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ENVIRONMENTAL SCIENCE AND POLICY MASTER'S PORTFOLIO

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NATHANIEL K. LAPIDES

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A MASTER'S PORTFOLIO

Submitted to the faculty of Clark University, Worcester,

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and Environment

And accepted on the recommendation of

Frederick T. Greenaway, Ph.D., Chief Instructor

SUMMARY

ENVIRONMENTAL SCIENCE AND POLICY MASTER'S PORTFOLIO

NATHANIEL K. LAPIDES

The following Environmental Science and Policy Master's Portfolio is a compilation of works completed individually and with peers in order to fulfill requirements for the Master of Science degree. These works demonstrate breadth, depth, and the interdisciplinary nature of the course of study. As an undergraduate student at Clark University I studied Environmental Science with a concentration in Earth Systems Science. I was interested in learning about the natural world and wanted to develop a deeper connection to it. Inevitably, I was exposed to courses that examined the causes and effects of global climate change and this topic became my passion. The Environmental Science and Policy program has provided an opportunity to shift my focus from deepening my understanding of the questions about how, and why the climate is changing, to advancing my knowledge of what should come next. As a whole, I have focused my efforts on environmental policy and how businesses can respond to environmental issues such as global climate change. The following describes the interdisciplinary works contained in this portfolio, the skills and learning outcomes achieved, and how the individual projects, papers, and reports connect coherently.

The first paper titled "Hydraulic Fracturing and Climate Change" was a final cumulative group project for Climate Change, Energy, and Development. It focused on investigating the environmental and climate implications of the process of hydraulic fracturing. We focused our research on developing a critical analysis of the process that had been considered as a possible bridge to aid the energy sector in transitioning to lower carbon generation. This paper touched on

many of my academic interests including the energy sector, climate change, and externalities impacting human and environmental health. In the paper titled "A Review of the 'Early Anthropogenic Hypothesis'" I researched a fascinating hypothesis that had been discussed in Climate System and Global Environmental Change class by conducting a literature review and analyzing ice core data that had not been considered in the literature. The "Water pollution from pharmaceutical products in waters: A policy case study" was one of three short assignments completed for United States Environmental Pollution Policy. In this paper I examined a significant policy gap in the United States that could have negative impacts on environmental and human health and concluded by presenting a couple brief policy recommendations. In "A Critical Analysis of Well-being, Consumption and Growth within New York City's OneNYC Plan for a Strong and Just City" my peers and I researched the extensive and ambitious plan that New York City has developed as a final project for a Sustainable Consumption and Production. We critically analyzed this plan while keeping in mind the existing socio-technical regime that exists across this country and its implications for increased sustainability. "Traditional Medicinals®: a sustainability infusion" is a case study completed for Green Business Management. I identified a company that aligned with my own thoughts and feelings about sustainability, analyzed their operations, and made recommendations that would allow them to further reduce their environmental impacts and be a better company. The second to last item included is the "IDCE Internship Report". This was created after a summer of full-time employment as an intern at the National Grid Sustainability Hub. This experience was tremendous in that it exposed me to an industry that I am interested in for future employment and allowed me to gain hands-on experience. I had numerous roles and responsibilities related to the operation of the hub and helping to ensure the success of the Smart Energy Solutions smart grid

modernization program in the city of Worcester. The "Determinants of National Football League ticket prices" was the only work that did not aim to examine something related directly to my academic focus. Instead, in this paper I chose to research an economic topic that allowed me to practice multivariate regression analysis methodology that I had learned in Intermediate Quantitative Methods class.

This portfolio highlights some of the products that resulted from the diverse coursework and practical internship experience gained through my program. I will depart my formal training at this university with a solid understanding of the most complex and pressing issue of our time—global climate change—and with the tools and expertise necessary to work to mitigate it and adapt to its effects.

ACADEMIC HISTORY

Name (in Full): Nathaniel K. Lapides Date: 25 March 2016

Baccalaureate Degree: Bachelor of Arts in Environmental Science, magna cum laude

Source: Clark University Date: 17 May 2015

TABLE OF CONTENTS

Title:

Hydraulic Fracturing and Climate Change

Course:

EN 207 - Climate Change, Energy, and Development

Description and notes:

This final cumulative project for Climate Change, Energy, and Development focused on investigating the environmental implications of the process of hydraulic fracturing. This work was also presented to our class.

Hydraulic Fracturing and Climate Change

Ethan Forauer
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En 207: Climate Change, Energy, and Development
Professor Trencher
December 9th 2014

1. Introduction

As time passes, it is becoming more and more clear that climate change is a real, tangible threat. It is also widely understood that many practices that have been in place for years, such as the combustion of fossil fuel for energy, are not sustainable. As such, the search has begun for a bridge fuel, bridging our energy dependence from fossil fuels to renewable sources. It is important for us to find and utilize a bridge fuel since our days with oil are numbered, but the technology for widespread use of renewables is not yet in place.

Hydraulic fracturing, or, fracking, is the process of drilling and injecting water into the ground at very high pressure to fracture shale rocks to release natural gas inside ("Dangers of Fracking" 2014). Fracking is a key technology for the extraction of natural gas, but has become a political and ethical "flashpoint", because of its accused shortcomings (Honberg 2012). Nevertheless, it is viewed as a key player in the United States' goal to achieving energy independence.

Fracking has been around for decades, however, it was not widely used until the early 21st century. The first fracking experiment took place in the Hugoton gas field of southwestern Kansas in 1947 (Montgomery 2014). While this experiment was not prolific, the Halliburton Oil Well Cementing Company realized the potential of the technique and submitted for a patent, which was granted in 1949 (Montgomery 2014). In the early 21st century, energy companies around the country started investigating the potential locked up deep in the shale fields of Pennsylvania, West Virginia, Maryland, and Texas ("A Brief History" 2014). Shale fields are areas of fine, sedimentary rock that can be sources of oil and gas and are of interest because of their low permeability and high porosity. This allows for relatively easy access to the natural gas inside. There are two methods of fracking- horizontal and vertical. Horizontal involves drilling vertically first, then horizontally. Vertical involves drilling only vertically. Horizontal is the most widely used method, but is also the most controversial.

Currently in the United States, fracking has become increasingly popular. In just five years, fracking grew from 4% to 25% of the US supply of natural gas (Schrag 2012). Additionally, shale gas

reserves have increased six fold since 2007, from under 25,000 billion cubic feet (BCF) in 2007 to nearly 160,000 BCF in 2013 (EIA 2014; see figure 1 in Appendix).

For these reasons it is becoming increasingly important to research the process of fracking and determine the impacts of continued growth and reliance on this industry. As such, a pertinent question must be answered: in light of global climate change, is hydraulic fracturing, and the subsequent burning of natural gas, a viable bridge from carbon intensive fossil fuels to renewable technologies? We will be looking at fracking from three different lenses: its impact on climate change, the environment and health, and policy.

2. Hydraulic Fracturing and Climate Change

2.1 Energy Sector and Greenhouse Gas Emissions

The energy sector is the largest contributor to global greenhouse gas (GHG) emissions (Bruckner et al. 2014). In the United States specifically, the combustion of natural gas is responsible for a full quarter of GHG emissions. Although the production of traditional natural gas in the United States fell by 39% from 1990 to 2009, the unconventional natural gas production, which includes the fracking process, has picked up. By 2035, shale gas obtained via fracking processes is expected to make up approximately half of all natural gas production in the United States (Hou et al. 2012).

2.2 Hydraulic Fracturing and GHG Footprint

Although the process of fracking to extract shale gas from the Earth is not new, there is a controversy regarding the total GHGs emitted from this method of natural gas extraction. Without taking extraction methods into consideration, one of the climatic benefits of natural gas is that when combusted, emissions are 45% less than coal, the fossil fuel that is has been predominantly replacing in the United States (Hou et al. 2012). One study investigated the total GHG footprint of shale gas by taking into account the "direct emissions of CO_2 from end use consumption, indirect emissions of CO_2 from fossil fuels used to extract, develop, and transport the gas, and methane fugitive emissions and venting" (Howarth et al. 2011). A major claim of this study is that methane leakage occurs during the life cycle of the average shale gas well in the magnitude of 3.6 to 7.9% of total volumetric well production (Howarth et al. 2011). Most

of this leakage is said to occur after the well has undergone fracking and brine and water are able to escape the well. This leakage estimation is greater than the 1.7 to 6% of the "life-cycle methane emissions" estimated for conventionally extracted natural gas (Howarth et al. 2011). This study concludes that substituting shale gas for other fossil fuels such as oil and coal would not help mitigate the effects of climate change.

Daniel P. Schrag of Harvard University debates the findings of Howarth et al. (2011) in his 2012 article. Schrag states that there is a good deal of controversy surrounding the findings of the study, and he backs his claim with an argument related to the global warming potentials (GWPs) and global temperature potential (GTPs) of fossil fuels. The time period chosen determines the GWP of particular GHGs because gases have unique residence times in the atmosphere. Although methane has a much greater potential for warming in the short-term, it stays in the atmosphere for a shorter time period compared to carbon dioxide. Schrag argues that GWP is not an extremely useful metric because when a 500-year time scale is taken into account, methane has a GWP of 8, while a shorter 20-year time scale calculates methane's GWP as 70 times that of carbon dioxide. According to Schrag, GTP should be used because it relies on climate models rather than just the amount of radiative forcing caused by emissions. Methane's GTP for a 20-year time scale is a full fifteen times lower than for GWP (Schrag 2012). Additionally, studies show cumulative emissions over a century, not the rate of emissions, are most important for the climate response to GHG emissions (Matthews et al. 2009). The disparity that exists between GTP and GWP makes it difficult to compare the importance of certain fossil fuel related emissions in causing global climate change.

Despite contentions over the GWP of methane, Schrag's main argument regarding hydraulic fracturing and shale gas is not about whether the production and combustion of additional natural gas extraction would mitigate or exacerbate climate change. Instead it has to do with how the availability of relatively cheap natural gas affects investment in the "research, development, and deployment of truly low-carbon technologies" such as renewable energy and carbon sequestration (2012). Additionally, he claims that the true benefit of increased natural gas production could be that it takes power away from the coal industry. A weakened coal industry would have less political might and would be less likely to dictate

energy policies that are in place in the United States (Schrag 2012). This, in turn, may allow for policies encouraging reductions in fossil fuel consumption and increases in renewable energy, eventually reducing the need for the bridge fuel.

2.3 Hydraulic Fracturing and Renewable Energies

So far, the uncertainty surrounding the total GHG footprint of shale gas and fracking has made it difficult to make a conclusive statement about whether it is a more environmentally friendly fossil fuel than coal (Howarth et al. 2011; Schrag 2012). There are other concerns associated with having access to a cheap and abundant fossil fuel such as natural gas. Natural gas could negatively impact the research and development of renewable energy technologies such as wind and solar power. With the goal of minimizing cumulative GHG emissions in mind, renewable energy technologies will have to play a much larger role in the production of energy in the future. Eventually, renewable energies will likely have to dominate the energy industry in order to reach a zero, or near-zero GHG emissions scenario. Low prices on natural gas in the United States would most definitely delay the development and expansion of renewable energy technologies. And although an expansion of natural gas production and consumption in the United States would reduce our dependence on coal, any short-term emissions reductions would likely be cancelled out in the long term by restricting the growth of low carbon renewable energy technologies (Schrag 2012).

3. Environmental Impacts of Hydraulic Fracturing

3.1 Water Consumption

The process of fracking is incredibly resource intensive, requiring upwards of one to eight million gallons at each fracking well. At over 500,000 wells in the United States alone, an excessive amount of water is consumed. The next step is to mix the water with sand and chemicals to create the fracking fluid, which is injected into the wells. There are 600 different chemicals used, depending on the state and environmental regulations. These chemicals range from lead and mercury, to formaldehyde and hydrochloric acid. Approximately 40,000 gallons of chemicals are used at each well ("Dangers of Fracking" 2014). Adding this all up, given our current use of the technique, we require 72 trillion gallons of water and

360 billion gallons of chemicals to run our current gas wells. During this process, the chemical filled fracking fluid can leach into groundwater, contaminating it with hundreds of known carcinogens and other chemicals that are harmful to human and ecosystem health. Current data estimates that only 30-50% of the fracking fluid is recovered after the process, leaving the remaining 50-70% in the ground ("Dangers of Fracking" 2014).

Over 90% of fracking fluid is comprised of water, in addition to the 9% of sand and small percentage of additives used (Haluszczak et al. 2013). However, the proportion of water and chemicals used to prepare the fracking fluid is variable and designed according to the well type and the geological characteristics of each target formation (Chen et al. 2014). For example, a coal bed methane well water requirements can range from 50,000 to 350,000 gallons per well, whereas a shale gas well requires about 2 to 4 million gallons of water (Chen et al. 2014). These differences in water usage for both well types can be attributed to the length of the well.

The fracking industry argues that the water used in hydraulic fracturing is insignificant compared to the total annual water withdrawn. In 2010, over 355 billions of gallons of water were withdrawn for various uses in the US – primarily for thermoelectric power, irrigation, and public supply (Alpern 2014; See Figure 2). In comparison to these human activities, the water usage for fracking purposes does not appear to be significant. However, shale gas rigs are typically situated in dry and remote areas, thus water consumption in these areas for the purpose of fracking can deplete water stressed regions of their water supply for human, crop, and livestock use. Texas for example, is a state with a wet and dry season. In a time frame of 3 years from 2008 to 2011, the total water use for fracking in Texas increased by from 36,000 acre feet (AF) (0.04 cubic kilometers) to 81,500 AF (0.01 cubic kilometers). As a result, fracking expanded into drier parts of the state, adapted to the new conditions by decreasing its fresh-water consumption, and increasing their amount of recycled water (Chen et al. 2014).

While water withdrawals could directly affect the availability of water, it may also inadvertently affect the water quality. Withdrawals of large volumes of water can impact groundwater quality by mobilizing naturally occurring substances and exposing naturally occurring minerals to an oxygen-rich

environment, which can lead to chemical changes that affect mineral solubility and mobility. In addition, vast water withdrawals can promote bacterial growth, which can cause taste and odor problems, and it can mobilize lower quality of water from surrounding areas (US EPA 2011).

3.2 Water Contamination

One of the main concerns against fracking is the issue of groundwater chemical contamination. Water contaminations can arise as a result of flow back and surface spills, in addition to leaks through geological structures – either natural or artificial cracks. However, studies have shown that water contamination is a result from well leaks due to inadequate cementing rather than fracking itself. In a study performed by Thomas H. Darrah from the University of Utah, Darrah collected various water samples from Pennsylvania and Texas and identified the mechanisms that caused the elevated hydrocarbon concentrations in drinking water by using noble gas and hydrocarbon tracers. Researchers found no evidence that fractured shale led to water contamination. On the other hand, they concluded the cement used to seal the outside of the vertical wells was at fault (Darrah et al. 2014). Failure to properly seal wells can allow contaminants to travel up the wellbore into aquifers that provide drinking water.

The chemicals used in the fracking fluid are hazardous. Between 2009 and 2010, 630 environmental health and safety violations were reported from the 4,000 gas wells in Marcellus Shale in Pennsylvania and half were associated with leaks and spills of the flow back fluids (Rozell and Reaven 2012). BTEX, an acronym that stands for benzene, toluene, ethylbenzene, and xylene, are all chemicals present in fracking fluid. In the event of a surface spill, BTEX can pass through soil into the groundwater after spills (Rozell and Reaven 2012). In 2013, Gross and Associates assessed spills in Weld County, Colorado by collecting groundwater samples on/near multiple spill sites prior to or after remediation. Over 90% of the groundwater samples collected contained benzene concentrations well above their maximum contaminant levels (MCLs), whereas 30% of samples contained toluene (Gross et al. 2013).

