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Catching the Cloud and Pinning It Down: the Social and Environmental Impacts of Data Centers

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ABSTRACT

As reliance on social media, mobile devices, and computers has grown in developed nations worldwide, data centers have become an important, but poorly understood, part of this digital age. These massive structures, which are increasingly built in rural areas, store digital files and images. Despite the clear importance of cloud computing, geographers have not studied this infrastructure or its effect on nearby communities and the physical environment. This project examines the social and environmental impacts of the development and operation of data centers, using a Facebook data center in Prineville, Oregon as a case study. It explores what impact the technology industry has on local social and natural environment, as well as the broader implications of data center operations. It also seeks to situate data centers within increasingly common visions of sustainable businesses and 'greening' capitalism. Through interviews with Facebook managers, town officials, and local citizens, I came to several conclusions about such data centers. First, big data companies have tried to accommodate local concerns about the facilities and to integrate them within the social fabric of the communities where they are built and operated. Consequently, in the short-term, they appear to have little or no impact on the social life of local citizens. Second, the environmental impacts of data centers are difficult to determine at a global scale. While big data companies invest in 'green' energy, they share little information about their waste disposal and recycling, and the amount of space these buildings require is growing. Finally, by following the tenets of sustainable enterprise, these companies have sought to minimize potential negative social and environmental impacts of data center operation, resulting in greater profits and sustainability, as well as a more positive public image.

CATCHING THE CLOUD AND PINNING IT DOWN: THE SOCIAL AND ENVIRONMENTAL IMPACTS OF DATA CENTERS

By

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INTRODUCTION

CATCHING THE CLOUD

It was a hot summer day in June 2017, and after a three hour drive from Portland, I had finally made it to the outskirts of Prineville, a town of about 9,000 people in Central Oregon. The land adjacent to the road was covered in sand, junipers, and sagebrush. I drove past a tiny private airport on my left, before approaching an industrial park, mostly consisting of warehouse buildings and trailers. Having typed 'Facebook data center' into my iPhone's GPS, I followed Siri's directions to turn left down Tom McCall Road. In the distance loomed a large warehouse-like building with a tall black fence bordering the property. A blue Facebook sign, proudly displayed amongst the desert shrubs, greeted me. I angled the truck toward the entrance, but seeing the security guard in the booth nearby, I changed my mind as I did not want to appear suspicious. I parked in the construction lot across the road. The data center was enormous, the size of an Olympic stadium (about 475,000 square feet), but still seemed stylish and new. I wanted to take pictures of the data center's manicured exterior—unexpectedly complementary to the desert setting—but I soon realized that the guard in front of the building was staring at me. I decided I had better not take any photos after all and headed into downtown Prineville.

I was immediately surprised by how far removed the data center was from downtown. Heading back out onto Route 126, I found myself descending a mountain on a winding road that overlooked Prineville. I could see the entire town from the viewpoint above (Figure 1). There were acres of surprisingly lush green grass to my right, a stark contrast to the dry desert dominating the rest of the landscape. I later found out that this was Prineville's (heavily irrigated) Meadow Lakes Golf Course. When I got to the bottom of the valley, things looked about as I expected they would in a small rural Western town: plenty of barbeque restaurants and

bars, a few gas stations, and several mom-and-pop stores along North Main Street. The quaint city hall and courthouse were located within twenty feet of one another, adjacent to two small parks. Few people milled about on the sidewalks, and all the traffic was concentrated onto the single highway going through town. Trucks and trailers were parked on all the side streets, and several families sat outside the Tastee Treat, enjoying some ice cream in attempt to beat the summer heat.

Figure 1. Prineville, Oregon, from the scenic viewpoint on the hill above town. The Facebook data center is directly behind the site, about half a mile from where this photo was taken. *Photo by author*.

I pulled into a parking spot near the city courthouse, pleasantly surprised that there was not a single parking meter in sight. I crossed the street to get a better look around, a driver stopping to let me walk in front of him. I found myself warming to the cozy feel of the town, but something struck me as odd about it. There was certainly a lot of obvious Western stereotypes

here, manifested in benches engraved with cowboys, signs for an upcoming rodeo, and dusty mountains looming in the distance; yet there was something that seemed ephemeral about these things. What struck me as unusual was the juxtaposition in Prineville between the stereotypically small-town things it harbored and the amenities I was used to seeing everywhere else. For instance, next to the town's only motel was a Best Western Inn. Down the street from Les Schwabs Tire Center and a small church was a Chase bank, a Starbucks, and a Sears's department store. The golden arches of McDonalds jutted out above the locally owned Oochoco Brewing Co. restaurant sign (Figure 2). Prineville also seemed at odds with the sleek, manicured Facebook data center campus, hidden high on the hill overlooking the little town (Figure 3). Prineville thus appeared to straddle two identities at once: a rural Western town and a miniature city you could find anywhere else in the United States. I could not help but wonder what this meant for its future. What impacts would big data have on this town's ability to retain its current small-town character?

Figure 2. Sites on NW 3rd Street in Prineville, Oregon. This is the main road that brings people through town on one of two highways running through Prineville, Highway 26. The chain stores and local venues are intermingled along the road, a mix of old and new infrastructure and style. *Photos by author*.

Figure 3. A view of the Facebook data center from Tom McCall Road in Prineville, Oregon. The bulldozers located around the site are a constant presence. Plans for construction of a fourth data center are currently underway. *Photo by author*.

The Facebook data center raises many questions about Prineville. But the story is not necessarily unique to this town as these facilities are increasingly common in more and more rural places. The reason I originally became interested in Prineville was not because it has that 'small-town charm' to which I am partial, but because I hoped it could provide a concrete example of a larger phenomenon: the construction of resource-hungry data centers that consume land, water, and energy across the United States. When I learned about electronic waste (e-waste) and how dirty technology production can be through other research projects, I wondered what effect our everyday use of the internet and the 'cloud' could have in the real world. The cloud is a seemingly boundless and illusory space that promises to keep our information safe forever (Carruth 2014). As more people are becoming addicted to technological gadgets and virtual reality, they have begun to use the cloud to store pictures, videos, documents, and other files. Moreover, large corporations, such as the National Security Agency (NSA), also require safe and secure locations for their information (Hogan 2015). As a result, we face a growing need to store all of these data somewhere (Starosielski and Walker 2016). The cloud appears to have endless space, as our data are sent to live in an invisible sky. Yet, I knew there had to be some material impacts big data companies do not allow us to see. All the things that go onto the cloud seemed to disappear into the abyss, but that could not be the end of the story. So, I set out to catch the cloud and find where it lived. As I discovered, the cloud has a real, physical, geographical presence that has real material impacts on human and environmental health. The cloud dwells within the infrastructure of remote data centers.

In the last few years, big data companies like Facebook have rapidly constructed data centers across the world. Facebook has already constructed hyper-scale data centers in ten

locations over the past decade—seven of which began construction within the past two years—and another will be added shortly (Karkaria 2018). There are generally at least four data centers per location, stretching up to 400,000 square feet each (Data Center Knowledge 2010). Although many data centers are located in cities, they are increasingly common in small rural towns that have experienced the hardship of recent economic downturns (Pickren 2016). These buildings, often compared to war bunkers (Brennan 2016), require copious amounts of energy and resources to store and protect data. They have a substantial footprint in terms of land, water, and energy use. Data centers require roughly the same amount of electricity as a small city and consume millions of gallons of water each day to cool their servers (Hogan 2015). Many data centers also receive power from grids reliant upon the burning of fossil fuels for energy (Greenpeace 2011). As a result, the seemingly abstract technological space of the cloud may actually contribute to climate change through its physical infrastructure (Hogan 2013).

Greenpeace brought this issue to light in their recent and ongoing campaign, *Click Clean.*[1] In response, companies like Facebook, Apple, and Google have tried to promote an environmentally-friendly image of their data centers by posting photos and videos of the 'green' and highly efficient buildings they have constructed in various parts of the world (e.g. Google's YouTube video on their new center in Hamina, Finland)[2]. Facebook, as part of the Open Compute Project, has created a special profile for each data center that proudly displays their 'power-usage effectiveness' (PUE). PUE supposedly shows the efficiency of internal operations for a given location (Burrington 2015). However, some have deemed PUE an essentially useless measurement of environmental impact because it gives no specific details about the *amount* of energy and water these data centers are using (Hogan 2013; Burrington 2015). Moreover, as media studies scholar Mél Hogan (2015) suggests, data centers are problematic in that not only

are they rapidly increasing in number, but the resource- and energy-intensive characteristics they have in common have also become normalized. Clearly, data centers are complex spaces involving internal and external dynamics that have material and immaterial, as well as social and environmental impacts that are worth studying.

With my preliminary research on data centers, I quickly learned that my suspicions had been correct. We *are* being purposely fed select information by big data companies like Facebook, Apple, and Google, which allows them to continue their monopoly on information and its infrastructure (Foer 2017). The cloud, even as it seems to be nowhere, is right there in peoples' backyards, housed inauspiciously in industrial buildings like any other and using water, power, and land. How could this be? Considering the fact that people are so unaware of data centers, what exactly are the environmental and social consequences of this infrastructure for the communities in which they are located?

My curiosity and concerns about data centers led me to Oregon. Prineville, Oregon was the first of many small rural communities that Facebook adopted as home for the company's numerous data centers. The year 2010 was the beginning of an emergent trend to move data storage beyond city borders and into more rural areas (Streep 2017). Prineville, like many towns in the rural West, is a resource-dependent community with symbols of traditional Western culture (i.e. rodeos, pig roundups, barbeques, parades, etc.) but is also very much part of the twenty-first century. According to local officials, almost everyone there owns a cell phone and can easily access the internet. Not so long ago, however, the town was at risk of economic collapse—that is, until Facebook and Apple decided to invest in their dying town (City of Prineville 2017). Nonetheless, the ultimate fate of Prineville still remains in question. What will

a little community like Prineville look like twenty years after big data comes to town? Taking all these thoughts and questions into consideration, I decided to use Prineville as my case study, representative of the larger trend of data centers moving into to rural towns worldwide (Data Center Knowledge 2010). I hoped Prineville would help me show what these data centers really were and what they might be doing the unique areas in which they now reside.

Research Questions and Methodology

With my newfound knowledge about the material impacts of data centers in mind, I developed five primary research questions. First, *what impacts does data center operation have on the social character of Prineville?* I assumed that there would be tension between the incoming data center employees and long-term residents and ranchers in the town who may have conflicting interests with regards to natural resource use. Moreover, the rodeos and other stereotypically Western activities seemingly cherished by Prineville residents would appear to be at odds with the high-tech, trendy culture of Silicon Valley. Big data companies elicit images of fast-paced businesses, always updating to the latest and best version of technological gadgetry and software. Prineville moves a lot slower. To verify (or disprove) my assumptions about socio-cultural tensions, I utilized the month I spent in Prineville to complete nine formal interviews with local officials and numerous informal interviews with local residents. The contrast between the formal and informal interviews was telling, and doing both greatly helped me understand Prineville's story, both presently and perhaps in the future. I also spent hours walking around Prineville, sitting in its parks and stopping in various shops. I tried to immerse myself in Prineville's community during my stay, constantly looking and listening to gain an understanding of what

makes the town its own. Observation gave me equally as much information as the online resources I read about Prineville's development.

My second research question was, *what impact does the operation of data centers have on the physical environment?* It is clear that these data centers are water-, energy-, and land-intensive (Hogan 2015), but perhaps Facebook and Apple have succeeded in their carbon-neutral efforts and have been mitigating their footprints? I had to dig a bit deeper to answer this question. While Facebook is very open about the majority of their data center operations, they are still not entirely willing to give out too much information about the exact amount of any resources they use. To understand the full scope of their environmental impact, I travelled to Prineville in June 2017 to tour the data center. I was hoping to get specific numbers and figures about their resource use, but not only was it nearly impossible to get a tour of the data center, when I finally secured one, my tour guide was also not allowed to give out information about the water and electricity usage of the building. I received limited information from Facebook's Public Relations Manager, but it was not quite enough. I worked around Facebook's barriers by interviewing local officials, and reading online information about water usage. I also read books and legal documents that explained land-use planning for Prineville and the surrounding area.

For my third and fourth questions, I wanted to take a step back and look at how Prineville's story fit into larger global trends. My fourth question was thus, *are data centers representative of a shift toward a form of sustainable enterprise that values both nature and technology equally?* Often the environment and technology are seen as opposing forces (Bess 2003); yet corporations like Facebook and Apple have publically announced that they are investing in improvements to their facilities to combat climate change (Bell 2017). However, it is unclear whether the cloud's physical infrastructure is truly sustainable. To answer this question, I

read about the founders of Facebook and Apple and what likely influenced them as their companies grew. I searched through news articles and information from the Breakthrough Institute, in addition to reading books on the American counterculture and 'green capitalism.' The deep-rooted green visions of Facebook and Apple became clear through this research.

My final question was, *is Prineville representative of the larger trend of developing data centers, particularly in rural areas?* Although Prineville has its own unique character and identity, it has had eight years to grow and change (or perhaps, stay the same) as a result of data center construction. This is a time period longer than any other small rural town hosting a Facebook data center. It could therefore potentially display what will happen to other similar communities worldwide. This question was perhaps my most challenging to answer. The problem is that the phenomenon of rural data center construction is so new that other towns have yet to see many impacts at all, social, environmental, or otherwise. Consequently, much of what I have to say about the fate of the towns in which Facebook and/or Apple have chosen to locate is based on online articles published by local newspapers. I set up a 'Google Alert' for articles containing "Facebook 'data center,'" and had numerous journalistic pieces documenting the latest developments on data center construction in small rural towns like Prineville delivered to my email inbox each day. By reading this 'grey literature,' I am able to make some speculations about both Prineville and the other towns where Facebook has chosen to locate. What follows is an outline of my journey toward answering my research questions.

Thesis Outline

The first chapter of this work is a literature review. It begins by briefly surveying what little research has been done on data centers in disciplines other than geography. I note the few

scholars who have begun to study data centers in the way researchers have yet to examine them, adding my own questions and research to their conversation. I suggest that geographers should study data centers because it is well-aligned with the field's methodology and concerns, particularly with those of urban and first-world political ecology. I describe two primary sets of literature that lay the foundation of my thesis: scholarship on the New West and urban political ecology (UPE). I show how my work will contribute to and advance scholarship in these sub-fields.

The second chapter, entitled 'Rebooting a Town: Visions of Development in the Digital Age,' tells the story of Prineville's economic development since the 1960s. Drawing upon New West scholarship, I compare Prineville to the nearby city Bend, Oregon and that community's recent reliance on tourism to support its local economy. My concern in this chapter is whether or not Prineville has made what Hal Rothman (1998) calls a 'Devil's Bargain.' A devil's bargain in Rothman's view is the demise of a community's preexisting culture as a result of their decision to rebuild their economy on tourism (Rothman 1998). Similar to the communities in Rothman's book, Prineville is a town in transition from a resource-dependent economy to something new. Yet unlike those communities, Prineville has not chosen tourism as its redeemer. So, the ultimate question becomes whether or not data centers will bring about the same (negative) socio-cultural transformations as tourism. I suggest that Prineville, by relying on data centers instead, has been able to strike a delicate balance between the Old and the New in what could be called the 'New West 2.0'. I conclude this chapter by specifying what this balancing act may mean for the future of Prineville.

I chose to call the third chapter, 'The Nature of Data Centers,' because it aims to reveal the material environmental impacts of data centers. In this chapter I discuss the large footprint of

data centers, using information from company reports, government documents, and journalists. I divide the chapter into five parts: land, energy, water, waste, and sustainability. I also note the minimal data about data centers available to the public, especially with regards to pollution and electronic waste (e-waste). This chapter suggests that the scale at which data centers' impacts are examined is what ultimately shows whether or not this industry is as sustainable as it presents itself to be.

Chapter Four, 'Shades of Green: Ecomodernist Visions of the Future,' discusses the foundation of data centers and why they currently seem to have a minimal impact on human and environmental health. I describe how the founders of big data companies have 'green visions,' with roots in Stewart Brand's *Whole Earth Catalog* and its countercultural technophilia from the 1960s and 1970s. Data centers are the result of a worshipful trust in technology's ability to overcome capitalism's tendency to harm the environment, and following the tenants of what has been deemed the 'ecomodernist' movement. The 'greenness' of data centers is reflective of these roots and the green ethos of the big data companies that own them. Green data centers are also manifestations of the New West 2.0, a version of the American West that balances the Old and New, the traditional and the modern, and does not regard technological development and environmentalism as mutually exclusive. These companies have made sustainability part of their business model by investing in renewable energy, funding local events, and boosting the economy in small communities across the United States. Yet, as I note in this chapter, greenness is also about making money. Companies like Facebook and Apple are large industrial corporations that have a lot of power over our everyday lives, and their true motives are not entirely clear. As such, I argue that data centers are representative of the ambiguity present in the increasingly global 'light-green society' described by Michael Bess (2003). Data centers make it

possible to balance mass consumption with environmentalism—a seemingly contradictory and precarious balance that may or may not be sustainable.

I conclude my thesis by reiterating the important messages I have come to understand through my research on data centers. I return to the question of whether or not Prineville has in fact made a 'Devil's Bargain' with big data by considering what the future holds for the little town. I also suggest opportunities for more scholarly research projects similar to my own. Although data center construction has yet to catch the attention of more than a handful of scholars, my work contributes to what I hope will be the beginning of more intensive research that must be done to understand the larger issue at hand. Ultimately, we would be wise to continue studying the material impacts of data centers before those impacts become too great to reverse.

Notes

1. "#ClickClean." *Greenpeace*, 2017. Accessed 24 September 2017, http://www.greenpeace.org/usa/global-warming/click-clean/.
2. "Google's Hamina Data center," YouTube video, 2:10, posted by Google green, May 23, 2011, https://www.youtube.com/watch?v=VChOEvKicQQ.

CHAPTER ONE

TOWARD A GEOGRAPHY OF DATA CENTERS

On October 25, 2006 Kristina Shevory from *The New York Times* published an online article entitled, "Cultivating Server Farms." In this article, Shevory discusses how data centers were just beginning to emerge as an important industry in the United States. At least partially in response to Hurricane Katrina and the loss of crucial security information by numerous companies, cloud usage was starting to grow rapidly (Shevory 2006). Additionally, Facebook had launched its site for the first time in 2005, and an increasingly large number of people were signing up and creating profiles (Philips 2007). Consequently, data companies were pleasantly surprised that a seemingly stagnant industry was growing quickly. Since then, the data center industry has become a thriving business (Data Center Knowledge 2010). The rapid rise of social media and data storage needs has had numerous implications for the way we identify ourselves and the world around us (Knight and Weedon 2014); and yet, despite the attention they have been given in the news since the early 2000s, data centers have drawn surprisingly little attention from scholars.

The academic literature on data centers is sparse, and the majority of studies focus on aspects of the material infrastructure that are ephemeral and abstract. Knowledge about these energy-intensive buildings is only just emerging, predominantly through the work of investigative journalists hoping to reveal the dark secrets of social media's contribution to climate change (e.g. *The Atlantic's* "Beneath the Cloud" series[1]). Big data companies cleverly maintained the metaphor of the cloud as an *abstract space* (as opposed to a *physical place*) for many years, and some still do. Journalists however, have revealed in plain terms the immensity of the environmental problem at hand (e.g. Carlise 2013; Burrington 2015; Terdiman 2017). The

stories journalists tell are short and often open-ended because the towns in which data centers exist have yet to see the full impacts of these buildings on their social lives and the local environment. Consequently, journalists are able to report the big news about data centers popping up across the U.S., but these are surface-level analyses stating the obvious: data center operation seems like it will be good for these towns' economies (e.g. Boykin 2017; Hardy 2017). The narrow scope of these articles stems from the fact that journalists simply have neither time nor space to engage fully with scholarly work to inform the stories they tell.

Unlike journalism, academic data center literature is not nearly fully developed, and forward progress is slow. The very nature of data centers as both real and virtual spaces requires that research crosses disciplinary boundaries. Their impacts are neither just physical or social, nor spatial or temporal, but a mix of everything at once. Much of the existing literature is technical, where scholars note the intensive energy use of data centers, but fail to engage with the associated social or political dimensions this infrastructure can bring about (e.g. Koomey 2007; Kliazovich et al. 2010). One relatively well-developed body of literature comes from media studies, specifically through work on media infrastructure and sustainability. In contrast, while geographers have conducted some research on digital media in general, they have largely ignored these complex physical spaces. As a result, the specific sets of geography-based literature with which my thesis project engages are first world political ecology (FWPE), urban political ecology (UPE), and the New West scholarship. Though these three bodies of literature have not explicitly acknowledged one another—nor data centers or the cloud—in this chapter I show that there are overlaps that forward important ideas related to my own work on data centers and technology as a whole.

What follows, then, is a review of academic literature concerning data centers and relevant scholarship. I begin by describing the work of media and communication scholars, showcasing the important, though non-exhaustive work that has been completed in these fields. I then highlight the minimal research done by geographers, noting the many gaps and opportunities I find in it. I explain the potential for a data center discourse that combines ideas from FWPE, UPE and scholarship on the New West. Finally, I conclude this review by describing the importance of my own research and why we must study the geography of data centers.

Media and Communication Studies

Media studies has historically been somewhat silent on physical environmental matters, with a few notable exceptions. Richard Maxwell and Toby Miller (2012, p. 11) divide media studies scholarship into two broad groups: 1) "a cult of humanism" that focuses on "media technology as an enabler of human understanding", and 2) "a cult of scientism" that aims to "break down components of machines and study the entirety of communication." In my preliminary engagement with media studies literature, their generalization appears to hold true. There seems to be a multitude of humanistic studies that examine privacy, surveillance, and policy issues related to social media and its dissemination (Cohen 2008; Hogan 2013; Stoycheff 2016). These scholars tend to be either optimistic about the potential of social media to help generate political changes, or wary of its power to allow people and/or corporations to surveil others. Their arguments remain in the abstract world of digital media however, failing to acknowledge the material infrastructure that allows social media and its users their newfound political and social power.

Relatedly, some scholarly discourse surrounding capitalism and 'digital labor' associated with social media is ongoing (e.g. Fuchs 2010; Fisher 2010; Fish and Srinivasan 2011). This literature is mainly theoretical and makes little, if any mention of the real environmental impacts of media and the cloud. The central claim is that we are experiencing a 'third wave' of capitalism, which some theorists are calling 'information capitalism' (Webster 2000; Arvidsson and Colleoni 2012), or similarly, 'cognitive capitalism' (Scott 2014; Mahmoudi and Levenda 2016). Scholars argue that due to the overflow of technological devices and the rise of Web 2.0 (i.e. user-generated content), a new form of labor and means of production have developed, one that is immaterial and digital (Fuchs 2010; Fisher 2010; Fish and Srinivasan 2011). Some believe that this labor is another form of capitalist exploitation, while others see it as a force for democratization. This literature, too, remains ungrounded, as it never quite manages to put this so-called 'digital labor' and production in a physical place to which it owes its existence: the data center.

Perhaps the most useful insights media studies provides stem from research by authors who specifically examine the question of whether or not media can be made 'sustainable.' These scholars note how using the cloud for storage (as opposed to a bulky hard-drive, for example) is cast as 'being green;' however, this 'greenness' is counteracted, as the energy-intensive structures in which the cloud resides contribute to climate change (Bozak 2011; Maxwell and Miller 2012; Hogan 2013; Parks and Starosielski 2015). Paradoxically, these scholars contend that social media—even as it may harm the environment—is also a space for social cohesion and collaboration. The cloud is a medium through which social movements can garner support via social media platforms, including the environmental movement. Thus, hiding behind its label of inherent sustainability, the cloud is able to simultaneously save and harm the environment

unbeknownst to users (Bozak 2011; Brennan 2016). These scholars recognize the metaphor of the cloud as a way of shielding us from the material impacts of every video and photo we post. Our apparently virtual actions are contained in physical infrastructures that have potential to pollute the earth. As Allison Carruth (2014, pp. 340-342) puts it, "the vision of the Internet as a green space at once everywhere and nowhere in particular is pervasive… multinational corporations like Microsoft and Google represent the digital cloud as an ethereal system for communication and connection, itself without a footprint." This representation is problematic for obvious reasons. We cannot save the environment if we do not know we are harming it.

Evidently, the media studies literature is rich with valuable insights, but overall it does not specifically examine the physical spaces/places in where the cloud resides. That said, media scholar Mél Hogan, who has actually studied social media and data centers, sets a good example. Hogan both theorizes about the nature of these spaces, as well as states their very real environmental impacts. As she asserts, "Most users are unaware of the processes involved in being online, where a simple Facebook status update can travel thousands of kilometers in Internet conduits through numerous data centers… the Internet has completely thwarted our notion of time and of space" (Hogan 2013, p. 9). Hogan, even as a media scholar, makes it clear that data centers lend themselves to geographic analysis. Nonetheless, unfortunately, geographers have yet to realize the importance of studying the cloud and data centers. As I will discuss in the next section, however, there are two sets of literature from geography that do provide some useful tools with which data centers could be analyzed.

Geography

Geographers have barely scratched the surface of understanding the geography of social media or the cloud, let alone the data centers in which it resides. Matthew Zook (2006) and others have noted the complexity of the *internet* as a space with multiple geographies, in both its material infrastructure and the immaterial connectivity it provides, but what of *social media* and *the cloud* specifically? Media geography has closely examined many various forms of media in terms of space and place, including photography, film, radio, video games, and the internet (Adams et al. 2014). Social media is only just emerging as a topic of discussion. Early work by media geographers centered primarily on communications, namely sender-receiver transmission. More recently however, focus has shifted towards "power relations [that] are embedded in spaces and places through communications" (Adams et al. 2014, 2). In essence, the majority of media geography scholars continue to take a theoretical approach to understanding space and place in the abstract world of media communication.

Although a few media geographers have briefly touched upon the cloud, they have yet to consider the cloud's specific *physical* geography. For instance, as Darren Purcell (2014, p.142) states in his chapter on the internet, "Observers of cloud computing imply that the cloud is everywhere, and yet bracket out the immense infrastructure necessary to access the cloud everywhere…yet the infrastructure is quite mappable." Purcell's words are promising, but he then moves on to discuss communication networks and power relations in the abstract, rather than examining the material infrastructure in which the cloud itself resides. Relatedly, regarding social media, geographers have theorized a so-called 'information society' and 'network society' that the internet and its associated technology have created (Castells 1996; 1997; Warf 2014). Scholars engaging with this discourse examine the construction of the 'networked self' and the

complex, seemingly boundless geographies that social media facilitates (Warf 2014). Again, these studies include interesting and important insights, but they fail to examine the material places and spaces that allow the transformations of self and of power relations to occur.

Similarly, communications geography has also dabbled in research related to the digital media and social media networks, but this sub-field too has yet to concern itself with the real environmental impacts of social media and its infrastructure. For example, Paul Adams and colleagues (2017) published a collection of work by media and communication scholars that never even mentions the cloud. The authors state in the introduction, "Media practices, processes, and figures are deeply grounded in materiality and are themselves necessarily bound to material forms" (p. 6), and yet no scholar's work in their collection acknowledges the physicality of social media embodied in data centers. Instead, the majority of their chapters contain abstract theories about flows of information and knowledge in the digital age—a vital discourse with which to engage, but one that also fails to bring social media back down to earth.

