in size causing us to need more and more places to store data. This data generated is on an exponential trend meaning most of the data created was made in the last 2-3 years.

All of this data needs to be stored somewhere, either locally or nonlocally in a third-party Cloud storage business. The addition of the Cloud was a revolutionary advancement in data storage but now presents a pressing environmental concern. The Cloud's carbon footprint recently surpassed the airline industry as data centers require a lot of resources to run[2]. This chapter explores the creation of the Cloud, the environmental ramifications of Cloud servers, the sustainability efforts by Cloud companies, and the effect the Cloud has on the global supply chain.

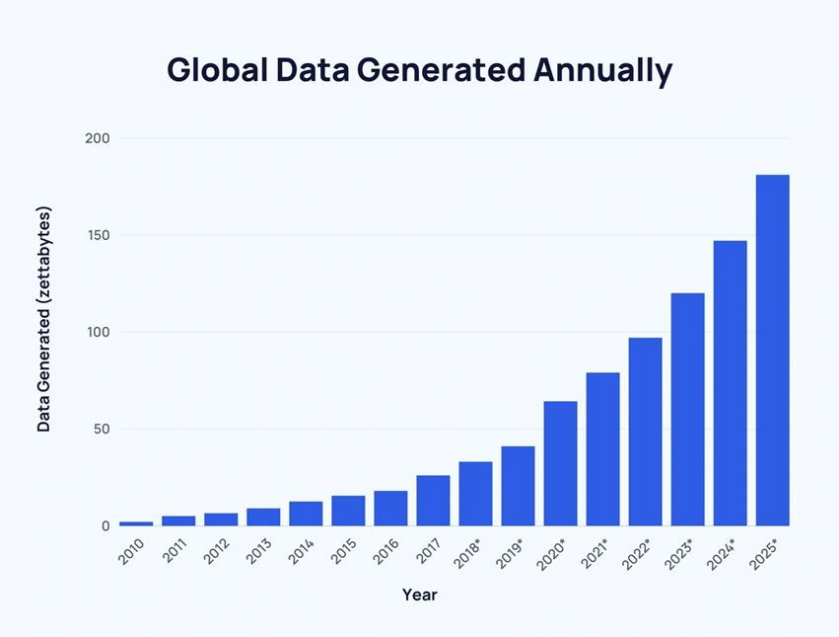

Figure 1. *Global Data Generated Annually* created by Exploding Topics shows the exponential growth of data over the last ten years.

[1] https://explodingtopics.com/blog/data-generated-per-day

[2] https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/

Evolution of Data Storage

In the past, data storage predominantly relied on personal hard drives and disk drives you had to buy. As time went on computer companies created newer and more advanced products which quickly made the old components obsolete. Two of the most popular methods despite all the different products were hard disk drives (HDD) and solid-state disks (SSD). For the average user, both of the products would work well to store your data locally. Some of their positives are low energy consumption and no water needed to cool products. However, these methods posed limitations due to storage capacity, their susceptibility to corruption, and the accessibility of data at multiple locations.

The transition to Cloud servers revolutionized data storage practices offering a solution to the problems of storing data with HDDs and SSDs. In 2006, Amazon Web Services (AWS) launched the first Cloud-based service which allowed users to rent the space that they used to store their data in the Cloud[3]. Users could scale capacity quickly and efficiently as they could simply pay more monthly for more space. Shortly after, the company Dropbox was created which copied Amazon's Cloud-based servers but allowed users to upload and access files from any device or computer via the web. This allowed employees to work from anywhere as long as their devices could connect to the internet. Similar services, like Google Drive and Apple's iCloud, quickly followed suit offering Cloud storage for a monthly cost.

Figure 2. *Inside Amazon's Massive Data Center* from Tech Vision shows us what Amazon's centers look like.

Figure 3. *The Cloud* from Amazon's sustainability website shows the overview of one date center.

[3] https://www.computerhistory.org/timeline/memory-storage/

This transition has provided so much convenience for everyone that it is hard to imagine a world without the Cloud. Many companies, from streaming services to social media, have a supply chain that requires the Cloud. Netflix is a great example as they changed their supply chain to rely on Cloud servers to store movies instead of DVDs. Netflix currently uses AWS Cloud services for online storage, recommendation engines, databases, and analytics. To use the Cloud services Netflix plans on spending $1 billion per year[4].