3.3 Air Pollutant Emissions

The toxic and mutagenic natures of the fracking additives pose a health hazard to the public health. In 2009, Mayor Calvin Tillman from Dish, Texas received numerous health-related and death of livestock complaints and commissioned Wolf Eagle Environmental to conduct an air quality study. The study confirmed "the presence in high concentrations of carcinogenic and neurotoxic compounds in ambient air and/or residential properties". Some of the compounds identified included benzene, xylene, carbon disulfide, naphthalene, dimethyl disulphide, methyl ethyl disulphide, and pyridine metabolites (Michaels et al. 2014).

3.4 Man-Made Earthquakes

It has long been understood that practices such as surface and underground mining, withdrawal of fluids and gas from the subsurface, and the injection of fluids into underground formations can induce earthquakes (Ellsworth 2014). However, the occurrence of earthquakes with a magnitude 3.0 or higher has increased dramatically over the past years within the central and eastern United States since 2001 (Ellsworth 2014; See Figure 3). The rapid increase in seismicity raised the question whether the increase in earthquakes was natural or man-made. In a study led by US Geological Survey scientist William Ellsworth, USGS scientists analyzed the changes in the rate of earthquakes in central and eastern United States and found a correlation in locations with an increase in seismicity and the injection of wastewater in deep disposal wells (USGS 2014). In another study led by Katie Keranen from Cornell University, four of Oklahoma's wastewater wells were linked to the 2,547 small earthquakes near Jones, Oklahoma (Keranen 2001).

The injection of fluids into underground formations as part of the fracking process induces micro earthquakes in the order of 1-3 on the Richter scale due to the fact that the injected fluid increases the underground pore pressure and weakens preexisting faults (Ellsworth 2014). The weakened faults are then more likely to slip and release the stored stress built up at the fault line, which could potentially result in a more damaging earthquake (Ellsworth 2014).

4. Fracking from a Policy and Legal Lens

The third lens we will be using to investigate the use of fracking as a bridge technology are environmental policies. While there are several policies aiming to control fracking, whether or not they are strict enough is questionable. There are large loopholes in all relevant policies, which are closely related to the entire technique, from technology to extraction. As such, we believe that the current policies are not strict enough to allow fracking, and the subsequent burning of natural gas, to continue to serve as a viable bridge technology.

When it comes to fracking, there are numerous loopholes and exemptions from environmental laws and regulations. The first regulation is the Safe Water Drinking Act, or SWDA. The SWDA was enacted in 1974 to mandate regulation of underground injection activities to protect groundwater resources. In 2005, Congress passed the Energy Policy Act. This act amended and legally changed the definition of "underground injection". This change specifically excluded, "the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities". As a result, oil and gas companies can now inject anything, except diesel, in conjunction with fracking operations without having to comply with SDWA provisions ("Environmental Defense Center" 2014).

Next, the Clean Water Act was enacted in 1972 and is the primary law in the United States regulating water pollution. When it comes to storm water discharge regulations, oil and gas drilling production activities are exempt. Additionally, the aforementioned Energy Policy Act further broadened the exemption to include storm water discharge from oil and gas activities. This allows storm water runoff of chemicals and proppant from drilling activities into waterways, without penalty ("Environmental Defense Center" 2014).

Following the devastating chemical explosion of 1984 in Bhopal, India, the Emergency Planning and Community Right to Know Act requires companies to disclose information related to location and quantity of chemicals stored, released or transferred to the public. However, oil and gas production chemicals and wastes are exempt from this regulation ("Environmental Defense Center" 2014).

The Resource Conservation and Recovery Act, or RCRA, was enacted in 1976 as a "cradle to grave" framework for managing and regulating the disposal of solid and hazardous wastes. In 1980, Congress exempted oil and gas exploration and production wastes from regulation as a result of the Solid Waste Disposal Act Amendment. This was to last for at least two years until the EPA completed a study to determine whether oil and gas wastes should be regulated as hazardous waste. In 1988, the study was finalized and it was concluded that regulation of hazardous oil and gas waste under the RCRA was unnecessary ("Environmental Defense Center" 2014).

One of the largest policies to this day is the Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA. Enacted in 1980, this policy created a framework for the cleanup of toxic materials and today is most well know by the Superfund program. Through a political compromise, the oil and gas industries were taxed to pay for the program and in exchange, were considered exempt from the regulations of CERCLA. This tax expired in 1985, yet both industries continue to enjoy exemptions ("Environmental Defense Center" 2014).

Finally, the Clean Air Act of 1970 was passed to regulate air pollution. Oil and gas production produces significant air pollution. Under this law, numerous small sources of air pollution, such as oil and gas extraction wells should be aggregated and treated as a major source, thus, subjecting them to more strict requirements. However, according to this law, oil and gas production activities are exempt from this aggregation and as such, have less strict requirements ("Environmental Defense Center" 2014).

Lawsuits surrounding fracking have been plentiful, however, the positive outcomes have not. After reviewing over a hundred court cases, ranging from Civil Tort Actions to Challenges to State and Federal Laws and Regulations, it is interesting to note that a lot the cases end in some type of consent decrees, or dismissal (Hydraulic Fracturing Case Chart 2014). A consent decree is a settlement of a lawsuit in which a person or company agrees to take specific actions without admitting fault or guilt for the situation that lead to the lawsuit (US Legal Definitions 2014). For example, in a case of Smith vs. Devon Energy Production Co, two individuals filed a lawsuit in federal court alleging that the activities of a natural gas drilling company polluted a well on their property. Plaintiffs alleged causes of action for trespass, nuisance,

negligence, fraud, and strict liability. After the case was reviewed, it was dismissed without prejudice (Hydraulic Fracturing Case Chart 2014). In another case, Tucker and Berry vs. Southwestern Energy Co, two class action lawsuits were filed on behalf of all residents living within three miles of wellheads or gas operations by defendant company. The plaintiffs allege that their water wells and groundwater were contaminated. The defendant required a more detailed statement. The parties were then left to reach a settlement. The court issued a judgment dismissing claims against the defendant (Hydraulic Fracturing Case Chart 2014).

Unless these regulations are tightened and fracking technology is improved to meet these standards, fracking cannot be considered an appropriate bridge technology. The multi-scale degradation that occurs for the extraction and combustion of natural gas outweighs the true benefits. As such, funds should be invested in improving the already existing renewable energy sources.

5. Conclusion

The findings discussed in this paper indicate that at present, with the current fracking operations, applicable policies, regulations, and environmental hazards, fracking should not be considered as an appropriate bridge from our fossil fuel based energy portfolio to a low carbon future. The uncertainty surrounding the GHG footprint of fracking makes it somewhat difficult to determine its potential impact on global climate change, making it a less desirable option than conventional natural gas extraction and production. Fracking alters the natural balance of the environment by depleting a region's water supply and introducing seismic activity to areas unfamiliar to earthquakes. In addition, the carcinogenic chemicals used put the public at risk of developing both short-term and long-term illnesses. Finally, we need tighter regulations and more research to ensure that fracking is not causing unnecessary harm to the environment. If such avenues are too expensive, it may be more worthwhile investing in improving the existing renewable energy sources.

6. Appendix

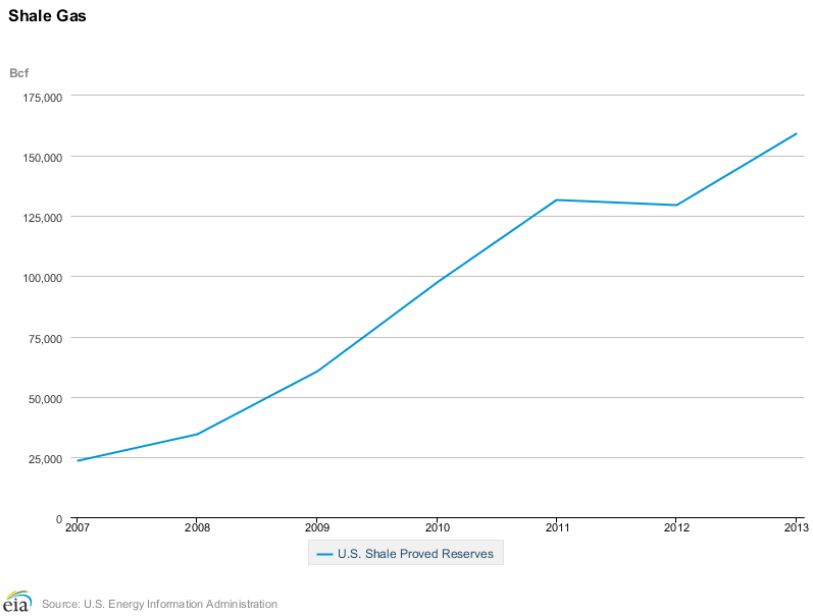

Figure 1. Displays proved shale gas reserves in the United States from 2007-2013. Obtained from the U.S. Energy Information Administration.

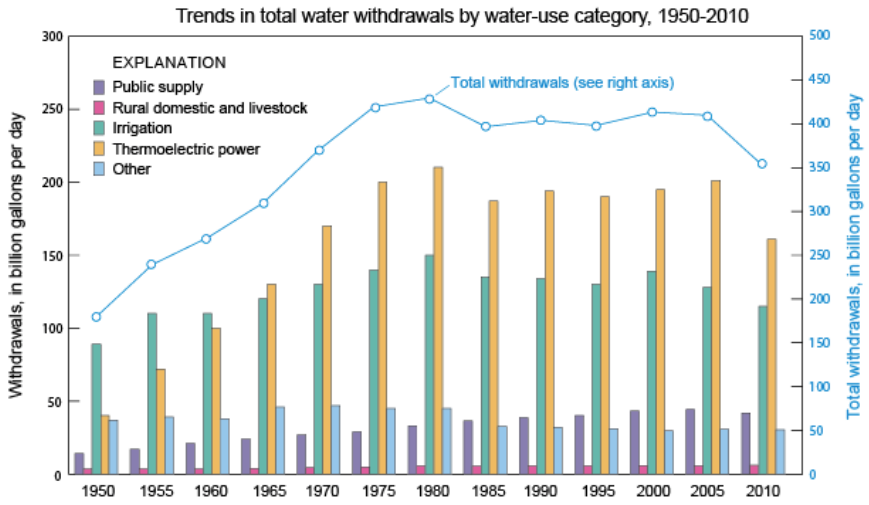

Figure 2. Trends in US total water usage, 1950-2010. Water withdrawn for thermoelectric power was the largest use nationally, followed by irrigation and public supply. All three utilize gallons of water in the billions on a daily basis. Obtained from the U.S. Geological Survey.

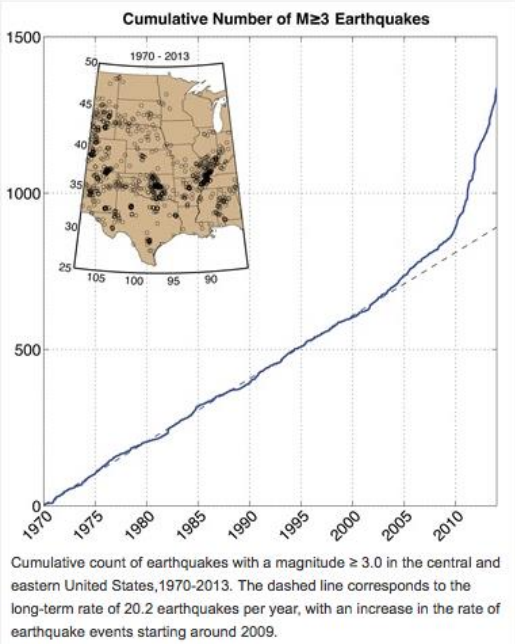

Figure 3. Total count of earthquakes with a magnitude greater than 3.0 in central and eastern US, 1970-2013. Central and eastern US experienced on average 20 earthquakes per year until 2009, where there was an increase in seismicity. Obtained from the U.S. Geological Survey.

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Title:

A Review of the “Early Anthropogenic Hypothesis”

Course:

Climate System and Global Environmental Change

Description and notes:

This project for Climate System and Global Environmental Change reviewed the “Early Anthropogenic Hypothesis” originally presented by William F. Ruddiman.

A Review of the "Early Anthropogenic Hypothesis"

Nathaniel K. Lapides

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Author Note

Nathaniel K. Lapides, B.A. Environmental Science expected May 2015, Clark University.

Special thanks to Professor Luke Trusel for providing an idea for a project topic and guidance.

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Abstract

In the past few decades it has become increasingly certain that humans are impacting Earth and causing changes in climate. These changes are being driven by increasing concentrations of greenhouse gases (GHGs) such as carbon dioxide (CO_2) and methane (CH_4) in Earth's atmosphere. Ever since the around the time of the industrial revolution (~1850), GHGs have been increasing drastically in atmospheric concentration, in ways that are unparalleled in Earth's paleoclimatic history. William F. Ruddiman first proposed the early anthropogenic hypothesis in 2003. The claim of this hypothesis is that early humans impacted GHGs and climate change, well before the era of the industrial revolution. He arrived at this conclusion by comparing the levels of GHGs during the most recent interglacial period to past interglacials. Increasing GHG levels during the time of early humans led Ruddiman to believe sources of anthropogenic land cover change (ALCC) such as deforestation for agricultural expansion were impactful enough to influence GHG concentrations in the atmosphere and climate change (Ruddiman, 2003). The overarching question that this project addresses is whether the early anthropogenic hypothesis is supported by the most recent ice core data for CO_2 and CH_4. This study is important because if humans have had this impact on the climate system in the paleoclimatic past, Earth may be overdue for glaciation and the climate may have entered the so-called Anthropocene epoch. Additionally, if so few humans could have caused such great changes in GHGs and climate in the past, what could an exponentially greater and more developed human population cause in the future?

Key words: Early anthropogenic hypothesis, global climate change, ice cores, paleoclimate, greenhouse gases

Literature Review

Ruddiman's early anthropogenic hypothesis claims that early agriculture and anthropogenic land cover change (ALCC) had a substantial impact on greenhouse gases (GHGs) and global climate change thousands of years ago (Ruddiman, 2014; 2007; 2005; 2003). The hypothesis is backed by some convincing evidence, but also has a number of criticisms and doubts. The original paper cited three main arguments backing its multi-part hypothesis. The first being that based on Earth-orbital influences such obliquity (axial tilt), eccentricity (shape of the ellipse of Earth), and precession (changing direction of Earth's axis), the increases in carbon dioxide (CO_2) and methane (CH_4) that began approximately 8,000 and 5,000 years ago respectively are anomalous and blatantly contrast the expected decreases that occurred previously during comparable interglacial time periods. The second part of the argument is that the explanations that currently exist attributing this anomalous trend to natural forcings have been proven invalid by paleoclimatic evidence. Lastly, Ruddiman cites geologic evidence of major ALCC towards using more of Earth's land around 5,000 and 8,000 years ago, corresponding to when GHG increases began (Ruddiman, 2003).