Still other geographers have examined the cloud in terms of its possibilities to improve mapping and Geographic Information Systems (GIS) analyses. For instance, Michael Goodchild is often cited for praising 'Web 2.0' for the social networks and public participation cultures it creates. Likewise, Michael Peterson (2015) speaks to the possibilities that the cloud presents for cartographers to expand their reach with both analysis and communication through mapping. Unfortunately, no connection to social media or its infrastructure is referenced in this literature either. As such, we can see that the holes in geographic research on social media and its physical location are large and begging to be filled. That being said, literature from FWPE, UPE, and scholarship on the 'New West' provide a helpful framework from which one can begin to construct a geography of data centers.

First-World Urban Political Ecology Framework

Taken as a whole, geography and media studies are both beginning to grasp the importance of studying the socio-environmental impacts of social media and the cloud. Although this research is neither unified nor physically grounded in empirical research, it is encouraging that various scholars have begun to examine the real spaces and places in which the cloud and social media come to life (e.g. Hogan 2013, 2015; Mahmoudi and Levenda 2016; Pickren 2016). Despite the fact that political ecologists (urban or otherwise) have yet to engage with the topic, the specific framework that best aligns with my research is a (modified) political ecology approach. Blaikie and Brookfield (1987, p.17) famously defined political ecology as encompassing "the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself." However, political ecology has largely focused on marginalized rural communities in the third world, ignoring both the city and the first world as viable regions of study (Heynen 2014; Angelo and Watchsmuth 2015). Hence, the charge has been made against political ecologists to move into different places and spaces, leading to the more recent development of First-world Political Ecology (FWPE) and Urban Political Ecology (UPE). Both sub-fields contribute to the basis of my research.

Critical of political ecology's almost exclusive focus on local-scale case studies of resource conflicts in rural Third-World communities, UPE and FWPE are becoming increasingly important in defining contemporary political ecology research. The FWPE discourse asks us to question the perceived First-Third World divide because in reality, the two are not as different as we might imagine. As James McCarthy (2002, p. 1297) suggests, the problems caused by capitalism in the first world "have at least as much causal power in contemporary ecological and

political economic dynamics as the struggles of agrarian peasant societies." One of the most valuable insights FWPE brings to light then, is the fact that the distinctions we make between different geographies of the world are becoming increasingly irrelevant, especially considering the growing digital network that spans across the earth (Castells 2010). Likewise, Peter Walker (2003, p. 8) argues, "the dismantling of the first and third worlds as geographic frames could be seen as promoting a kind of globalized political ecology project," a project that would allow political ecologists to escape the 'micro-politics' mode of analysis they currently employ. To holistically understand a conflict (rural, urban, or otherwise), scholars must examine issues through multi-scalar lenses, seeking connections between local, regional, national, and international scales (McCarthy 2002; Wainwright 2005). FWPE is a step in the right direction.

Similar to FWPE, UPE has served to broaden the scope of political ecology. The sub-field developed in response to the perceived lack of engagement with urban affairs by political ecologists. Scholars suggest that the primary reason political ecology research remained in the countryside rather than urban areas was because the field mainly asked questions of politics in relation to environmental degradation and rehabilitation. These were not, at first, explicitly urban matters (Braun 2005; Wachsmuth 2012). Nonetheless, a new field emerged in the 1990s, stressing the importance of examining urban spaces in geographic research. Initial UPE research could be condensed into studies of water flows (e.g. Smith 2001; Swyngedouw 2004; Kaika 2005), and of metabolic processes of diverse forms (e.g. Véron 2006; Heynen 2006; Evans 2007). Building on these crucial initial works, more recent scholarship has taken dialectical thinking about urban space to new levels. For instance, some have focused on the production of socio-environmental norms and cohesion (e.g. Bunce and Desfor 2007; Cook and Swyngedouw 2012), while others have examined political economy in relation to sustainability and

environmental justice (Aylett 2010) or neoliberal resource regimes (Heynen et al. 2007). Still others have begun to expand research into urban infrastructure (Monstad 2009) and ecological security in urban spaces (Hodson and Marvin 2009). Evidently, the subfield has become vast, and it is only getting larger and more varied. My research will only further expand its scope.

Throughout this seemingly disparate work, two particularly noteworthy and interconnected concepts have guided UPE: metabolism and circulation (Heynen et al. 2006). Metabolism, a concept borrowed from Marx, suggests that nature and society are constantly interchanging with one another, and the specific 'social metabolic order' of this interchange is created through different modes of production (Foster et al. 2010, p. 75). The circulation concept shows how accumulation, growth, and change occur as capital circulates money and commodities (Swyngedouw 2006). UPE scholars recognize that these processes work in tandem to socially produce nature in such a way that nature appears external to our existence (especially in the city), even though the dualisms constructed between nature and society are entirely false. As Smith (2006, p. xiii) states, "The notion of metabolism set up the circulation of matter, value and representations is the vortex of social nature." The conception of a socially produced, externalized nature is infinitely useful in that it can be used to explain human and environmental destruction in the hands of capitalists, inside the city and out. These ideas are key for understanding the social and environmental changes that occur in neighboring communities as a result of data center construction.

Despite having these instructive and uniting concepts, some scholars have criticized UPE scholarship for its 'methodological cityism.' That is to say, the city stubbornly remains urban political ecologists' main place of research, despite the fact that the urban social transformation processes they are studying extend beyond city borders (Angelo and Wachsmuth 2015). In short,

UPE has forgotten to address the city-country dualism that gave rise to the nature-society divide they so fervently oppose in the first place. As Bruce Braun (2005, p. 647) states in his critique:

> We [urban political ecologists] may have brought 'nature' into the city, but we may still be some way from truly grasping the transitivity, porosity and rhythms of these multiscalar 'machinic assemblages' that give urban life its potential and its risks.

William Cronon's (1991) book, *Nature's Metropolis*, serves as an excellent example of a way to discuss the rural-urban divide in relation to the nature-society divide. Cronon, although not a political ecologist himself, describes how the hinterland surrounding Chicago was necessary for the city's uprising and survival thereafter. He documents the continuous flow of natural resources and commodities that transformed both rural and urban spaces simultaneously, albeit without discussing the social production of nature and/or the power and class struggles involved (Wachsmuth 2012). Research that merged UPE and Cronon's work would thus represent the best of both worlds; or, at least it would eliminate the contradiction between the 'planetary' scale of urbanization accepted by UPE scholars and the fact that their analyses remain in cities alone.

So, how should UPE expand its reach? Joshua Newell and Joshua Cousins (2015, p.721) suggest that the subfield must develop a 'political-industrial ecology,' which fuses industrial ecology and urban ecology to create a new metaphor of "*metabolism of the urban ecosystem*…a global circulatory process of socio-natural relations that transforms and (re)creates urban ecosystems through the exchange of resources, capital, humans, and non-humans into and out of the spaces of global urbanization." Newell and Cousins claim that this new metaphor is an important step in moving UPE beyond 'cityism.' Matt Huber (2017) builds on this idea with his portrayal of nitrogen fertilizer plants as a 'hidden abode of production.' Huber contends that

political ecologists must politicize the industrial ecologies that support the urban way of life, particularly those located outside of city borders. Accordingly, my thesis research demonstrates the validity of these critics' claims regarding the importance of First-World political industrial ecology. Using the concepts of metabolism and the nature-society/rural-urban divides as a backdrop, my work offers a case study of a small rural town in the Western United States that has challenged such divisions since it was founded. FWPE and UPE (or UFWPE, as it may be called) thus lays the foundation of my analyses of Prineville, Oregon and its new data centers. Still, questions remain about the specific geographic and cultural setting in which Prineville exists that cannot be addressed using a UFWPE framework alone. Consequently, I also find myself amidst a debate that began in the 1990s about the American West as a whole. More specifically, I situate myself within the scholarship surrounding a so-called 'New West.'

The New West Scholarship

Considering the accusations of FWPE scholars, it is not surprising that the rural American West has only somewhat recently begun to gain political ecologists' attention (e.g. Robbins 1996). The concept of a 'New West' emerged in the early 1990s, around the same time that UPE began to gain a footing among geographers. Although the idea was hinted at prior to William Robbins' (1996) piece in *Montana: The Magazine of Western History*, his words seem to best solidify the concept. Robbins' (1996) work explained a curious emergent phenomenon in the rural American West: the extractive industries of the 'Old West' were being replaced by service-sector industries characteristic of a globalized capitalism. Robbins described how the "once decaying and sleepy cattle and mining towns" of the West were becoming "bustling, upscale commercial and recreative centers for refugees from elsewhere" (p. 70). In other words, new forms of capital

were taking over the West as unprecedented population growth occurred, reshaping the culture of small rural towns in particular. Robbins (1996) also noted the fact that this new capital was beginning to exacerbate economic inequalities and promote uneven development in the region. This unevenness has since grown in the West and is still evident in many communities today.

In the years since Robbins' (1996) essay, the body of literature surrounding the New West concept has quickly grown. For example, William Riebsame and colleagues (1997) created an *Atlas of the New West*, which contains colorful maps and detailed statistics that support Robbins' conclusions. Their work makes it clear that the West was, at the time, a region experiencing exciting and accelerating cultural, economic, and political changes. In the introduction to the atlas, the authors aptly state that the New West "is the archetypal case of an American region yanked from its historical and myth-based sense of place into hyper-development and plugged-in modernity." In agreement, ten years later, a study published in *Rural Sociology* on the Inter-Mountain region of the West confirmed that a New West had indeed emerged as 'outsiders' had immigrated and generated cultural change in the area (Winkler et al. 2007). Scholars thus began to set up a divisive distinction between the Old West's cowboys, ranchers, and farmers and the New West's Patagonia-wearing, Starbucks-drinking younger generation in search of outdoor leisurely activities on their days off from high-tech jobs in the city (Reisbame et al. 1997; Taylor 2004; Winkler et al. 2007). As a whole, this literature seems to have come to the conclusion that the rural American West has been completely transformed into a new and different place, one focused on what natural amenities and recreation resources it has to offer, rather than the traditional resource extraction industry that once attracted workers to the area.

In lieu of documenting these cultural, social, and environmental changes, scholars have examined the notion that 'rural gentrification' is occurring in the West. Similar to the urban gentrification geographers have thoroughly discussed, the term 'rural gentrification' is used to explain the process of people leaving the city for the countryside and remaking it as their own as they remove and replace those who originally resided there (Taylor 2004; Travis 2007; Bryson 2010). This in-migration of urbanites and suburanites is allegedly the cause of the shifts in the ways Western citizens have viewed and valued nature (e.g. Bryson 2010; Bryson and Wyckoff 2010). As cultural changes have occurred, western land became more valuable in terms of *amenity* uses and less valuable in terms of *productive* uses (Travis 2007, p. 176). Scholars have thus married ideas from UPE, FWPE, and the New West discourse by documenting the transformation of the rural Western United States from a landscape of production to one of consumption. Furthermore, it is clear that this rural gentrification has exacerbated the apparently inherent unevenness of the West, as certain areas within the region have been deemed more valuable than others because of their geographic proximity to natural amenities (Taylor 2004; Bryson 2012). Arguably, this uneven development is evident in that many small rural towns across the region have deteriorated while others have soared ahead in an economic boom thanks to tourism and other service-sector industries. Themes of unevenness, rural development, and attracting businesses and people to specific areas are important for the analyses of data centers in Prineville that I present in the next few chapters.

It is worth noting first however, that despite its widespread use, the New West idea is not without its critics. Some scholars contend that there is arguably nothing unique about the phenomenon occurring in the West. For instance, Taylor (2004) describes how similar trends in economic development are occurring globally, and therefore this 'boosterism' about the West is

unfounded. Moreover, as Winkler and colleagues (2007) indicate, cultural transformations have been concentrated only in rural towns that happened to be amenity-rich. That is to say, towns that are not lucky enough to be located near mountains or national parks and recreation resources have a hard time attracting those in favor of the New West way of life. As such, the social, cultural, and environmental changes occurring in the West are not all-encompassing. Furthermore, Robbins (1999) himself states, "the special conditions and circumstances shaping the landscapes of the modem American West are remarkably similar to influences that directed the course of change in the region during the previous century." It would thus seem that there is nothing new about change in the West. Accordingly, though not a critic of the New West idea, Travis (2007) points out that it is entirely unclear when the 'new' part of the New West emerged because the American West has experienced cycles of 'boom and bust' for hundreds of years. Again, the fact that socio-cultural transformations are taking place is apparently not unforeseen for this region. It is also more than likely that changes will continue as diversity increases with in-migration of people from various regions of the world (Reisbame et al. 1997). In contrast, more recently, other scholars have suggested that the dualism presented between the old and new has outright disappeared, since components of both lifestyles now appear to coexist in many regions (Duane 2012; Jenkins 2016). As such, perhaps the West is now experiencing a transformation that may ultimately result in yet another 'New' West. Cloud infrastructure is at the forefront of these recent developments.

Clearly, although scholarship on the New West is rich with insights about the shift from extractive industries to service industries, their conversation has become somewhat outdated. That is to say, scholars have failed to examine the role that technological infrastructure specifically, such as data centers, may play in shaping what has been deemed the 'Next West'

(Duane 2012). In this latest version of the American West, there is now "an uneven landscape where both old and new persist as archipelagos in a sea of one another" (Jenkins 2016, p. 184), which has been fostered by the technological development across the region. If this is true, social media and related technology have created networks not only of information, but also of infrastructure that blur the line between rural and urban spaces. This blurring suggests that while seemingly at odds with one another, the West is now able to host both the old and the new together, as landscapes of consumption and production are mixed. This occurrence clearly merits the attention of political ecologists and geographers more broadly, and yet they have failed speculate what it might mean for the rural American West.

A Geography of Data Centers

Journalists and media scholars have begun to document the ways in which technological infrastructure can reshape the world, but they are lacking a concreteness in their analyses. They do not speak to *where* or *why* in particular this reshaping occurs, or *to whom* it matters. UPE, FWPE, and the New West discourse also have not addressed the real-world impacts of technology infrastructure and social media. The key insight from reviewing this literature is that together, they challenge the separation between rural and urban spaces because every natural resource and human community are a part of a larger global system at work. The metabolism of nature by the industrial infrastructure of data centers maintains and supports the virtual world with which more and more people engage globally. Data centers connect us in a network that ignores any physical geographical distinctions between the city and countryside. And yet, many of these buildings exist in rural areas across the U.S., and everyone, regardless of where they live, is still shielded from understanding the real-world impacts of growing data consumption. As

the immense ecological 'footprint' of the information technology (IT) industry and data centers shows, the virtual world ultimately has big consequences for the real world. It is crucial that research is conducted on the transformations of place and space occurring as a result of consumption, production, and storage of data. Speaking in abstract terms about flows of information and power across space is simply not enough. As Graham Pickren (2017, n.p.) points out, we must think about "computing and big data as physical and historical phenomena… to contextualize the rapid social and technological change taking place within space and time, rather than viewing this shift as a movement towards a kind of inevitable end state." In essence, to combat any negative social, cultural, and environmental impacts our technology fetish has brought, geographers must conduct research and covey their results in a concrete manner that is meaningful to people in the real world.

Numerous data centers have been built by various data storage companies in areas that differ both geographically and culturally, especially in the United States (Figure 4). Hyper-scale data centers, however, are a more recent trend that has brought these high-tech buildings beyond city borders (Pickren 2016). But how do big data companies choose where to locate, since the physical locations of data centers are so widely dispersed? Based on Facebook and Apple's choices thus far, it appears that the most desirable locations will provide the companies with cheap land, low-cost and abundant power, access to water, tax breaks, and increasingly, the ability to invest in renewable sources of energy to power their data centers (Hogan 2013; Pickren 2016). These uniting characteristics show how big data companies are certainly interested in growing their business worldwide, but are also gradually becoming invested in 'greener' forms of capitalism (Data Center Knowledge 2010).

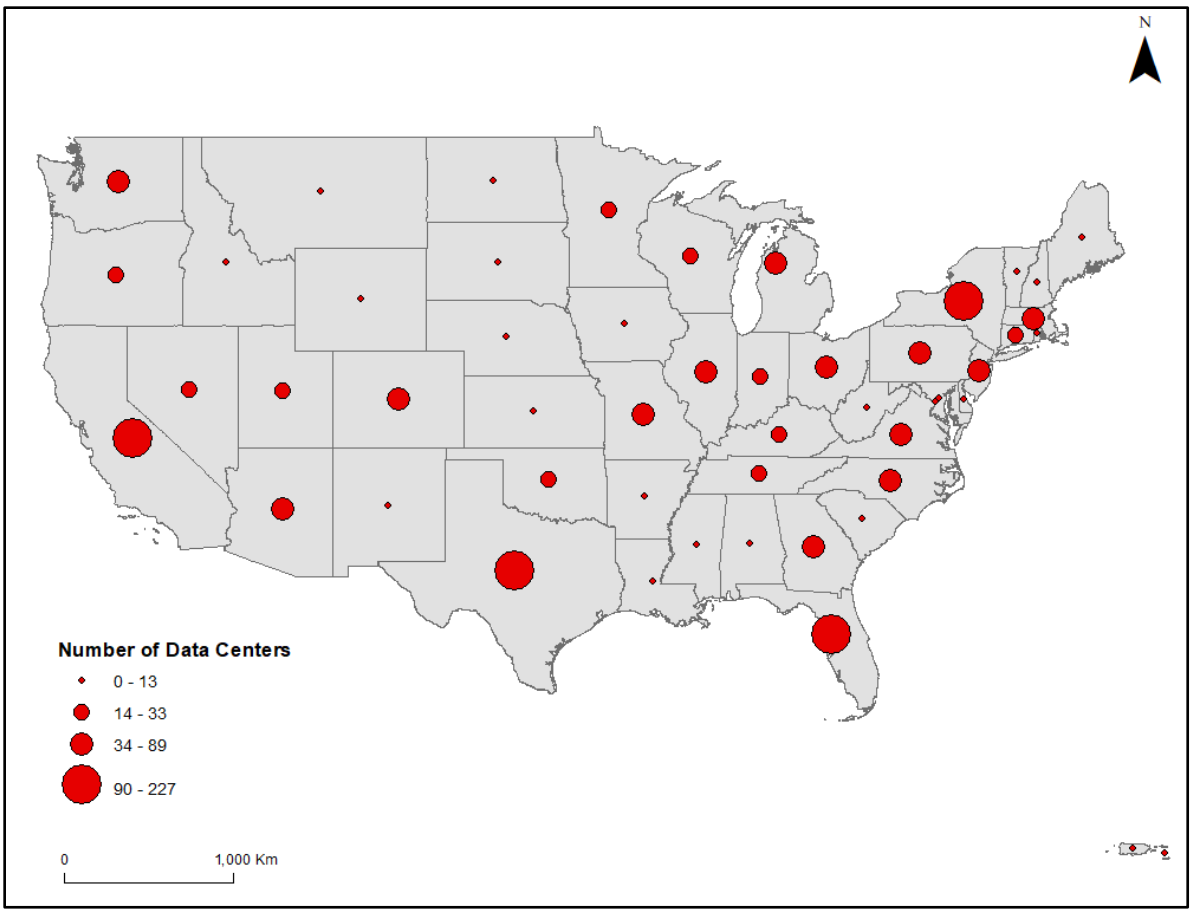

Figure 4. Locations of data centers in the United States. Dot sizes represent the number of data centers per state. These data do not include the new hyper-scale data centers built or under construction within the last three years. *Map by author, data obtained from Data Center Map, http://www.datacentermap.com/*.

In the chapters that follow, I examine the case of Prineville, Oregon with UFWPE and the New West discourse as a backdrop. Prineville, a small rural town in the Western U.S., is similar to many towns that have been included under the umbrella of the New West paradigm. It was once a booming timber town that quickly began to die out. Yet, unlike what New West scholarship would predict, Prineville turned to something other than tourism and outdoor recreation for survival: data centers. The town has been adopted (or coopted?) by technology and social media companies, and now, like neighboring Western towns, it is undergoing social, cultural, and environmental change. However, the crucial question is, *what sort* of change, and

how much? The goal of my thesis research is to 'catch the cloud' and bring it down to the earth, where the impact of our technophilia can be seen playing out on the socio-environmental landscape of the rural American West. This is where questions of the nature of technological development can be answered at a level that matters to real-world communities. It is here, in places like Prineville, where we can begin to construct a geography of data centers.

Notes

1. "Beneath the Cloud: Exploring what the internet is made of," *TheAtlantic.com*, last modified January 8, 2016, https://www.theatlantic.com/projects/beneath-the-cloud/.

CHAPTER TWO

REBOOTING A TOWN: VISIONS OF DEVELOPMENT IN THE DIGITAL AGE

To understand the decisions Prineville has made in the last decade, it is important to understand the story of a neighboring town: Bend. Bend is the classic example of what scholars would deem a stereotypical 'New West' town. Before coming to Oregon, I had read other scholars' work on Bend (e.g. Rothman 1998; Robbins 2004; Jackson and Kulkhen 2006) and learned how city transformed physically and culturally in recent years, which made me curious to see the differences between Prineville and the booming city nearby. So, on yet another swelteringly hot afternoon during my time in Central Oregon, I decided I should see Bend in person. Leaving behind the agricultural fields and ranches on the outskirts of Prineville, I felt oddly as if I had left Oregon suddenly and been transported back to my suburban town in New York. The first thing I saw when I approached Bend was a shopping mall. The plaza I passed by housed of all the standard commercial chains one would expect to find in any other small 'modern' city in the United States. *I could use some new running shoes*, I thought as I stopped at a traffic light near Dick's Sporting Goods. I shook my head in disbelief at the thought. Yesterday I was at a farmer's market in Pioneer Park speaking with ex-mill workers, and today I was stuck in a line of traffic thinking about buying shoes. I supposed this sort of jarring juxtaposition was precisely what New West scholars had been talking about. The difference between Prineville and Bend seemed to manifest the features of a transforming New West: Bend had become a busy city, full of noisy tourists, retail stores, and trendy coffee shops. I drove toward downtown, curious to see what other New West characteristics would come to fruition.

I was not disappointed. The center of Bend hosts a larger shopping center called the Old Mill District (Figure 5). Passing through at least ten traffic circles—and nearly getting lost

twice—I finally found a spot to park the truck. I got out and walked toward the center of the District. I was greeted by a building with three shiny smokestacks that towered over the mall. Here was the epitome of New West transformation: the old mill at the center of Bend had become an REI store, full of high-quality gear for the would-be hikers, kayakers, and mountain bikers passing through.

Figure 5. The Old Mill District in Bend, Oregon. The smokestacks, once part of a sawmill operation, are now decorations atop an REI store. In the distance, high-rise luxury apartments are also visible, an increasingly common sight around the growing city. *Source: Jennyfurniss (Jenny Furniss) [CC0], via Wikimedia Commons*.

Looking around at the surrounding stores and restaurants, more of the New West generalizations I had read about came to life. There were upscale houses surrounding the District, and brewpubs, salons, and other high-end retail stores were all within walking distance. Sitting in Farewell Bend Park later that afternoon (Figure 6), I saw people lounging on the grass or jogging, despite the oppressive 90-degree heat. Kayakers, standup paddle boarders, and river floaters coasted by on the steady, cool current of the Deschutes River. Everyone looked like they were having fun. Even still, something felt very forced about it. Bend seemed like a city-size

vacation resort. I couldn't help but think that the city embraces a kind of ephemeral bliss, a thin film covering the (literal) dirt of its past.

Figure 6. The Deschutes River running past a recreation trail in Farewell Bend Park in Bend, Oregon. Note the omnipresent luxury housing overlooking the park. *Photo by author*.

Bend and Prineville may seem worlds apart today but they had similar beginnings. In this chapter I explore how and why these towns have developed the way that they have, focusing on Prineville in particular, as well as what their development means for New West scholarship. The comparison between the two cities helps problematize the simplicity of the New West conception. According to New West logic (e.g. Reisbame et al. 1997; Rothman 1998), Prineville should have either become a busy tourist-filled city, as the town developed its economy to fit within the reshaped mold of modern capitalism like Bend—or else completely stagnate. However, I argue that Prineville has struck a peculiar balance between the New and Old West. As such, the town's development raises a number of questions: What type of economy *is*

Prineville, if not Old or New? Does its development indicate that the New West ideas are no longer applicable in this digital age? After providing a brief history of Bend, Prineville, and Central Oregon more broadly, I will address these questions and conclude with some thoughts about the broader implications of Prineville's story.

From Timber to Tourism or Tech

Oregon, once the ultimate journey's end, "is central to some of the deepest and most fiercely held narratives of American frontier history" (Cronon 1997, p. xi). As such, the landscape here embodies the historic romanticism about the pristine nature of the Western Frontier. Oregon's story begins much like other states' stories in the Pacific Northwest by dispossessing Native peoples of their land and a swift transition into a landscape rife with pioneer yeoman farmers—and over time, with bureaucratic institutions and large corporations (Robbins 2004, p. xvii-xxi). Nonetheless, Oregon is distinctive because it is here that tensions are visible between the desire to live out the dreams of agrarian community and progress and the reality of this region's historical environment (Cronon 1997). The landscape of Oregon provided great hope and promise to pioneers long ago for its vast stores of environmental resources, but what happens to it now in the digital age is becoming increasingly uncertain.

Central Oregon in particular is worth examining because it is both literally and metaphorically central to the state. It is optimally located for resource extraction and movement of goods to the larger cities in Oregon, though it is certainly not its sole resource supplier (Pedersen 2016). The area consists of three primary counties including Deschutes, Crook, and Jefferson County. These three counties cover 7,833 square miles, and are surrounded by the Cascades, the Blue Mountains, and the Columbia River Plateau. Although Central Oregon has an

arid climate, several important water bodies flow through its cities and towns (Orr and Orr 2006). The Deschutes River is the primary water source, which flows to the Columbia River and also branches into the Metolius River and the Crooked River further south (Figure 7). History has proven this geographic location to be both strategic and problematic (Jackson and Kulkhen 2006).