Environmental Impact of Cloud Servers

However, this transition to the Cloud comes at a cost as it requires heightened energy and water consumption that impacts the environment. Cloud servers require significant energy usage, far exceeding that of traditional data storage methods. These servers need to be running all the time, which uses a lot of energy creating heat as a byproduct. Heat is one of the biggest enemies of Cloud servers. To stop servers from overheating they either use more energy with expensive air conditioning or a more cost-effective solution water. The downside of using water is it could severely compromise local water supplies, wasting a limited resource.

In a five-year server farm study, anthropologist Steven Gonzalez Monserrate recently discovered the staggering environmental impact of data storage. Steven describes the Cloud as a "carbonivore" due to their extreme energy use that comes from 'dirty' electricity grids that use coal and other natural resources. Most of this energy is used to cool the data centers and to support redundant fail-safes to prevent any downtime. Customers can always access their data anytime and anywhere, so data centers are designed to be hyper-redundant for round-the-clock operations. They are equipped with diesel generators ready to power the Cloud in case of an emergency. Steven also learned that the Cloud is "quite thirsty" as many companies choose water to cool the servers. Water is piped through the servers because water is more efficient at cooling the facility compared to air which is an attempt to reduce their carbon footprint[5].

Google has always boasted about its energy-efficient and environmentally friendly data centers, however, it requires a lot of water to run these centers. Google places its data centers as close as it can to large population hubs to be more efficient by reducing the time and resources to

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[4] https://www.cloudzero.com/blog/netflix-aws/

[5] https://thereader.mitpress.mit.edu/the-staggering-ecological-impacts-of-computation-and-the-cloud/

move data. This sometimes forces Google to build in hot and dry areas like Mesa, Arizona. Google made a deal with Arizona that allows them to use 1 million gallons of water every day and up to 4 million if the center hits its projected milestone[6]. This water usage in data centers poses a threat to local water resources and ecosystems especially if they are in a drought. If Google and other Cloud server companies built their centers in colder areas, they would not require so much cooling. In 2019, public records and legal filings show that Google either requested or was granted 2.3 billion gallons of water for data centers in only three states. Just because a company claims they are environmentally friendly doesn't always mean they make the best choice for the environment.

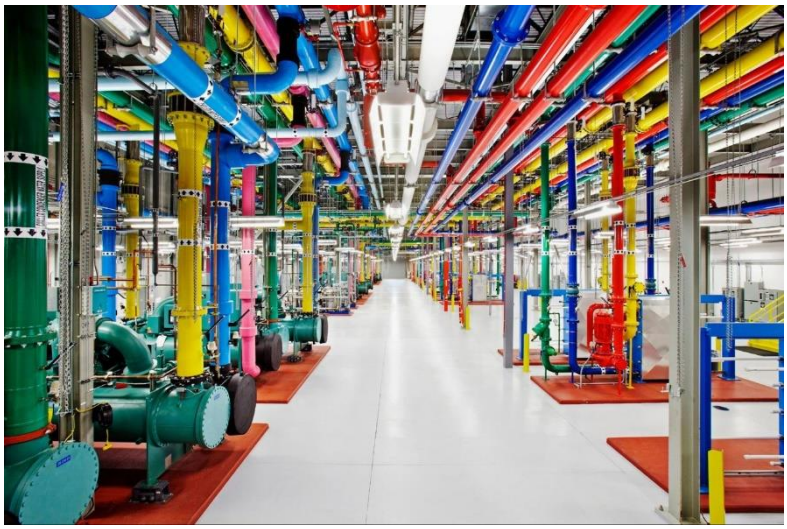

Figure 4. *Google Data Center* shows us the complex network of pipes needed to cool the Cloud.

The exponential growth of cloud servers has led to a significant increase in energy consumption. This is primarily driven by the need for constant operation and cooling of these big servers. Despite efforts by companies like Google to portray their data centers as energy-efficient and environmentally friendly, the reality reveals a heavy reliance on water-intensive cooling systems. This reliance poses a threat to local water supplies and ecosystems, especially in drought-prone areas. The environmental impact of cloud computing, characterized by its high energy and water consumption, underscores the need to explore other alternative sustainable solutions.

[6] https://time.com/5814276/google-data-centers-water/

Sustainability Efforts by Cloud Companies

Leading Cloud data companies are starting to invest lots of resources into sustainability initiatives that will lower their environmental impact. To emphasize their commitment to sustainability, cloud servers are undergoing a rebranding effort. They are using the term 'Green Cloud' which means that it is an environment-friendly cloud that reduces carbon emissions and uses renewable energy. This shift involves adopting renewable energy sources to power data centers, alongside investments in renewable energy infrastructure, and optimization of facilities and workflows to reduce energy consumption[7].