CH_4 concentrations follow a 23,000 year cycle with orbital based insolation changes. Orbital insolation changes impact the strength of tropical monsoons. As tropical monsoons become stronger, more CH_4 is released to the atmosphere because wetlands are flooded. The most recent CH_4 maximum occurred between 11,000 and 10,500 years ago, which coincides with the last insolation and monsoon maximum (Blunier et al., 1995 as cited in Ruddiman, 2003). CH_4 values had matched insolation decreases and were falling until 5,000 years BP, at which point they began to increase and deviate from the expected trend. The CH_4 increase observed at

around 5,000 years BP corresponds to the time that humans in southern Asia began irrigating to grow rice, and the continued increase in CH_4 corresponds with the expansion of rice production throughout other parts of Asia. All in all, this late Holocene CH_4 concentration trend is unexplained by previous paleoclimatic records from 350,000 years BP (Ruddiman, 2003) and the total anomaly when considering the observed value in comparison to the expected natural CH_4 concentration is approximately 230 parts per billion (ppb) (Ruddiman, 2007).

A similar unexpected and anomalous trend is present in CO_2 records as well. CO_2 is a very abundant greenhouse gas in the atmosphere (especially in comparison to CH_4) and thus has a relatively greater impact on the climate (Personal communication, L. Trusel, Fall 2014). Ruddiman (2003) explains that the trends in CO_2 are much more complicated than for CH_4 because it is impacted by all three orbital time scale effects (obliquity, precession, and eccentricity). According to paleoclimatic evidence, the amount of CO_2 in the atmosphere after reaching a peak interglacial should decrease. Ice core records from Antarctica show that initially this is the case during the last interglacial period, but rather than continuing to decrease as occurred during the three previous interglacial periods, the CO_2 concentration in the atmosphere began to increase around 8,000 years BP (Ruddiman, 2003). Overall, the anomaly in CO_2 is approximately 35 parts per million (ppm) when considering the levels that would be expected if natural forcings held complete control of CO_2 concentration during the late Holocene (Ruddiman, 2007).

The early anthropogenic hypothesis makes a couple of additional claims regarding what impacts humans may have caused to occur in the climate system during recent millennia. Ruddiman (2003 and 2007) mentions that the climate system may be overdue for glacial expansion. When taking into consideration the 35 ppm and 230 ppb anomalies observed for CO_2

and CH_4 respectively, mean global temperatures should increase approximately 0.75°C. However, due to the ice-albedo temperature feedback and other factors, the increase high latitude regions would be much larger, approximately 2°C. The magnitude of this warming may have cancelled out the "insolation-driven" cooling that otherwise would have been expected based on orbital changes. As a result, ice sheets may not have been able to grow in the northern hemisphere. An additional claim made by the early anthropogenic hypothesis is that the abrupt short-term decreases in CO_2 concentration during the past couple of thousand years may be a result of human species' large scale epidemics. The deaths of millions of people from a variety of major illnesses may have allowed land that had been cleared and farmed to be reforested, subsequently sequestering carbon from the atmosphere and lowering associated CO_2 levels. In Europe two major plagues that occurred late in the Roman Era and during medieval times correlate with decreases in CO_2 seen in Antarctic ice cores. Furthermore, the most prominent decrease in CO_2 observed from proxies occurred in the 1500s when Europeans first came in contact with indigenous peoples in the Americas and caused large scale mortality (Ruddiman, 2007).

The Ruddiman (2003) paper that first outlined the early anthropogenic hypothesis was contested by peers (Joos, Gerber, Prentice, Otto-Bliesner, and Valdes, 2004; Olofsson and Hickler, 2007). Ruddiman consequently wrote two responses to these critiques in which he further expanded upon his hypothesis and rebutted common arguments and doubts that had come about. The Ruddiman (2005) editorial article titled "The Early Anthropogenic Hypothesis a Year Later" responded to the claim made by Joos et al. (2004) that humans could not have burned enough forest biomass to reach the Joos et al. (2004) estimate of 550-700 billion tons of carbon released into the atmosphere to cause the CO_2 anomaly originally published by Ruddiman (2003)

of 40 parts per million (ppm). Ruddiman (2005) responds to this criticism by stating that most of the late-Holocene CO_2 anomaly may have been a result of processes other than biomass burning caused by humans. Ruddiman's original CO_2 anomaly has two parts. The first is the CO_2 rise that occurred in the most recent interglacial period but not previous ones, while the second part is the CO_2 fall that occurred during previous observed interglacial periods but not during the most recent one. In the four interglaciations before the Holocene, CO_2 values decreased between 30-45 ppm in the thousand years following the CO_2 maxima. However, during the Holocene this decrease did not occur. As such, Ruddiman (2005) proposes that direct carbon emissions from "anthropogenic (mostly agricultural) sources" accounted for a majority of the CH_4 and about a third of the CO_2 anomalies observed during the Holocene. As a result of these direct carbon emissions from humans, small ice sheets in the northern hemisphere did not grow and southern hemisphere sea ice around Antarctica did not advance as had occurred in the past. These resulting natural processes, triggered by humans through positive feedbacks, might have then been able to contribute the remaining portion of the CO_2 anomaly (Ruddiman, 2005).

Ruddiman (2005) also made his own critique of the Joos et al. (2004) paper which cites changes in terrestrial vegetation, ocean carbonate, and coral reefs as possible natural sources of carbon that together could account for the rise in CO_2 observed during the Holocene. The past few interglacials were very similar to the Holocene in terms of significant climate parameters and proxies; the major ice sheets melted, relatively high sea levels existed, interglacial boreal vegetation existed, and there was decreased tropical monsoon vegetation and similar insolation trends to the Holocene. Thus, Ruddiman's claim is that Joos et al. (2004) and other critics of early anthropogenic hypothesis would simulate similar increases in CO_2 during past intervals that simply did not occur.

Shortly after publishing an editorial, Ruddiman went on to release "The Early Anthropogenic Hypothesis: Challenges and Responses" in an effort to address the continued questions and critiques that had been made of his hypothesis (2007). He responds extremely comprehensively to questions of what the best insolation analog for the Holocene is, whether preindustrial agriculture is able to account for CH_4 and CO_2 anomalies, whether humans have effectively prevented a new glaciation from occurring on Earth, and whether pandemics contributed to decreases in atmospheric CO_2 (Ruddiman, 2007). In response to these questions Ruddiman (2007) concludes that the CO_2 and CH_4 anomalies are only approximately 35 ppm and 230 ppb, respectively, values that are 10% smaller than the originally proposed figures of 40 ppm and 250 ppb. Additionally he states that the CH_4 anomaly remains mostly explained by agricultural activities and climate feedbacks while the CO_2 anomaly remains 75% unexplained by the early anthropogenic hypothesis and its claims. This is admittedly the greatest uncertainty in the hypothesis. Although imperfect in explaining the majority of the CO_2 anomaly directly during the Holocene, the early anthropogenic hypothesis is defended continuously by Ruddiman and critics have been unable to definitively propose other more plausible hypotheses for the anomalous CO_2 and CH_4 trends observed via climate proxies.

Kaplan, Krumhardt, Ellis, Ruddiman, Lemmen, and Goldewijk (2010) studied the effects of ALCC on the carbon budget during the past 8,000 thousand years. Their study and simulations are based off of the assumption that land use per capita has changed over time rather than stayed constant. Land use per person has decreased with time as "populations increase, land availability per capita declines, technologies improve, and land use intensifies" (Kaplan et al., 2010). Two scenarios are used. The KK10 scenario assumes decreasing per capita land use with increasing population density through time, while the HYDE data base does not assume much change in per

capita land use through time. In the KK10 scenario, ALCC is much more "widely distributed" in regions that could support agriculture. The HYDE scenario conversely had a greater focus on "smaller, more concentrated areas of land clearance". The two scenarios disagree in terms of what the past impacts of humans on the Earth. The HYDE scenario assumes the world was nearly untouched by humans until around 3 thousand years BP. The KK10 scenario conversely makes different assumptions about the level of ALCC in the past. In comparing two contrasting scenarios they found that the scenario KK10 that modeled decreasing per capita land use with increasing population density "consistently produces higher levels of preindustrial ALCC" in comparison to the HYDE data set which assumes constant per capita land cover use. The geographic distribution of changes in carbon storage of land is another important aspect in modeling the ALCC and subsequent carbon emissions. For example, in some parts of the world that have relatively low levels of biomass such as grassland or savannas, a high level of ALCC would only cause a low level of carbon loss. While in other areas that are naturally forested and have greater amounts of biomass, a relatively small ALCC relates to a much larger carbon loss to the atmosphere (Kaplan et al., 2010).

In summary, there are a few main differences between the results of the HYDE and KK10 scenarios. The HYDE data set predicts lower cumulative carbon emissions throughout the past 8,000 years ranging from 137-189 Petagrams (Pg) carbon (C), and it simulates a great portion of these ALCC carbon emissions occurring just 500 years before the world began industrializing. The KK10 scenario predicts a much greater cumulative ALCC carbon emissions throughout the past 8,000 years of between 325 and 357 Pg C, and these emissions are simulated to have occurred more gradually throughout time. Both of these scenarios predict greater amounts of

ALCC carbon emissions during preindustrial times than previous studies had found. The previous estimates ranged from 48 to 153 Pg C (Kaplan et al., 2010).

The large amount of difference between the two ALCC data sets in this study, and the previous studies examining ALCC carbon emissions, highlight how much uncertainty and disagreement still exists about how much carbon preindustrial human populations could have possibly managed to emit. ALCC models that take into account "land use intensification" in response to population pressure and improvements in agricultural technologies depict much greater amounts of ALCC carbon emissions during preindustrial times than do those that consider land use to be relatively constant throughout time (Kaplan et al., 2010).

Data and Methods

Data

The data for this study were obtained from climate studies analyzing GHG concentrations in ice core climate proxy records. These ice core records are from the Vostok ice core (Barnola, et al., 1987; Chappellaz, et al., 1990), the Taylor Dome ice core (Indermühle, et al., 1999; Brook, et al., 2000), the GISP2 ice core (Brook et al., 2000), and the European Project for Ice Coring in Antarctica (EPICA) Dome C ice core (Lüthi, Le Floch, et al., 2008; Loulergue, et al., 2008) [see reference list for complete original citations]. All of these ice core records except for the Taylor Dome CO_2 (Indermühle et al., 1999) which is a higher resolution, shorter data set, spans at least to the last interglacial period, the Eemian. The Taylor Dome data set for CO_2 only spans around 11 thousand years BP. The EPICA Dome C CO_2 and CH_4 (Lüthi et al., 2008; Loulergue et al., 2008) records are composite data sets using the published results of many different authors and studies to create long-term 800,000 year records. The Taylor Dome and GISP2 records for CH_4 (Brook et al., 2000) were used to calibrate and determine the gas age at different depths in the

two ice cores. The Vostok ice core record is from two different studies (Barnola et al., 1987; Chappellaz et al., 1990).

The early anthropogenic hypothesis based its findings off of data from the Vostok ice core in Antarctica, the Taylor Dome ice core in Antarctica, but the long-term data from the EPICA Dome C ice core in Antarctica had not yet been published. All of the data sources for CO_2 and CH_4 used in this study are from Antarctica or Greenland. This is because at present, long term ice core records that span to the Eemian interglacial period have not been published from other geographic locations.

Methods

The data sets described were plotted to confirm the trends cited in the Ruddiman (2003) early anthropogenic hypothesis. Past interglacials and the Holocene were the focus of these plots. Special attention was given to the EPICA Dome C ice core record because it was the one record not available at the time of publication of the early anthropogenic hypothesis. The full Vostok ice core was plotted to get a picture of the last interglacial period, the Eemian. The Taylor Dome and GISP2 ice cores were plotted from 12,000 years BP to present to display what has occurred since the last glacial maximum in terms of CH_4. The Taylor Dome CO_2 ice core was plotted in full to analyze when CO_2 began to increase since the last glacial maximum. CO_2 and CH_4 from the EPICA Dome C ice core were also plotted.

Results and Discussion

Results

After plotting the ice core records from Antarctica, the trends described by Ruddiman in his works were confirmed. The Vostok ice core record (see Figure 1) below spans from approximately 1,700 to 160,000 years BP. The CH_4 and CO_2 trends generally follow the same

patterns throughout the time scale plotted. Late in the CH_4 and CO_2 records both gases are observed to begin to increase.

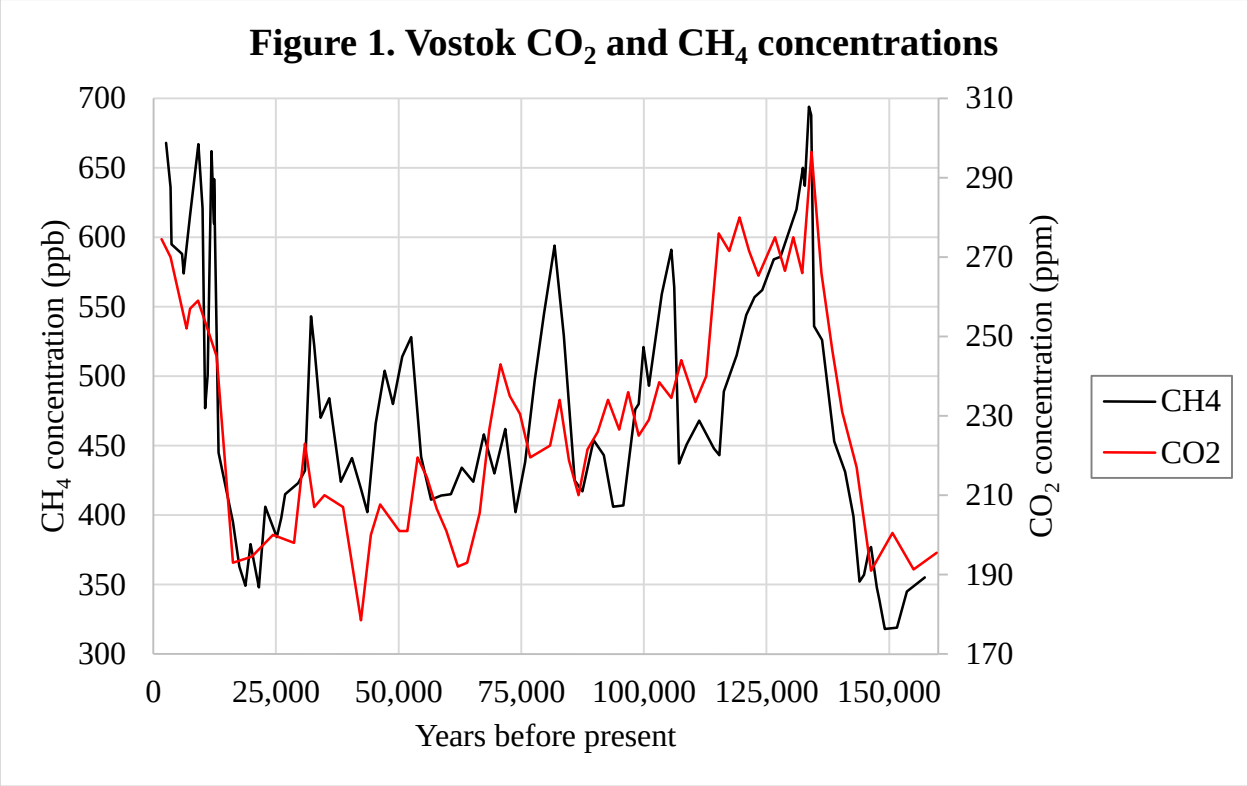

Figure 1. Displays the full Vostok ice core record for CO_2 and CH_4 concentrations from approximately 1,700 to 160,000 years BP.

The GISP2 and Taylor Dome ice core records for CH_4 concentrations throughout the past millennia follow very similar trends (see Figure 2. below). Both records begin to increase in concentration around 5,000-6,000 years BP after a period of decreasing concentration since between 11,000 and 12,000 years BP.