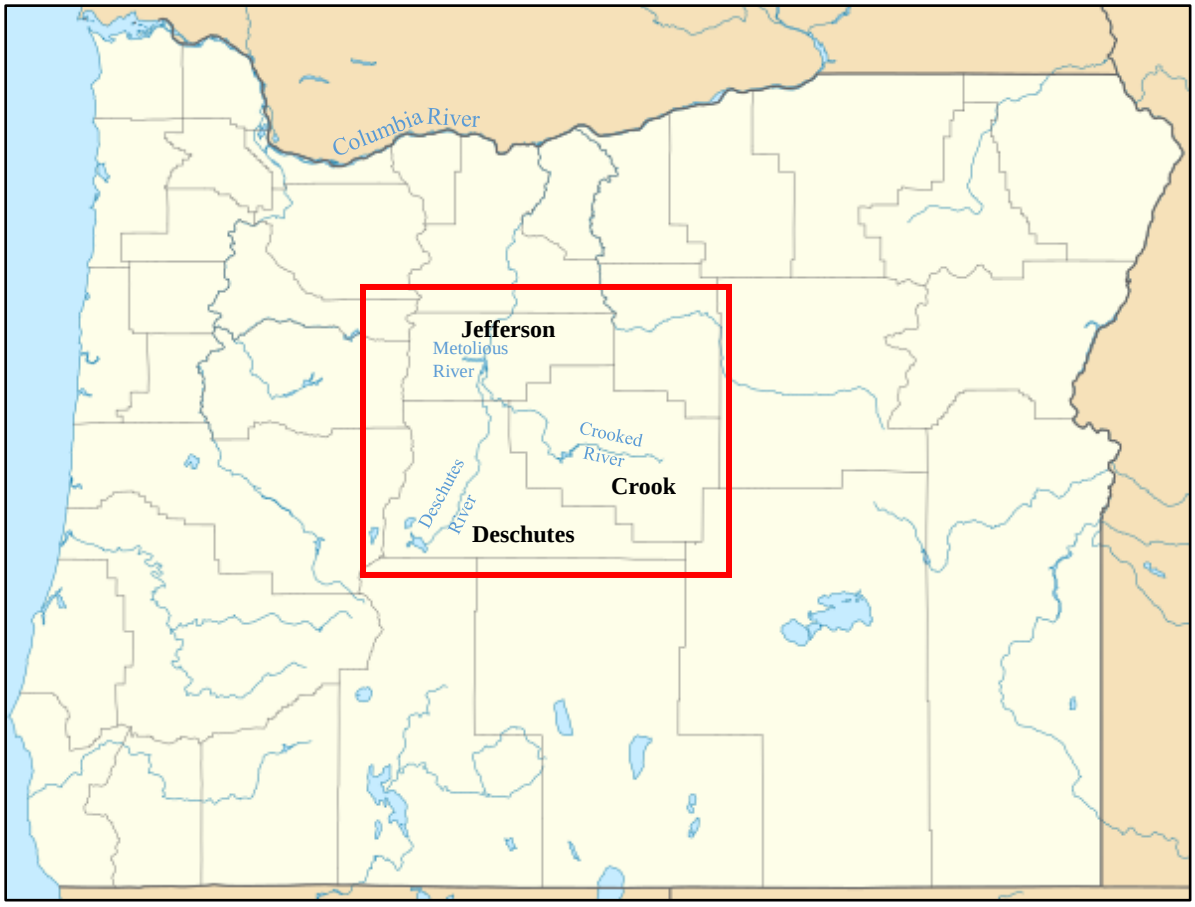

Figure 7. Map of Central Oregon. *Modified from Alexrk2 via Wikimedia Commons*.

Central Oregon is situated such that it lends itself to both resource extraction and to enjoyment of the landscape's natural amenities. For this reason, Central Oregon originated as a hub of mining, ranching, agriculture, and forestry (Jackson and Kulken 2006, p. 171-177). The economy of the region's towns and cities centered on these extractive industries, making them an

important part of capitalism's worldwide expansion (Robbins 1997). However, before towns could build up around these industries in the early 1900s, people had to be able to get there—and they had to want to stay there. As such, the railroads were crucial to the economic and cultural development of Central Oregon from their advent. Transporting goods between rural and urban spaces was essential if small towns wanted to survive in the high desert (Jackson and Kuhlken 2006, p. 176). The need for mobility shaped Central Oregon's history and its natural landscape. Transportation infrastructure primarily maintained these towns as an important part of the nation's development as a whole for many years (Olson 2012). The Second World War transformed much of the American West, Central Oregon included, which was made possible at least in part by the railways constructed a half-century before. Oregon's physical and cultural landscape was largely restructured by economic forces after 1945, especially as the nation's desires shifted toward consumerism, in conjunction with the rise of the automobile industry and an increase in the number of affluent middle-class citizens (Robbins 2004). The American West was "in perpetual motion" after WWII, "operating at a frenzied pitch for more than three decades" (Robbins 2004, p.17). As such, the extractive industries experienced accelerated growth and activity, sending Central Oregon into a boom of economic prosperity.

Despite this mid-century prosperity, however, conflicts began to emerge (Robbins 2004). The desire to remain an integral part of the global capitalistic market—and provide for the WWII effort—started to deplete Oregon's natural resources, as "early comers and their successor generations plowed the soil, hewed the timber, and fished the region's streams with neither caution, introspection, nor reflection" (Robbins 2004, p. xvii). Accordingly, with the rising national concern for environmental health and subsequent federal regulation in the 1960s and 1970s, Central Oregon's extractive industries were suddenly seen in a less positive light, and

their productivity decreased gradually (Robbins 2005). Oregon in 1980s and 1990s was thus characterized by a decline in the once-booming extractive industries, in part because environmental groups worked to limit their activity in the name of conservation (Robbins 2004). Moreover, increasing automation within agriculture and timber industries between 1950 and 2000 led to fewer available jobs (Robbins 2005, p. 144). This trend has also continued into the twenty-first century, leading to economic decline in many regions of the rural American West. As New West scholarship indicates, with the loss of traditional livelihoods, the region began a rapid transformation into a completely different landscape (e.g. Reisbame et al. 1997). Parts of the West soon became a place for the enjoyment of natural amenities, reliant on service-sector jobs for its economic base rather than extractive industries.

Before discussing the implications of such a transition, it is worth mentioning the key role of technology in driving these economic changes. As previously noted, Central Oregon has been historically reliant upon technological innovation to sustain its existence (e.g. railroads, telephone lines, water infrastructure etc.), and arguably it still must be due to its geographic location. Consequently, the region was long ago described as a "western zone of experiment" by Isaiah Bowman (1931, p. 93). In Bowman's view, the combination between old and new technologies and rural and urban spaces produced extremes of both wealth and poverty. As a result, traditional ways of life and values were promoted simultaneously with modern ones in Central Oregon (Olson 2012). This strange combination of old and new is still visible in the landscape of the rural West. The place where Bowman's 'zone of experiment' is currently coming to life is Prineville, Oregon.

The city of Prineville has relied upon technological innovation since it was founded in 1868 (Juris 2017). Prineville sits nestled in the Crooked River/Ochoco Creek valley, essentially a

human-made oasis in the desert (Figure 8). By 1880, Prineville became a busy frontier town of 200 people that worked to provide goods and materials to those living in Central Oregon (Juris 2017). Unfortunately however, the city was left behind when railroad companies neglected to connect Prineville to the main railways due to geographic constraints (Juris 2017).

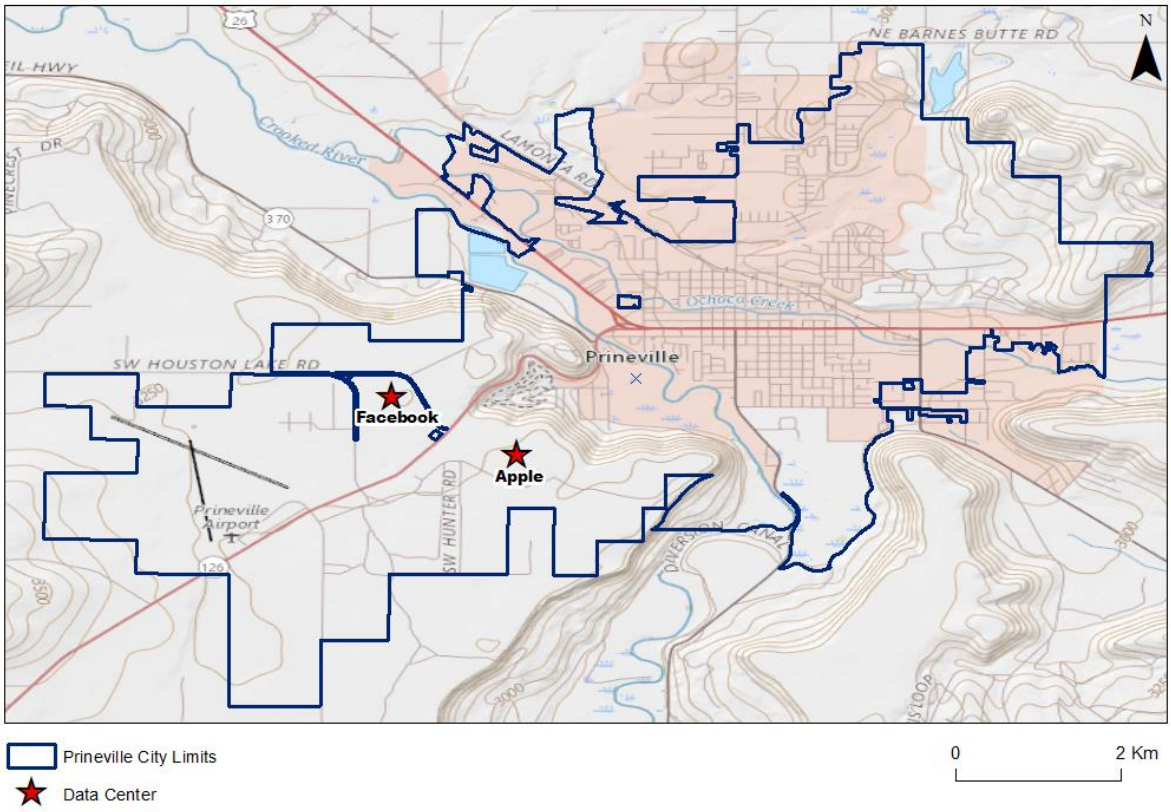

Figure 8. Map of Prineville, Oregon. The data centers are marked by stars. *Map by author*.

In spite of these companies' neglect, Prineville began building its own rail line in 1917, and with the help of newly constructed roads, the town remained an important part in the state's economy (Mills 1941). The Prineville City Railway still runs today, but the booming town of the past has changed immensely in recent years (Figure 9). Prineville's story largely reflects the same pattern of decline as the American West overall, yet it is unique in a few regards. As geographers Philip Jackson and Robert Kuhlken (2006, p. 176) put it, "Economically, Prineville

has always been both lucky and somewhat stubborn." As I explain, rather than following the path set forth by surrounding New West communities, Prineville has chosen its own new path.

Figure 9. A railcar on the train tracks outside of downtown Prineville, Oregon, not currently in use. *Photo by author*.

In the early years of its development, Prineville became a quintessential timber town, harvesting timber from nearby Ochoco National Forest and home to seven mills in constant motion (Jackson and Kuhlken 2006, p.176). These mills supported the town's economy for many decades, but there was more prosperity to come. In 1952, one of the largest sustaining industries in Prineville was founded by a man born-and-raised in Central Oregon: Les Schwab. He created a company called Les Schwab Tire Centers, which has also helped maintain Prineville's economy since its establishment, as it employed the largest proportion of the town's residents not working in the mills (Figure 10). Today, the company handles over one billion dollars in annual sales, and has expanded operation to seven different states (Bates 1997). Les Schwab's is also still one of the major employers in Prineville and the wider Central Oregon region (City of Prineville 2016). Nonetheless, just as in other neighboring cities, as logging depleted the forests

and sustained yield laws in the late twentieth century made Prineville's economy slide sharply downhill.

Figure 10. Les Schwab Tire Center, located on NW 3rd Street in Prineville, Oregon. Les Schwab's remains one of the largest employers in the area, and has expanded its operations significantly since its foundation in 1952. The company has helped maintain Prineville's economic vitality through difficult times.

Perhaps at least partly due to its 'stubborn' nature, Prineville was able to survive through to the early 2000s, relying upon Les Schwab Tire Centers and a dwindling number of timber and construction jobs to support its local economy (Juris 2017). The town's economic situation became dismal according to local officials, however, in 2007-2009 as they felt the widespread effects of the national recession and housing bubble. Much to the locals' dismay, Prineville's unemployment rate reached twenty-one percent in 2008 (City of Prineville 2017). To make matters worse, historically, Prineville's in-migration has outpaced its job growth, but during the recession the town actually lost more people than it gained for the first time (EDCO 2017). As

such, local officials knew when they hit this all-time-low that they must begin searching in earnest for something to keep their community alive.

Taking a step back from Prineville's story momentarily, it is important to discuss the larger factors at play in the changes taking place in the American West. Namely, there seems to be a broad consensus that the best way for rural towns in the American West to survive in our capitalism-centered world is through economic growth and development (e.g. Robbins 1996). David Harvey's (1989) concept of 'urban entrepreneurialism' helps explain what has been happening recently in Prineville, as well as in Central Oregon overall. Harvey (1989) describes how, beginning in the 1970s and 1980s, cities started to take an entrepreneurial approach to urban governance rather than a managerial one. In other words, in response to globalization, mobile capital, and subsequent increased urban competition, Harvey (1989, p. 5) notes how local officials in cities began "doing the best they [could] to maximise the attractiveness of the local site as a lure for capitalist development." In essence, to survive in the global economy, cities have realized that they must make themselves attractive to big businesses and modern industries. Harvey (1989) outlines four strategies for urban entrepreneurialism: (1) use natural advantages (e.g. geographic location or resource base) for the production of goods and services, (2) attract consumerism by highlighting the local quality of life, (3) make infrastructural investments and improvements, and (4) redistribute surpluses to higher levels of state control. These strategies may be mixed by local leaders to achieve said 'attractiveness.' Arguably, the small cities and towns of Western rural America are undergoing a similar transition.

As the New West scholarship indicates, when the extractive industries that once sustained small cities like Prineville declined, a transition to a service-based economy began (Reisbame et al. 1997; Taylor 2004; Robbins 2005). During this transition, rural places effectively needed to

establish a stronger, more viable economic base to survive in competition with their urban counterparts (Robbins 1997). So, based on the economic transformations visible in the West, approaches to entrepreneurialism used by urban cities have been applied by rural ones. In the face of global capitalism and technological innovation, rural towns in the American West were left with few options other than to conform to a new sort of economy. As I will discuss, one option, tourism, can lead to transformations that may reverse a community's character forever. Another (more recent) option, data center construction, may or may not do the same.

As a result of these limited options, Harvey's (1989) ideas about entrepreneurialism can thus be seen playing out in Central Oregon, albeit in varying, localized ways. For example, Prineville was not the only city that had to seek a new, stronger economic base. Bend, thirty-six miles southwest of Prineville, has a parallel story. However, although Bend and Prineville had similar experiences of economic development and decline initially, the two cities have had vastly dissimilar experiences in re-development since the turn of the century. The reason for the differing outcomes of this process is a result of a combination of factors; however, the most direct cause is likely the industries each city attracted when it came time to rethink their economic bases. Whereas the officials in Prineville chose the technology industry to rebuild their little town, Bend made what Hal Rothman (1998) calls a 'devil's bargain': an economy based on tourism and outdoor recreation.

What the Devil Did Bend Do?

Bend, like Prineville, was once a bustling timber town (Robbins 2004). When that industry declined, the city began to rely on the natural amenities of Deschutes County to support its economy (Olson 2012). In short, Bend became a tourist town. Unfortunately for long-term

residents, this shift to tourism and outdoor recreation came at a great cost. As Rothman (1998, p. 10) states, "Tourism is a devil's bargain…Regions, communities, and locales welcome tourism as an economic boon, only to find that it irrevocably changes them in unanticipated and uncontrollable ways." That is to say, as tourists are welcomed into a given community, they tend to bring with them a new way of life and certain characteristics and values that may be at odds with a region's preexisting one. As the concept of 'rural gentrification' suggests, locals are slowly pushed out by the increasing inequality of wealth and the redistribution of power (Rothman 1998; Bryson 2010). There then follows a progression of 'colonialism,' both external because new people are coming in and taking over the physical town, and internal because, "as the industry reflects to visitors more of what they want it to be, it changes the people of those [towns] even more" (Rothman 1998, p. 370). As such, the seemingly benign tourism industry becomes a domineering power over the places and people that adopt it. Ironically, the very thing a community believes will save their town or city can end up destroying their cherished cultural identity and/or sense of place as a result.

In Central Oregon more specifically, Robbins (2005) discusses how incoming tourists have marginalized locals and their traditional livelihoods, in part due to increases in rental prices, property taxes, and real estate prices. Bend and other cities of the American West have been gentrified into playgrounds for affluent newcomers (Bryson 2010). Tourists and retirees can escape into the mountains for a few days, then return home to gated communities, golf courses, trendy boutiques, and upscale cafes. Consequently, there is more traffic and noise. The long-term residents have become the bus drivers, waiters, janitors, and other service workers that keep the city going instead of mill workers or farmers (Robbins 2005, p. 200). And yet the city in which these people now reside is no longer recognizable as theirs. The uniqueness of a local culture

dissolves under the pressure of the newcomers that import their own values and customs to this space (Rothman 1998). The result is a growing class division between the wealthy visitors and the local service workers (Putman 2015, p. 47).

Accordingly, Bend is no longer recognizable as the resource-dependent city it once was. Due to their new economic strategy, Deschutes County has experienced the most rapid growth in all of Central Oregon since the 1990s (Putman 2015, p.46). With this influx of people from elsewhere, Bend has become "a frustrating case of the good, the bad, and the ugly" that has "failed to guide the growth that should have been so easily anticipated" (Jackson and Kuhlken 2006, p.174). The locals who welcomed tourists and their money with welcome arms, have suffered culturally as a result of tourism—even if they have prospered economically. The juniper trees and desert grasses surrounding large saw mills have given way to trendy shops and restaurants in the newly urbanized core, along with sprawling suburbs in the periphery. The city is more crowded, surrounded by expensive and expansive modern homes that original inhabitants of Bend generally could not hope to afford (Robbins 2005, p. 200). In short, Bend's strategic location in the middle of an outdoor recreation mecca has caused a complete economic and cultural transformation in the city. Some argue that this change has represented a turn for the worst in Western communities. Bend's story provides a cautionary tale of what can happen when communities make a devil's bargain. Has Prineville done the same?

Develop or Die?

Since the 1990s, Bend and Prineville have taken divergent paths in developing their respective economies. Even as both cities have become focused on entrepreneurialism and attracting big businesses, Prineville's economy has taken an entirely different shape. Prineville too was once a

dying town that needed to reconsider its reliance on traditional extractive industries. Now, as a top local official, Beth Robbins, put it, "We [Prineville officials] don't want all our eggs in one basket, and so we're trying to diversify…We're open for business. We need it." Robins is not alone in her sentiments. Based on my interviews, it appears that most officials in Prineville have grand visions of economic redevelopment for their town. Thinking more broadly, however, it is crucial to question what motivates this desire for new development. Seeing what happened to Bend as a result of capital (re)development has made some long-term Prineville residents wary of such economic endeavors. Almost all my interviewees noted how they, in agreement with Rothman's (1998) 'devil's bargain' idea, saw Bend's story as a tragedy, rather than a success story. Based on Bend's experience, one might wonder why Prineville would want to redevelop at all. As Kirsten Smith, the spokesperson for a local non-profit investment foundation put it, "It's sad what's happened to Bend. It used to be a nice little timber town, like us, but now you can't go anywhere in town without them building something or fixing the street…it's just changing so fast, and not always for better."

It seems that both Bend and Prineville had little choice in the matter, because whether they wanted to change or not, the world around them was. With increasing globalization and technological innovation, the town officials saw that they needed to grow the local economy to keep up, or else they would be left behind. Rural development has been historically defined as any strategy meant to improve the lives of people living in rural areas (Singh 1986), and 'improvement,' according to capitalism, usually means economic and technological growth. However, the development of rural places as part of global capitalism and neoliberalism has resulted in 'uneven geographies' that have not benefitted all communities that undergo development (Harvey 2005). In other words, some regions that chose to develop and compete in

the global market have won, while others have lost. Consequently, Prineville approaches development with caution. The fear that the town could lose its rural Western charm is palpable. Local residents certainly can see the parallels between themselves and Bend, and that worries many of them. As a town historian Sean Liebers put it bluntly, "I sure hope Prineville is never a convoluted mess like Bend." And yet, officials seemed to realize that to compete, they can no longer rely solely on traditional livelihoods from natural resource extraction and agriculture.

Small rural towns like Prineville and Bend thus necessarily got swept into entrepreneurialism as they began attempting to sell their communities as ideal places for profitable businesses and nice places to live. Unlike Bend, however, Prineville could not and cannot rely on tourism alone. Prineville officials sought other options not only because they are not quite near enough to recreation sites for skiing, rafting, and mountain biking. Even an official with the Prineville Chamber of Commerce, Cole Kent, said that the growth in Bend had made the town lose "some of the attributes that were attracting people to the [Central Oregon] area." And because of their desire to grow, Kent stated, Bend has become "almost its own worst enemy in that respect: you can't go on a bike trail within five miles of Bend without meeting three-hundred other people on there." Evidently, the people of Prineville understand that adopting tourism as their only means of economic development would be a detriment to the community culture they cherish. In short, the locals simply "don't want to be the next Bend."

Despite their aversion to Bend, however, with over twenty percent unemployment in 2008, Prineville was looking at the prospect of becoming a ghost town in a matter of years if they did not rethink their economic base. Other neighboring towns, such as Sisters, chose the same tourism tactics as Bend, but that simply did not sit well with Prineville residents. Evan Kasey, city official, pointed out that "Prineville is located where it is because of natural

resources… but unfortunately that [industry] is no longer available." One would think that with such a grim outlook, Prineville's population would have declined further. Yet those who could stay in Prineville through those hard times still stayed. As a long-term local put it, they "loved their town and couldn't imagine leaving it," regardless of the economic decline.

Not surprisingly, Prineville pride has become a strong driver of the city's visions to develop economically today. Almost everyone I spoke to in Prineville, official or otherwise, had lived there for most of their lives. Many had moved away and come back after going to college. There is clearly something about the small town that pulls its residents back in and makes them protective of it. As Cole Kent noted, "People that move to our community appreciate its character and they want to preserve it." This sentiment is largely why officials have become determined to bring businesses to the area, while at the same time trying to maintain the traditional "Prineville way of life." For instance, Beth Robins emphasized the desire for continuing the tradition of housing multi-generational families in Prineville. "Our goal is to be able to make families, if they want to stay, stay by choice, and know that they can find a job. That hasn't always been true," she said adamantly. Town officials have allegedly said all along that they needed to "maintain Prineville as Prineville [because] it's a way of life that a lot of people treasure." Consequently, in the face of economic decline, Prineville officials earnestly sought something to save their dying timber town—anything that would prevent them from meeting the same fate as Bend.

Prineville's luck changed in late 2009, when a mysterious company using the code name "Vitesse" began emailing Prineville officials. Prineville official Pete Stenner stated, "There's a number of communities in central Oregon that we've seen struggle, especially after that downturn of the economy…You see a little town kind of just go away. [It's] kind of sad. But

we've been able to adjust." This adjustment was largely made possible by the "Vitesse" company, which eventually revealed itself as Facebook. The company had chosen Prineville as a prospective site for a new data center, and local officials were sure that this was just the thing that Prineville needed to turn everything around. Rural entrepreneurialism was at work as town officials made Prineville look as desirable as possible through tax cuts and incentive packages, in addition to their "transparency, honesty, and work ethic" (City of Prineville 2017)—a common tactic cities use to lure businesses (Harvey 1989). As a result, they were able to outcompete other rural towns vying for Facebook's business investments. As Crook County official, Chris Ford, put it, Prineville is "a nice place to live. And as we get more amenities, it'll be a nice place to raise your family. I've lived here all my life and you look at it differently through time, but right now it's in a boom…I still wonder though, how do we handle or manage the expansion without changing what our look might have always been?" Ford's question was much like my own. Thanks to Facebook, Prineville now seems to be on the cusp of what was and what might be. Are data centers be the next tourism? Did Prineville make a devil's bargain too, by signing on with Facebook, and later, Apple?

High-Tech and High Time for Reassessment

On the surface, the answer to the above questions appears to be no. Since Facebook brought the data center to Prineville, the city's unemployment rate dipped to less than six percent. Water and electricity infrastructure have been redone, improving service not only to the Facebook data center, but also to the entirety of Prineville (Kadel 2017). Moreover, when Facebook moved in, Apple soon followed, and $45 million has since been invested in the local economy. The number of jobs created is surprisingly high as well, as there have been about three-hundred direct jobs

added between the two big data companies—a significant number for a city with a population of 9,253 people (Kadel 2017). Seventy-five percent of Facebook's direct employees and fifty percent of Apple's direct employees are also Prineville residents. The deal negotiated by town officials was that these workers would also receive 150 percent of minimum wage, which allots to an average salary of about $64,000 per year (City of Prineville 2017). As the study by ECONorthwest indicates, there is also a 'job multiplier,' meaning that for every one data center job, two other indirect jobs are created (Wilkerson 2014). More specifically, since this is also an ever-expanding industry, indirect jobs such as construction work and security positions are continually added. Economically speaking, it is thus clear that Prineville is now fairing much better than it was a decade ago.

Nonetheless, despite the excitement of local officials from the construction project's outset, Facebook was not necessarily welcomed by all residents. Through my interviews I came to understand that there was (and perhaps still is) some resistance among non-officials in the town. Many locals were especially concerned about the tax breaks Prineville gave Facebook and Apple. The deal negotiated by officials stipulated that Facebook and Apple would receive a fifteen year tax abatement on all new property and equipment needed for data center construction as part of the Long Term Rural Enterprise Zone (LTREZ) program. LTREZ is a statewide program aimed at helping rural areas develop their economies by providing seven- to fifteen-year tax abatements to incoming businesses (City of Prineville 2017). What the locals I spoke to apparently didn't realize, is that the requirements to be accepted in the LTREZ program involve $11.35 million in capital investments and at least 35 jobs created in the first three years after construction. Residents that were concerned about this tax abatement also did not know that Facebook and Apple still must pay taxes on the land they purchased (for a total of $6 million)

that was already on the Prineville tax rolls (City of Prineville 2017). As such, the town did not lose any tax revenue they already brought in, and in a few more years, they will be happily accepting millions of dollars annually from both companies as the newly built land is brought onto tax rolls. Not to mention the fact that Facebook and Apple had to pay $2 million in inspection permits, $1.4 million in franchise fees in fiscal year 2016, and city and county payments between $250,000 and $300,000 each year from 2017 onwards (City of Prineville 2017). Had local residents known these figures, perhaps their opinions of the data centers may have been a bit more positive.

Another common complaint I heard was that these data centers were a menace because people perceived that the buildings were using up all the town's water and energy. I will discuss this assumption further in the next chapter, but suffice it to say that another part of the agreement Facebook and Apple made with Prineville officials was that they had to invest in improving the town's infrastructure before construction (City of Prineville 2017). As a result, many infrastructural improvements have come to fruition over the last seven years, improvements that benefit both the data centers and the local residents alike. According to local official, Cole Kent, through investments in fiber, power, water wells, roads, and traffic improvements, the companies are not only making the town much more attractive to other industries, but they are also making local projects possible. "The capital infusion that has come into the community as a result [of the data center construction] has made a lot of things possible that wouldn't have been otherwise," he asserted during our interview. Evidently, the economic benefits of data center construction for Prineville are far-reaching and hard to ignore. Prineville official, Evan Kasey, said that numerous journalists have come to the area looking for a negative spin on the story, but they have been hard-pressed to succeed in finding one.

That said, even if the economic improvements seem indisputable, what about the social and cultural differences data centers could potentially bring? As discussions of the rural-urban 'digital divide' suggest, urban areas tend to be the epitome of the fast-paced, tech-savvy communities, while their rural counterparts lag behind (Hindman 2000, Wilson et al. 2003). It therefore seems odd then that Facebook and Apple would choose to locate in a place like Prineville—or any small rural town for that matter. But residents insisted that they were technologically savvy and their community had reliable Internet access. A primary official in Prineville, Stanley Franklin, said adamantly, "I wouldn't underestimate the [technological] knowledge of the community here…Even in a little rural community like Prineville, we have a lot of technologically-advanced systems, not unlike what you would see in an urban area." Evan Kasey and Beth Robins also noted that some of their community members rely upon the Internet to obtain the same education and services that urban residents enjoy. As Kasey put it, "When you live in eastern Oregon, Amazon Prime kicks ass! I mean, two day shipping when it takes you two hours to drive to a store? That is pretty cool." Prineville has allegedly always had a "strong Internet backbone" because cities such as Portland needed to keep in contact with Prineville to order and receive raw materials such as timber and tires. Consequently, although it seems the high-tech infrastructure is at odds with stereotypically rural places, Prineville no longer fits that mold. To be specific, Franklin noted:

> If you go to a high school rodeo tomorrow, and you look around at the parents and kids at these rodeos, they're all on their iPhones, they all have pictures, they all have the ability to search for an address, to make calculations, to check the weather…these kids are very sophisticated on their phones.