Amazon Web Services has one of the largest carbon footprints due to its extensive data center network but they are trying to reduce it. One of the six pillars of the framework for their Cloud is sustainability. Amazon claims that this is a continuous effort that primarily focuses on energy reduction and efficiency for all components to achieve maximum benefit from resources[8]. Amazon is always setting targets for improvement and is adopting new processes to improve efficiency. Currently, they have set a goal to be net-zero carbon by 2040 and power their operations with 100% renewable energy by 2025. In order to reach these goals Amazon would need to invest in carbon offset projects where they pay a third-party company to remove carbon from the air. They also see sustainability as a shared responsibility between customers and themselves.

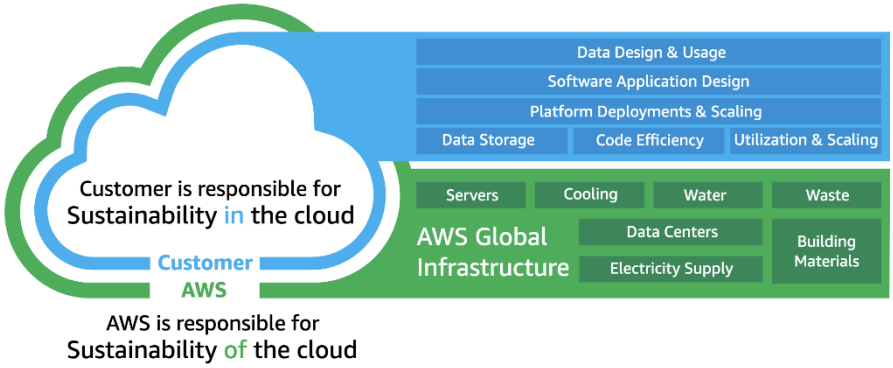

Figure 5. *The shared responsibility model – Sustainability pillar* shows that the customer and AWS are responsible for being sustainable.

[7] https://www.linkedin.com/pulse/cloud-computing-sustainability-how-green-neal-davis/
[8] https://docs.aws.amazon.com/pdfs/wellarchitected/latest/sustainability-pillar/wellarchitected-sustainability-pillar.pdf#cloud-sustainability

These large corporations are making big pledges to help the environment but they are not enforceable and they appear impossible given the exponential growth of data in the world. From a customer's perspective, the Cloud could make their business more environmentally friendly by reducing electronic waste. Cloud-based storage ensures technology remains relevant for longer periods, unlike traditional hardware, which contributes to e-waste over time. These large corporations have the resources to maximize the utilization of hardware, investing in the longevity of their data servers.

Future Outlook for Supply Chains

This shift to the Cloud allows companies to save as much data as they want. This might seem like a good thing but if companies automatically send data to the cloud without checking the relevance of the data it could be a waste of storage. Nowadays, it is so easy to store anything in the cloud that people and even companies are storing pointless data that will never be used. There is also the concern about cyber-attacks when using a third-party Cloud provider. If you are storing sensitive data, you would probably use local storage methods so the information isn't getting sent back and forth over the internet.

On the other hand, supply chains have become more efficient and with lower costs due to the addition of the Cloud. Companies that use Cloud-based supply chain management systems are provided with real-time data just by connection to the Internet. Easy access to data helps supply chain managers make better-informed decisions as well as open communication with suppliers and logistic providers about their needs. The Cloud offers scalability meaning that data storage and computing can grow and adjust based on the business resources and demand. This flexibility allows businesses to allocate funds to other expenses eliminating the upfront costs with hardware needed to store data.

The Cloud also changed work culture; it made many positions able to work remotely. This prevents employees from making long commutes to the office. Around 10% of global CO2 emissions come from cars and vans which is five times as much as the cloud[9]. From a business perspective, it is not always best for employees to work from home but it is the best option for

[9] https://www.statista.com/statistics/1388092/carbon-dioxide-emissions-cars-vans-transport/#:~:text=Cars%20and%20vans%20account%20for,with%20the%20Net%20Zero%20Scenario

the environment. Moving data back and forth does affect the environment but this does not compare to driving back a car to and from work.

Conclusion

The environmental impact of cloud servers demands attention and action. As we reflect on the evolution of data storage practices, it becomes evident that sustainable solutions should be the most important. By embracing sustainability efforts, Cloud companies are paving an eco-friendly future. Businesses must prioritize sustainability in their everyday practices to ensure a healthier planet for future generations. As customers, we need to realize the impact of storing data in the Cloud. We need to think about the data we create and save as it might have an impact on the environment. The Cloud is a valuable resource that should be used responsibly and cautiously in today's data-hungry world.

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