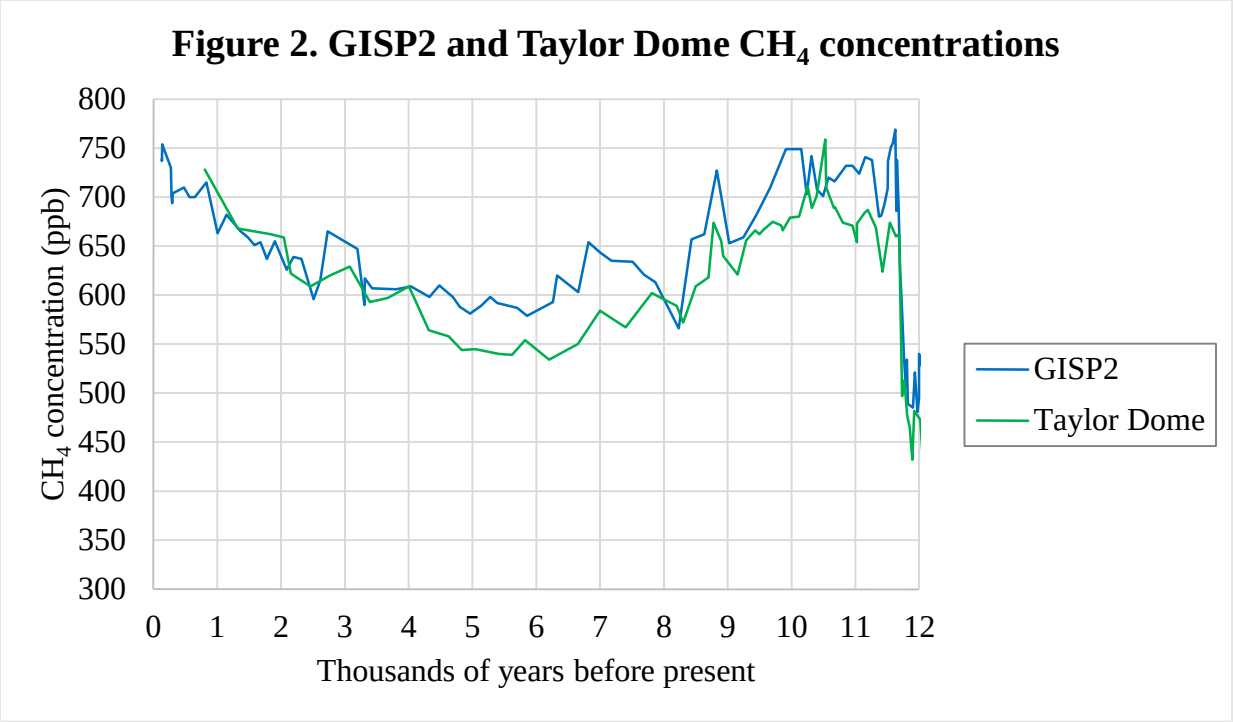

Figure 2. Displays the CH_4 concentrations from the GISP2 and Taylor Dome ice core records. The full GISP2 record spans the time period from 133 to approximately 109,000 years BP. The full Taylor Dome record spans from approximately 80 to 128,000 years BP.

The Taylor Dome CO_2 record is a higher resolution record, but it has a shorter time scale (see Figure 3. below). This record clearly shows that CO_2 began to increase steadily at around 8,000 years before 1950 with smaller magnitude fluctuations starting at around 5,000 years before 1950. The record does not capture the rather drastic CO_2 increases that have occurred since the middle of the 20th century.

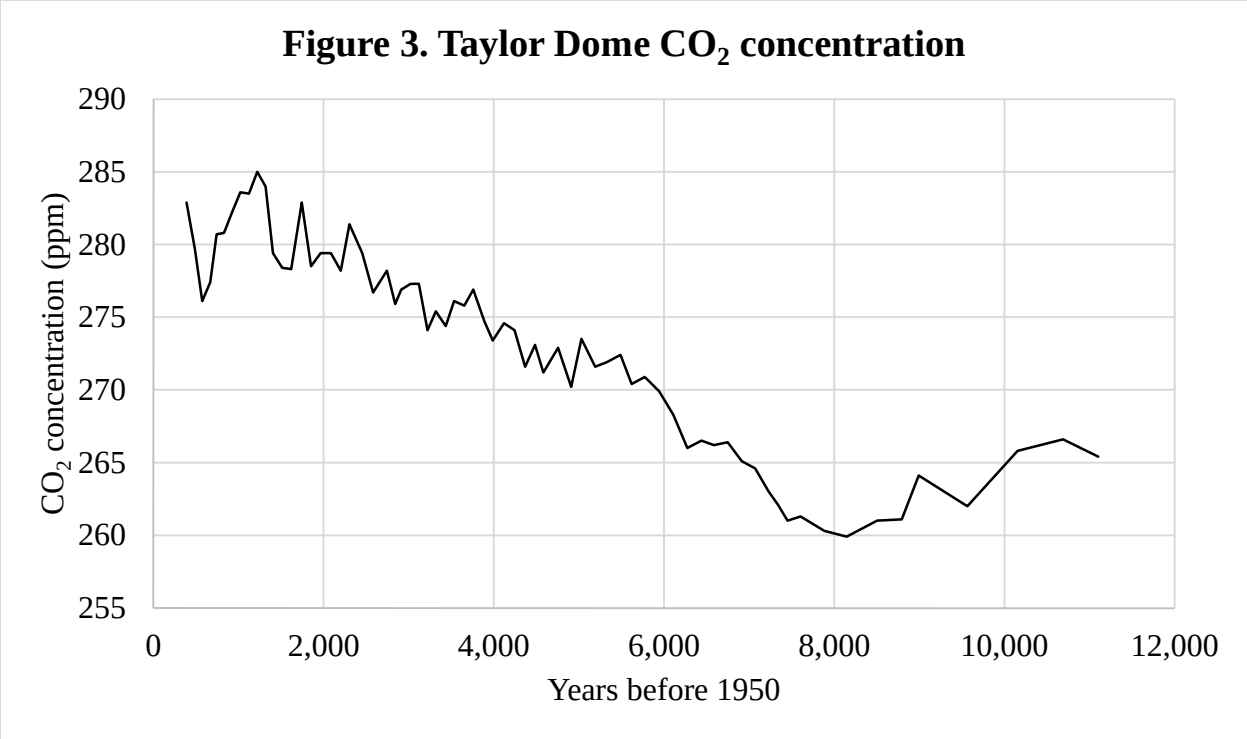

Figure 3. Displays the full Taylor Dome ice core record for CO_2. The record spans from approximately 390 to 11,100 years BP.

The EPICA Dome C ice core contains records of both CO_2 and CH_4 (see Figures. 4 and 5 below). In Fig. 4 the CO_2 record begins to fall around 11,000 years BP but then begins to increase around 7,000 to 8,000 years BP. The CH_4 record also begins to decrease around 10,000 to 11,000 years BP but is shown to start to increase around 4,000 to 5,000 years BP. Fig. 5 shows that CO_2 and CH_4 have followed very similar trends over the past 800,000 years.

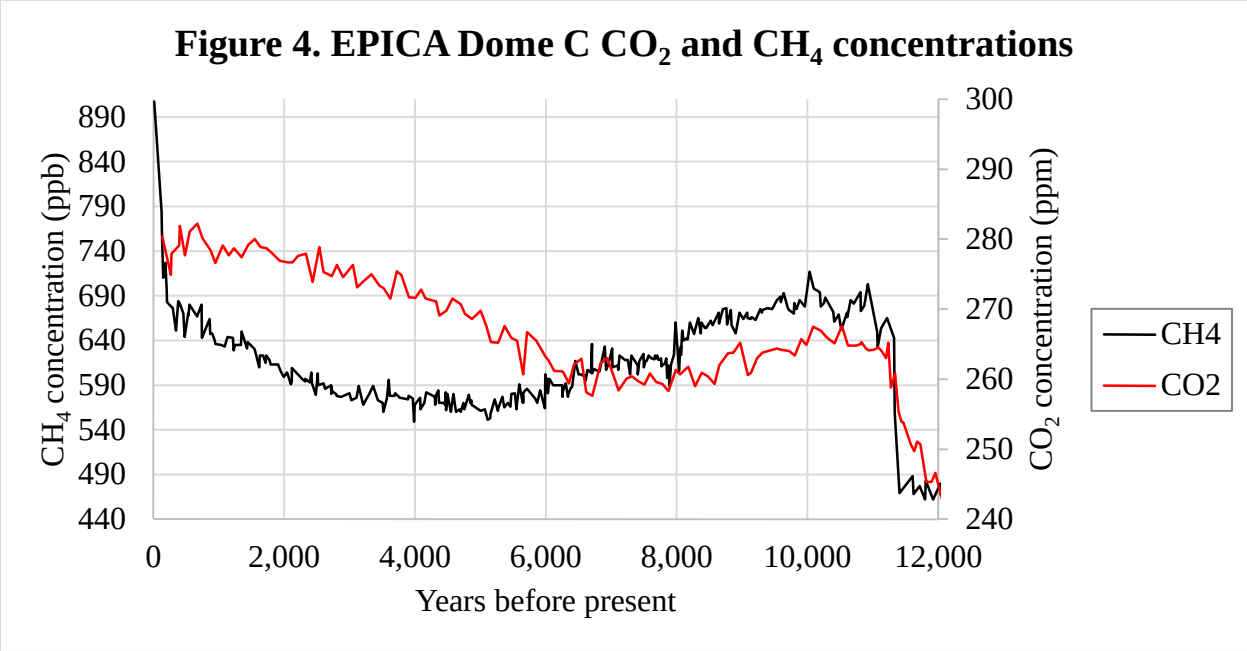

Figure 4. Displays the CH_4 and CO_2 records from the EPICA Dome C ice core. The CH_4 long-term record spans from approximately 137 to 800,000 years BP. The CO_2 long-term record spans from approximately 13 to 800,000 years BP. Both gases are plotted from 12,000 years BP to present.

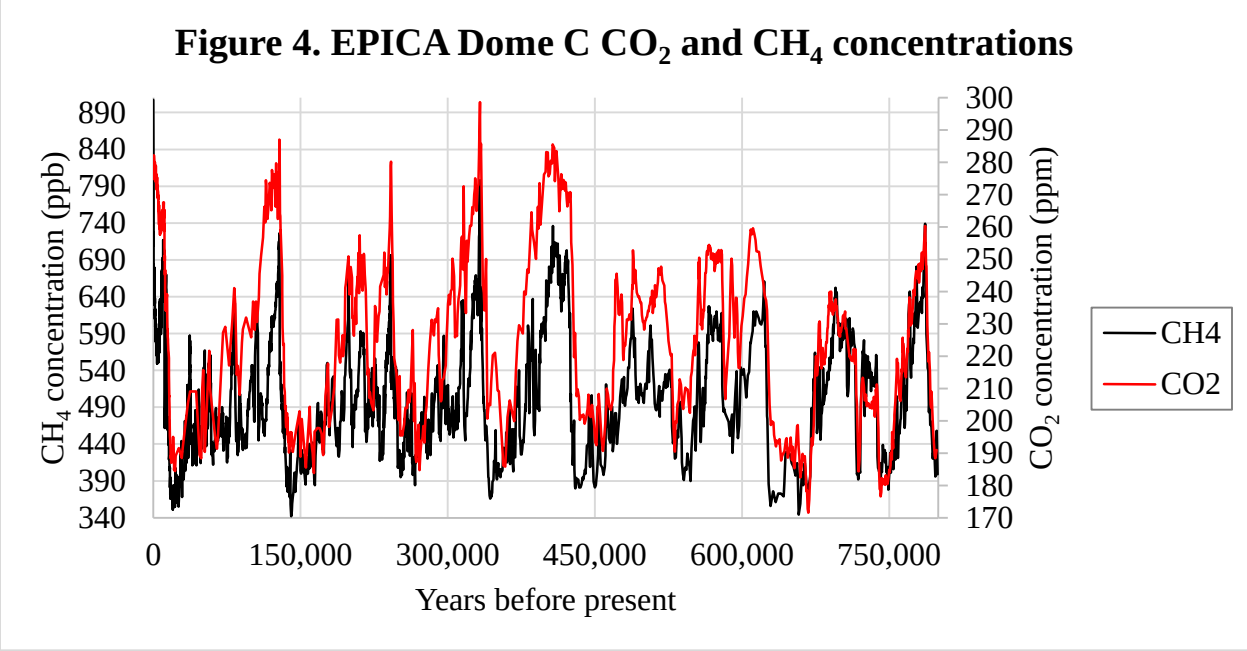

Figure 5. Displays the full CH4 and CO2 records from the EPICA Dome C ice core from 800,000 years BP to present.

Discussion

The results described confirm the trends described by Ruddiman in his early anthropogenic hypothesis. The concentrations of both CO_2 and CH_4 were observed to increase in the late Holocene when in previous interglacial periods they had been decreasing. The EPICA Dome C ice core was new to the analysis of the hypothesis and it also shows trends similar to the other records from Antarctica.

One of the limitations of this study is that long-term ice core proxy records are only available from Antarctica. This does not allow a comparison of GHGs at multiple locations to be made. Fortunately, studies show that GHGs such as CO_2 and CH_4 are generally well mixed in the atmosphere (Watson, Meira Filho, Sanhueza, and Janetos, 1992). Meaning, the trends observed for the long-term records at Antarctica are presumed to be very close to what other geographic locations experienced during past climate.

Conclusions

Multiple lines of evidence point towards similar GHG trends during the period since the last interglacial. Both CO_2 and CH_4 have been observed to increase, at different times, and follow increasing trends that are unfamiliar to climate scientists. Although Ruddiman's (2003) early anthropogenic hypothesis received plenty of doubts and scrutiny by peers in the science community he was able to respond and provide clarification and additional research. Over a decade after original publication the early anthropogenic hypothesis still holds and appears to provide the most plausible explanation for the anomalous GHG trends of CO_2 and CH_4 in recent millennia.

The EPICA Dome C ice core adds an additional line of evidence to the early anthropogenic hypothesis as both CO_2 and CH_4 increase independently around 7,000 to 8,000

and 4,000 to 5,000 years BP, respectively. If long-term ice cores from other geographical locations on Earth (such as the northern hemisphere) could be obtained and analyzed at least as far back as the last interglacial period it would provide evidence as to how well atmospheric GHGs mixed in the past and it would be an additional piece of evidence to compare to the already existing Antarctic ice core records.

Further research could be useful in strengthening the early anthropogenic hypothesis or providing an alternative explanation to the claim that early human agricultural activity and land cover changes released carbon to the atmosphere at a level significant enough to alter global climate. This research could be focused in attempting to make more accurate assessments of early human land cover change extent, impacts, and its associated global climate system impact (Kaplan et al., 2010). There exists considerable uncertainty in quantifying these estimates. As such, it is still unclear how much the increasing GHG concentrations observed throughout the late-Holocene actually could have been due to direct or indirect emissions of GHGs by humans.

The question of whether or not Earth has left the Holocene and entered the so-called Anthropocene and missed the beginning of a glaciation remains highly controversial and should receive attention. Further analysis of future and existing paleoclimate records may be the best way to gain insight into this question.

Another important question for climate scientists to consider in coming years has to do with what the effects of an exponentially growing global population with much more developed technologies will have on the climate system. If the much smaller early human population was able to cause global climate change in the past, how will our climate respond to what our species has become today? What will the climate look like in a decade, century, or millennia? These are all questions that bear further investigation.