In short, Prineville never lagged behind in terms of digital infrastructure. To town residents, the urban-rural digital divide was never a concern. Cowboys, ranchers, farmers, or not, the majority of their residents allegedly have cellphones and internet access, and the data centers moving in

did nothing to hinder that according to local officials. In fact, if anything, the big data companies' presence improved their connectivity and access.

Yet even if computer and information-based technology itself is not at odds with the Prineville way of life, some residents indicated that they were somewhat worried that big data companies could bring larger cultural changes that would rid of their traditional and cherished small-town character. If these companies brought in people similar to those that the tourist industry in Bend attracts, Prineville could be utterly transformed. As an Economic Development for Central Oregon (EDCO) team member in Prineville, Carol Ericson, put it, "We still have a few people in our community that will never change their mind no matter how much education they have. They have this idea in their heads of how things work, maybe even if that's not reality. Some people just don't want to see change." It is hard for long-term residents to imagine Prineville any different from the close-knit mining, ranching, and agricultural community it has always been until now. Yet when I asked locals to describe changes that have taken place in Prineville since Facebook's arrival, they had trouble coming up with any significant differences in the community's structure. Local official Pete Stenner acknowledged that new workers have certainly come to the area, but they aren't isolated or at odds with long-term residents, "they are just part of the fabric."

Perhaps the only significant problem cited by officials and townspeople alike was the housing shortage in recent years. According to a Crook County official, Chris Ford, "Housing is just a growing pain here." The region has seen an enormous increase in demand for new homes in the last two decades, generating a flurry of building activity in the greater central Oregon area (Bousquet 2004). However, while data center construction in Prineville has potentially exacerbated the problem by bringing new workers to the area, the presence of big data

companies is not apparently the root cause. As neighboring cities such as Bend and Redmond have seemingly reached a saturation point with new residential construction, people are looking for Prineville to become a 'bedroom community' because it is located within commuting distance and the land costs about half as much (Bousquet 2004). Consequently, new people have certainly come to the area, but they are not necessarily from the Information and Communications Technology (ICT) industry, nor have they caused a significant change to the community as a whole. Or at least they haven't done so yet. More construction is on the way, but for now, as Ford put it, "We're a bedroom community without any bedrooms left."

While Prineville officials realize there is a housing problem, they seem unconcerned because overall, they have seen nothing but positive outcomes for their community since Facebook and Apple first arrived. Cole Kent asserts that the integration of big data companies into their economy "has been a game-changer for this little town." It seems that other locals agree for the most part. The majority of residents said they saw increases in hope and prosperity of the community since the data centers arrived. Chris Ford affirmed that big data companies "really changed what the face of Prineville is today and what it will be." He thinks the new tech industry will "plant a seed that will help us regrow our economy." Beth Robins indicated that while it is true the town simply can't build houses fast enough to keep up with demand, she didn't see that as a bad thing. Residents come to Prineville because they want to live in a small community, and that is what they will continue to get for the time being. Robins assured that Prineville "will continue to grow, but not at the speed Bend is growing. In twenty years we will probably be 20,000 people, but I think we will retain our small community."

For now, Robins appears to be correct. Growth is happening in Prineville, but somehow, the town has managed to grow just slowly enough that the community has maintained its small-

town charm over the last decade. They have not become the next Bend because of these data centers—or at least not yet.

From New West to New West 2.0

Taken as a whole, New West scholars might be intrigued by Prineville's story. While it is true Prineville has transitioned away from its exclusive reliance upon traditional extractive industries, farming, and ranching, it still has not transformed into the stereotypical New West city. Of course, there are aspects of Prineville that suggest it has at least partially been overcome by homogenizing forces, as other American cities have (i.e. they have a Starbucks, DollarTree, and McDonald's), and the town even features a trendy coffee shop and a few brewpubs off of East Main Street. And yet there are many other characteristics of Prineville that do not adhere to the New West idea at all. To name a few, the town still holds rodeos each week, Pioneer Park hosts craft fairs with live country music fairly regularly, and they have parades for every imaginable occasion (Figure 11). On the surface, it appears that the original character of Prineville has not been lost at all. The precarious marriage of Old and New West characteristics exists in this small rural town, and it seems to be working well for them.

Figure 11. Performers on stage in Pioneer Park, where live country music is regularly enjoyed by local residents. The park also serves as a farmers market a few times a month. *Photo by author*.

The significance of Prineville's development to New West scholarship should not be overlooked. This story suggests that the points made about the emergent New West are increasingly becoming moot. As scholars have already pointed out, the American West has always been a landscape of change and forward motion (Taylor 2004). It is a region that could likely be classified as 'new' with each decade. In its latest technological transformation, many Western towns are indeed changing, but these changes cannot be put neatly in the New West box. As Prineville's development over the past decade shows, the experiences of small rural Western towns are somewhat place-dependent, or at least more so than New West scholarship suggests. While it is true that many places like Bend have made devil's bargains and have come to fit the New West mold, other places like Prineville are trying to hold on to both the Old and New together, walking the thin line between two very different worlds. It would thus seem that the 'New West' term has become outdated—at least for Prineville, and perhaps other Western

communities with data centers. I argue that a better way to conceptualize regional transitions in the digital age is by thinking of these places as hybrid, in that, as Bowman (1931) indicated long ago, modern technology and traditional culture can and do in fact inhabit the same space, mixing together despite their apparent contradictions. The American West is always becoming 'New,' and the current changes the region is experiencing cannot be put into the confines of the simplistic model New West scholarship made for it. As such, we are experiencing a transition into the New West 2.0, a West that revolves around the ICT industry and its ever-expanding, high-speed, interconnected nature.

The New West 2.0 label is clearly a play on words, but in all seriousness, it is fitting. The entire rural American West can no longer be lumped into a uniform region in transition from resource-dependent to tourism mecca. Prineville and other towns that host data centers in the future are not like Bend, Oregon, or Aspen, Colorado. Prineville is neither Old nor New, it has simply updated to the latest high(er)-tech version of itself, which happens to include data centers. The West has been increasingly reliant upon the high-tech industry since the 1980s (Walker and Hurley 2011, p. 73), but now these industries are expanding into rural regions. Here they must attempt to weave themselves together with once resource-dependent communities. By accepting big data companies' presence, small towns like Prineville are becoming active participants in the creation of this new hybridized Old/New West. The community is participating in its own reprogramming and redevelopment as they readily allow Facebook and Apple to expand their operations on what was once county-owned land and take jobs working for these companies. Prineville is thus the beginning of the New West 2.0, a trend that will surely spread to other areas of the Pacific Northwest in coming years.

Still, I have only told a small part of Prineville's story. The New West 2.0 is also characterized by physical transformations of the landscape. The cultural shifts seem to be minimal as a result of data center construction in Prineville, but what about the physical environment? Data centers certainly take up space and use natural resources, but are they any worse that tourism industry or any other business? The chapter that follows seeks answers to these questions and more, as I attempt to convey the true nature of data centers.

CHAPTER THREE

THE NATURE OF DATA CENTERS

I stood on the side of the road on the outskirts of Prineville, cell phone in hand. I had stopped the truck to take a picture of the scenic mountains in the distance, enjoying how their snowcapped peaks provided a stark contrast to the dry dust coating my hiking boots. To my left was the white split-rail fence of a small farm, beyond which an enormous sprinkler spewed a thick stream of water onto a field of crops (Figure 12). Being an environmentalist, I watched in dismay, not understanding how farmers could be so wasteful by watering in at three o'clock in the afternoon. I was mesmerized by the rainbows cast above the green plants as the water showered down in the sunlight. Standing there, I considered the fact that these people had been farming here for years, and my research suggested that there had only very recently been any water shortages in the area. It made no sense to me, but I supposed that meant the people of Prineville knew something I did not about water conservation. I snapped a photo of the field as I got into the truck, thinking I had better learn more about water use in the high desert before I finished this project.

It was odd to contrast this scene with the Facebook data center. A week after stopping to take that picture, I was finally given permission to tour the buildings. There were no industrial sprinklers inside or outside the complex. I saw water exactly three times during my visit to Facebook: in the bathroom, inside the complimentary water bottle I received, and in one of the data center's air-flow rooms. The guide assured me that the buildings were extremely environmentally friendly, and that water systems were continually monitored for efficiency. I watched as water dripped down walls that looked like soggy cardboard and was recirculated through oddly-shaped pipes. Though the guide was unable to provide the exact number of gallons of water the data center uses, I was surprised to see that it did not seem like very much.

In comparison to the farms I had seen lining Highway 126, the data center appeared to be using less water. That certainly rearranged my perception of big data companies. Yet still, I knew that water was not the only limited resource data centers use. Standing on the roof of the building, I squinted in the bright light, noticing massive water storage tanks and generators lining the building. I raised my eyebrows at the guide. “In case of emergencies,” he said, smiling. “We’ve got to be prepared.”

Figure 12. Water spraying from industrial sprinklers across fields outside of Prineville, Oregon in the late afternoon. *Photo by author*.

Data centers are where the cloud comes down to Earth. They are the places that we can see the real-world effects of our increasing desire to produce, consume, and store data (Starosielski and Walker 2016). Although it is hard to imagine a ‘cloud’—named after a perfectly natural part of our earth system—having any negative impacts on environmental health, there are very real consequences of our increasing data demands (Cubitt et al. 2011). As this

chapter will show, however, these consequences are highly nuanced. It is not so simple as to conclude that data centers are necessarily worse for social and environmental well-being than any other industry that may have chosen to locate in the same place. The real concern then, is perhaps more about whether or not the technology industry's impacts at both local and global scales are worth problematizing. I believe that they are.

There are many ways to examine the environmental impact of data centers, but I will focus on four key areas to help explain these impacts: land, energy, water, and waste. The following sections will discuss how each of these elements, in turn, are affected by our growing data fetish. Continuing the conception of the New West 2.0, and drawing on concepts from Urban Political Ecology (UPE) and toxic dumping literature, I will try to answer the question *what are the environmental impacts of data centers?* Answering this question is more difficult than it seems.

One of the greatest challenges of researching data centers is that so little information is given out to the public about their operations. I had hoped this chapter would reveal in detail the specific environmental impacts of data centers at both local and global scales. Unfortunately, there is not much data that has been gathered about data centers. As previously noted, few scholars have researched the physical aspects of cloud computing, including land, water, and energy use for data centers. As such, this chapter relies largely on limited information provided by government agencies, NGOs, journalists, and big data companies themselves. Reports by these stakeholders are helpful, but even still, gaps remain, particularly in the case of waste and pollution. The lack of data on data centers is disconcerting. Nevertheless, what follows represents my attempt to determine the true nature of data centers and whether they are sustainable or not.

This Land Is Not Your Land… Or Is It?

Traditionally, political ecologists have sought to unpack the social and environmental damage capitalism has caused through case studies of conflicts between poor rural communities and resource-extractive industries (Walker 2005). When I began this project, I was sure that I would be describing a similar situation with data centers in the rural American West. I thought my interviewees would tell tales of fighting hard for their right to the land and resources that were being taken from them, and of long debates between officials and residents that lasted late into the evenings. But this was not the case. After speaking with locals I quickly realized that I had exaggerated notions of drama surrounding data center construction and operation. However, just as 'no result' in a laboratory experiment is significant in and of itself, so too is 'no drama.' Prineville's story, although not one of great contestation over the land and resources the Facebook and Apple data centers take, is important because it can spur discussions about the broader implications of future technological development.

On the surface, land use in Prineville and Central Oregon as a whole seems relatively simple. Prineville official Pete Stenner stated that in Central Oregon, "Everything that isn't city is farmland or forest." However, unlike many other states in the U.S., Oregon's comprehensive plan is quite complex and well-developed (Walker and Hurley 2011). A comprehensive plan is a document that sets goals for statewide land use and development. Based on the premise that sprawl and resource waste must be avoided, Oregon's comprehensive plan was created by Senator Hector Macpherson Jr in the 1970s. Macpherson allegedly had three primary goals in developing the planning system: to identify the "wisest use" of land for both the present and the future, to allow for public participation, and to incentivize communities to accept the plan rather

than coercing them (Walker and Hurley 2011, p. 25). With these goals in mind, the planning system was implemented in 1973, and after only a few modifications made over the last forty-five years, it remains in place. The plan features a total of nineteen goals, and any cities or towns with a population over 2,500 people are required to comply with the statewide standards, though a few goals apply only to specific areas within the state. The Department of Land Conservation and Development (DLCD) and the Land Conservation and Development Commission (LCDC) review the county- and city-wide plans regularly to assure compliance throughout Oregon (Walker and Hurley 2011, p. 30).

To provide a brief overview of the plan, the first and second goals emphasize citizen involvement and land use planning more broadly, while goals 2-7 focus on natural and cultural/historical resources. Goals 8-14 apply to the economy and development, which includes specifications about housing, waste, energy, and transportation. Goals 15-19 deal with specific areas within the state and are not relevant to planning in Central Oregon (Walker and Hurley 2011, p. 30). It is worth highlighting Goal 2, which seeks to "establish a land use planning process and policy framework as a basis for all decisions and actions related to use of land and to assure an adequate factual base for such decisions and actions" (DCCP 2011, p. 3). This goal is important because in the past, it has been used to shift land use from forestry or agriculture to residential, with the claim that certain parcels were unsuitable for the former purposes (Walker and Hurley 2011, p. 31). As such, there is some flexibility in the plan, allowing for changes that mirror the increased demand for using land for new industries and purposes. It is also important to note that there are goals for recreational needs (Goal 8), energy conservation (Goal 13), and urbanization (Goal 14) in the plan as well (DLCD 2010). I highlight these goals because they display how Oregon attempts to contend with the inherently challenging task of fostering

economic development while conserving undeveloped land and natural resources. The tension this creates has become especially evident in recent years, as scholarship on the New West and rural gentrification indicates (e.g. Reisbame et al., 1997; Robbins 2005; Bryson 2010). These tensions are important in Prineville's story as well, though in a nuanced way.

In the 1990s, the basic statewide plan was modified slightly to create rural and urban 'reserves' so that urban growth boundaries (UGBs) could be extended when cities wanted to expand their borders to accommodate population and infrastructural growth. The development of these reserves also meant that locals must now agree upon what land would remain dedicated to forestry and agriculture, and what land would be designated for future urbanization (Walker and Hurley 2011, p. 35-36). Furthermore, there was a push in the 1990s to emphasize problem-solving at the regional level. A 1996 piece of legislation aimed to increase collaboration between cities in close proximity to avoid conflicting land-use plans, while also allowing for state control over planning (Walker and Hurley 2011, p. 36). These changes helped strengthen the plan and continue its widespread acceptance. The modified comprehensive plan has been increasingly important for Central Oregon in particular, as it has recently experienced the most rapid growth in the state (Jackson and Kuhlken 2006, p.171). For instance, Bend has had to consider possible UGB expansions as a result of tourism and subsequent increases in population (Walker and Hurley 2011, p. 40). While Prineville has experienced growth as well, growth there has been slower. However, with the new data center construction and its continual expansion, the town will surely be constantly (re)assessing the 'wisest use' for the land surrounding Prineville's borders in coming years.

The land that Facebook chose for its data center on the outskirts of Prineville had little significance to local residents. As director of a local charity foundation, Kirsten Smith, put it, if the land "had been good farmland, with access to water, it[s development] would have happened a long, long time ago. It wasn't even really good for grazing. It was just rocks and sagebrush… [the data center] is just up there on top of a rock pile." Similarly, local official Pete Stenner laughed as he showed me a picture of the data center site before Facebook built there. The image featured a beat-up abandoned car surrounded by desert shrubs and a sandy path that looked like it might have been a road for ATVs. He told me the land acted as a makeshift rifle range and teenage-trouble-maker hangout. In other words, the land space itself was not exactly cherished by Prineville residents—nor was it important for native plants and animals, as Stenner asserts. There were allegedly two environmental impact assessments completed prior to data center construction, but Facebook and the City of Prineville officials were unable to release these documents.

Despite the locals' apparent lack of concern about the land itself, they did have (and some *still* have) trouble accepting the tax breaks given to both Facebook and Apple by the city. However, as a member of the Crook County Chamber of Commerce, Cole Kent, pointed out, the land was producing no revenue for the town before Facebook purchased it. It was not within the tax base, and only once a private investor bought the land would it have generated any profit. So, the fact that a portion of the data center's land is not yet on tax rolls, Kent asserts, should not concern residents. Facebook will be paying the town what they owe in a few more years. What *is* concerning, however, is the sheer amount of space the Prineville data centers and other data centers worldwide consume.

Data centers are massive. The Prineville complex currently houses three buildings, and each covers between 150,000 and 300,000 square feet—larger than two Walmart Supercenters put together (Data Center Knowledge 2010). Plans have recently been announced to expand this campus to five data centers, the two additional buildings spanning upwards of 450,000 square feet. Apple has also cleared land to begin constructing a third data center across the road from Facebook in Prineville (Miller 2017). More broadly speaking, Facebook is showing no signs of slowing construction either (Figure 13). For example, within the last two years alone, they have announced plans to construct multiple immense data centers in seven new locations worldwide: Fort Worth, Texas; Clonee, Ireland; Los Lunas, New Mexico; Odense, Denmark; Papillion, Nebraska; New Albany, Ohio; and Henrico, Virginia (Facebook 2017). This rapid increase in land-grabbing suggests that in many diverse places where suitable land space is available for data centers, big data companies are taking advantage of it.

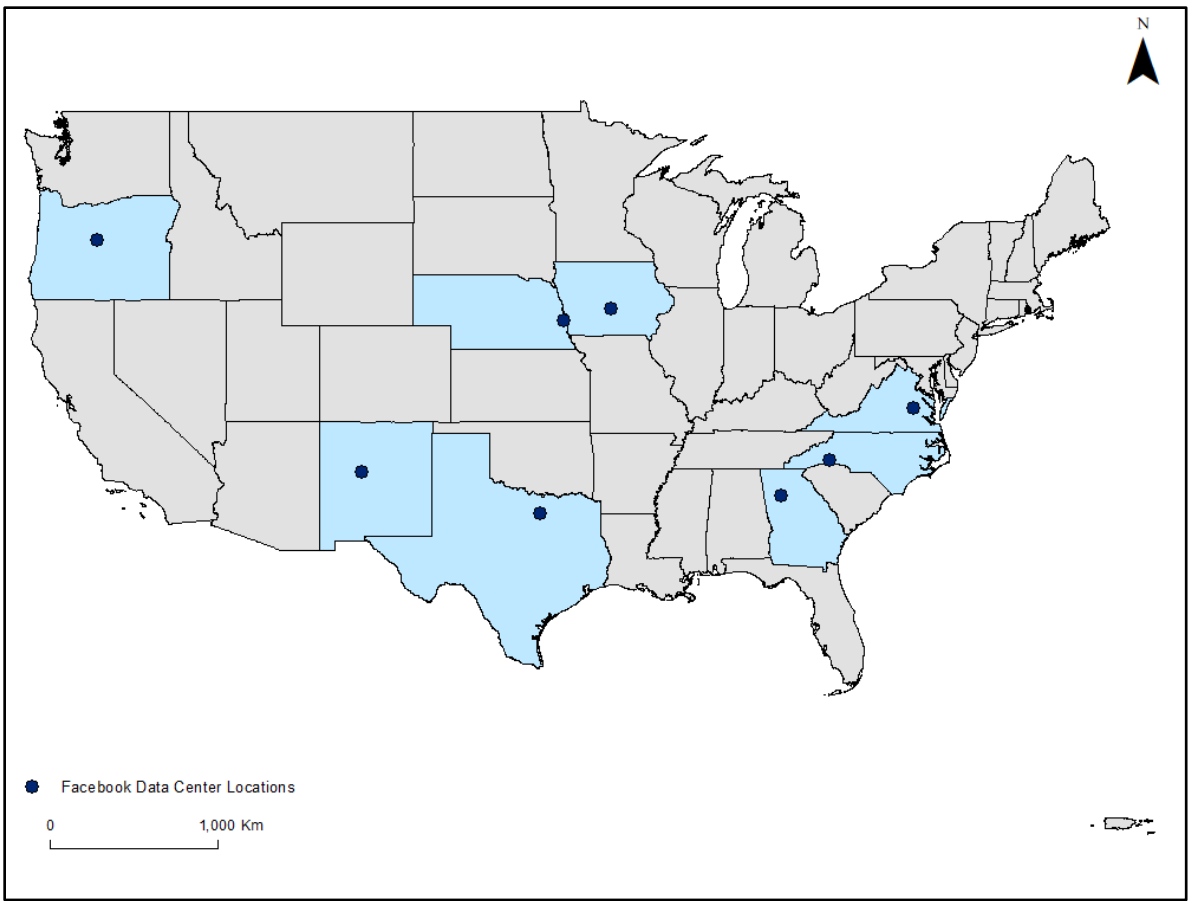

Figure 13. Locations of Facebook data centers in the United States. This map does not include those built or under construction abroad in Lulea, Sweden, Clonee, Ireland, and Odense, Denmark. *Map by author*.

Yet it is hard to conclude that data centers are necessarily bad in terms of their land use—or at least that they are any worse than any other industry. In a capitalist system, industries must necessarily grow to remain competitive (Brooks and Bryant 2014). If an industry larger than Facebook moved to Prineville, perhaps said industry would be claiming even more land. Moreover, in Prineville and some of the other sites, the land is not seemingly helping anyone by remaining vacant and collecting tumbleweeds. That said, data centers are enormous, and their physical footprint will get even larger as data demands increase and more storage space is required (Figure 14). It is worth questioning whether or not it is necessary to develop every piece of land available for development. Is it better to use the land for storing Facebook selfies and cat

videos, or for another farm that could grow food, but would also consume water and leech fertilizers and animal waste into nearby streams? Or is it better to simply leave the land to collect dust? The answer is hard to determine, since the 'wisest use' for land will depend on the person asked and the people with the power to make that decision.

Figure 14. Facebook data centers in Prineville, Oregon in 2015. Since then, another data center has been built, and a fourth is under construction. *Source: used with permission from* http://svlg.org/wp-content/uploads/2013/11/SVLG-Presentation-10.25.13-Facebook.pdf.

Power IT Up

In addition to taking up a lot of space, data centers are generally inefficient energy users (NRDC 2014; Greenpeace 2017). The vast majority of the power going into these buildings ends up being wasted, since a typical data center server operates at less than 18 percent efficiency (NRDC 2014). This means that up to 82 percent of the energy entering an average data center server may be lost, usually as heat (NRDC 2104). Perhaps to combat the notoriety for inefficiency, Facebook measures its data centers' power usage in terms of a Power Usage Effectiveness (PUE) ratio. PUE scores represent the amount of power coming into a data center

divided by the amount used by computing equipment inside of it (Green on Facebook 2017). Facebook proudly displays an average PUE of 1.10 for all data centers on its sustainability website. The EPA standard is 1.5 (Facebook Sustainability 2017). Yet some have criticized the validity of PUE as a way to measure energy usage because it says little about the actual amount of energy being consumed by data centers, and therefore conceals their aggregate environmental impacts (Brady et al. 2013; Burrington 2015).

The Information Technology (IT) sector consumes about 7 percent of global electricity (Greenpeace 2017), and data centers are responsible for using approximately 1.5 percent of that total (Koomey 2011). Overall, data centers consumed 91 billion kWh of electricity globally in 2013, a figure that has been predicted to almost double by 2020. This amount would mean data centers will require the energy equivalent of fifty coal-fired power plants (NRDC 2014). As of 2016, Facebook used an average of 1.83 million MWh of electricity annually, almost all of which was consumed by data centers. The Prineville site alone used 327,000 MWh of the total that year (Facebook Sustainability 2017). Furthermore, a worldwide increase in electricity use for computing and secondary building services by data centers, in combination with a rising number of servers needed to support data demands, has led to a higher level of CO_2 emissions by big data companies in recent years (Brady et al. 2013). Consequently, the IT sector now accounts for approximately two percent of global CO_2 emissions (Whitehead et al. 2014). The carbon footprint of all Facebook's buildings in 2016 was 718,000 metric tons of carbon dioxide equivalent (MT CO_2e). 516,000 of those 718,000 MT CO_2e came from data center operations, and 239,000 MT CO_2e came from the Prineville site specifically (Facebook Sustainability 2017). For comparison, these amounts are on the order of thousands of times higher than a typical college campus and hundreds of times higher than grocery stores on average in the United States

(National Grid 2002, 2013). It is thus clear that big data companies are major energy users, and as their physical footprint grows, so too will their power usage.

Perhaps the more concerning question is where exactly data centers are getting their power. Many make use of 'dirty' energy sources, such as coal-fired power plants, because they are currently the cheapest (Greenpeace 2017). Of course, where the power comes from largely depends on a data center's location, and some big data companies are trying to curb this energy-intensive trend. Influential companies like Facebook, Google, and Apple have begun to publically invest in renewable energy sources to power their data centers. For example, Facebook has made deals with local renewable energy companies in each new construction site since 2015. More specifically, the company most recently partnered with Dominion Energy in Henrico County, Virginia to power their two planned data centers with solar power (Augusta Free Press 2017). Facebook has also invested in Tradewind Energy in Omaha, Nebraska to buy 200 MW of wind power for their data centers in Papillion, 120 miles away (Spaen 2017). Greenpeace (2017) praises companies like Facebook for beginning this new environmentally-friendly trend, but many other data centers still rely on fossil fuels to run, emitting millions of metric tons of carbon into the atmosphere each year. As such, if we were able to 'green' the IT industry, it could greatly help the effort to combat climate change (Starosielski and Walker 2016).

That said, Prineville in particular posed an unanticipated challenge to Facebook's climate change mitigation efforts. According to the local Facebook PR President Luke Weston, "In Prineville, Facebook would like to have access to more renewable power but we are challenged by the site, utility, and boundaries." The company, Weston assured me, supported legislation to help launch the Voluntary Renewable Energy Tariff (VRET) process in 2014, which would

allow Facebook and other companies to secure low-cost renewables. Weston noted that unfortunately, the VRET docket has not yet been successfully implemented by the Oregon Public Utility Commission. The Prineville data centers thus obtain their power from the same company most Prineville residents do, Pacific Power.

In terms of renewable energy use, 71 percent of electricity in Oregon comes from hydropower, and Prineville has at least six hydroelectric and two solar power plants within 60 miles of the town's center (U.S. EIA 2017). Pacific Power, however, currently sources the majority of its electricity from coal-fired power plants, even though the nearest coal-fired power plant to Prineville is over 100 miles away (U.S. EIA 2017). The reason for this apparent discrepancy is because, as an employee from the company specified, "Once electrons are put into the system [via any source], they are only traceable system-wide…so, while it is likely that Prineville is getting electrons from hydropower, there is no way to actually track that." In other words, the data center *might* be getting electricity from hydropower plants nearby, but because Pacific Power also gets electricity from coal-fired power plants across the United States and puts it into the same grid, they cannot be certain that Facebook is being powered by renewable energy sources alone. Fortunately, however, Pacific Power is gradually adding more renewables—specifically wind power—to their mix in response to the Oregon Clean Electricity & Coal Transition Law. The company has promised to be completely coal-free by 2030 (Pacificorp IRP 2017).