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Title:

Water pollution from pharmaceutical products in waters: A policy case study

Course:

GEOG 361 - United States Environmental Pollution Policy

Description and notes:

The following paper was the first of three short assignments produced for United States Environmental Pollution Policy class. It focuses on the relatively newly discovered environmental and public health concern of pharmaceutical pollution that has received little policy guidance in the past.

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IDCE 382 - US Pollution Policy
Professor Van Atten
29 September 2015

Water pollution from pharmaceutical products in waters: A policy case study

Problem description:

Globally, the demand for high quality water for drinking, sanitation, and industry is rising along with population and development (Gadipelly et al., 2014). Pharmaceutical pollution (PP) and by-products (BP) are a new area of concern for policy makers and citizens alike. PPs that are found in surface water, groundwater, and drinking water, originate from both point and nonpoint sources, and are known to bioaccumulate and remain persistent in the environment over time (Mompelat, Le Bot, and Thomas, 2009). Although they have become an issue of recent concern for policy makers and scientists, human and veterinary PPs and BPs have not been studied extensively to determine their presence and concentrations in different types of water. Their effects on human and environmental life are largely unknown as well (Mompelat, Le Bot, and Thomas, 2009; Jones, Lester, and Voulvoulis, 2005). According to Mompelat, Le Bot, and Thomas (2009), there are over 4,000 pharmaceutical products used in modern medicine in Europe, the majority of which have the potential to penetrate all areas of the environment. Multiple sources exist from which PPs and BPs could reach the environment and mix with water. These sources include but are not limited to: "failing septic tanks or other on-site waste-treatment systems, leaking sewer lines, permitted and accidental discharges, illicit and unpermitted dumping, sanitary-sewer/storm-sewer cross-connections, and unmanaged or poorly managed pet and livestock wastes". It is estimated that over half of wastewater containing PP is discharged without receiving treatment. The most common conduit by which PPs contaminate the environment is through discharges of pharmaceutical industry wastewater to wastewater treatment plants (WWTP), and then from municipal effluent to the environment. Additionally, the efficacy of treatment processes ability to remove unwanted compounds from water is largely unknown (Gadipelly et al., 2014).

The health effects of discharged pharmaceuticals is of special concern. Though there is still a research gap regarding potential side effects of varying temporal exposures to different types of PPs and BPs, studies have demonstrated damaging health effects to living organisms in certain contexts. In the aquatic environment for example, PPs have been shown to promote the success of bacteria with antibiotic resistance (Lim et al., 2011; Gadipelly et al. 2014). Other recent studies on the effects of PPs in the aquatic environment found fish and alligators to feminize. In India, a specific pharmaceutical compound was at fault in the near population collapse of a species of vulture (Gadipelly et al., 2014). Another serious concern for scientists and policy makers is the potential for PPs and BPs to cause synergistic effects in exposed populations of organisms (Jones, Lester, and Voulvoulis, 2005). PPs that reach drinking water remain after "environmental transformation processes and engineered treatment processes". Meaning they are likely to have certain characteristics including: "high usage rates or excretion rates (mirrored by low biodegradability), high chemical stability, high water solubility, and reduced propensity for sorption (such as to sewage sludge)" (Daughton, 2010). Jones, Lester, and Voulvoulis (2005) have claimed that legislative action might be needed shortly in order to better manage this newly identified and unaddressed environmental problem.

Policy remedies:

It would be wise for environmental policy makers and managers to apply the precautionary principle to the issue of PP in water. The known negative effects of PPs and BPs on the environment, the extent of unknown factors relating to concentrations of PPs and BPs in surface water, drinking water, and groundwater, and potential synergistic effects warrant further research. While investigating this topic the precautionary principle should be applied by policy makers and steps must be taken to mitigate risks. Two policy solutions are outlined below and associated pros and cons are discussed.

The first policy solution to this pollution problem aims to regulate the pharmaceutical industry because it is a primary source of PP to watersheds. Technological research and development would be useful to improve the treatment of wastewaters from manufacturing of pharmaceutical products. A tax on emissions of PPs would encourage these types of developments and improve the quality of effluents leaving manufacturing facilities. In the United States, the Clean Water Act (CWA) could serve as the basis for this type of regulation because it is in place to control toxic effluents. The challenge in enacting a policy encouraging reduced PPs in effluent streams is that technology-based effluent standards (Field and Field, 2013) would not yet be possible because detailed data are not available to help policy makers determine the effluent standards appropriate for each type of pharmaceutical product. Instead of relying on technology-based effluent standards strictly, this policy is more stringent. Manufacturers of pharmaceuticals are expected to develop means of improving the quality of their wastewater. Governing agencies have the responsibility of randomly selecting manufacturing plants to test. Compliance with the regulation is reached if PPs are undetectable in tests. Although this might seem harsh, without a more complete understanding of the effects of PPs on the environment and human health strict measures must be put in place. The details of the regulation are as follows: A grace period is to be set forth during which the agency compiles effluent data to determine the PPs present and their respective concentrations. After completion of the grace period manufacturers have time (2 years) to change their operations to decrease levels of PPs discharged. Afterwards, further random testing leaves manufacturers subject to penalties if they are found to be emitting levels of PPs that exceed the averages calculated during the grace period. Manufacturers are subject to monetary reward if concentrations of PPs were below the averages calculated during the grace period, thereby incentivizing creating an effluent stream of higher quality water. The benefit of this solution is that it offers policy makers the ability to act on incomplete information and adhere to the precautionary principle. The downfall of enacting this solution includes poor cost effectiveness, and poor overall effectiveness in improving wastewater quality. If the manufacturers are able to find solutions to improving wastewater quality the governing agency would be responsible for providing funds to these companies. However, this water quality improvement may not even be noticeable from the standpoint of municipal WWTP operators, or the public because concentrations of PPs are often very low, especially after the substances have gone from wastewater into the environment (Jones et al., 2005; Mompelat, Le Bot, and Thomas, 2009). Though this solution applies the precautionary principle, many policy makers, members of affected industries, and politically active citizens would likely agree that it is far-reaching and inappropriate considering a comprehensive body of scientific literature describing the toxicity of low concentrations of PP to human and environmental wellbeing does not exist.

The second policy solution proposed aims to reduce the amount of PPs and BPs in wastewater from residential and hospital settings resulting from healthcare use. Instead of focusing on the manufacturers of pharmaceuticals, a more manageable approach would be to focus on the users of the drugs, who are not always cognizant of the implications of improper disposal. The regulation incentivizes safer disposal of PPs in residential settings, and PPs and BPs in healthcare settings. Instead of focusing on an end-of-pipe pollution program the goal of this policy is to introduce recycling of old and unused pharmaceutical products so that less PP and BP are emitted to wastewater streams. To start, residential take back programs would be enacted. The basis of this policy is that the U.S. Food and Drug Administration (FDA) and U.S. Environmental Protection Agency (EPA) work in unison to offer incentives such as future rebates and discounts on prescriptions accepted at pharmacies and retailers of pharmaceutical products in exchange for returning unused or expired drugs. Pharmacies would become a central drop-off location for unwanted pharmaceutical products so that they could be transported to pharmaceutical manufacturers for use in recycling, thereby reducing the total amount of residual PP created in the production process.

Hospitals would be another drop-off location and would also be mandated to recycle their pharmaceutical products. Additionally, wastewater from hospitals would be subject to random testing for effluent quality, in a similar fashion as in the first policy described above. This testing would seek to encourage technological treatment improvements and reduce the PPs being discharged as wastewater and entering the environment.

The benefits to this policy are wide ranging. Better recycling technology would be developed so that manufacturers of pharmaceuticals could take full advantage of new inputs in their production processes. Pollution prevention would become a focus and end-of-pipe pollution would be reduced. For this reason, WWTP would have less PPs to treat. Additionally, customers would engage in thinking about recycling environmentally harmful compounds because of the incentive available to them, leading to an overall increase in environmental consciousness. Issues with this policy include the fact that marginal abatement costs may exceed the gains in water quality realized, especially in the beginning stages of the program when details in the recycling operations are being figured out. Another downfall to this policy is that does not incentivize manufacturers of pharmaceuticals to decrease the PP they produce.

The issue of PP of water is complex. The science behind PP is not well understood. Neither policy outlined is complete enough to work in practice. However, the policies show how very different approaches can help achieve similar solutions.

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Title:

A Critical Analysis of Well-being, Consumption and Growth within New York City's OneNYC Plan for a Strong and Just City

Course:

IDCE 30277 (EN 277) – Sustainable Consumption and Production

Description and notes:

The document that follows is the final product my peers and I created for our course titled Sustainable Consumption and Production. The content contained in this paper was also presented to our class.

A Critical Analysis of Well-being, Consumption and Growth within New York City's OneNYC Plan for a Strong and Just City

Source: www.nyc.gov

EN 277- Sustainable Consumption and Production
Professor Brown
15 December 2015

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Introduction

New York City is working towards environmental and economic sustainability to ensure continued growth and prosperity in the wake of climate change and OneNYC is the plan the city is using to achieve it. Mayor Bill de Blasio released this plan in April 2015, which sets stringent goals with specific targets for a strong, sustainable, equitable and resilient city. Mayor de Blasio's plan draws the link between poverty, consumption, and pollution, enabling the administration to present steps to make New York City one of the most environmentally sustainable cities in the United States. The plan is broken down into four visions which provide environmental protection policies with economic and social benefits. The visions include a vision for a growing, thriving city; a just and equitable city; a sustainable city; and a resilient city. This plan is an example of sustainable development for the prosperity of future generations (NYC press office, 2015).

The visions within OneNYC are interwoven and strongly connected through addressing the well-being, economic viability, and growth of New York. The plan includes a separate vision for sustainability, but sustainability is implicated throughout each of the other visions. Since a major goal of this plan is to ensure well-being and growth through resilience, equity and sustainability, a major disparity arises between sustainable development and sustainable consumption. Society's level of consumption is deeply embedded in the psychological and cultural search for meaning in life, which is subsequently linked to social practices and the structural features of the economic system. This plan does not explicitly address consumption through a social practices lens. New York City has a major financial sector which exponentially increases the city's economic income, but does not cycle through the local economy. In order to achieve sustainable development, New York City addresses the growth of the local economy.

Our economy is founded in the expectation that consumers will act under free markets, leading to growth and improved quality of life. This neoliberal ideology locks us into our levels of consumption in order to obtain a certain level of well-being while continuing to promote increasing consumption. Therefore, is it clear that sustainable development, which is present in OneNYC, addresses climate change issues through policies that encourage us to continue to consume at higher levels, only more efficiently and with fewer planned environmental impacts. The plan addresses persistent poverty issues within New York as urban environmental problems hit the poor and working classes the hardest. As New York plans to lift people out of poverty, it becomes more critical to address sustainable consumption, for with increased economic income, follows increased consumption. It is critical to break this link to attain sustainability. OneNYC successfully addresses the well-being and growth of New York City in a sustainable manner, but there is an implicit need to address sustainable consumption in the city and break the connection between economic growth and increased consumption within each vision to achieve a good life.

Background

OneNYC builds off of a previous effort the city first released in 2007, under the prior Mayor Michael R. Bloomberg administration, titled "PlaNYC: A Greener, Greater New York". The overarching purpose of this document was to help the city responsibly meet the growing infrastructural needs of its ever-expanding population. PlaNYC included the city's first approaches to sustainability and proposed a commitment to reduce greenhouse gas emissions. When the United States was struck by a severe economic recession in 2008, New York City was highly affected. As a result, the first version of the plan was expanded in 2011 to include additional and stronger commitments to improved environmental quality and to making neighborhoods more livable by increasing factors that impact quality of life. Disaster struck New York City again in the fall of 2012 when Hurricane Sandy touched down on the northeast United States. This initiated the release of the third and final version of PlaNYC in 2013 titled "A Stronger, More Resilient New York" which added in themes of resiliency and adaptation to the threats of climate change. Prior to the release of OneNYC, the city made significant progress on reaching goals set forth in PlaNYC through reducing greenhouse gas emissions, protecting their water supply, planting trees, installing bike lanes, phasing out heavily polluting oils used for heating, strengthening coastal infrastructure, improving the resiliency of neighborhoods, among other initiatives. That being said, the city recognized that PlaNYC was inadequate to address the needs facing the city in 2015 and beyond; OneNYC was born in the spring of 2015 under the Mayor Bill de Blasio administration (OneNYC, 2015).

The needs of New York City are continuously changing, and presenting new challenges. The population is at an all time high, currently numbering nearly 8.4 million and expected to increase to 9 million by 2040. The population is also getting older. By 2040 citizens over 65 are expected to exceed school-aged children, which will make for a new challenges relating to social services and the built environment. Population growth and demographic shift are paralleled by an economy that is expected to change over time. Infrastructure is failing and leaving New Yorkers with the highest average commuting time of all large cities, 47 minutes (OneNYC, 2015). Additionally, climate change poses real and imminent risks to the city. According to a 2015 report published by the New York City Panel on Climate Change, by 2050 the city could expect average temperatures to increase 4.1 to 5.7 °F, extremely hot days over 90 °F to double in frequency, and precipitation to increase by 4 to 11 percent compared to a baseline calculated between 1971 and 2000 (NPCC, 2015).

OneNYC differs from its predecessor in many ways. OneNYC offers a new focus on inequality, proposes a regional perspective, and recognizes that collaboration with a multitude of public and private actors will be needed in order to achieve the ambitious goals it sets forth. In OneNYC the city states that the poverty rate and level of income inequality remains concerning, and that reducing poverty would lead to a healthier, safer, and more economically successful city. The regional perspective that the document proclaims is a means by which the city can help to extend its national and global influence. The city also recognizes that it will have to work with a number of outside stakeholders in order to successfully address OneNYC goals because some

of them lie outside the scope of traditional city government control. Nonetheless, the city will lead the way with every aspect of the plan, even when goals are somewhat out of their control. The Mayor's Office of Sustainability oversees the development of the plan, and shares accountability for implementation with the Mayor's Office of Recovery and Resiliency; yet, all sectors of the city's government will be involved. OneNYC took into account the opinions of city residents in order to ensure a democratic process and that the plan would adequately address their concerns. Online and telephone surveys were conducted, community meetings in all boroughs were held, organizations from around the city had the opportunity to meet with elected officials, and leaders from outside communities were invited in to provide their feedback (OneNYC, 2015).

Well-being

Our Sustainable City

The "Our Sustainable City" vision is innately intertwined with city residents' ability to improve upon their own personal sense of well-being and happiness. The six goals presented in this section of OneNYC all have implications for personal well-being. Environmental justice is highlighted in this vision as, not a goal in and of itself, but as a result of a number of the initiatives that can be found in the vision (OneNYC, 2015). Addressing environmental justice is important as it aims to improve the quality of health for many New Yorkers who are subject to disproportionately poor environmental quality. Health is a key factor in happiness and the creation of feelings of well-being (Layard, 2005) so the focus on environmental justice should improve relative happiness.

The first goal of the "Our Sustainable City" vision aims to reduce New York City's greenhouse gas emissions 80 percent by the year 2050 compared to 2005 levels. The reduction of greenhouse gases will likely lead to reductions in other air pollutants, thereby reducing the risk of diseases brought on by air pollution. The second goal aims to stop sending waste to landfills by 2030. Focusing on reducing waste, is not guaranteed to, but should make neighborhoods cleaner and more aesthetically pleasing. The air quality goal in this vision aims for New York City to achieve the best air quality among all large U.S. cities by 2030. This goal should improve health outcomes in the city and reduce morbidity and mortality among residents. Healthier residents in turn are happier and able to achieve a greater sense of well-being (OneNYC, 2015).

The brownfields goal within this vision aims to "clean up contaminated land to address disproportionately high exposures in low-income communities and convert land to safe and beneficial use". The first initiative within this goal is to "Accelerate cleanup of brownfields to improve public safety and encourage private investment in new development on brownfield sites". This initiative should improve environmental quality, health, and public safety within the city, leading residents to feel safer, and happier in their own communities. The second initiative within this part supports community engagement in creating community brownfield planning areas (OneNYC, 2015). Getting the community involved in decision-making and brownfield

cleanup and redevelopment will bring new power and opportunities to residents looking to make a positive difference in their community.

Water Management is a goal within the vision that aims to "mitigate neighborhood flooding and offer high quality water services". Water is a basic need, thus these management services are vital to the well-being and health of the city's residents. One of the initiatives within this goal is to expand green infrastructure and design in order to manage storm water throughout the city (OneNYC, 2015). This initiative should reduce infrastructural damage resulting from flooding and help in avoiding any overbearing costs these disasters might cause financially or otherwise.

The last goal in the "Our Sustainable City" vision is to address parks and natural resources in the city to allow all New Yorkers to benefit from beautiful, useful, and accessible public spaces. The expansion of parks and open space within the city should help promote vibrant communities. The first initiative under this goal is to target the improvement of parks and other public land in "under-resourced and growing neighborhoods". Another interesting initiative within this goal is to repurpose underutilized streets around to city to become "pedestrian plazas" or other types of areas where people can get together. This goal also has an initiative, which will improve aesthetics by planting trees and installing other amenities across the city (OneNYC, 2015). These initiatives are all important in creating a city that promotes healthy living and happiness among its residents.

The six goals contained in the "Our Sustainable City" vision have the potential to positively impact the community by increasing New Yorkers' ability to thrive. Environmental justice is a focus of this vision, which positively impacts health and also reduces inequality. When considering the well-being of city residents, most of these goals and associated initiatives are technical remedies (e.g. brownfield planning, cleanup, and redevelopment), however some of the remedies have a social aspect as well as a technical one (e.g. turning streets into places for people to congregate).

Our Growing Thriving City

The goals within the "Growing Thriving City" vision of the OneNYC plan have the potential to help people attain parts of the American idea of a "good life". Although the main point behind this section is to create infrastructural and economic growth of the city, these ideas are likely to improve quality of life for the residents. This vision addresses increasing job opportunities at all skill levels for New Yorkers. Unfortunately, the lower paying jobs are not living wage. The OneNYC plan addresses that by creating the Career Pathways Strategy. It is a program made to "support training programs that give people who historically struggle to enter the labor market the skills needed for entry-level work" (OneNYC, 2015) . This strategy address helping people gain the skills they need to progress their careers, but they do not address that even median wage jobs do not provide a particularly prosperous life.

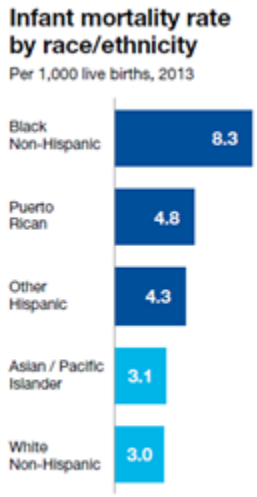
This vision also makes reasonable commuting times a priority. A large goal of the OneNYC plan is to provide 90 percent of New Yorkers with at least 200,000 jobs within a 45-minute commute on public transit (OneNYC, 2015). It has been shown that higher commuting

times are strongly linked to a reduction in health related activities such as exercising, sleeping, preparing food, and eating with family (Christian, 2012). This goal of reducing commuting times for New York City residents is likely to allow for healthier behaviors and increase well-being for New Yorkers.

Mayor de Blasio and the creators of this plan also laid out a plan to create easy access to cultural resources and activities for all New Yorkers by ensuring cultural facilities in each neighborhood. They frame this as a way to provide jobs for New Yorkers, which would improve well-being and quality of life if they are living wage jobs, but leisure time and community engagement are tenants of a "good life". They aim to increase local cultural partnerships and make the permitting process much easier for community centers. They ensure providing cultural experiences to people of all income ranges by expanding cultural programming in New York City's public parks (OneNYC, 2015). In conjunction with reduced commuting time, this has the potential to positively affect the well-being of NYC residents. Unfortunately, many people, especially those who are paid low wages and must have many jobs, work hours too long to enjoy this cultural programming.

Our Just and Equitable City

The goals within "Our Just and Equitable City" also aim to increase well-being and happiness of the residents of New York. Poverty and its negative impacts on residents' well-being and happiness is the overarching issue within this vision. Currently 45.1 percent of residents are at, near, or in extreme poverty. The six goals in this vision are aimed at those who are most affected by reduced income and those who have the largest gap in well-being. This vision aims to take 800,000 New Yorkers out of poverty or near poverty by 2025. This will be done through increasing government and public services, as well as increasing the minimum wage. By following through with both of these, the cost of living for many residents will go down while income goes up (OneNYC, 2015).



The first goal in "Our Just and Equitable City" aims to increase childhood well-being and happiness through increased education and childcare. The plan aims to reduce infant mortality rates, mainly in areas of high poverty. High poverty areas see nearly double the average infant mortality rate (IMR), 5.2 deaths versus 2.8 per 1,000 births. The figure to the right shows differences in race and ethnicity when it comes to IMRs. By targeting areas of high poverty, IMRs can see the largest reduction over time. About 80 percent of all infant mortalities come from injuries from either the baby's sleeping position or a dangerous environment. Through parent education and increased access to quality child health care, many of those could be prevented (OneNYC, 2015).

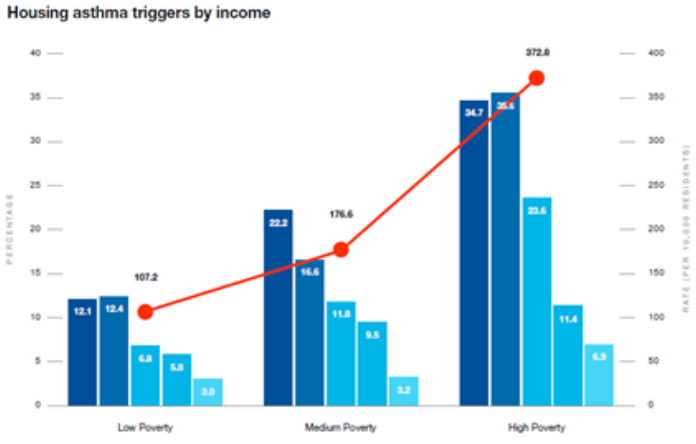
Another initiative is providing free all day quality kindergarten for four-year-olds. Increased education leads to increased cognitive and academic ability, increasing the high school graduation rate, reducing crime involvement and increasing college attendance. Many families

are unable to afford pre-k; those in poverty benefit the most decreasing inequalities while increasing happiness and well-being (OneNYC, 2015).

The other 6 goals include: Integrated Government and Social Services; Healthy Neighborhoods, Active Living; Health Care Access; Criminal Justice Reform; Vision Zero. The other goals intend to increase education for college and career success, increase transportation for workers, increase environmental quality and health care, increase affordable housing, increase government and community services and access to broadband (Wi-Fi) for all (OneNYC, 2015). Each goal intends to increase general health and education, or reduce poverty. This is done through a couple general means: increasing access to a resources and services, reducing the costs of living, increasing minimum wage and days in workforce, changing the physical environment, and changing social practices.

The second goal, listed above, creates more local and accessible government resources allowing more civic participation, which can be usually limited by: physical location, information, transportation, language, etc. The city plans to make each school a community school. Within a community school students have high quality education, families have access to social services and communities have a place to address local issues and share resources. This gives the ability for families to have a larger role in child education, which is not seen in large public schools. Students are given dental, mental, and overall free health screenings at community schools. Neighborhood Health Hubs (NHHs) will be implemented in areas of "high health disparities". NHHs plan to reduce health inequalities within the city while also being a one-stop solution to many service needs (OneNYC, 2015).

The third goal's initiatives are to improve health include increasing food quality and affordability, change social behaviors to increase residential housing environmental quality, as well as create safer cleaner neighborhoods. As New Yorkers spend around 90 percent of their time inside, building design that increases physical activity can increase the number of people who meet daily activity goals. Residents with lower income see more negative health impacts from their physical environments. The figure above "Housing asthma triggers by income" shows a large difference between those in low to high poverty. Again, many of the initiatives are aimed at groups who will see the greatest changes (OneNYC, 2015).



The fourth goal is to increase healthcare for residents at the highest risk and those who have not had adequate access. This is done through smaller community and government based

preventative care . Instead of a few large centralized hospital campuses, the vision is planning on creating many smaller health care access points within communities.

The fifth goal is aimed at reducing crime and incarceration through new technology, environmental design, new methodologies to use data, and increased community involvement in Justice Reform. This goal also plans to increase help for domestic violence victims including shelters and social services. By reducing crime rates within the city, residents will feel safer and spend more time outside, therefore improving overall well-being (OneNYC, 2015).

The last goal plans to reduce traffic fatalities to zero. This will be done by targeting high fatality roads, increasing biking and walking lanes, shortening pedestrian crossing distances, increasing shoulder sizes, increasing medians and repainting road lines (OneNYC, 2015).

This vision's main theme is that the root of inequalities in health, education, well-being and happiness come from poverty and the gap in living cost and income. That is why initiatives aim at decreasing the living costs of the poorest while increasing the amount and quality of services. New York's plan will try to pull 800,000 residents out of poverty or near poverty by increasing minimum wage to $13/hour and by lowering the cost of living. The costs to the city of increased government services (healthcare, education, civic) along with new construction will be immense (OneNYC, 2015).

Our Resilient City

The social dimension of sustainability and the social infrastructure affects social equity within the city. A community that is sustainable and resilient displays a higher level of social capital and social cohesion. Social cohesion is the pride in and attachment to a place, social interaction, safety, trust and stability. Social capital and cohesion are likely to offer residents a good quality of life, with high levels of satisfaction with home and neighborhood and an appreciation of the local environment (Bramley G. et al., 2010). Therefore, by focusing on the growth of the local economy, in "Our Resilient City", to withstand any future shock events, New York City will be improving the social capital. People living in communities with a higher level of social capital are more likely to benefit from personal well-being, reduced crime rates, more empowerment, and a higher quality of life than those living in communities where social capital is lacking (Healey and Côté, 2001).

Social sustainability represents both public and collective goods and some key drivers of individual private choice. Social sustainability can save public costs, promote happiness, and can contribute to the kind of urban vitality, which underpins modern economic competitiveness. Sustainability and quality of life are inevitably linked. The resiliency indicator used to measure this is to reduce the Social Vulnerability Index (SoVI) for neighborhoods across the city and reduce average annual economic losses resulting from climate-related events (OneNYC, 2015). The SoVI measures the social vulnerability of U.S. counties to environmental hazards. According to the National Oceanic and Atmospheric Administration (NOAA), the index is a comparative metric that facilitates the examination of differences in social vulnerability among counties. SoVI is a valuable tool for policy makers and practitioners because it provides a tool to evaluate progress on different initiatives towards resiliency. This tool graphically illustrates any

geographic variation in social vulnerability and shows where there is uneven capacity for preparedness and response (NOAA, 2011). This resiliency indicator is useful in measuring the well-being of New Yorkers because it takes into account the social and economic variables to vulnerability and can show which boroughs are most susceptible to climate change. SoVI can be used to measure improved quality of life. Below is a list of initiatives in OneNYC resiliency that contribute to the well-being of New Yorkers (OneNYC Indicators, 2015).

Initiatives	Supporting Initiatives	Lead Agencies	Funding Status	Funding Sources
Initiative 1				
Strengthen community-based organizations	Work to build capacity in communities by strengthening community- based organizations that serve their neighbors and by working to expand civic engagement and volunteerism. Take steps to mitigate the risks of heat in order to reduce heat-related illnesses and deaths, and reduce disparities in vulnerability to climate change.	Mayor's Office, DYCD, NYC Service, DoITT	Funded*	City capital and operating
Initiative 2				
Improve emergency preparedness and planning	Secure and bolster operations and physical assets for emergency response, and expand public education efforts on how to prepare for and respond to extreme weather events and other disasters.	Mayor's Office, NYC EM, FDNY	Funded	City capital and operating
Initiative 3				
Support small businesses and local commercial corridors	Provide financial investments, technical assistance and tailored resources regarding preparedness and resiliency to small businesses and commercial corridors.	Mayor's Office, SBS, DOT	Funded	Federal and State
Initiative 4				
Ensure that workforce development is a part of all resiliency investments	Ensure that all investments in resiliency will create job opportunities for residents and low-income applicants, and build on successful workforce development models to encourage the hiring of Sandy-impacted residents.	Mayor's Office	Budget neutral	City operating and federal
Initiative 5				
Mitigate the risks of heat	Take steps to mitigate the risks of heat in order to reduce heat-related illnesses and deaths, and reduce disparities in vulnerability to climate change.	DOHMH, Mayor's Office	In planning	N/A

Social infrastructure costs include education, health, personal social services, and environmental, protective and cultural services together with public goods such as police and the fire service. A major focus present in the table above is social infrastructure, which strengthens communities, such as hospitals, community centers, libraries, and schools. OneNYC intends to ensure that New York City adheres to the utmost standards of resiliency in the social infrastructure by providing each borough with access to top notch social services (OneNYC, 2015). This can enhance social resilience and assist in immediate response after a disruptive event. Parks, in particular, can play a role in protecting adjacent neighborhoods from severe weather, and serve as gathering places after an event. Parks and rain gardens also help reduce heavy flows into sewage systems.

OneNYC sets the precedence to adopt policies to support infrastructural adaptation. The city will use the best available climate science, as well as robust research, legislative action, advocacy, and regional coordination to adapt the city's infrastructure to be resilient against disruption. In order to do this, the city will design standardized guidelines by 2018 for resiliency that ensure the city adheres to the highest performance standards (OneNYC, 2015). These performance standards will include energy efficiency, as well as improved processes within the social and physical structure of the city. This initiative will ensure there are enough food, fuel, materials and consumer goods to sustain the city during a shock event. This will encourage the growth of local food and urban gardening, as well as alternative forms of energy. This will improve the well-being of New Yorkers because the political infrastructure will set standards for better food quality through local sources, as well as growth in the local economy. By growing the local economy, the money is not going to national or multinational corporations; it is staying within the parameters of New York. There will be a growth in urban and sustainable agriculture, as well as investment in the Hunts Point Food Distribution Center, which provides almost all New Yorkers with their food (OneNYC, 2015). While OneNYC may not explicitly say the word well-being in its initiatives for resiliency, it is clear that the quality of life is inevitably improved through a truly sustainable and resilient city.

Consumption

Our Sustainable City

Consumption and production are not addressed explicitly in the "Our Sustainable City" vision. The first goal of reducing New York City's greenhouse gas emissions focuses on the electricity, transportation, solid waste, and building construction sectors. Significantly altering the behavior of consumers is not addressed in these initiatives.