So, despite the challenges of measuring renewable energy use, Facebook set a goal in 2012 to have 25 percent clean and renewable energy in their electricity supply mix in 2015 for all data centers, and were able to exceed that. As a result, Facebook is now aiming to have at least 50 percent clean and renewable energy in their mix by 2018 (Facebook Sustainability

2017). Doing so has greatly reduced the carbon footprint of the majority of their data centers. This attention to renewable energy sources is a promising trend in data center construction.

Taken as a whole, the electricity usage of data centers is certainly alarming. Although specific data for the amount of electricity used by the town before and after data center construction, according to Prineville's latest Adopted Budget for fiscal year 2017, the city has been collecting increasingly large electrical franchise fees. In the report, they specifically site how the 'local data centers' were instrumental in the increase of annual fees from $350,000 in 2010 (the year the Facebook data center was constructed) to a projected $2,225,000 in 2018 (City of Prineville 2018). This sharp increase suggests that the Prineville data centers are continually drawing more power from the local electricity grid. Nonetheless, there is more to this issue than simply saying data centers are contributing to climate change. Following the larger 'greening' trend, big data companies have been slowly committing to environmentally-friendly practices in general, such as investments in renewables and efforts to find new technological systems that limit water and electricity waste in data centers (Greenpeace 2017). As such, it appears that in the coming years, data centers will likely not be much worse than many other industries in terms of electricity and power demands, provided that they continue to invest in renewable energy. However, as the following sections of this chapter will show, electricity use is only one of many factors adding to the environmental impacts of data centers. Namely, water and waste are also important issues to discuss in more detail, especially in the high desert of Central Oregon.

Water IT Down

It takes a large amount of water to support the world's data. Studies from Hewitt-Packard (HP) Laboratories show that a typical 1 MW data center uses about 18,000 gallons of water a day, or 68 cubic-meters (Sharma et al. 2008). Although not all data centers currently use water to cool their servers, it is still very common (Pickren 2016). Based on Entity Water Reports from Oregon Water Resources Department[1], Facebook's data center in Prineville used about 9 million gallons of water from their privately-owned wells in 2016. In 2014, they also used about 1.3 million gallons of water from Prineville streams (Darling 2015). In combination with Apple's draw of millions of gallons from the city each year, these data centers have placed extra demand on an already stressed water system. This prompted *The Bulletin*, a local Central Oregon newspaper, to post an article online entitled, "Water sources scarce near Prineville: City tries various solutions, including mapping underwater 'streams'" (Hidle 2011). Though perhaps slightly exaggerated, the article's title is fitting. Irrigation has historically proven a challenge for Oregon as a whole, but it is especially problematic in the arid regions of the state such as Prineville. Precipitation in these areas tends to take place outside of the growing season, making farming nearly impossible without irrigation infrastructure in place (Robbins 2004, p. 101). Although most of the contestation about irrigation projects has occurred elsewhere, such as the Klamath Basin, water is certainly a prized natural resource in Central Oregon due to its limited availability (Robbins 2004, p. 105). As local official Pete Stenner put it, "Water is very limited in our area and it is all allocated. There is no extra water… [but this] community has always been focused on conservation of water for hundreds of years." Pete's comment seemed odd, however, based on the fact that while driving into Prineville I saw industrial sprinklers spanning across

acres of fields, spurting water in the 100-degree heat at high noon. Conservation apparently has different meanings in different places.

The data centers in Prineville are without a doubt taking some of the town's precious water too; however, were another industry to develop the same plot of land, it is possible that water supply may have become even scarcer. For instance, Prineville official Evan Kasey noted that the data centers are surprisingly not the top water users in Prineville. The golf course in town uses about 1 million gallons per day—or 365 million gallons a year—and local farms average at about 10,000 gallons per day (Darling 2015). Clearly, data centers are not the only industries stressing the irrigation system. Prineville draws water from wells in the city, as well as streams—and up until recently, they were struggling not to waste significant amounts of it. In 2016, the City of Prineville website posted figures for their "unaccounted for water percentage" over the course of the past decade. The city allegedly pumped 615 million gallons of water in 2008, but lost almost 172 million gallons of it, or about 28 percent of Prineville's total water supply (City of Prineville 2016). Prineville has to comply with the regulation requirements that mandate mitigation credits must be purchased before wells are drilled, so it is hard for them to add new water sources from which they can draw (Hidle 2011). More recently, however, Evan Kasey and his team worked to reduce the total water loss to about 4 percent in 2015 through infrastructural improvements. These improvements, interestingly, were made possible in part because of the data centers' arrival.

Facebook in particular publically takes pride in minimizing water usage at their data centers. They have essentially designed their data centers to be self-contained climate systems. Luke Weston, with Facebook's PR team, asserts that Facebook saves a large amount of energy by using evaporative cooling rather than the cooling towers and chillers that traditional data

centers have used (Figure 15). Their system involves a simple series of rooms, each of which houses different walls that control the air flow composition and temperature. Air enters from outside in a room above the servers and is mixed with hot air from below as it passes through a filter wall. This stage is called ‘outside air economization’ (Leed 2012). The next stage, evaporative cooling, occurs as the air passes through a misting wall. The wall contains misting devices that lower the temperature of the air significantly as they change liquid water to water vapor in the direct path of air supplying the servers below (Leed 2012). The misting system contains ‘booster pumps’ that take water from the water storage tanks outside the data center and filter it by pumping the water through carbon filters. Water softeners are used to extract minerals such as magnesium and calcium. About 85 percent of the misted water evaporates into the air stream, while 15 percent goes into a ‘mist eliminator.’ This water goes through a micron filter and UV lamp, ultimately leading to water storage tanks to conserve water (Leed 2012). In the final stage, the fans move air into the data center through ‘dry wall supply airshafts’ (Leed 2012). According to Weston, a new ‘wetted media’ cooling system has also recently replaced the misting system to help eliminate the need for water treatment.

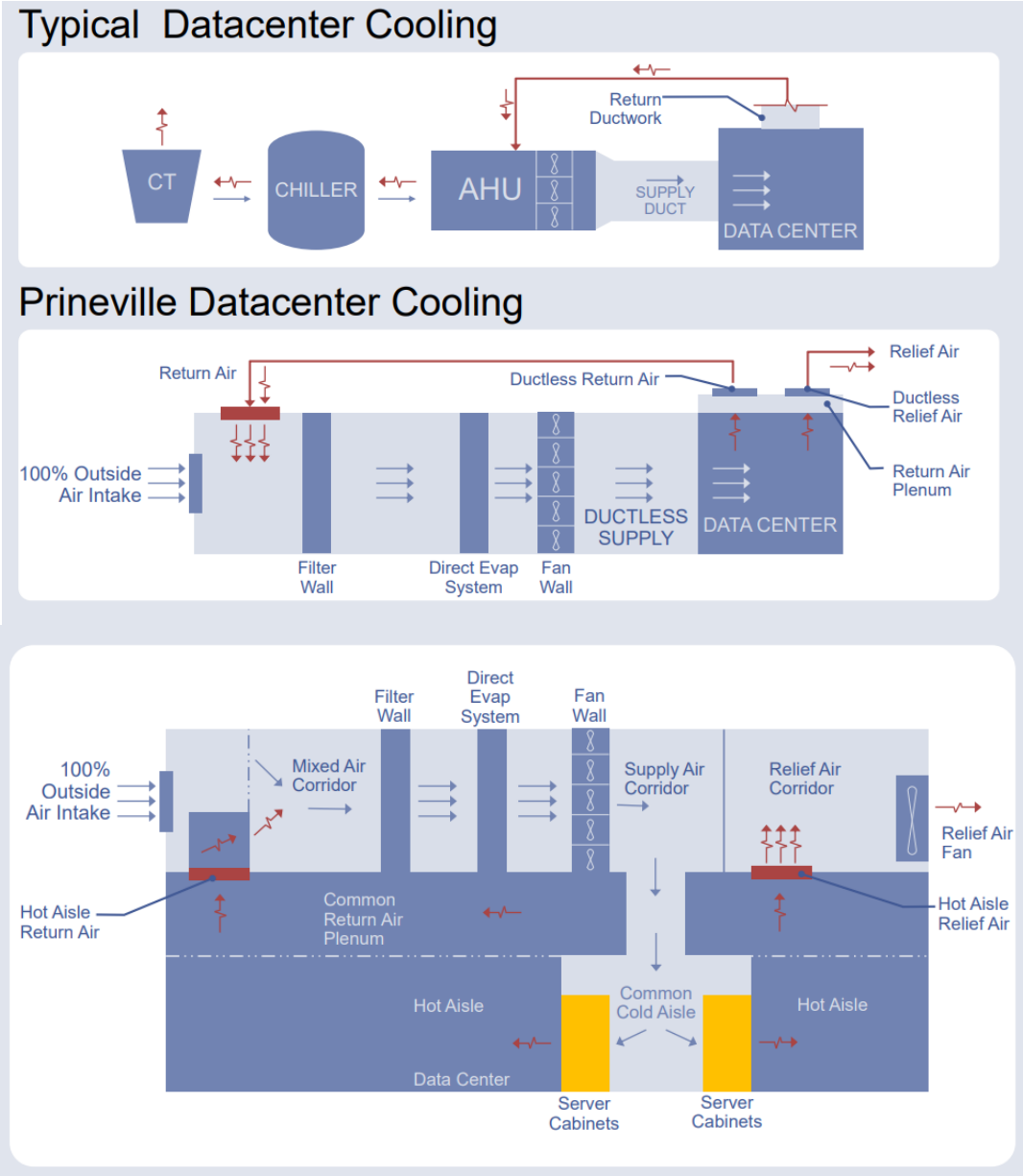

Figure 15. The climate system of Facebook data centers. The top image compares Prineville's system to traditional data centers, while the bottom is a more detailed diagram of the system's interworking. *Source: used with permission from* http://svlg.org/wp-content/uploads/2013/11/SVLG-Presentation-10.25.13-Facebook.pdf.

This new method of water usage is an improvement over past data centers' designs, but the water demands are still quite high. Several towns have struggled to meet other data centers' demands. For instance, a National Security Agency (NSA) data center in Bluffdale, Utah has attracted controversy because of its water use practices (Hogan 2015). A local representative

wanted to halt the data center's water supply after journalists exposed that the NSA had made a deal with the town to get water for less than city guidelines mandate because the agency claimed they would boost the economy with their new pipelines (Carlisle 2014; Hogan 2015). After a series of electrical failures and seizure of more than the NSA's allotted water intake, locals were ready to rid of the data center, regardless of whether or not it brought any economic prosperity (Carlisle 2013). It is thus clear that data centers' water use can elicit controversy if big data companies are careless about how they utilize local resources. Based on the lack of water wars near Facebook data centers (so far), however, the company is once again seemingly ahead of other industries on developing ways to have less of a negative environmental impact.

Facebook measures its water consumption using 'water usage effeciveness' (WUE), which is similar to PUE. Created by the company in 2012, WUE is a ratio of water used by the data center divided by the energy used by the servers (Facebook Sustainability 2017). The average WUE for all data centers in 2016 was 0.21; however, because The Green Grid and Facebook developed the WUE measurement so recently, there is no baseline or standard for comparison (Facebook Sustainability 2017). Regardless, the company is trying hard to find ways to save water, and of course, money. Weston noted how "Facebook also reuses water as much as possible. If the original water quality is high, we can reuse it multiple times. When we can no longer reuse the water, it is discharged back into the sewer system for treatment." Therefore, not only is water access and affordability important for data center locations, so too is waste disposal.

It is important to note that little data has been collected about pollution of water resources as a result of data center operations. Most articles concerning data center pollution focus solely on carbon emissions from use of coal or other non-renewables to power the buildings (Koomey

2011; Ristic et al. 2015). Water footprint measurements have been established, however, which do include a pollution component. If data centers are designed such that they have "once-through cooling systems without a cooling pond," they will discharge hot water, resulting in thermal pollution (Ristic et al. 2015, p. 11268). Chemicals may also be emitted from data centers that have cooling towers, as water will need treating and replacing in the coolant loop to prevent the servers from overheating (Ristic et al 2015). Nevertheless, the pollution measurement is not widely used, if at all by big data companies to date. Facebook and Apple were unresponsive to questions about possible water pollutants coming from their data centers. Despite the lack of communication by big data companies, journalists have discussed how even the most water-efficient data centers cannot recycle water endlessly because minerals tend to build up, clogging the system (Rogoway 2016; McLaughin 2017). These mineral buildups are not particularly concerning for the environment, but heat pollution can pose a threat to local ecosystems if the water is not cooled before sending it to the treatment plant. In short, the pollution of water by data centers can neither be confirmed nor denied until big data companies release this information. Their silence on the matter is troubling.

Water use and pollution is thus another area in data centers' environmental impacts that remains open to debate. It seems like Facebook, Apple, and other companies may be attempting to conserve water resources with new, more water-efficient cooling systems. Moreover, any pollutants their data centers discharge are likely better for the environment than are the chemical fertilizers and animal waste emitted by industrial agriculture operations. However, without widespread use of measurements like WUE and water footprint, there is simply not enough data to conclude that data centers are good or bad in terms of their effects on the hydrological cycle, locally or globally. If big data companies were more open about their water usage, perhaps their

operations would seem less suspicious. Until then, it is worth questioning all the claims these companies make about being 'green,' when they give no evidence to support this conclusion. Relatedly, the following section will address several localized and broader concerns about waste related to data storage, consumption, and production—another matter on which big data companies remain mute.

Don't Waste IT

There are two categories of waste from data centers. The first is waste from the data center itself. Beyond the trash generated by their offices, the data center sullies the water it uses, as previously mentioned. This means that when data centers move in, small-scale waste systems in towns like Prineville must suddenly handle a large amount of wastewater from this industrial facility. The second category of waste is electronic waste (e-waste) that comes from the data centers and is shipped elsewhere. Servers can only last so long, and where the waste machinery is deposited is an important consideration for human and environmental health. Moreover, data centers' existence presumably allows for more electronic device usage, ultimately leading to more e-waste from the frequent disposal of said devices for newer, faster models (Forge 2007). Considering data center waste is imperative for analyzing both the environmental and geographical implications of data center construction, as the effects of this infrastructure are manifested at both local and global scales.

As suggested by the above sections in this chapter, the Facebook has made efforts to mitigate the large-scale environmental impacts of their data centers, and other companies have followed their example. At a more local scale, the data center in Prineville has implications for the town's ability to handle the extra load of waste added to its system. According to local

officials, Facebook paid a "system development charge" to assure that the company would pay for the part of the wastewater treatment plant they would need to use for their operations. Prineville was struggling to improve the facility's efficiency when the data centers moved in. More recently, however, the town finished a 120-acre wetlands project in which they built a buffer zone for wastewater to avoid spending about $60 billion on improvements to their current system (McDuff 2017). This project was made possible by a $1 million grant from the USDA, in addition to contributions from the data centers and other local companies (McDuff 2017). The wetlands project is another good example of how data centers stress local infrastructure, but the companies that own them are working to mitigate these stresses by improving systems of energy delivery and waste treatment. Nonetheless, data centers will still grow in size and number to meet rising data storage needs, which will increase the aggregate demand on waste disposal systems no matter how efficient the buildings are. As such, it is unclear at what point small towns like Prineville will no longer have enough infrastructure capacity to handle data center expansions, regardless of the mitigation efforts and system improvements big data companies may make.

Although Facebook is seemingly able to assure that their data centers' waste*water* has little negative impact on their host towns, they are curiously silent on the subject of direct and indirect *e-waste* related to their data center operations. When I asked the Facebook data center tour guide about where their unusable servers went, his response was very vague. He mentioned that he thought the company had "some sort of recycling program" for them, but ultimately they would end up wherever the rest of Facebook's e-waste was transported. Finding out the exact end-location for data center e-waste has yet to be accomplished by myself, or any other researchers to my knowledge, which is odd considering the fact that Facebook founded the Open

Compute Project in attempt to be more open with the public about their operations. Their sustainability website does not provide any information about electronics recycling, although they do note that their offices have compost and recycling bins (Facebook Sustainability 2017). Google is the only big data company that seems to be making an effort to be more open about their waste stream. They recently released a report about their partnering with the Ellen MacArthur Foundation (EMF), to introduce 'circular economy' practices to their company. According to the report, "Key elements of the circular economy model optimise resources by circulating products, components and materials in use through different loops of the use cycle," including maintenance, remanufacturing, reuse, and recycling (Rana and Brandt 2016). The authors conclude that Google manages its non-reusable or sellable waste by sending them "to a recycling partner for secure processing and recycling" (Rana and Brandt 2016). While Google's report is also somewhat vague, it is the only such report I have found in my research on data center e-waste.

There is plenty of grey literature on the matter of data center e-waste, but scholars have not examined data centers' role in contributing to the IT industry's resource consumption, waste, and dumping. Journalists covering the technology and/or environmental beat have suggested that as even as the devices consumers buy are getting smaller, the data centers needed to support them are expanding (Clancy 2013). This expansion has meant more waste, especially considering the fact that, similar to personal electronic devices, data center equipment is constantly updated. Big data companies must therefore continually bring in new servers and computers and get rid of the unusable ones (Gossin and LaBrie 2013; Clark 2014). Measureable standards have apparently been created by companies such as the Green Grid, which published a white paper about an Electronics Disposal Efficiency (EDE) metric that shows the proportion of the total

weight of equipment that was decommissioned by known responsible groups (Brown et al. 2013). In remains to be seen whether or not EDE, like PUE and WUE, is a useful measurement, especially considering the fact that big data companies such as Google or Facebook have yet to use it. Moreover, the 'responsible groups' in the EDE equation are not necessarily easy to find, since the majority of 'green' recyclers do not seem to mention the ultimate resting place for the potentially dangerous and toxic wastes generated by data centers[2]. Presumably, these facilities' e-waste ends up in the same places documented by the Basal Action Network (BAN) and other researchers (Clark 2014), but without any concrete e-waste information from data companies, no definite conclusions can be made about the environmental impacts of direct e-waste from data centers.

Indirect e-waste, however, has been documented by several scholars and research organizations (e.g. BAN 2002; Gabrys 2011; Maxwell and Miller 2011). Data centers arguably help foster our obsession with technological devices. Their services support all the data needs for mobile phones, computers, laptops, tablets, etc. that have rapidly increased in number in recent years (Pew Research 2017). Research by NGOs such as BAN and others shows that each year, billions of pounds of toxic waste are dumped in developing countries, such as remote portions of China and Africa, unbeknownst to most American citizens (Brigden et al. 2005; Widmer et al. 2005; Gabrys 2011). Not only are these wastes harmful to the environment, but they also take the lives of thousands of people who generally do not produce the waste themselves (BAN 2002; Brigden et al. 2005). As such, it is evident why a small, but well-developed scholarly literature has emerged about the toxic dumping and e-waste. Much of this scholarship could be categorized as a critique of consumption and technology, but environmental and social justice discussions are also largely important in forming a theoretical basis for understanding the impacts of e-waste.

A central theory examined in this literature is that of 'commodity fetishism.' Marx (1976) established the concept to describe how people in modern society develop a love affair with the 'products of labor.' More importantly however, not only do they become obsessed with material goods, but consumers are detached from the means of production by a "veil of market-exchange" (Brooks and Bryant 2014, p. 2). Consequently, industries have an excuse to both exploit natural and human resources and to overproduce because consumers believe they need more goods than they actually do (Marcuse 1964; Brooks and Bryant 2014). Marxist scholars thus contend that labor is at the core of capitalism and consumption. Yet as Maxwell and Miller (2012, p. 88) put it, "Since the nineteenth century, capitalism has largely treated labor and the environment as things to be controlled long distance, connected to transnational textual and military domination." Consequently, consumers in the global North cannot see the negative impacts of the products they buy, and because they do not produce these things themselves, they cannot possibly understand what it takes to create the tiny gadgets in their hands. Hence, as Gabrys (2011, p.106) states, "commodity and rubbish anticipate each other." Of course, what scholars have failed to note, is that these technological commodities are now reliant on the existence of data centers.

Although it would be an overstatement to say data centers are completely responsible for global e-waste and toxic dumping, their contribution to the problem should not be ignored. They are certainly allowing our fetishism to continue and grow, particularly in the face of increasingly rapid production, use, and disposal of technological devices. As such, it is crucial that scholars begin to examine the social and environmental impacts of wastes that data centers may generate both directly and indirectly. It is also important for NGOs like BAN and Greenpeace to continue publishing reports featuring case studies of the real-world impacts of the cloud, including e-

waste, so that big data companies can be held responsible for better waste disposal practices in the future.

As such, e-waste is another grey area for the environmental impacts of data centers. At the local scale, in Prineville for instance, it is unlikely that the wastes produced by data centers have any impact at all. At a global scale, however, the impact of data centers' e-waste is potentially threatening to human and environmental health. But again, because big data companies are unwilling to share information about their large-scale waste disposal (unless it makes their company look good, that is), it cannot be said for sure whether or not data centers are truly any worse for the environment than any other industry that produces wastes. So, perhaps the better question is: *at what scale are data center operations truly sustainable?*

Is IT Sustainable?

Perhaps the most important implication of data center operation for the environment is the multi-scale nature of their impacts. The localized effects of data centers seem minimal. As I will discuss further in the next chapter, the Prineville example shows how conscientious companies like Facebook attempt to minimize their impacts on a local scale by improving the town's infrastructure and choosing sites that are not otherwise economically or ecologically productive. Looking at data center operations on a micro-scale thus makes them appear almost entirely beneficial. On a broader scale however, data centers' potential negative impacts are hard to overlook. Although many companies such as Google, Facebook, and Apple are making efforts to be more environmentally responsible, data centers will presumably need vast infrastructural improvements if they wish to have no harmful impacts.

Since capitalism requires endless growth and tends toward ecological crisis (Foster et al. 2010), big data companies will necessarily take up more space and resources—and produce more waste—as operations expand and spatial crises emerge. Consequently, in terms of land, data centers can and will be taking up more space worldwide, and there is no guarantee that they will always choose vacant teenager hangouts covered in dust. Facebook and Apple are certainly expanding operations in Prineville due to the fact that its climate is ideal for cheap cooling (Miller 2017), but money is most likely the true deciding factor in location decisions. Big data companies will choose those that offer tax breaks and access to cheap land, water, and power over any others (Hogan 2013, 2015). Why else would they choose to build in the middle of remote rural areas worldwide? Moreover, many data centers are still inefficient energy and water users too, which means they are contributing to climate change and wasting natural resources, regardless of how 'green' they claim to be. In short, an increase in the number of data centers will certainly mean an increase in resource use—and subsequently, an increase in the amount of waste with which we must contend on a global scale.

Taking all this into consideration, it is clear that at a macro-scale, data centers are an ecological and political problem. Their localized effects may appear minimal, but globally, the aggregate total of resources taken and wastes produced will be progressively larger. Moreover, e-waste disposal and water pollution must be addressed because they are environmental justice issues that, unless they prove otherwise, big data companies will need to take part in mitigating as their operations multiply. Even so, on any scale, it is fundamentally unclear whether or not data centers are any worse for the environment than any other industry. Again, there simply is not currently enough information available to the public for anyone to make a definitive conclusion about the full environmental impacts of data centers. The data big data companies do

release is selectively positive and posits the companies as wholly environmentally-friendly without mentioning anything about their e-waste disposal or possible water and air pollution. Doing so would, of course, shatter the fragile façade of eco-friendly data centers, which is a very profitable business strategy. It is the avoidance of full-disclosure on the part of big data companies, however, that makes the issue of environmental impacts one worth problematizing. The nature of data centers is, then, that their impacts on the environment are highly nuanced and largely uncertain—but they will surely have important implications for human and ecological health worldwide. It would be wise for scholars to draw attention to these possible implications in the near future, since as the following chapter will show, big data companies work hard to assure that we cannot identify data centers' true nature.

Notes

1. Figures calculated based on reports posted on the OWRD website. Available at https://apps.wrd.state.or.us/apps/wr/wateruse_query/wr_wur_entity_report.aspx?directory_id=127318&start_year=&end_year=

2. See for example: World Data Products https://www.wdpi.com/ or Green Recycling Co. https://www.greenrecyclingco.com/index.html

CHAPTER FOUR

LIGHT GREEN DATA CENTERS

On June 1, 2017 Apple CEO Tim Cook wrote a succinct, but noteworthy letter to his employees. It was not a letter about technology or profits, as one might expect from the head of a powerful tech company. Cook was writing in response to U.S. President Donald Trump's decision to withdraw from the Paris Agreement a few days earlier. In the letter he wrote:

> Climate change is real and we all share a responsibility to fight it. I want to reassure you that today's developments will have no impact on Apple's efforts to protect the environment. We power nearly all of our operations with renewable energy, which we believe is an example of something that's good for our planet and makes good business sense as well… Our mission has always been to leave the world better than we found it. We will never waver, because we know that future generations depend on us (Bell 2017).

Cook's words might seem surprising considering how technological development and environmentalism have historically been cast as opposites (Bess 2003). It is also unexpected that a big data company, especially Apple, would make such bold statements. Some might argue that Cook's comments are nothing more than 'greenwashing.' The term 'greenwashing' was developed to describe when corporations give only selective positive information about their green practices to create a favorable public image (Bowen and Aragon-Correa 2014; Villarino and Font 2015). Yet Cook's words are not so hollow. As this chapter will show, they are reflective of a larger green ethos present in Silicon Valley, as well as among many tech companies worldwide. Cook's green vision has deep roots, as it echoes green ideas reminiscent of the American counterculture and the *Whole Earth Catalogs* produced by Stewart Brand in the 1960s (Kirk 2008). Furthermore, examining Cook's words in a more contemporary view, his letter supports the notion that increasingly more industries have adopted green visions, whether

they are greenwashing or not. These visions indicate the pervasiveness of what Michael Bess (2003) deems the 'light-green society.'

Bess's book, *The Light Green Society: Ecology and Technological Modernity in France, 1960-2000*, traces the development of the environmental movement in France and its social impacts since 1960. He describes how an unlikely balance between radical environmentalism and postwar modernization developed, resulting in a half-revolution embodied by France's 'light-green society.' Bess explains how France ardently adopted and developed new technologies in postwar years—nuclear in particular—because they were afraid that their country would die out if they did not keep up with technological development in other nations. Yet the French people also consequently began to fear the disappearance of their nation's romanticized peasant life in an untrammeled countryside. Accordingly, France experienced a shift towards conservation and environmental awareness in the 1960s and 1970s. As such, citizens of France were faced with two drastically different alternatives—radical environmentalism or industrial modernism—neither of which was entirely satisfactory alone. So, they simply chose the middle ground: a watered-down version of both environmentalism and modernism combined, the light-green society.