The goal of zero waste addresses consumption to an extent, though not as much as would be ideal in order to help the city achieve this ambitious goal. Zero waste should encourage reduced consumption, at all levels of society. One of the supporting initiatives is to reduce the 15 pounds of waste that New Yorker's create at home every week and the other 9 pounds created while at work and away from home. These figures are staggering when considered over the course of a year. Three million tons of residential waste, plus another three million tons of

commercial waste are created every year in the city that diverts only 15.4 percent of this waste. The initiative most likely to alter consumptive behavior is the proposed "Pay-As-You-Throw" volume based program. This type of program incentivizes residents and property owners to dispose of less waste because they are charged by volume for disposal. This program will decrease waste generation, increase recycling, increase organics composting, and create consumers who reduce their consumption and are cognizant of the products and associated packaging that they purchase. The city expects that this initiative could reduce waste by up to 30 percent. Another initiative supporting the goal of zero waste that may prove to have a beneficial impact on consumptive patterns is the expansion of the New York City Organics program to all residents by 2018. The city plans to expand their organics program by creating more curbside organics collection and drop-off sites. The expansion of organics composting would have to be instituted along with significant behavior change and marketing campaigns around the city to ensure success. Composting will likely be new to many urban dwellers thus it will be vital to disseminate information about the benefits of composting, what can be composted, and how to properly prepare waste for organic collection (OneNYC, 2015). These behavior changes and marketing campaigns should prove to raise environmental consciousness among residents, leading to a society that is more thoughtful and critical of the purchases that they make and the goods and services consumed.

The other goals in the "Our Sustainable City" vision do not explicitly touch on reducing consumption and production however they could be expected to result in a more environmentally conscious and sustainability minded population which could lead to decreased consumption.

Our Growing Thriving City

The "Growing Thriving City" vision of the OneNYC plan proposes growth in a variety of both the public and private sectors. This plan promises great investment in public transportation for the city. This means that people can spend their money on public goods instead of having the need to increase consumption of products private vehicles and all of the products that come with them. These investments that the city is putting into public transportation infrastructure promote the use of public transportation rather than private vehicles and are a more sustainable option for the city. This vision of the OneNYC plan looks to expand the availability of broadband across the city. This availability of the internet is intended to allow New Yorkers to have an equal playing field for connectivity and access to information, but this will increase the consumption of the internet, and therefore, energy within the city.

We cannot forget that this plan is still functioning within the parameters of hyper-consumerist capitalist America. It does not challenge the culture of consumerism at all. In fact it promotes growth of jobs. The commitment that they have to reducing commuting time and create job training may provide residents with slightly more money and more free time if they are successful. This may be the increase in income that makes their well-being better which is undoubtedly important and needed, but in that, they may be consuming more. This consumption is not necessarily bad but increased consumption would decrease the true sustainability of this plan. This plan encourages growth within the city and consumption is key for that. Since gross

domestic product (GDP) is largely made up of consumption and growth of GDP is important in capitalism for achieving perceived prosperity, consumption is likely to continue to increase in this plan. A large flaw of this plan is that it completely avoids discussing behaviors or cultural practices. Without personal changes in behavior or changes in cultural practices, sustainability becomes much more difficult if not impossible to attain.

Our Just and Equitable City

In the section of consumption, "Our Just and Equitable City" brings to question the increase in consumer buying power, a reduction in prices and sustainability. Are the goals of the sustainability vision possible, while increasing the wages and reducing costs of living for about 50 percent of the population? Demand theory says that individuals will change behaviors if price or income changes. "Our Just and Equitable City" plans to do two things, increase wages and decrease living cost for those with the least. By increasing accessibility to social services and reducing their costs residents will end up using more of those services. Not only will they use more services intended to increase health and education these families will have more income left over for other goods. Not only will there be a large increase in residential consumption most of the initiatives to increase health and education will mean new construction and increased energy consumption.

In the work of Daniel Aaronson, research has been done to show that minimum wage increases can lead to increased debt and spending beyond the amount of income. In a $1 wage increase minimum wage families spent $750 more a quarter while only increasing income by $250. Data was taken from 1982-2008 looking at multiple federal and state minimum wage increases. A $1 wage increase doubles quarterly spending on durable goods (furniture, floors and windows, household items, large appliances, electronics, leisure activities, miscellaneous household equipment, and net outlays on transportation). About 90 percent of the increase in durable goods comes from transportation, or the purchase of vehicles. The biggest issue is that previously workers on minimum wage spent 85 percent of income on non-durable goods (Aaronson et al., 2011).

If New York City plans to increase minimum wage while reducing the cost of living research needs to be done to show if they can reduce greenhouse gas emissions as well as solid waste. In Aaronson's work the largest change in consumption comes from material consumption and transportation possibly jeopardizing sustainability within New York City. To reduce the amount of spending on luxury goods serious social practices would have to be altered. If this vision is carried out allowing a more face-to-face community social practices could change. Education of residents through social services and community groups could help curb some of the problems facing a growing class when it comes to sustainability and consumption.

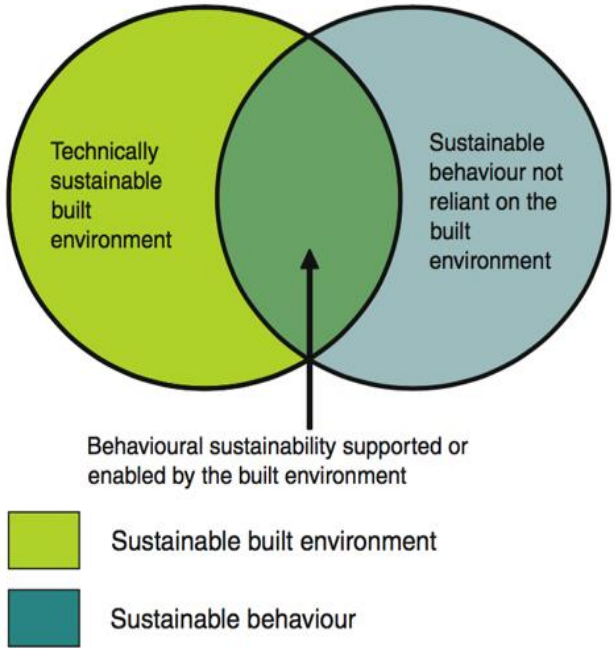
Our Resilient City

Reduced consumption of energy may result indirectly from OneNYC as a product of having accessible key services within each neighborhood. This is very important for different groups of residents such as the unemployed, older people, and young families. It will help reduce

the gap in equity across New York City, which will enable the city to become more resilient (Bramley G. et al., 2010). The OneNYC resiliency vision includes technical changes that do not call for sociotechnical changes to the system in New York City that will change the social behavior around consumption. This vision is calling for improved infrastructure (technology) to prepare for shock events and ensure the city is able to recover even stronger than before. Reduced consumption of energy will be seen through the buildings and infrastructure initiatives that seek to upgrade them against changing climate, make the more efficient, and adopt policies to support infrastructure adaptation.

The issue is that the determinants of energy use are not simply determined by the nature of the built form as it is recognized that lifestyle and the dynamic effects of occupant behavior (Baker K. et al., 2010). Therefore, reluctance to address sustainable consumption in resiliency leaves a gulf between sustainable development of the city and mitigating the effect of climate change. By addressing consumption, the plan would be able to combat climate change along the entire supply chain. Only addressing the infrastructure and building efficiency will create a rebound effect, particularly when the gap in income equality begins to decrease, bringing thousands of New Yorkers out of poverty, enabling them to consume at greater lengths. The relationship between energy consumption in buildings and urban form suggest that while the nature of the building is important, equally important are the ownership and use of appliances and the fitting of energy efficiency measures (Baker K. et al., 2010).

The figure to the right from Williams et al. (2010) shows some elements of the built environment can enable or support behavioral sustainability, which would reduce consumption. For example, New York City should invest in bicycle paths and pedestrian routes, as well as reduce the number of taxis on the road. There are also sustainable behaviors that are not reliant on the built environment, such as New Yorkers social practices. OneNYC address the technically sustainable built environment, but does not thoroughly address sustainable behavior that is not reliant on the built environment. It would be beneficial to include initiatives under the resiliency vision that include consumption because it will help create social practices that will not be devastated during shock events. This can be done through home-based sustainable behavior such as reducing energy consumption, using water efficiently, waste recycling and composting, urban gardening, as well as travel behavior using public transportation or walking/biking. By adopting these sustainable practices, residents will be able to further conserve during shock events. These



practices will also help New York City mitigate the effects of climate change, the ultimate goal of OneNYC.

The initiatives in OneNYC's vision for resiliency sets the foundation to include consumption by creating the link between social participation and the physical environment by providing access to community facilities and amenities within each neighborhood. Including consumption in the plan will also encourage social participation, which is at the cornerstone for building and maintaining social capital, which is one of the goals of OneNYC (Williams et al., 2010).

Growth

Our Sustainable City

The "Our Sustainable City" vision does not address growth or gentrification explicitly, though some of the goals' supporting initiatives relate to these notions. The goal of reducing greenhouse gas emissions stresses increasing renewable energy generation in and outside of the city. Developers of renewable energy could encroach on certain communities, and build installations around the city. This goal also stresses the reduction of greenhouse gas emissions from transportation. The consideration of alternative transportation methods such as walking and biking, using low or zero emission vehicles, increased and improved public transit, and the continued alteration of zoning and parking policies could help this transition (OneNYC, 2015). These sort of changes could significantly change many neighborhoods across the city, though if the changes are properly planned it should benefit neighborhoods by reducing congestion on streets and air pollution from fossil fuel burning vehicles.

The goal of reaching zero waste includes plans of increasing construction by building facilities to accept, sort, and process increased organic waste streams. Implementing community composting has also been proposed to ensure the success of the city-wide composting initiative. Community composting initiatives would be great opportunities to involve and engage residents in an important waste reducing activity while reducing the need for municipality or privately held organic waste processing facilities to be developed (OneNYC, 2015).

Other goals, such as cleaning contaminated land in order to convert it to safe and beneficial use imply growth in order to succeed. For example the first supporting initiative under the brownfields goal aims to clean up, and then redevelop approximately 750 properties, of which 375 exist in "low- and moderate-income communities". This initiative is expected to "enable $14 billion in private investment and create 5,000 new units of affordable housing" (OneNYC, 2015). Remediating polluted and dangerous land is great for the neighborhoods and city but this initiative assumes that all of these sites will turn into construction projects after the environmental issues have been resolved. The city might benefit from considering connecting this goal with the goal of providing and improving upon its parks and natural resources. As long as remediation efforts are successful, brownfields could be turned into parks and open space much easier than into housing or other kinds of development.

The "Our Sustainable City" vision does not guarantee gentrification, though growth appears an inevitable result of its goals and supporting initiatives. The city should consider the

effects of growth critically and analyze how new infrastructure contributes to its enormous environmental footprint.

Our Growing Thriving City

The "Growing Thriving City" vision of the OneNYC plan proposes prosperity through the capitalist framework that New York City is already centered around. As the physical location of America's stock market, it was unlikely that Mayor De Blasio would have proposed a system of prosperity to undermine these capitalist frameworks that are so firmly in place. This vision proposes 8 main goals that focus on growing New York City in its infrastructure, workforce, industries, and culture and thriving neighborhoods. All of these goals are clearly aimed towards expanding economic growth, as a growth in GDP is viewed as a cornerstone of economic prosperity. However, this proposal still attempts to reconcile environmentalism and growth through proposing triple bottom line investments in infrastructure and publicly owned goods. Triple bottom line investments mean that any investments done will produce the highest economic, social, and environmental returns.

This plan does not intend to physically expand the sprawl of New York City, but instead plans to grow its businesses and the economy. Its proposed Small Business First Initiative is intended to make it easy for entrepreneurs to navigate legal parameters. This allows opportunity for people to create more jobs, hopefully living wage jobs, for residents. This section does a good job at promoting consumption of public goods like transportation, but it still works within the capitalist idea of prioritizing growth. This prioritization of growth at all costs has some clear flaws. The economic growth intended is not necessarily growth and prosperity for all. Without implementing citywide living wage and paid sick leave policies, many residents will not see improvements in their quality of life from the growth of the city. The words living wage are only mentioned once in this entire proposal, which can be interpreted to mean that it is not necessarily a priority.

Our Just and Equitable City

As community schools, Neighborhood Health Hubs, and clinics are created jobs will be made in areas of higher poverty (OneNYC, 2015). The plan does not mention them within Vision 2, but if local residents are given some of these jobs they can create further community involvement, along with the ability to reduce commuting. With the creation of more services, infrastructure and housing in low-income neighborhoods gentrification could occur due to increased taxes and rent. But, New York City plans increase and maintains current affordable houses to reduce tax and rent burdens for the lowest income group.

If consumption increases with income, New York City should see economic growth as residents spend more within local communities. Having increased numbers of local services and businesses money will more likely stay in New York as residents consume. Even though increased consumption may not be sustainable, if money recycles longer in low-income communities, economic growth should increase.

Our Resilient City

OneNYC includes the vision to become a resilient city where the neighborhoods, economy, and public services will be ready to withstand and emerge stronger from the impacts of climate change and other 21st century threats. In this plan resiliency is referring to the ability of people, the places where they live, and the infrastructure systems—such as transportation and energy—to withstand a stress or shock event, to recover, and emerge even stronger than before. Through this the city will ensure the growth and well-being of New Yorkers. In order to achieve this New York City will have to achieve social sustainability that is defined by Polese and Stren (2000) as

> Development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population.

This emphasizes the need to empower all sectors of the community to participate in decision-making and to consider the social and community impacts with an emphasis on economic and environmental objectives.

In order for New York City to continue to grow in a sustainable manner, it is vital to employ mitigation within the resiliency efforts. This reduces the impact of a stress or shock event or prevents the impact altogether, such as bolstering the defenses of coastal communities to withstand flooding. The resiliency indicator employed to measure this is to eliminate disaster-related long-term displacement (more than one year) of New Yorkers from homes by 2050. In response to future threats, adaptation takes place to change the physical form or function of a structure, a place, or a community, such as hardening power supplies to withstand the effects of extreme weather and a changing climate. This plays an important role in the growth of New York, not only in the sense of being able to recover from a shock event, but enabling the city to sustain its growing population and demand on the physical infrastructure within the city (OneNYC, 2015).

Michael Berkowitz, President of 100 Resilient Cities, pioneered by the Rockefeller Foundation, said, "To truly build resilience a city must not only consider sustainability and disaster response, but also take into account social and economic issues, and it needs to consider them together" (NYC Press Office, 2015). Growing economic inequality poses challenges to the city's social fabric. Inequality threatens to disrupt the connections between neighborhoods, institutions, and communities that are relied on in times of crisis and prolonged stress. OneNYC addresses these issues of inequality to ensure these connections remain so that recovery is possible (OneNYC, 2015). By considering social, physical and economic issues together, the city will be able to address not only the challenges it knows are coming, but also those it does not anticipate. Making the city stronger overall, in the wake of climate change, makes the city better able to withstand all types of shocks.

By focusing on strengthening the local economy to achieve resiliency, New York can focus on the urbanization of economies that result from the common location of firms belonging

to different and unrelated industries. There are numerous benefits to this including the availability of a range of municipal services, public utilities, transportation and communication facilities, the existence of a wide variety of business and commercial services, and a complementary of labor supply (Henderson, 1974).