Bess's book shows that environmentalism comes in various shades of green. For him, the light-green shade is representative of the "moderation, compromise, half-measures [and] the profound ambiguity that has characterized the reception of ecological ideas among the French citizenry" (Bess 2003, p. 3). Although referring to specifically to France in his book, Bess (2003, p. 237) assures readers that what is occurring in France is reflective of a larger global trend, visible in many different industrialized nations. The importance of Bess's light-green society concept, then, is that it shows how technological development and environmentalism can and do

coexist. Even as we place them on opposite ends of the natural spectrum, in many nations people have decided that neither is more important than the other, and the two do not necessarily have to be mutually exclusive. In short, the compromises and half-measures that embody a light-green society are a result of the desire to be simultaneously environmentally conscious and mass-consumers, and to cherish the traditional while also embracing the modern (Bess 2003, p. 4). The visions of big data companies like Apple exemplify how many parts of the developed world have become light-green societies, including the American West in particular.

Drawing on the work of those who have studied the green ethos of the American West (e.g. Kirk 2008; Isaacson 2011), documents from the Breakthrough Institute,[1] and from news stories about Facebook's and Apple's CEOs, this chapter will describe how the collision of technophilia and environmentalism fostered in Silicon Valley is reflected by data center construction in small rural towns. I will show how data centers are the physical manifestations of the green ethos common in the Bay Area and Silicon Valley. I argue that Facebook and Apple's environmental visions echo key themes in ecomodernism, particularly from the *Ecomodernist Manifesto*. I will also examine the deeper roots of the ecomodernist philosophy by analyzing Stewart Brand's *Whole Earth Catalog* and the idea of 'appropriate technology.' Although big data companies like Facebook and Apple are at their core profit-seeking companies that influence our everyday lives in a myriad of ways, considering the strides they have made toward 'greening' capitalism, one cannot say with certainty that money is their sole motivator. They have in fact become an asset for small communities like Prineville. Thus, perhaps the green technology Facebook and Apple embrace will help fix—or at least mitigate—the destruction

caused by industrial capitalism since its advent, and data centers can help continue the progress toward a greener capitalism.

A 'Brand' New Way of Thinking

The roots of Facebook and Apple's green capitalist visions stem from the American countercultural movement and the story of Stewart Brand. As this section will explain, as a Stanford graduate and founder of the *Whole Earth Catalog*, Stewart Brand was arguably one of the most important figures in rise of the 'appropriate technology' (AT) movement in the United States, and the American West in particular (Kirk 2008). This movement and the associated green ethos that it embraces has helped set the standards for modern Bay Area technology companies and their data center operations.

In February 1966, Stewart Brand sat on North Beach in San Francisco, California. He had just taken LSD, and this particular trip would be an important one, one that would generate big change. There on the beach, Brand decided to ask, "Why haven't we seen a photograph of the whole Earth yet?" (Brand 1977). After that day, he called for the National Aeronautics and Space Administration (NASA) to show everyone what the earth looked like from space. A year later, his drug-induced wish came true. The resulting picture could be cited as one of the first steps toward the environmental movement of the 1970s (Kirk 2007, 2008). In a similar vein of thought, two years later, Brand founded the *Whole Earth Catalog*, a publication that was meant to mix "the liberal social values of the counterculture with the technological enthusiasm of his Stanford classmates" and "advocate decentralized organization" (Kirk 2008, p. 294). This catalog's goal was essentially to marry technology and environmentalism—a goal that seems

almost oxymoronic at first, but is nonetheless an increasingly popular vision (Rome 2017), especially in the New West 2.0.

Brand was a key figure in the American countercultural movements of the 1960s and 1970s (Kirk 2008). Despite the common popularized tropes about the American counterculture, there have been many different versions of counterculture throughout American history (Braunstein and Doyle 2002). The word 'counterculture' likely inspires images of anti-establishment, liberal hippies on communes, trying to grow their own food and to live without the help of the technology. However, counterculture is defined in various ways depending on the context in which it is used. In their volume on the subject, Peter Braunstein and Michael Doyle (2002, p. 10) explain that counterculture was less of a "movement" and more of a "direction." The American counterculture was "an inherently unstable collection of attitudes, tendencies, postures, 'lifestyles,' ideals, visions, hedonistic pleasures, moralisms, negations, and affirmations." And the people involved were those "who defined themselves first by what they were not" rather than what they actually were (Braunstein and Doyle 2002, p. 10). The commonalities amongst the various versions of counterculture were that these groups of individuals believed that the nation's culture was in need of change, and that change could be made by large numbers of people modifying their behavior on an individual basis (Braunstein and Doyle 2002, p.10). In short, they were pushing for liberation and reform. It makes sense then, that in the 1970s, the counterculture manifested itself in fragmented movements of different capacity, but with the similar core value of creating and supporting an 'alternative lifestyle' (Braunstein and Doyle 2002, p. 12). One of those movements was founded upon ideas put forth by Stewart Brand and his organization.

Brand's version of American counterculture envisioned a future that, unlike traditional environmentalist visions of utopia, included and relied upon 'appropriate technology' (AT) because he was convinced that technology would allow humans and nature to co-exist (Kirk 2008). The AT movement, stemming primarily from anti-war New Left environmental politics, forwarded the idea that small-scale, individualized technology made by self-educated people was the panacea for the environmentally destructive system of capitalism (Kirk 2002, p. 360). In this view, simple, low-cost, ecologically safe technology would lead to self-sufficiency and a new, more democratic social structure. In response to the evident damage post-war industrialization had on the environment, people like Brand began trying to "reconcile dreams for reform with competing fears that the [capitalistic] system was beyond repair" (Kirk 2002, p. 358). The resultant philosophy of technophilia and a hope for a 'greener capitalism' laid the foundation for Stewart Brand's business model, and would also influence other Silicon Valley companies in later years. As Andrew Kirk (2008, p. 296) puts it, "Brand was a pioneer in the greening of American business, and his corporations were a harbinger of a new political calculus at least two decades ahead of its time."

Brand's pioneering is evident in the foundation of Bay Area tech companies, especially Apple (Isaacson 2011). Steve Jobs, Apple's founder, was largely influenced by Brand and the AT counterculture. Jobs allegedly embodied the "fusion of flower power and processor power, enlightenment and technology" (Isaacson 2011, p. 56). He was an avid reader of the *Whole Earth Catalog*, and Brand himself was quoted as deeming Jobs to be "'at the nexus of the counterculture and technology'" (Isaacson 2011, p. 59). The connections between the companies that run modern data centers and the AT counterculture of the past are clear in that the very founders of Silicon Valley-based tech companies embrace the same valuation of both technology

and environmentalism simultaneously. Although the counterculture is no longer its own separate way of life, its remnants can still be found, exemplified in the way companies in the Bay Area, such as Apple and Facebook, operate.

The counterculture manifested in the *Whole Earth Catalog* has also played out in the broader social and political landscape of the American West (Kirk 2007), and subsequently, the New West 2.0. Capitalism has made materialism and consumption part of the American way of life since its origins, but that lifestyle is at odds with the notion that it is the job of individuals and their government to protect the environment. Brand thus believed that technological innovation was the best antidote to the tension between consumption and government-controlled industrialization (Kirk 2008). The Bay Area of the American West seemingly embraces this green ethos today, along with support for a left-right blend of states' rights and libertarian politics (Kirk 2007). Traditional accounts of New West development in the academic literature on the subject are well-aligned with this new brand of environmentalism: visions of stylish hipsters in coffee shops, outdoor enthusiasts clad in Patagonia gear, and tech-obsessed young adults wearing their computers on their wrists are popular characterizations within New West scholarship (Kirk 2008). The importance of these characterizations is that they have resulted in the embrace of 'green capitalism' and 'green consumerism' (Rome 2017) by businesses and individuals in the latest version of the American West. As I will explain, the way Facebook and Apple operate their data centers provides a good example of this new sustainable enterprise approach.

In essence, green capitalism aims to find a technological solution to the problem that arises as capitalism requires endless growth within a finite resource base (Rome 2017). This philosophy is very much aligned with Brand's countercultural visions for the future because it

suggests that technology can and should be used 'appropriately,' or in a manner that is less harmful to the environment while still allowing for business growth (Kirk 2008). Of course, greening capitalism is first and foremost a business opportunity because it is a "marketing claim and a fashion, a reaction to changing markets;" but it is also "a result of generational change" because the CEOs now in charge have been influenced by the environmental movement and are presumably at least slightly more concerned about the environmental impacts of industrial operations (Berghoff 2017, p. 27). This is evident in Silicon Valley-founded tech companies like Facebook and Apple. Here, activism is not about marching in a protest through the streets of a city, rather it is buying eco-friendly goods and developing 'sustainable' technology and production methods (Kirk 2008). This is the "middle ground between capitalism and environmentalism" (Kirk 2008, p. 291), precisely where big data companies reside.

The counterculture faded over time, but Brand's vision of appropriate technology (AT) and green technology have recently found new life with the rise of ecomodernism (Asafu-Adjaye et al. 2015). The ecomodernism movement is synonymous with ecological modernization, a school of thought that supports green capitalism and sustainable development (Isenhour 2016). Ecomodernists believe that decoupling economic growth from resource extraction and use is necessary to combat climate change, and that this is achieved through creating more sustainable technology (Hayden 2014, p. 4). In other words, the ultimate goal is to reduce human dependence on the living natural environment via technological development (Isenhour 2016).

One group that supports this ethos is The Breakthrough Institute, a Bay Area-centered environmental think tank. The institute is a group of ecomodernists seeking to alter "the way people think about energy and the environment to meet the global challenges of the 21st century" (Breakthrough Institute 2016) and, in some ways, the organization has becoming the leading

popularizer of ecomodernist ideas. The Institute developed a controversial document in 2015 called *The Ecomoderist Manifesto*. This manifesto, also signed by Stewart Brand, highlights the importance of technological development as a primary means of mitigating the deleterious effects of climate change. The signers assert that "knowledge and technology, applied with wisdom, might allow for a good, or even great, Anthropocene" (Asafu-Adjaye et al. 2015, p. 6). The authors are certain that technological development with sustainability in mind will cancel out any negative impacts industrial capitalism has had on the environment. The document also fittingly contains statements reminiscent of the Wise Use movement of the 1990s, as the authors call for "using resources more productively" and for us to "seek to liberate the environment from the economy" (Asafu-Adjaye et al. 2015, p. 18). So, unlike most environmentalists, ecomodernists contend that modernization and development are crucial to climate change mitigation. To them, modernization results in "vastly improved material well-being, public health, resource productivity, economic integration, shared infrastructure, and personal freedom" (Adjaye et al. 2015, p. 28). The *Ecomodernist Manifesto* is therefore the epitome of the green capitalism trend: we can, and should, modernize and grow the economy—as long as it is done in a way that is environmentally responsible.

The manifesto advocates five key aspects of ecomodernism: (1) economic growth must be decoupled from environmental impacts, (2) technology is the primary solution to environmental degradation, (3) human development can and will continue as long as appropriate technology is used to support this development, (4) the transition to using more renewable sources of energy must happen soon and rapidly, and (5) 'wild' nature must be protected for its deep aesthetic and emotional value. These five tenants and the associated political undertones of the manifesto are directly aligned with the green ethos present in Silicon Valley and the New

West 2.0, as they are visible in the way that tech companies there operate. According to ecomodernists and green capitalism/consumerism, no one needs to give up their cell phone or computer to be an environmentalist; engineers simply have to work to design them more responsibly, with sustainability in mind (Berghoff 2017). This confidence our ability to continue capitalism and consumption in a sustainable manner represents the foundation of big data companies like Facebook and Apple. As the next section will discuss, the companies' business models and statements by their founders and managers are clearly in support of the ecomodernism movement's five basic principles—manifested in data center operations—even if they do not overtly say so.

It's Easy Being Green?

Ecomodernism is seductive. According to ecomodernists, companies and society as a whole can achieve sustainability through technological innovation and wise business practices. Moreover, the recent trend in green capitalism and subsequent rise in sustainable enterprise have made corporations realize the competitive advantage initiatives like Corporate Social Responsibility (CSR) can now give their businesses (Wirtenberg et al. 2009). In brief, CSR involves a corporation voluntarily taking action to support stakeholders' needs and values in its pursuit of profit, which also includes considerations for environmental health (Hartman et al. 2007; Coombs and Holladay 2012). Adopting CSR strategies is beneficial because in theory, doing so minimizes negative human and environmental health impacts of business operations, while also maximizing profits and positive public image (Ingenhoff and Sommer 2011). As such, ecomodernism and the green capitalism it inspires offer a win-win for most companies: they can

be stewards of the environment and please stakeholders, while also enjoying profits from their sustainability-related investments.

Big data companies like Facebook and Apple have followed this trend with their investments in green energy and attention to their employees' and local communities' well-being. As noted in previous chapters, Facebook in particular has begun to support renewable energy projects, while also helping strengthen local infrastructure of the towns where they are building their data centers (Facebook Sustainability 2017). The green capitalist, ecomodernist tendencies of Facebook and Apple are easy to see in statements made by various leaders of their organizations. For example, when President Trump announced that the U.S. would withdraw from the 2015 Paris Climate agreement last year, Facebook Founder Mark Zuckerberg posted on Facebook:

> Withdrawing from the Paris climate agreement is bad for the environment, bad for the economy, and it puts our children's future at risk. For our part, we've committed that every new data center we build will be powered by 100% renewable energy. Stopping climate change is something we can only do as a global community, and we have to act together before it's too late.[2]

In Zuckerberg's statement, the connections to ecomodernism and green capitalism are clear. He mentions the importance of considering the economy *and* the environment (not either-or), as well as renewable energy investments and community support. Such statements are not uncommon for Zuckerberg. He boldly discussed climate change and renewable energy in his Commencement Address at Harvard University in May 2017 (Harvard Gazette 2017). Facebook also has several people working as part of its 'sustainability team' that have made similar statements about the company's progress towards mitigating their environmental impact.

Likewise, Apple's CEO Tim Cook has spoken overtly about the need to conduct business in a sustainable manner. As noted in the introduction of this chapter, he too spoke out against

President Trump's decision on the Paris Agreement, but to no avail (Bell 2017). Cook has also done numerous interviews on Apple's sustainability initiatives. In an interview with *Forbes*, he stated, "We also try to change the world by the way we run the company… [we are] very focused on the environment and making sure that we have a no-carbon footprint, essentially, or running our company on 100% renewable energy…We advocate for human rights…we believe that education is a great equalizer".[3] These sort of statements make a lot of sense based on the fact that Apple was founded by Steve Jobs in the 1970s, under the same guiding principles as the *Whole Earth Catalog* (Dormehl 2014). Accordingly, Cook ended his *Forbes* interview by saying that Apple "will always try to change the world for the better. That was the motivation behind creating Apple when it was created back in the '70s. And it's still the motivation today…we want to do what's right, not what's easy."

Yet, being green for these companies has arguably been relatively easy from a monetary standpoint. While it may have posed a financial risk initially, they have certainly profited from their sustainability investments since they began their greening efforts (Facebook Sustainability 2017). Facebook and Apple have evidently taken the lead on sustainable enterprise in the tech industry and have subsequently formed a coalition with other tech giants to put millions of dollars toward climate change mitigation efforts (Lapowsky 2015). Furthermore, the latest updates to their data centers are perhaps the most important development in their sustainability initiatives in recent years. They have followed the core tenants of ecomodernism. As the case of Prineville shows, data centers are the embodiment of green capitalism and ecomodernism's influence on data companies.

Making Data Great Again

The way Facebook and Apple data centers are constructed and how they operate supports most of the five basic tenants of ecomoderism. Evidently, data centers are the physical infrastructure that supports our ability to use and embrace individualized technology. The companies that run data centers have become big businesses that decouple economic growth from environmental impacts (the first tenant) by embracing green technology (the second tenant), obtaining environmental certifications like LEED for their buildings, and creating calculable metrics for their resource usage.[4] They are also rapidly investing in local renewable energy sources as they build up and expand their data campuses (the fourth tenant). Consequently, while their operations and physical footprint continues to grow, the spread of data centers is certainly less devastating for local ecosystems than a strip mine or another resource-intensive industry might be. They are therefore developing land to support data centers—the buildings that support appropriate technology—but in what appears to be a relatively ecologically safe way (the third tenant). It is therefore clear data centers exhibit the first four tenants, but the fifth tenant, a valuation of 'wild nature,' is harder to identify. Nevertheless, in Prineville at least, Facebook has donated millions to support outdoor recreation locally, suggesting that the company values nature for purposes beyond technological development.

The tenants of ecomodernism collectively indicate that there are essentially two main important components that make technology promising: its potential for achieving more sustainable modes of industrial capitalism, and its increasingly small-scale, individualized nature (Kirk 2007). Data centers fulfill both of these promises thanks to the latest trends set by Facebook and Apple. As noted in the introduction of this work, most data centers are not known

for being very environmentally-friendly, and have even been cited for contributing to climate change (e.g. Cubitt et al. 2011; Greenpeace 2017). Acting in response to these accusations, Facebook and Apple have outwardly solved the sustainability problem data centers posed through their attempts to green data center operations via investments in renewable energy and innovative engineering. These corporate-owned data storage warehouses are also maintaining the privatization of data rather than allowing such information to become solely government-controlled. This is reflective of the countercultural desire to place faith in corporations and the individuals that run them rather than trusting a domineering, central governing body with our data. Furthermore, data centers are the heart of the infrastructure that allows our favorite individualized technologies to exist (i.e. phones, laptops, tablets, etc.). Without them, social media platforms like Facebook would not have been possible. What is more, the case study of Prineville suggests that Facebook and Apple will simultaneously empower small rural communities by boosting their economy and contribute to local events and infrastructure, rather than take these towns for granted.

It is, however, important to point out that efforts by powerful companies like Facebook and Apple, while certainly beneficial to the local environment and communities in which their data centers reside, are also part of a business plan. Big data companies are good capitalists, and being green is a very good business strategy right now. They know how to make money and they take advantage of situations that they can essentially guarantee will help their business. But does this mean that data centers are built with solely malicious motives? Are they any worse than any other industry that might move in to similar towns? Based on my research thus far, it is very hard to say. Certainly at the local level, big data companies seem to be doing less harm than good, which is an encouraging and surprising revelation.

The previous two chapters noted how, despite my preconceived notions of social media and computer companies paving over small rural towns, it has become clear to me that the many citizens of Prineville consider the Facebook and Apple data centers positive economically, socially, and environmentally. It appears that the big data companies have in fact taken into account all three elements of sustainability. That said, relative to environmental impacts at the local scale, Facebook has been less successful in using renewable energy in Prineville than elsewhere. According to company spokesmen, that is primarily due to site constraints, not because the company is uninterested in investing in renewables. Central Oregon is powered mainly by PacifiCorp, an energy company whose officials admitted that their current energy mix primarily relies upon coal and natural gas. PacifiCorp does, however, have plans to greatly increase the amount of renewable energy in their mix by 2020. Facebook responded to such constraints by publicly fighting for the Voluntary Renewable Energy Tariff (VRET) to show that they are trying their best to promote environmentally-friendly business practices in Prineville. Moreover, they have helped fund many local community improvement and educational projects.

One such project was the enormous new wetlands area Prineville developed to help with wastewater treatment (City of Prineville 2016). This project is a certainly a wise investment for Facebook and Apple. It fosters a more positive image of the companies in the minds of Prineville residents, while also boosting their competitive advantage over other green businesses worldwide. Yet it is also beneficial for the Prineville community because it has reduced the data centers' impact on local ecosystems, has saved the town an enormous sum of money in infrastructural improvements, and has resulted in a new outdoor recreational area available for use by visitors and residents (City of Prineville 2017). Clearly the sustainability of data centers is more nuanced than I originally imagined, especially when considering their investments in

almost all aspects of community life in Prineville. The ecomodernist way of conducting business outwardly has many benefits for stakeholders involved, but there are still things about data centers worth problematizing.

Changing the Game

> *With the natural resources economy dwindling, the investment of these data centers in our economic infrastructure, their contributions have really been a game-changer for our little town.*
>
> —Cole Kent, Crook County Chamber of Commerce

It is important to examine big data companies' embrace of ecomodernism and sustainability critically. Their motivation for taking part in the ecomodernist movement makes sense based on Facebook and Apple's connections to Silicon Valley's green ethos, but there are surely other motivating factors involved. This section aims to show how ecomodernism is likely not the sole force influencing the actions of these Silicon Valley-based corporations. This is an important consideration to make because it prevents the acceptance of a certain power dynamic that has developed and continued without question.

Big data companies are corporations that construct consent for their existence in small rural communities by highlighting their positive qualities while casually not addressing their negative ones. For many of the residents of Prineville, the data center appears to have been an entirely positive addition to their community. As local official Pete Stenner put it, "Facebook has been nothing but stellar in terms of community involvement…Their outreach and their grants have been a huge deal." And indeed, they have. As of spring 2017, Facebook had donated $1.2 million to the town beginning in 2011, primarily in the form of grants to support local schools, research, and sports (City of Prineville 2017—Fact Sheet). After my interview with Stenner, I visited a softball field near the Prineville high school at his request. He wanted me to see how

proud and thankful the town was for Facebook and Apple's help. When I arrived at the high school, I found a Facebook sign displayed prominently underneath the scoreboard, advertising the company's contributions to all who attend softball games (Figure 16). Stenner informed me that there were more signs around town marking Facebook's donations, but they must have been located in less obvious places or had been taken down. Nevertheless, it was clear to me that Facebook likes to demonstrate its support for various local endeavors, and local officials are happy to oblige.

Figure 16. Facebook sign overlooking a softball field near Crook County High School in Prineville, Oregon. *Photo by author*.

Due to their financial aid to the community, many Prineville residents—officials in particular—view the data centers with an almost worshipful appreciation and respect. Stenner went so far as to say, "We have a new school, a new hospital. We have these things that at the

end of the day, if they [the data centers] hadn't arrived, we wouldn't have them. They gave the community the hope, the ability to ponder their future and get behind the movement forward." Facebook is hence seen as heroic for having lifted this dying timber town out of the economic depression (Streep 2017). Although the building resides high on the hill above the town, seemingly isolated from residents, a top local official, Beth Robins, asserts that "they have been extremely good neighbors," helping her and other officials keep Prineville and its unique rural-Western charm alive by blending into the community fabric rather than tearing it apart. Consequently, it seems the residents of Prineville are more than willing to allow Facebook to continue to use the land, energy, and water that perhaps could have gone to other local operations. It appears a small price to pay for all the benefits the company brings to the local community.

Yet why exactly do big data companies care about the residents of Prineville? Is it simply because these people happen to be living in a town that has a favorable climate for data center operations, and because the city gave them generous tax breaks and access to relatively cheap land, water, and energy? Perhaps if Prineville had been a dying rural town elsewhere in America, Facebook would not have given them a second glance. It is true that there has been a notable increase in uneven development with regards to the internet, since some communities, rural or otherwise, are simply better geographically suited to adopt Information and Communication Technology (ICT) industries (Whitacre and Mills 2007). In the rural American West, for example, communities that have been able to survive the transition from extractive to service-based economies in the New West have integrated updated technology and the associated infrastructure (Robbins 2005). Those towns that are left to struggle remain reliant upon the dying extractive industries because they lack the ability and funds to construct the internet

infrastructure that would be required for data center operations (Whitacre and Mills 2007). It is important to note that in both the tourism and technology industries for instance, uneven geography is often apparently a result of comparative advantages (Hogan 2015). That is, a place must be optimally located to support a given industry. As such, the cities and towns that are able to succeed in a digital economy have geographic advantages that make them more readily able to adapt to technological infrastructure and thus more attractive to ICT business in general.

Here it is worth describing what scholars have deemed the 'digital divide,' a concept that exposes such uneven geographies (e.g. Malecki 2003; Aquili and Moghaddam 2007; Whitacre and Mills 2007). The idea of a 'digital divide' was originally used to describe how rural regions tend to be slower or unable to adopt innovations in ICT due to their remoteness and low-density populations (Whitacre and Mills 2007). However, some studies suggest that despite the fact that it can be more difficult to create technological infrastructure to support less densely populated areas, whether or not people have internet now has less to do with where they live geographically, and more to do with income and education levels (Malecki 2003). Although the existence of a digital divide is therefore somewhat contested amongst scholars (Aquili and Moghaddam 2007), the term is still useful to point out the implications this digital age has for overcoming spatial barriers. When a rural community does receive internet access and technological infrastructure, it certainly shatters spatial divisions between the rural and the urban in not only a real sense, but also a virtual one.

The importance of these new digital and spatial connections are that they have made capital more mobile than ever before. The mobility of capital means that most businesses can now locate in many different, as long as they can conduct business remotely, and the locations are desirable to those who work for a given company (Riebsame et al. 1997). Consequently,

mobile capital also increases the likelihood that rural towns like Prineville feel the pressure to compete with their urban counterparts for a place in the digital economy, incentivizing the rural entrepreneurialism, as discussed in chapter two. As the recent scramble by cities to get Amazon headquarters to locate in their communities shows (Selyukh 2017), leaders have been made aware of the apparent promise big tech companies can bring. It is no surprise then that Prineville and other small towns that have been decimated as a result of economic decline are fighting to win over big data companies such as Facebook, Apple and Amazon. Towns like Prineville have come to realize that the technology industry may be their last hope for a vital economy, largely as a result of globalization. That gives big data companies a lot of power.

So what can be said about other rural communities that do not have broadband or easy access to cheap land and resources? Unfortunately, big data companies probably will not pay much attention to them. Prineville officials noted that Facebook considered other similar towns for their first data center, but the town leaders made Prineville look good enough to be the 'chosen one' by offering generous tax breaks and access to cheap land, water, and energy. It is clear who has the power in this relationship. Facebook, like Amazon, makes itself look so enticing that towns are vying for their attention, hoping to be the tech giant's next charity project. Oddly enough, residents seem to know this subconsciously, but they also do not seem to care. As one of Prineville's historians, Sean Leibers, put it with a shrug, Facebook and Apple are "just taking advantage of what is being given to them as far as benefits, and that is one of the reasons they are located here [in Prineville]. Otherwise they would go somewhere else that did give them a big [tax] break."

Leibers' statement is most certainly true. Again, Facebook and Apple are at the core, private corporations that need to make money to stay afloat in this globalized economy—and they hold a lot of power because of the success they have had in doing so. The massive amount of sway Facebook and Apple have in our everyday lives is astounding. We let Facebook filter out news, creating a personal bubble of customized information that can shield us from the things the computer thinks we do not want to see (Pariser 2011). We wear Apple on our wrists, letting them track our heart beat, or put them in our pocket, while our location is broadcast to unknown people in unknown places. We consent to big data companies' existence and power every time we log on to their websites and plug into their devices (Foer 2016). And their use of the cloud metaphor makes matters even more confusing because it singularizes data centers as a solitary white object in the sky (Carruth 2014; Hu 2015). How could a harmless mass of water vapor hurt humans and the environment? Most would say it could not. A woman living in Prineville told me that she figured "everything just disappears [in the cloud] when I post. I never even thought about it." She, like most people who use social media and the cloud, has been assured that her information is safe with Facebook or Apple, stored somewhere high in the sky where no one can reach it. This too gives big data companies power because it prevents people from questioning what real world impacts their data demands could be having in the long-term.

Yet big data companies are not necessarily using all this power irresponsibly. While it is true that other towns have been (and will be) left behind by the tech industry, those that are able to attract them to their area certainly do not suffer for their efforts. Prineville is a case-in-point. There is no denying that accepting data centers' presence is easy when Facebook and Apple do everything they can to tread lightly on the towns where they choose to build. They blend in surprisingly well, even in a place where high-tech industrial operations have never taken place.

So, despite all the commotion about their community contributions amongst local officials, on a day-to-day basis, it is easy for residents of Prineville to forget the data centers even exist. Cole Kent from Crook County Chamber of Commerce said that fairly often, visitors will come to Prineville and not even know the data centers are there until someone tells them about the buildings. After all, most people do not come to Prineville to see data centers—and from a distance, they look like any other industrial warehouse. The buildings are also not open to the public for tours, as I quickly found out when I traveled to Oregon. And, as local official Evan Kasey, put it, "As compared to a community without data centers, the average person might know a bit more [about the cloud]. But then again, does the average person really care where their material is? They just want their pictures to come up when they need them." As such, even if people are aware of where the data centers are, they seemingly have little influence on local residents' everyday lives—and that is just fine with them, so long as they can still post their selfies on Facebook.

Taken as a whole, what all of this suggests is that the American West is very much immersed in the light-green society, and data centers allow it to be possible. Prineville residents likely do not want to consider any negative environmental impacts of data centers, but nor would they accept an industry that posed a threat to their cherished historical roots. The town itself, housing data centers and hosting rodeos all at once, is reflective of this unwillingness to choose between modern and traditional and environmentalism and technology. Prineville too, has thus taken the middle path; but it was ecomodernist companies like Facebook and Apple that took their hand and led them. Whether or not this was for financial reasons or due to the influence of Silicon Valley green ethos perhaps does not matter. Both Prineville and the tech industry giants it now hosts have struck a balance.

Wrapping Up: Unpacking the Green Box

Evidently, it is challenging to unpack the true sustainability of data centers. It is clear that this physical infrastructure, while hidden in plain sight by cloud metaphors, is central to the maintenance of big data companies' power. Data centers are quite literally the heart of our technological obsession. But because their greenness is promoted by Facebook, Apple, and others in the tech industry, we are convinced we need not worry about demanding increasingly large amounts of data storage space. Data centers seem to be helping local communities by aiding in their economic and social development. They also appear to be environmentally friendly because of their investments in renewable energy and the green visions put forth by the CEOs of the top tech industry leaders. So, with their overt efforts at addressing the social, environmental, and economic components of sustainability, no one wants to or needs to question the influence big data companies have globally. Big data companies cloaked themselves behind a green curtain.

Yet because these companies are rooted in a countercultural ecomodernist brand of environmentalism, they have worked to achieve a form of sustainability that, like the light-green society, remains largely ambiguous. For instance, although Facebook has certainly set a wonderful example by investing in renewable energy, one cannot be entirely sure how 'green' their energy sources truly are. As previously mentioned, the leading power supply company for Central Oregon, PacifiCorp, gets the majority of their energy from coal and natural gas. These are certainly not renewable and sustainable sources of power, especially considering the evident contribution of fossil fuels to global climate change. Moreover, as noted in chapter three, Facebook has not released any information regarding their electronic waste (e-waste) recycling

and/or disposal. E-waste also poses social and environmental justice concerns (e.g. BAN 2002) that would certainly taint Facebook's image if they are indeed taking part in toxic dumping, even if it may be unknowingly. The bold statements made by Facebook and Apple CEOs about their green efforts are thus perhaps not quite as well-founded as they appear.

Nevertheless, their attempts to operate even somewhat sustainably is commendable. Big data companies are trying to ameliorate the environmental harm their operations could potentially cause, while also promoting more data consumption among users. Data centers are thus certainly evidence that the ambivalent light-green society is still thriving today. They are the result of our desire to be able to go outside and enjoy nature, while also taking pictures of our adventures with our cell phones and storing those memories safely in the ephemeral cloud. Because of data centers, we have the ability to balance these two outwardly conflicting desires. Ecomodernist companies such as Facebook and Apple have made this possible by constructing consent to build data centers in small rural towns worldwide. These data centers are a digital variant of the light-green society.

Notes

1. The Breakthrough Institute is, as defined on their website, "a global research center that identifies and promotes technological solutions to environmental and human development challenges." See https://thebreakthrough.org/about for more information on the mission of the institute, as well as those involved and their various publications.

2. Statement excerpted from Kurt Wagner, "Mark Zuckerberg says Donald Trump's decision on the Paris agreement 'puts our children's future at risk'," *Recode*, June 1, 2017, https://www.recode.net/2017/6/1/15727122/mark-zuckerberg-trump-paris-agreement-statement.

3. The full interview is available at http://fortune.com/2017/09/11/apple-tim-cook-education-health-care/.

4. These metrics include Water Usage Efficiency (WUE), Power Usage Efficiency (PUE), and others. See Chapter Three for a more detailed discussion of the environmental initiatives of big data companies.

CONCLUSION

PINNING IT DOWN

When I returned to New York after my month-long stay in Oregon, I discovered there was still much more to learn about data centers online. One morning I was looking for information about the Prineville Facebook data center's energy use, and I thought I should see if they had listed any information on the internet. I discovered that there were Facebook pages dedicated to each of the company's data centers, as well as one entitled "Green on Facebook,"[1] which discusses Facebook's sustainability measures and related information. As I recorded the data from these pages in a Word document, I thought I ought to save my work somewhere other than on the USB flash drive that held my entire thesis project. I did not know what I would do if I lost it. So, I decided to put everything onto my online Google Drive account. As I watched the little blue wheel spin at the bottom of my screen, I began laughing, realizing the irony of my actions: I was uploading my thesis project to the cloud, to the cloud, and using the internet and Facebook itself to gather more data about these very things.

Yet, I suppose that irony helps display one of the points I have made in this project. We are in fact, very reliant upon big data companies today. I want my personal documents to be accessible anywhere, at any time. I trust the virtual space of the cloud more than a personal, physical hard drive or flash drive. The cloud is untouchable to me and others, even though, as a result of my research I know that the cloud is very much a physical space too. Data centers are well-hidden in plain sight. Without a second thought, we put our information into the cloud, trusting big data companies with photos of ourselves and our precious documents.

In this thesis, I have sought to catch the ethereal cloud and pin it down. I have pinned it down in three ways. First, to identify and examine the geography of data centers. I found where

many are located and have speculated as to why they are located there. Second, to pin down and survey their social and environmental consequences. I discovered the minimal negative impacts on the local scale, and the potentially large negative impacts at the global scale. And third, to examine how these digital storage campuses fit into the sustainability visions of Silicon Valley tech companies such as Facebook and Apple. But, as the following sections discuss, despite my efforts to catch the cloud and pin it down, much about data centers remains elusive.

The Data on Data Centers

Based on the first chapter of this work, data centers appear heroic and almost entirely beneficial to community life, especially to small rural towns. It is certainly true that big data companies have saved Prineville from having to make the 'devil's bargain' that their neighboring town Bend has made. Hal Rothman's (1998) ideas about tourism having destroyed cultures across American West and worldwide are currently inapplicable to data centers' presence in their host communities. Like the tourism industry, big data companies improve the local economy; yet they do so in a way that does not erase preexisting community values and characteristics—at least in the short-term. Facebook and Apple have nearly single-handedly lifted Prineville out of an economic depression (City of Prineville 2017), and presumably can do so for other small rural towns in other similar locations (O'Connor 2017). Facebook and Apple make it clear that data centers can indeed improve the economy in small rural towns, despite being unable to replace the much larger number of jobs provided by traditional extractive industries.

In this particular case study of Prineville, data centers appear to have minimal socio-cultural implications. Facebook has made efforts to blend into the cultural fabric of Prineville and other towns in which it has constructed data centers. For example, the first manager

Facebook hired in Prineville grew up on a ranch in a nearby town and allegedly knew several of the local officials prior to taking the position (Streep 2017). Prineville officials also assert that Facebook attempts to hire locals as much as possible, and 75 percent of their employees are in fact residents of Crook County (City of Prineville 2017). Of course, this is 75 percent of a small number of employees, but it is impressively high, especially in a town with a relatively low population. As such, the shifts visible in the physical and cultural landscape of the neighboring town Bend, as a result of tourism, are not noticeably present in Prineville right now. While it is true that there are a few brewpubs and chain restaurants in town, Prineville's history and traditions (e.g. parades, rodeos, etc.) remain prevalent in the community. This would suggest that no devil's bargain has been made as a result of Prineville's acceptance of big data companies' support. Furthermore, these conclusions make clear that the conceptions of a New West, at least in this case, are outdated. Prineville is a hybridized mix of Old and New, a delicate balance between two different ways of life that are, at least for now, able to coexist. A New West 2.0 has begun to emerge in parts of the rural American West.

Yet still, aside from economic improvements and socio-cultural blending, there are less prominent aspects of data centers that are quite disconcerting. While their investments in renewable energy sources and alleged minimal environmental impacts on the local scale are commendable, how much better will these companies truly be for the environment than other industries, especially in the long term and at broader scales? Regardless of the source of the power and water these companies draw from, they are using up increasingly larger amounts of resources to maintain the ever-expanding cloud. And these operations are only intensifying. Each week it seems there are headlines in local newspapers about expansion of preexisting data campuses or completely new data center construction. Even Prineville's data centers have

expanded multiple times, and they announced the purchase of 540 million acres of county land in December 2017 for further data center construction over the next four years (Quintana 2017). The footprint of data centers is growing such that they will certainly be taking up more land space and natural resources, which puts a greater demand on local infrastructure. Whether or not this increased load—renewably sourced or not—will prove to be harmful at any scale remains to be seen.

Furthermore, the issue of electronic waste (e-waste) deserves a closer examination. If big data companies are willing to boast openly about their green initiatives, why have they remained silent about e-waste? Most of them seem to think that sustainability is achieved merely through a reduction in their carbon emissions. Yet sustainability encompasses much more than that. The companies' lack of communication about e-waste makes it appear as if they do not take responsibility for the enormous amount of e-waste they surely generate, including used servers, broken server parts, wires, and computers. Employees themselves seem to have little idea what happens to e-waste from their own data centers. However, based on the research conducted by NGOs to date, we can be certain that e-waste is a serious global environmental justice problem that must be given the public attention it deserves (BAN 2002). Big data companies' silence is worrisome, as they may very well be contributing to such global injustices. Scholars can surely play an important role in exposing and addressing issues surrounding data center e-waste, as information will hopefully become available in coming years.

As such, the true sustainability of such large-scale operations warrants questioning. It is hard to determine their ultimate level of sustainability with such a dearth of reliable information available to the public; however, no matter how small or large the ecological 'footprint' of each individual data center is, the aggregate total land space and resources they consume will continue

to expand as demand for data storage space increases and new types data-intensive media are developed (e.g. 360-degree photos and video and virtual and augmented reality) (Sverdlik 2017). As data centers grow in size and number, they will necessarily require more land, energy, and water—and they will generate more waste. So, perhaps it is true that big data are not as bad for local ecosystems as some other industries may be, but considering the industry's exponential growth rate and probable contributions to the global e-waste problem, big data may not be as good and green as Facebook and others make it out to be. It is impossible to say for certain what the environmental outcome will be if big data companies are not more forthcoming with measurements of their sustainability.

As I explained in chapter four, it is not just the companies casting their operations as 'green' that clouds our perception of cloud usage; the cloud metaphor itself plays a large part in making it seem as if our data fetish has no impact on the environment. Data centers are very much physical structures that metabolize nature, but big data companies are able to use green energy investments and the illusion that the cloud is a virtual, boundless space to prevent anyone from questioning their true sustainability. Many corporations and people, including myself, have become dependent on the cloud to store the data they value most. This dependency is gives big data companies a lot of power. By using their services daily, we allow big data companies the ability to further control our information, as well as certain aspects of our lives (Foer 2017). Yet whether or not this is something to fear is made unclear by the unmistakable positive contributions big data companies like Facebook and Apple have made to local communities and the surrounding environment. With their green visions and adherence to econmodernist tenants,

these companies have helped continue the trend toward a greener version of capitalism—if such a thing is indeed possible.

So, perhaps one could conclude that cloud infrastructure is indeed better characterized as an example of what Michael Bess (2003) has deemed the 'light-green society.' Aspects of environmentalism and technological modernism are clearly now coexisting in places like Prineville, as Facebook and Apple make technology and data storage as environmentally-friendly and socio-economically beneficial as possible at a local scale. This odd balance between environmental concern and technological fetishism, and an ambivalence toward modern versus traditional, seems to be the most probable future for many communities of the developed world (Bess 2003, p. 237). If this is true, the story I have told is one with a precariously happy ending. Prineville and big data companies are now sewn together in a peculiar patchwork quilt of traditional rural Western ways of life and the urban-based rapid development of modern ICT and New West culture. The New West 2.0 conceptualization is one that helps reveal the multifaceted nature of these changing landscapes big data companies have created by building data centers and 'updating' small rural towns: they have become at once modern, traditional, ecological, and technological.

As a whole, towns that Facebook and others have approached with a business deal have rightfully welcomed data centers (Steer 2017). Presumably, these towns' eagerness is at least in part due to the alleged success of data center construction in towns like Prineville (O'Connor 2017). Again, because this construction is ongoing and continual however, it is hard to say whether Henrico County, Los Lunas, Papillion, and other towns will strike the same balance with big data companies as Prineville has been able to. Because Prineville is located in the rural American West, a place generalized as one having gone through constant changes over time

(Taylor 2004), it could conceivably be better suited to adapt to data centers in a way that preserves their cherished community character. Then again, maybe this balance is made possible simply due to the fact that Facebook is making such a concerted effort to blend in with (and not necessarily take over) the communities near to their data centers—at least for the time being. Perhaps it is possible for a high tech company to stitch itself neatly into the fabric of any rural community.

Data Centers Down the Road

Over time, the impacts of data centers will certainly change, and there is no guarantee that the hidden aspects of data center operation are entirely sustainable (e.g. electronic waste and the physical footprint of data centers). Data centers certainly metabolize nature in their consumption of land, water, and energy, regardless of how 'green' their model of capitalism is. And this metabolism will probably be increasingly intense in the near future, as the operations of big data companies expand. Moreover, although data centers are not necessarily sites of production and/or consumption, they do allow those actions to occur and they act as an instrument of information transmission, as data is shared and sold. They are key in producing digital space, acting like warehouses rather than factories. It is therefore true that even in the case of data centers, "industrial environments often entail uncontested power over massive flows of raw materials, energy, and waste" (Huber 2017, p. 151)—and now, information could be added to this list of flows. As such, there is a need to politicize industrial sites, including data centers, so everyone think critically about the real-world impacts of our increasingly digital lives in this capitalistic society. However, data centers are currently not political in a negative sense. In fact, companies like Facebook and Apple have empowered some small communities, including

Prineville, making them more viable in the digital age. Of course, there are still some less fortunate communities that are geographically ill-suited for data center operations that will be overlooked by big data companies. There is an apparent limit to the extent of their charity.

Still, in Prineville at least, residents seem convinced that Facebook has done only good things for their community—which outwardly, it has. There is no denying the economic improvements Facebook and Apple helped create for Prineville.[2] But there is also no denying that company has used, and will continue to use, the town's resources and land-space, no matter how much renewable legislation they may push for. Data centers are far from stagnant, and they will continue to grow in size and number (Hogan 2013). Yet as with many other industries, the implications of such growth are hidden behind the 'veil of capitalism' (Brooks and Bryant, 2014)—which now perhaps could be deemed the veil of *green* capitalism. There is no way to say with certainty whether or not everything Facebook and Apple do is for the sake of profit or if it is for the sake of economic, social, and environmental components of sustainability. Most likely, it is a combination of both because when it comes to green capitalism, these companies come out on top either way. How many companies (for which it is feasible) would choose not to profit from sustainability investments? Probably not many.

So for now, Prineville remains honored to have the data companies there. Facebook and Apple have seemingly done nothing but help the town regain its economic vitality in a way that appears to be economically sustainable, especially considering the growth of the technology industry (and our data fetish) in recent years. There is no question that Prineville needed to shift its economic base. Because they did not want to turn to tourism like their neighboring town Bend, something else needed to take the place of the timber industry. Based on the limited number of jobs data centers create, however, the town has still not found a total solution.

Nonetheless, the 'game-changing' tech companies have been enough to get the town out of an economic depression. As a result, regardless of the data companies' motivations, they have struck a balance with the town—at least for the time being. For now, leaders of Prineville and the leaders of other towns that welcome data centers will likely still believe that big data are their shining ray of hope for a better future, despite any broader negative impacts data centers may have. As Prineville official Beth Robins asserted, "Facebook encourages us to fly, to reach new limits, and we certainly intend to do that."

In sum, this project suggests that I cannot assure that data centers are entirely positive or negative on a local scale at the present time. That said, I can deduce that on a larger, aggregate scale, big data companies are important, and they warrant the attention of scholars. While it is true that there is not enough data about data centers' social or environmental impacts, their operations are expanding and it is worth questioning just how sustainable such ever-growing companies can be. Although data centers' development has only relatively recently been brought to the public's attention, it is regrettable that so few scholars have taken the time to question something so well-entrenched into our everyday lives. Arguably, it is our job to question such things. Currently, data centers are the uncontested and unproblematized foundation of the ICT industry. If they are not examined, the uneven geographies and the unique power relations that big data companies create will not be fully comprehendible—or if need be, combatable.

Fortunately, several scholars have begun this important work, but many pieces of the complicated ICT network remain unexposed. Data centers are a good place to start if we wish to understand the profound influence big data companies will have on humans and the environment in which we live in the future. I have caught the cloud and pinned it down in one place, but the

number of case-studies worthy of examination is rapidly growing. Perhaps the metaphorical patchwork quilt does not need to unravel in Prineville, or anywhere else where similar ones are sure to be sewn. There is more work to be done on data centers, and I hope geographers will realize that they can, and should, take the lead.

Notes

1. The "Green on Facebook" company profile is available at https://www.facebook.com/green/.
2. See Chapter Two for more specific economic impacts of the data centers in Prineville.

REFERENCES

Adams, Paul C., Jim Craine, and Jason Dittmer. *The Ashgate Research Companion to Media Geography*. Burlington: Ashgate Publishing Company, 2014.

Adams, Paul C., Julie Cupples, Kevin Glynn, Andre Jansson, and Shaun Moores. *Communications/ Media/Geographies*. New York: Routledge, 2017.

Andersson, Magnus and André Jansson. Rural Media Spaces: Communication Geography on New Terrain. *Culture Unbound: Journal of Current Cultural Research* 2 (2010): 121-130.

Angelo, Hillary and David Watchsmuth. Urbanizing Urban Political Ecology: A Critique of Methodological Cityism. *International Journal of Urban and Regional Research* 39, 1 (2015): 16-27.

Arvidsson, A. and Colleoni, E. Value in Informational Capitalism and on the Internet. *The Information Society* 28, 3 (2012): 135-150.

Asafu-Adjaye, John, Linus Blomqvist, Stewart Brand, Barry Brook, Ruth DeFries, Erle Ellis, Christopher Foreman, David Keith, Martin Lewis, Mark Lynas, Ted Nordhaus, Roger Pielke, Jr., Rachel Pritzker, Joyashree Roy, Mark Sagoff, Michael Shellenberger, Robert Stone, and Peter Teague. *An Ecomodernist Manifesto*. (April 2015). Accessed 27 Jan 2017. http://www.ecomodernism.org/.

Augusta Free Press. Dominion Energy Virginia to power new Facebook data center with renewable energy. (October 6, 2017). Accessed 30 November 2017. http://augustafreepress.com/dominion-energy-virginia-power-new-facebook-data-center-renewable-energy/.

Aylett, A. Conflict, collaboration and climate change: participatory democracy and urban environmental struggles in Durban, South Africa. *International Journal of Urban and Regional Research* 34, 3 (2010): 478-95.

BAN (Basel Action Network). *Exporting Harm: The High-Tech Trashing of Asia***.** Basel Action Network (2002). Accessed 25 November 2017. http://svtc.org/wp-content/uploads/technotrash.pdf.

Bates, Doug. "The tire king: Les Schwab at 80." *The Oregonian*. Last modified Sept. 28, 1997. Accessed Oct. 8, 2017. http://blog.oregonlive.com/oregonianextra/1997/09/profile_of_les_schwab_in_1997.html.

Bell, Karissa. Tim Cook tried to talk Trump out of pulling out of the Paris Climate Agreement. Mashable (June 1, 2017). Accessed 28 January 2018. https://mashable.com/2017/06/01/apple-ceo-time-cook-responds-paris-climate-agreeement/#30EXxprnfkq3.

Berghoff, Hartmut. Shades of Green: A Business History Perspective on Eco-Capitalism. In Berghoff, H. and Rome, A. (eds). *Green Capitalism?* Philadelphia, Pennsylvania: University of Pennsylvania Press, 2017.

Bess, Michael. *The Light-Green Society: Ecology and Technological Modernity in France, 1960-2000*. Chicago, IL: University of Chicago Press, 2003.

Blaikie, Piers, and Harold Brookfield (eds.). *Land Degradation and Society*. London and New York: Methuen, 1987.

Botelho, Anabela, Paula Ferreira, Fátima Lima, Lígia M. Costa Pinto, and Sara Sousa. Assessment of the environmental impacts associated with hydropower, Renewable and *Sustainable Energy Reviews* 70 (April 2017): 896-904.

Bowen, Frances and J. Alberto Aragon-Correa. Greenwashing in Corporate Environmentalism Research and Practice: The Importance of What We Say and Do. *Organization & Environment* 27, 2 (2014): 107-112.

Bowman, Isaiah. *The Pioneer Fringe*. New York, NY: American Geographical Society, 1931.

Bousquet, Ernestine. "Growth spreads to rural town: Affordable housing and land lures throngs of people to Prineville." Cascade Business News (July, 2004). Accessed November 5, 2017. http://www.bendbulletin.com/news/1492281-151/growth-spreads-to-rural-town.

Boykin, Sam. "Charlotte Region Is Using Data Center Development To Boost Its Economy." Accessed September 16, 2017. https://www.bisnow.com.

Bozak, Nadia. *The Cinematic Footprint: Lights, Camera, Natural Resources*. Piscataway: Rutgers University Press, 2011.

Brady, Gemma A., Nikil Kapur, Jonathan L. Summers, and Harvey M. Thompson. "A case study and critical assessment in calculating power usage effectiveness for a data centre." *Energy Conversion and Management* 76, (July 2013): 155–161.

Brand, Stewart. The "Whole Earth" Origin. In L. Obst (ed.), *Sixties: The Decade Remembered Now, by the People Who Lived It Then*. New York, New York: Random House, Inc., 1977.

Braun, Bruce. Environmental issues: writing a more-than-human urban geography. *Progress in Human Geography* 29, 5 (2005): 635–650.

Braunstein, Peter and Michael W. Doyle. *Imagine Nation: The American Counterculture of the 1960s and '70s.* New York, New York: Routledge, 2002.

Brennan, Shane. Making Data Sustainable. In Nicole Starosielski and Janet Walker (eds.), *Sustainable Media: Critical Approaches to Media and the Environment*. New York: Routledge, 2016.

Brigden, K., Labunska, I., Santillo, D., and Allsopp, M. *Recycling of electronic wastes in India and China: workplace and environmental contamination*. Greenpeace. (2005). Accessed 25 November 2017. http://www.greenpeace.org/international/PageFiles/25134/recycling-of-electronic-waste.pdf.

Brooks, Andrew and Raymond Bryant. "Consumption" In Carl Death (ed). *Critical Environmental Politics*, London: Routledge, 2014.

Brown, Eric et al. WP#53 - Electronics Disposal Efficiency (EDE): an IT recycling metric for enterprises and data centers. The Green Grid. (March 5, 2013). Accessed 30 November 2017. https://www.thegreengrid.org/en/resources/library-and-tools/235-WP#53---Electronics-Disposal-Efficiency-(EDE):-An-IT-Recycling-Metric-for-Enterprises-and-Data-Centers-.

Bryson, Jeremy. The Nature of Gentrification: Urban Environments and Redevelopment in the Inland Northwest. PhD Dissertation. Syracuse University, 2010.
Bryson, Jeremy and William Wyckoff. Rural Gentrification and Nature in the Old and New Wests. Journal of Cultural Geography 27, 1 (2010): 53-75.

Bunce, S. and G. Desfor. Introduction to 'political ecologies of urban waterfront transformations.' *Cities* 24, 4 (2007): 251-258.

Burrington, Ingrid. The Environmental Toll of a Netflix Binge. *The Altantic*. (December 16, 2015). Accessed March 9, 2018. https://www.theatlantic.com/technology/archive/2015/12/there-are-no-clean-clouds/420744/.

Carlisle, Nate. "Water use hints at problems at Utah Data Center." *The Salt Lake Tribune*. (October 8, 2013). Accessed 30 November 2017. http://archive.sltrib.com/story.php?ref=%2Fsltrib%2Fnews%2F56973004-78%2Fcenter-data-utah-nsa.html.csp.

Carlisle, Nate. "Utah legislator to propose halting water to NSA data center." *The Salt Lake Tribune*. (February 12, 2014). Accessed 30 November 2017. http://archive.sltrib.com/story.php?ref=%2Fsltrib%2Fpolitics%2F57534964-90%2Fnsa-data-center-utah.html.csp.

Carlson, Edward and Justin Goss. "The State of the Urban/Rural Digital Divide." NTIA (August 2016). Accessed November 4, 2017. https://www.ntia.doc.gov/blog/2016/state-urbanrural-digital-divide.

Carruth, Allison. The Digital Cloud and the Micropolitics of Energy. *Public Culture* 26, 2 (2014): 339-364.

Castells, Manuel. *The Information Age, Vol. I: The Rise of the Network Society*. Oxford: Blackwell, 1996.

Castells, Manuel. *The Information Age, Vol. II: The Power of Identity*. Cambridge: Blackwell, 1997.

City of Prineville. *Data Center Fast Facts—Spring 2017*. City of Prineville, 2017.

City of Prineville. Water Conservation – Prineville Leads the Way. (March 23, 2016). Accessed 30 November 2017. http://www.cityofprineville.com/publicworks/page/water-conservation-%E2%80%93-prineville-leads-way.

City of Prineville. *Adopted Budget, Fiscal Year 2017-2018*. City of Prineville, 2018.

Clancy, Heather. "The Green Grid's next target: Data center e-waste." GreenBiz. (June 11, 2013). Accessed 30 November 2017. https://www.greenbiz.com/blog/2013/06/11/green-grids-next-target-data-center-e-waste.

Clark, Jeff. "What should you do with your e-waste?" *Data Center Journal*. (March 11, 2014). Accessed 30 November 2017. http://www.datacenterjournal.com/ewaste/.

Cook, Ian R. and Erik Swyngedouw. Cities, social cohesion and the environment: Towards a future research agenda. *Urban Studies* 49, 9 (2012): 1959–1979.

Coombs, W. Timothy and Sherry J. Holladay. *Managing Corporate Social Responsibility: A Communication Approach*. Malden, MA: Wiley-Blackwell, 2012.

Cohen, Nicole. The Valorization of Surveillance: Towards a Political Economy of Facebook. *Democratic Communiqué* 22, 1 (2008): 5–22.

Cronon, William. "Foreword: Dreams of Plenty," in *Landscapes of Promise: The Oregon Story 1800-1940* by W.G. Robbins. Washington: University of Washington Press, 1997.
Orr, William N. and Elizabeth L. Orr. *Geology of the Pacific Northwest, 2nd. Ed*. Long Grove, Illinois: Waveland Press, Inc., 2006.

Cubitt, Sean, Robert Hassan, and Ingrid Volkmer. Does cloud computing have a silver lining? *Media, Culture, and Society* 33, 1 (2011): 149-158.

Darling, Dylan J. "Data centers' water use: measure of Prineville's change." The Bulletin. (November 15, 2015). Accessed 30 November 2017. http://www.bendbulletin.com/localstate/3681615-151/data-centers-water-use-measure-of-prinevilles-change.

Data Center Knowledge. The Facebook Data center FAQs. (September 27, 2010). Accessed 30 November 2017. http://www.datacenterknowledge.com/data-center-faqs/facebook-data-center-faq.

DCCP (Deschutes County Comprehensive Plan). *Chapter 1: Comprehensive Planning*. Deschutes County, 2011.

DLCD (Oregon Department of Land Conservation and Development). Oregon's Statewide Planning Goals and Guidelines. (12 March 2010). Accessed December 12, 2017. http://www.oregon.gov/LCD/Pages/goals.aspx

Dormehl, Luke. Why Tim Cook's green push goes back to Apple's roots. Cult of Mac (May 1, 2014). Accessed 28 January 2018. https://www.cultofmac.com/275699/apple-green-campaign/.

Duane, Tim P. "The Next West." Working Paper. University of California, Santa Cruz (2012).

EDCO (Economic Development for Central Oregon). *2017 Central Oregon Profile*. EDCO, 2017.

Evans, James P. Wildlife corridors: An urban political ecology. *Local Environment* 12, 7 (2007): 129-152.

Facebook. Company Info. (2017). Accessed 30 November 2017. https://newsroom.fb.com/company-info/.

Facebook Sustainability. (2017). Accessed 30 November 2017. https://sustainability.fb.com/our-footprint/.

Fish, Adam and Ramesh Srinivasan. Digital labor is the new killer app. *New Media & Society* 14, 1 (2011): 137–152.

Fisher, Eric. 2010. Contemporary Technology Discourse and the Legitimation of Capitalism. *European Journal of Social Theory* 13, 2 (2010): 229–252.

Foer, Franklin. *World Without Mind: The Existential Threat of Big Tech*. New York, NY: Penguin Press, 2017.

Forge, Simon. Powering down: remedies for unsustainable ICT. *Foresight* 9, 4 (2007): 3-21.

Foster, John B., Brett Clark, and Richard York. The Ecological Rift: Capitalism's War on Earth. New York: Monthly Review Press, 2010.

Fuchs, Christopher. 2010. Labor in Informational Capitalism and on the Internet. *The Information Society* 26, 3 (2010): 179-196.

Gabrys, Jenifer. *Digital Rubbish: a natural history of electronic waste*. Ann Arbor: University of Michigan Press, 2011.

Galston, William A., and Baehler, Karen J. *Rural Development in the United States: Connecting Theory, Practice, and Possibilities*. Washington, DC: Island Press, 1995.

Glasmeier, Amy and Howland, Marie. *From Combines to Computers: Rural Services and Development in the Age of Information Technology*. Albany, New York: State University of New York Press, 1995.

Gossin, Peter C. and Ryan C. LaBrie. "Chapter 14: Data Center Waste Management" In Patricia Ordóñez de Pablos (ed.). *Green Technologies and Business Practices: An IT Approach*. Hershey, PA: IGI Global, 2013.

Green on Facebook. PUE/WUE Dashboard FAQ. (2017b). Accessed 30 November 2017. https://www.facebook.com/green/app/511488285582837/.

Greenpeace. How Dirty Is Your Data. Greenpeace (April 21, 2011). Accessed March 9, 2018. http://www.greenpeace.org/international/en/publications/reports/How-dirty-is-your-data.

Greenstein, Shane. The Economic Geography of Internet Infrastructure in the United States. In Martin Cave, Sumit Majumdar, and Ingo Vogelsang (eds.), *Handbook of Telecommunications Economics, Volume II*. Amsterdam, The Netherlands: Elsevier, 2005.

Greenwood, Shannon, Andrew Perrin, and Maeve Duggan. *Social Media Update 2016*. (November 11, 2016). Accessed 30 November 2017. http://www.pewinternet.org/2016/11/11/social-media-update-2016/.

Hardy, Kevin. "Will Iowa's giant data centers spur growth in technology jobs here?" The Des Moines Register. Last Modified September 3, 2017. Accessed October 1, 2017. http://www.desmoinesregister.com/story/money/business/2017/09/03/iowas-giant-data-centers-spur-growth-technology-jobs-here/617848001/.

Hartman, L.P., Rubin, R.S., & Dhanda, K.K. The Communication of Corporate Social Responsibility: United States and European Union Multinational Corporations. *Journal of Business Ethics* 74 (2007): 373–389.

Harvard Gazette. Mark Zuckerberg's Commencement address at Harvard. The Harvard Gazette (May 25, 2017). Accessed 28 January 2018. https://news.harvard.edu/gazette/story/2017/05/mark-zuckerbergs-speech-as-written-for-harvards-class-of-2017/.

Harvey, David. From managerialism to entrepreneurialism: the transformation in urban governance in late capitalism. *Geografiska Annaler* 71 B, No. 1 (1989): 3-17.

Harvey, David. *Spaces of neoliberalization: towards a theory of uneven geographical development*. Stuttgart: Franz Steiner Verlag, 2005.

Hayden, Anders. *When Green Growth Is Not Enough: Climate Change, Ecological Modernization, and Sufficiency*. Montreal and Kingston, Québec: MQUP, 2014.

Heynen, Nik. Urban political ecology I: The urban century. *Progress in Human Geography* 38, 4 (2014): 598–604.

Heynen, Nik, Maria Kaika, and Erik Swyngedouw. *In the Nature of Cities: Urban Political Ecology and the Politics of Urban Metabolism*. New York: Routledge, 2006.

Heynen, Nik, James McCarthy, S. Prudham and Paul Robbins (eds.). *Neoliberal environments: false promises and unnatural consequences.* New York: Routledge, 2007.

Hidel, Erik. "Water sources scarce near Prineville: City tries various solutions, including mapping underwater 'streams'." *The Bulletin* (January 21, 2011). Accessed 30 November 2017. http://www.bendbulletin.com/localstate/1397055-151/water-sources-scarce-near-prineville.

Hindman, Douglas Blanks. "The rural-urban digital divide." *Journalism and Mass Communication Quarterly* 77, No. 3 (Autumn, 2000): 549-560.

Hodson, Michael and Simon Marvin. 'Urban ecological security': A new urban paradigm? *International Journal of Urban and Regional Research* 33, 1 (2009): 193–215.

Hogan, Mél. Data flows and water woes: The Utah Data Center. *Big Data & Society* 2, 2 (July 13, 2015): 1-12.

Hogan, Mél. Facebook Data Storage Centers as the Archive's Underbelly. *Television New Media* 20, 10 (2013): 1-16.

Huber, Matthew. Hidden Abodes: Industrializing Political Ecology. *Annals of the American Association of Geographers* 107, 1 (2017): 151-166.

Isaacson, Walter. *Steve Jobs*. New York, NY: Simon & Schuster, 2011.

Isenhour, Cindy. Unearthing human progress? Ecomodernism and contrasting definitions of technological progress in the Anthropocene. *Economic Anthropology* 3 (2016): 315–328.

Jackson, Philip L. and Robert Kuhlken. A Rediscovered Frontier: Land Use and Resource Issues in the New West. Lanham, Maryland: Rowman and Littlefield Publishers, Inc., 2006.

Jenkins, Jeffrey. "Contested terrain of extractive development in the American West: using a regional political ecology framework to understand scalar governance, biocentric values, and anthropocentric values." *Journal of Political Ecology* 23 (2016): 182-196.

Juris, Frances. "Early History of the City of Prineville Railway." Last Modified Sept. 8, 2017. Accessed Oct. 8, 2017. http://crookcountyhistorycenter.org/2017/09/early-history-of-the-city-of-prineville-railway/.

Kadel, Steve. “Prineville Positioning for Viable Economic Future.” *Cascade Business News* 24, No. 12 (June 21, 2017): 17-18.

Kaika, Maria. *City of Flows*. New York: Routledge, 2005.

Karkaria, Urvaksh. New Georgia Facebook data center to be powered entirely by renewable energy. *Atlanta Business Chronicle* (March 7, 2018). Accessed 9 March 2018. https://www.bizjournals.com/atlanta/news/2018/03/07/new-georgia-facebook-data-center-to-be-powered.html.

Knight, Julia, and Alexis Weedon. Identity and social media. *Convergence* 20, 3 (2014): 257-258.

Kirk, Andrew. Free Minds and Free Markets: Counterculture Libertarians, Natural Capitalists, and an Alternative Vision of Wester Political Authenticity. In J. Roche (ed.), *The Political Culture of the New West*. Lawrence, Kansas: University Press of Kansas, 2008.

Kliazovich, Dzmitry, Pascal Bouvry, and Samee Ullah Khan. “GreenCloud: a packet-level simulator of energy-aware cloud computing data centers.” *Journal of Supercomputers* (November 9, 2010): 1-21.

Koomey, Johnathan G. “Estimating Total Power Consumption by Servers in the U.S. and the World.” PhD dissertation, Stanford University, 2007.

Koomey, Jonathon G. *Growth in data center electricity use 2005 to 2010*. El Dorado Hills, CA: Analytical Press, 2011.

Lapowsky, Issie. Tech Billionaires Take on Climate Change. *Wired* (November 30, 2015). Accessed 28 January 2018. https://www.wired.com/2015/11/zuckerberg-gates-climate-change-breakthrough-energy-coalition/.

Leed. “Water Efficiency at Facebook's Prineville Data Center.” Blog. Open Compute Project. (August 09, 2012). Accessed 30 November. http://www.opencompute.org/blog/water-efficiency-at-facebooks-prineville-data-center/.

Mahmoudi, Dillon and Anthony Levenda. Beyond the Screen: Uneven Geographies, Digital Labour, and the City of Cognitive-Cultural Capitalism. *tripleC* 14, 1 (2016): 99-120.

Malecki, Edward J. Digital development in rural areas: potentials and pitfalls. *Journal of rural studies* 19, 2 (2003): 201-214.

Marcuse, Herbert. *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society*, Boston: Beacon, 1964.

Marx, Karl. *Capital: A Critique of Political Economy*. Harmondsworth, U.K.: Penguin, 1976.

Marx, Karl. *Capital, Volume III*. London: Penguin Books, 1991.

Maxwell, Richard and Toby Miller. *Greening the Media*. New York: Oxford University Press, 2012.

Messersmith, James. "Managing work-life conflict among information technology workers." *Human Resource Management* 46, No. 3 (Fall 2007): 429-445.

McCarthy, James. First World political ecology: lessons from the Wise Use movement. *Environment and Planning A* 34, (2002): 1281-1302.

McDuff, Erin. "Prineville Opens Wetlands, Environmentally-friendly Wastewater Treatment Plant in Earth Day Celebration." USDA. (April 28, 2017). Accessed 30 November 2017. https://www.rd.usda.gov/newsroom/news-release/prineville-opens-wetlands-environmentally-friendly-wastewater-treatment-plant.

McLaughin, Kathleen. Apple plans to expand Prineville data center: New treatment plant to cover computing giant's water use. *The Union Democrat* (2017). Accessed December 17, 2017. http://www.uniondemocrat.com/newsroomstafflist/4467272-153/apple-plans-to-expand-prineville-data-center.

Miller, Rich. Facebook Unveils Major Data Center Campus Expansion in Prineville. Data Center Frontier. (12 December 2017). Accessed December 20, 2017. https://datacenterfrontier.com/facebook-unveils-major-data-center-campus-expansion-in-prineville/.

Mills, Randall V. "Prineville's Municipal Railroad in Central Oregon." *Oregon Historical Quarterly* 42, No. 3 (Sept. 1941): 256-262.

Monstadt, Jochen. Conceptualizing the political ecology of urban infrastructures: Insights from technology and urban studies. *Environment and Planning A* 41, 8 (2009): 1924–1942.

National Grid. Managing Energy Costs in Grocery Stores. (2002). Accessed 30 November 2017. https://www9.nationalgridus.com/non_html/shared_energyeff_groceries.pdf

National Grid. Managing Energy Costs in Colleges and Universities. (2013). Accessed 30 November 2017. https://bea.touchstoneenergy.com/sites/beabea/files/PDF/Sector/Colleges-Universities.pdf.

Newell, Joshua and Joshua Cousins. The boundaries of urban metabolism: Towards a political–industrial ecology. *Progress in Human Geography* 39, 6 (2015): 702–28.

NRDC (National Resource Defense Council). Data Center Efficiency Assessment, Scaling Up Energy Efficiency Across the Data Center Industry: Evaluating Key Drivers and Barriers. Issue

paper. (August 2014). Accessed 30 November 2017. https://www.nrdc.org/sites/default/files/data-center-efficiency-assessment-IP.pdf.

O'Connor, Michael. Henrico county manager touts 'magical time in our county's history.' *Richmond Times Dispatch*. (8 December 2017). Accessed December 13, 2017. http://www.richmond.com/news/local/henrico/henrico-county-manager-touts-magical-time-in-our-county-s/article_199feee5-ddf0-5d28-8e02-c792f6ba08e1.html.

Olson, Brent. *Recreation Capital: Natural Resources, Amenity Development, and Outdoor Recreation in Bend, Oregon*. PhD Dissertation. Syracuse University, 2012.

Orr, William N. and Elizabeth L. Orr. *Geology of the Pacific Northwest, 2nd. Ed*. Long Grove, Illinois: Waveland Press, Inc., 2006.

Parks, Lisa and Nicole Starosielski. *Signal Traffic: Critical Studies of Media Infrastructure*. Chicago: University of Illinois Press, 2015.

Pedersen, Nathan. "Prineville." Oregon Historical Society (2016). Accessed November 5, 2017. https://oregonencyclopedia.org/articles/prineville/#.Wf95CdCnHIU.

Peterson, Michael P. Maps and the Meaning of the Cloud. *Cartographica: The International Journal for Geographic Information and Geovisualization* 50, 4 (2015): 238-247.

Pew Research Center. Mobile and Internet Fact Sheets. (January 12, 2017). Accessed 30 November 2017. http://www.pewinternet.org/fact-sheet/mobile/.

Philips, Sarah. "A brief history of Facebook." *The Guardian* (25 July 2007). Accessed December 12, 2017. https://www.theguardian.com/technology/2007/jul/25/media.newmedia.

Pickren, Graham. 'The global assemblage of digital flow': Critical data studies and the infrastructures of computing. *Progress in Human Geography* 42, 2 (2016): 225 - 243

Pickren, Graham. "The Factories of the Past are Turning Into the Data Centers of the Future." *Imaginations* 8, 2 (September 2017). Assessed October 1, 2017. http://imaginations.csj.ualberta.ca/?p=9954.

Purcell, Darren. The Internet. In Paul C. Adams, Jim Craine, and Jason Dittmer (eds.), *The Ashgate Research Companion to Media Geography*. Burlington: Ashgate Publishing Company, 2014.

Putman, Robert. *Our Kids: The American Dream in Crisis.* New York, NY: Simon & Schuster, 2015.

Quintana, Pedro. Prineville is ready for another Facebook boost. *NewsChannel 21, Central Oregon*. (12 December 2017). Accessed December 13, 2017.

http://www.ktvz.com/news/facebook-announces-big-prineville-data-center-expansion/671786175.

Rainie, Lee. “Digital Divides – Feeding America.” Pew Research Reports (February 2017). Accessed November 4, 2017. http://www.pewinternet.org/2017/02/09/digital-divides-feeding-america/.

Rana, Shobhit and Kate Brandt. Circular economy at work in Google data centers. Ellen Macarthur Foundation (September 2016). Accessed 30 November 2017. https://static.googleusercontent.com/media/www.google.com/en//green/pdf/data-center-case-study.pdf.

Riebsame, W.E., J. Robb, H. Gosnell, and D.M. Theobald. *Atlas of the New West: Portrait of a Changing Region*. New York: Norton, 1997

Ristic, Bora, Kaveh Madani, and Zen Makuch. The Water Footprint of Data Centers. *Sustainability* 7 (August 2015): 11260-11284.

Robbins, Paul, Katherine Meehan, Hannah Gosnell, and Susan J. Gilbertz. Writing the New West: A Critical Review. *Rural Sociology* 74, 3 (2009): 356–382.

Robbins, William G. “Creating a 'New' West: Big Money Returns to the Hinterland.” *Montana: The Magazine of Western History* 46, No. 2 (1996): 66-72.

Robbins, William G. *Oregon: This Storied Land*. Washington: Washington University Press, 2005.

Rogoway, Mike. Apple's newest innovation: Wastewater treatment to cool Prineville data centers. The Oregonian. (12 June 2016). Accessed December 17, 2017. http://www.oregonlive.com/silicon-forest/index.ssf/2016/06/apples_newest_innovation_waste.html.

Rome, Adam. The Ecology of Commerce: Environmental History of the Challenge of Buliding a Sustainable Economy. In Berghoff, H. and Rome, A. (eds). *Green Capitalism?* Philadelphia, Pennsylvania: University of Pennsylvania Press, 2017.

Rothman, Hal. Devil’s Bargains: Tourism in the Twentieth-Century American West. Lawrence, Kansas: University of Kansas Press, 1998.

Scott, Allen. *Social Economy of the Metropolis: Cognitive-Cultural Capitalism and the Global Resurgence of Cities*. Oxford; New York: Oxford University Press, 2009.

Scott, Allen. Beyond the Creative City: Cognitive–Cultural Capitalism and the New Urbanism. *Regional Studies* 48, 4 (2014): 565-578.

Selyukh, Alina. “Cities Try Convincing Amazon They're Ready For Its New Headquarters.” *National Public Radio*. Last Modified Sept. 18, 2017. Accessed Nov. 11, 2017. http://www.npr.org/sections/alltechconsidered/2017/09/18/551773552/cities-try-convincing-amazon-they-re-ready-for-its-new-headquarters.

Shevory, Kristina. “Cultivating Server Farms.” *The New York Times* (25 October 2006). Accessed December 12, 2017. http://www.nytimes.com/2006/10/25/realestate/commercial/25server.html.

Singh, Katar. *Rural Development Principles, Policies, and Management*. New Delhi: Sage Publications, 1986.

Smith, Laila. 2001. The urban political ecology of water in Cape Town. *Urban Forum* 12(2): 204-224.

Smith, Neil. Forward. In Nik Heynen, Maria Kaika, and Erik Swyngedouw (eds.), *In the Nature of Cities*. New York, New York: Routledge, 2006.

Spaen, Brian. “Facebook To Create Second-Biggest Wind Farm In Nebraska.” *Greenmatters*. (October 30, 2017). Accessed 30 November 2017. http://www.greenmatters.com/news/2017/10/26/Z1wsUWN/facebook-second-biggest-wind-farm-nebraska.

Starosielski, Nicole and Janet Walker. *Sustainable Media: Critical Approaches to Media and the Environment*. New York: Routledge, 2016.

Stoycheff, Elizabeth. Under Surveillance: Examining Facebook’s Spiral of Silence Effects in the Wake of NSA Internet Monitoring. *Journalism & Mass Communication Quarterly* 93, 2 (June 2016): 1-16.

Streep, Abe. How Big Data Saved the Mountain Town. *Outside* (August 4, 2017). Accessed 4 January 2018. https://www.outsideonline.com/2231051/living-cloud.

Sverdlik, Yevgeniy. Facebook to Build Two More Massive Data Centers in Oregon. Data Center Knowledge. (12 Dec 2017). Accessed December 13, 2017. http://www.datacenterknowledge.com/facebook/facebook-build-two-more-massive-data-centers-oregon.

Swyngedouw, Erik. *Social Power and the Urbanization of Water: Flows of Power*. Oxford, UK: Oxford University Press, 2004.

Taylor, Joseph E. The Many Lives of the New West. *Western Historical Quarterly* 35, 2 (2004): 141–65.

Terdiman, Daniel. “Your Yearly Facebook Usage Has a Lower Carbon Footprint Than a Latte.” *Fast Company*. Last Modified June 28, 2017. Accessed October 1, 2017.

https://www.fastcompany.com/40435847/your-yearly-facebook-usage-has-a-lower-carbon-footprint-than-a-latte.

The Breakthrough Institute. History. The Breakthrough Institute (2016). Accessed 28 January 2018. https://thebreakthrough.org/about/history/.

Travis, William. *New Geographies of the American West: Land Use and the Changing Patterns of Place*. Washington D.C.: Island Press, 2007.

U.S. EIA (United States Energy Information Administration). Oregon: State Profile and Energy Estimates (16 November 2017). Accessed December 16, 2017. https://www.eia.gov/state/?sid=OR#tabs-1.
Villarino, Javiera and Xavier Font. Sustainability marketing myopia: The lack of persuasiveness in sustainability communication. *Journal of Vacation Marketing* 21, 4 (2015): 326–335.

Véron René. Remaking urban environments: The political ecology of air pollution in Delhi. *Environment and Planning A* 38, 11 (2006): 2093–2109.

Wainwright, Joel. The geographies of political ecology: after Edward Said. *Environment and Planning A* 37 (2005):1033- 1043.

Walker, Peter A. Reconsidering 'regional' political ecologies: toward a political ecology of the rural American West. *Progress in Human Geography* 27, 1 (2003): 7–24.

Walker, Peter A. Political ecology: where is the ecology? *Progress in Human Geography* 29, 1 (2005): 73-82.

Warf, Barney. Spaces of Telemediated Sociability. In Paul C. Adams, Jim Craine, and Jason Dittmer (eds.), *The Ashgate Research Companion to Media Geography*. Burlington: Ashgate Publishing Company, 2014.

Wachsmuth, David. 2012. Three Ecologies: Urban Metabolism and the Society-Nature Opposition. *The Sociological Quarterly* 53 (2012): 506–523.

Webster, Frank. Information, Capitalism, and Uncertainty. *Information, Communication & Society* 3, 1 (2000): 69-90.

Whitacre, Brian E. and Brandford F. Mills. Infrastructure and the Rural-Urban Divide In High-Speed Residential Internet Access. *International Regional Science Review* 30, 3 (July 2007): 249–273.

Whitehead, Beth, Deborah Andrews, Amip Shah, and Graeme Maidment. "Assessing the environmental impact of data centres part 1: Background, energy use and metrics." *Building and Environment* 82, (August 2014): 151-159.

Widmer, Rolf, Heidi Oswald-Krapf, Deepali Sinha-Khetriwal, Max Schnellmann, and Heinz Böni. Global perspectives on e-waste. *Environmental Impact Assessment Review* 25, 5 (2005): 436-458.

Wilkerson, Michael. *Prineville Data Center Economic and Fiscal Impact Study, Executive Summary*. ECONorthwest, 2014.

Wirtenberg, Jeana, William G. Russell, and David Lipsky. The Sustainable Enterprise Fieldbook: When it All Comes Together. American Management Association. New York, New York: AMACOM, 2009.

Wilson, Kenneth R., Jennifer S. Wallin, and Christa Reiser. "Social Stratification and the Digital Divide." *Social Science Computer Review* 21, No. 2 (Summer, 2003): 133-143.

Winkler, Richelle, Donald R. Field, A. E. Luloff, Richard S. Krannich and Tracy Williams. "Social Landscapes of the Inter-Mountain West: A Comparison of 'Old West' and 'New West' Communities." *Rural Sociology* 72, No. 3 (2007): 478–501.

Zook, Matthew. The Geographies of the Internet. *Annual Review of Information, Science, and Technology* 40 (2006): 53–78.

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Syracuse University Department of Geography
Advisor: Dr. Jane Read

- Conducted research on Onondaga Lake and spatial storytelling; Reviewed and edited labs for future classes.

Howard Hughes Medical Institute (HHMI) Fellowship (Senior Honor's Thesis) 6/2015-12/2015
Gettysburg College Department of Environmental Studies
Advisor: Dr. Sarah Principato

- Conducted independent research; Used ArcGIS and Google Earth to conduct quantitative analyses of cirques on eastern Iceland; Fieldwork in Iceland (summer 2015) completed for ground-truth analyses of glacial landforms. Results were presented at GSA in Baltimore, MD (11/2015).

Undergraduate Research Assistant 2/2013-1/2014
Gettysburg College Department of Environmental Studies
Advisor: Dr. Sarah Principato

- Quantified streamlined glacial landforms and geology of northern Iceland by analyzing aerial photos and mapping with ArcGIS.

Undergraduate Research Assistant
Gettysburg College Department of Environmental Studies
Advisor: Dr. Rutherford Platt

- Developed and analyzed maps in ArcGIS to study land-cover changes in India based on the relocation of native tribes outside of a national park.

TEACHING EXPERIENCE

Teaching Assistantship 1/2018-5/2018
Course: Global Environmental Change
Instructor: Dr. Sherburne Abbott, Syracuse University Dept. of Geography

- Teach students about Global Environmental Change through leading discussion sections classes each week.

- Assign and grade student work; meet with students individually to review and explain course material.

Teaching Assistantship 8/2017-12/2017
Course: Human Geographies
Instructor: Dr. Tod Rutherford, Syracuse University Department of Geography

- Teach students about selected topics in Human Geography through leading discussion sections classes each week.

- Assign and grade student work; aid students with coursework outside of class periods.

Teaching Assistantship 1/2017-5/2017
Course: Environmental Applications of Remote Sensing
Instructor: Dr. Jane Read, Syracuse University Department of Geography

- Prepare laboratory exercises to introduce undergraduate and graduate students to remote sensing and its real-world applications; run weekly laboratory sessions.

- Meet with students on an individual basis to review and explain course and lab material; grade course assessments.

PROFESSIONAL EXPERIENCE

Recycling and Sustainability Intern 5/2013-6/2015
Gettysburg College Facilities Services Department
Supervisor: Ruth Miller

- Educated incoming and current students about college recycling programs, attended meetings with Facilities Services directors/supervisors, updated website, created advertisements, researched sustainability efforts, completed a GHG assessment and STARS report on a semi-annual basis.

CONFERENCES, PROFESSIONAL MEETINGS & CONTINUING EDUCATION

Geography Colloquia Series	8/2016-5/2018
AAG Annual Meeting	4/2018
47th Annual International Arctic Workshop	3/2017
Northeast GSA	3/2016
GSA International Conference	11/2015
Howard Hughes Medical Institute Brown Bag Lunch Series	5/2015-7/2015

SKILLS AND VOLUNTEERISM

Research: Quantitative field sampling experience in terrestrial, freshwater, and marine systems including quadrats, transects, and plotless techniques; Qualitative interviews with local officials and residents; Statistical experience with regressions, parametric, and non-parametric tests; Spatial analyses and mapping; rock and mineral identification; Stream gauging and nutrient analysis; Morista's and Holgate Indexes
Computer: ArcGIS, Google Earth, ENVI, Microsoft Excel, Powerpoint, Word, and Publisher
Miscellaneous*:* Basic Graphic Design, Photography, and Textile Art; Music-Cello, Ukulele, Mandolin, Singing; Intermediate French (reading, writing, speaking*)*
Community Service/Volunteer Work: SICM Food Pantry (2016); Summer Lunch/Edible Playgrounds Program Schenectady, NY (2015); First Year Orientation/ GIV Day (2015); The Gleaning Project of South Central PA (2013); ACOFA, Gettysburg, PA (2013-2015)
Mission Trips: Dulac, Louisiana (2010)**,** Toronto, Canada (2011), and Santo Domingo, Dominican Republic (2012).