Urban transportation is a theme of urban economics because it affects land-use patterns because transportation affects the relative accessibility of goods and services. Issues that tie urban transportation to urban economics include the deficit that most transit authorities have, and efficiency questions about proposed transportation developments (Jones C. et al., 2010). OneNYC has initiatives centered on the transportation sector to improve its efficiency and ability to withstand climate change. One of these initiatives intends to pursue programs that coordinate resiliency investments across city agencies and infrastructure providers and operators (transportation, utilities, cell phone providers, etc.) (OneNYC Indicators, 2015). Improved transportation within the city will enable New Yorkers to access jobs, as well as goods and services that will contribute to the local economy. This is extremely important because cities and urban systems have been subject to decentralization pressures. This is a result of a combination of the transport infrastructure in large cities unable to resolve congestion and increasingly improved inter-urban transport links, which fosters growth in medium sized towns (Jones C. et al., 2010). This enables suburbanization outside of cities with commuters coming into New York, while low-income residents who cannot afford to take advantage of the inter-urban transportation methods remain stuck. By addressing transportation and other infrastructural problems, New York City will be able to decrease the threat of decentralization, which will allow the city to continue to grow.

The fact that NYC is a coastal city is an important factor to its resiliency initiatives. This calls for the need for a diversified economy because it can become extremely difficult to access New York City after a shock event. Local economic growth helps the city recover from emergencies, particularly when outside resources are cut off. To be resilient, New York City cannot solely rely on outside sources for emergency aid. The resiliency indicator to measure this is to reduce the average annual economic losses resulting from climate-related events. This indicator ensures that all resiliencies related initiatives are met because the core threat to resiliency is economic and social issues. By addressing these issues, the city will see reduced economic losses from climate change.

Recommendations

Based on the analyses of each vision under the perspectives of growth, well-being, and consumption, we have developed recommendations for the OneNYC plan to better address social and economic aspects. The following recommendations fit within each vision and their standing initiatives, including open spaces and public parks, local energy and food sources, a measurement of growth, and the economic feasibility of the plan. With these recommendations New York City will be able to bridge any gaps that are present with the plan, as it exists today.

Brownfields to public parks and open spaces

Within the "Our Sustainable City" vision the goals of addressing brownfields, and increasing and improving upon parks and natural spaces are presented separately. Thinking about and restructuring these two goals, as one would be useful for the city in its quest to become more sustainable. Instead of focusing solely on improving parks and natural spaces that already exist, the city should refocus its efforts on increasing the total area of city parks and natural spaces by assigning some of its brownfield land to be turned into parks and open space.

Currently, over 40 percent of New York City's land area is made up of "parks, public spaces, streets, and natural habitats" which are utilized every day by residents and visitors. However, most streets differ significantly from other public spaces such as parks and natural habitat in that they primarily serve vehicles and aid in transportation. The OneNYC parks and natural resources goal that aims to allow all residents to equally benefit from "useful, accessible, and beautiful open spaces" would be more achievable if the goal of transforming contaminated land to constructive and safer uses was reconsidered so some brownfields are turned into natural spaces. New York City has over 10,000 commercial and residential sites that have been flagged for environmental review, up to 40 percent are brownfields. As it currently stands, the city plans to redevelop and turn a proportion of these sites into affordable housing units (OneNYC, 2015) which makes sense considering the expected continued growth in coming years. Nonetheless, additional resources could be utilized to convert remaining brownfields into parks and natural spaces by planting native species of plants and increasing greenery in the urban setting.

Research has demonstrated that natural areas contribute positively to quality of life of urban residents in numerous ways. The most commonly considered impacts are environmental and ecological (e.g. flood suppression, air quality improvements, etc.), however natural spaces in urban settings can also provide residents with psychological and social benefits. Parks have been shown to produce a calming effect in visitors by reducing stress (Ulrich, 1981), which allows for contemplation, rejuvenation, and senses of tranquility and peacefulness (Kaplan, 1985)—experiences and feelings not common to life in urban areas. Chiesura (2004) conducted a study involving a survey and secondary research in the Netherlands to determine why people visit nature in urban settings and what emotional responses are invoked by these visits. The most common reason for visitation was to relax, while feelings of freedom, unity with nature, and happiness were three of the most commonly experienced emotions by survey respondents. In her discussion she claimed these feelings and emotions produced by the park were perceived by those participating as very important to personal well feelings of well-being. When discussing her survey results she wrote:

> Direct benefits are perceived in terms of regeneration of psychophysical equilibrium, relaxation, break from the daily routine, and the stimulation of a spiritual connection with the natural world. All these emotional and psychological benefits contribute critically to the quality of human life, which in turn is a key component of sustainable development. (Chiesura, 2004)

Nature itself is valuable to people for the benefits it provides, even beyond those in the environmental and ecological realm.

By combining these two important goals within the “Our Sustainable City” vision New York City could improve sustainability by offering its residents additional opportunities to visit open, natural spaces and experience beneficial psychological and social impacts firsthand. Parks and natural spaces could help satiate people’s need for novelty, one of the major drivers of consumerism.

Invest in local energy and food sources in preparedness for shock events

New York City has invested in anaerobic digestion in Brooklyn, which will convert local food waste into clean, renewable energy instead of paying millions of dollars each year to send it to landfills. This is an example of how to combat organic waste, as well as investment into renewable energy. Yet, this is not enough, particularly if the goal is to prepare for any future shock events. Therefore, New York City should look into other forms of renewable energy. Renewable energy provides energy "insurance". This is because renewable energy sources lend themselves to distributed generation and microgrids, which will help keep the lights on and the house warm during natural disasters and other grid interruptions (New York State, 2015). This will provide energy resiliency for New York City.

Renewables also provide economic vitality. Locally generated renewables means that the money spent for energy is invested into supporting stable, well-paid jobs, right in New York. Renewable energy products, systems and services are already playing into New York's traditional strength in technology, industry, commerce and finance (New York State, 2015). In continuing to do so, the local economy will become much stronger and help take an abundant amount of New Yorkers out of poverty and into viable jobs.

Investing in local food sources will also strengthen the economy by putting cash flow into urban agriculture. Local food sources in New York City can include community gardens and sustainable forms of agriculture, such as vertical farming and aquaponics. This investment will foster sustainable behavior by encouraging New Yorkers to buy their foods locally and efficiently, without over purchasing and therefore wasting. There should be access to farmers markets in each neighborhood, and it would be beneficial to do so indoors so that they can subsist year round. By having local agriculture and a local, sustainable form of disposal through composting and anaerobic digestion, New York can reduce travel miles for both food and waste, therefore reducing the city’s ecological footprint.

Implement a measure of growth and well-being beyond GDP

New York City should implement a measure of growth and well-being that extends beyond GDP. The SoVI is used as an indicator for resiliency, but there should be an index that measures areas within each vision to get an overall sense of growth and well-being in New York City. An alternate measure a well-being beyond GDP, such as the Canadian Index of well-being

(CIW), should be considered for New York City. This plan intends to improve NYC in a variety of ways, yet still works within the capitalist framework of celebrating constant growth. This plan discusses providing jobs for a variety of NYC residents as well as lifting many of them out of poverty. While increased income may be beneficial it does not provide a well-rounded picture of the lives of New Yorkers. This new index of well-being would allow the NYC government to better analyze the effectiveness of each of their visions and goals as well as pin-point what is still needed. Creating this indicator may even provide less motivation for incessant growth for growth's sake. It would allow government to assess the health of NYC instead of just the size of its economy.

Economic & Environmental Feasibility of OneNYC

The plan needs to include a section on where the funding is coming from for each initiative, and if long term funding is necessary for the subsistence of the plan. Currently the plan includes a section on the different initiatives for each goal under each vision. It states whether the funding is from the state, federal, city level, or N/A, but this does not include whether further funding will be needed to support the initiative in the long-term. Since this plan focuses so heavily on sustainable development for future generations to ensure the continued growth of the city, it is vital to ensure funding is available to make any repairs to the physical changes within New York, as well as social changes that might occur. New York City should also include research on rebounds in consumption when income increases and the gap in inequality shrinks. For those living on minimum wage, increases in consumption can lead to spending greater than increased income (Aaronson et al., 2011). This connects back to the structure of our economic system where increased consumption represents the good life and well-being. Unless this social practice can be broken, increased consumption in New York City due to increased income levels is inevitable; therefore it would be wise to citywide access to broadband to communicate to residents about sustainable practices, as well as financial assistance in saving and investing income. Education about consumption patterns must be included within the visions about increased minimum wage if New York City plans to bring 3.7 million more spending dollars into the city. While this increased revenue for this city will increase GPD, the city should focus on encouraging New Yorkers to spend their money within the local community to ensure New York's growth, not the growth of multinational corporations or Wall Street.

Conclusion

OneNYC is a wide-ranging and comprehensive plan that aims to address growth, inequality, sustainability, and resiliency within New York City. It addresses mostly technical remedies and leaves social practices unaddressed. However, after analyzing the initiatives within the document, it has become clear that some social practices would change as a result of the initiatives the plan proposes to address within its four visions. Reduced consumption of energy will result in the early stages of implementation with infrastructural upgrades and building

efficiency, but this will be met with the rebound effect with increased income of the lower class. Therefore, it is vital in ensure New Yorkers understand the implications of their consumption and sustainable best practices. Incorporating the local communities into each vision and strengthening the social fabric of New York will do this. The plan works towards a “strong and just city”, therefore it tackles issues of social justice and sustainable growth to ensure the city adheres to its highest performance standards, both environmentally and economically. While this plan is not a complete solution to the challenges ahead, it is a step in the right direction. Successfully implementing this plan will place New York City at the forefront of sustainable development and a model for other urban areas.

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Title:

Traditional Medicinals®: a sustainability infusion

Course:

MGMT 5505 – Intro to Greening the Organization

Description and notes:

This final project was completed for Intro to Greening the Organization, a course taken in the Graduate School of Management. Its purpose was to examine our own sustainability ethics, and find a company or organization to make sustainability recommendations for. This work was also presented in class.

Traditional Medicinals®: a sustainability infusion

MGMT 5505 Introduction to Greening the Organization

7 December 2015

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B.A. Environmental Science, 2015

M.S. Environmental Science and Policy, expected 2016

CLARK UNIVERSITY

1. My story and interests:

My interest in sustainability and environmental issues began before I journeyed to Clark University in the summer of 2011. I consider myself indecisive and was no different in high school. As a senior I struggled to decide upon a topic for my senior project so I decided to ask my English teacher what he would choose as a topic had the opportunity to complete one. His response, invasive species, caught my attention even though it was not familiar. That year I went on to conduct a project that included fieldwork with a mentor from the local land trust in Rhode Island. I also independently I investigated invasive plant and animal species and their negative effects on the environment, economy, and society alike to write a cumulative research paper.

The project was eye opening. I had never considered the tremendous damages of invasive species before. Of equal importance was the fact that the project was also enjoyable. I liked working outside, learning to identify different species that were non-native and detrimental to our local ecosystems. This experience really sparked my career as an environmental scientist - it was the development of my own personal land ethic. I hated the fact that I knew very little about the region's local species and functions of the ecosystem. Upon graduation and deciding that I would attend Clark University I figured I should learn more about the natural world around me, and all of its wonder.

To my delight when I arrived at Clark I learned that my major of interest, Environmental Science, incorporated more than I had anticipated. I spent the next few years concentrating on earth systems science by studying interdisciplinary coursework. I became well-versed in climate science and the dooming scenario of global climate change and decided that the best use of my time was not to continue with the earth systems focus that I began my career in higher education with. Though I received a diploma in Environmental Science with a concentration in earth

systems science I had additional interests in business, policy, and understanding what measures could and would have be taken to reduce the human impact on earth and mitigate global climate change. As a result I enrolled as a graduate student in Environmental Science and Policy and ended up taking coursework that made the business case for sustainability abundantly clear.

2. Sustainability from my perspective:

Sustainability is a moving target. Although it has not produced a common definition, or assumed the role as a core subject in our nation's education system I believe it to be the most important notion, or call to action that we as a species should consider. Since a common definition for sustainability has not been agreed upon, the best one can do is learn about it, alter their morals and ethics accordingly, and act in line with these newly developed beliefs. The same standards apply to a business or organization. Instead of a common and simple definition, the term garners many depending on the perspective of the beholder. One of the most pertinent and widely applicable definitions of sustainability is that proposed by Herman E. Daly, "The future should be at least as well off as the present in terms of its access to biophysical resources and services supplied by the ecosystem" (1999). This definition implies that we as a species should not deplete natural resources beyond their capacity for regeneration or harm the ecosystem in a way that reduces its ability to function.

In order for sustainability to be meaningful, and part of a person's moral code or an organization's mission, a Leopoldian land ethic must be developed. In my own experience it was not until after feeling a connectedness to the land that I started to sense a strong obligation to practice and implement sustainability in my own life. In high school, the completion of my senior project and research was this time for me. I spent hours outside appreciating the existence of species and their role in the continued propagation of the environment in which they were

found. I learned about ecology and specific functions of Rhode Island's forested ecosystems, the damages that invasive plant species brought about, but even more importantly than this, I developed a deep respect for the natural world. For a business, organization, or other institution made up of multiple people this is a much more difficult task but it must be accomplished. Not everyone will approach and develop an appreciation of sustainability in way I did. Some will find their respect for the land through other means. For a business that could mean employees conceptualizing the wide array of business functions impacting the earth in negative ways. Most successful organizations today have begun to take sustainability and environmental issues into account, however that does not imply that sustainability has become inherent piece of their corporate culture, mission, or goals. Those that are most successful in their sustainability efforts tend to be led by powerful people who have developed their own versions of a land ethic (eg. Ray Anderson of Interface, Inc.). In these cases sustainability is ingrained in organizational culture. It is never an afterthought but rather at the forefront of all decisions made. If sustainability is introduced to an organization from the bottom up it may still be successfully assimilated into the mission and operations but it will take more time and significant effort.

Thus, a truly sustainable organization will depend on sustainability as a driving force behind its actions, the development of its mission, and conducting its operations. Much of the developed world is late in recognizing the importance of sustainability. Those who have written about sustainability as being the next business megatrend are accurate and will continue to be pertinent long as we experience anthropogenic climate change, pollution, depletion of natural resources, loss of biodiversity, and all other remaining and related environmental issues (Lubin and Esty, 2010). The earth and its resources are finite and being depleted and exploited at unprecedented rates that warrant the attention of all of its occupants, including profit seeking

business people and corporations. Unfortunately, most companies have not transitioned to focus on sustainability. Those that have are realizing its benefits but are presented with obstacles in veering from business as usual operations towards business models that will have a positive impact on the triple bottom line of the environment, economy, and society. The company profiled and critiqued in this work is as close to a sustainable company as any.

3. The organization of choice - Traditional Medicinals:

A company that has truly embraced sustainability to its core, and done so successfully in a for-profit model is Traditional Medicinals® (hereafter referred to as TMs). The company was founded in 1974 by a third generation herbalist Rosemary Gladstar and her husband and community and environmental activist Drake Sadler (Who we are, 2013). In 2014 the company produced 61 herbal medicinal teas which were sourced from 117 botanical components from over 35 countries around the globe and distributed mostly in the United States of America and Canada through "health and natural food stores, cooperative grocers, independent grocers, major grocery chains, mass market retailers, and drug stores". Over 50 percent of the volume of botanical ingredients used in the production of herbal products came from the Republic of India, the Arab Republic of Egypt, the United States of America, and the Republic of Bulgaria (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

The company employs approximately 153 people and has headquarters in Sebastopol, California but also operates facilities in two other locations in the state. It focuses on producing certified organic teas not containing genetically modified organisms (GMOs). They have been certified by a number of programs that attest to their commitment to sustainably producing herbal medicinal products. These certifications and program memberships include being a California Benefit Corporation, Certified B Corporation, California Certified Green Business,

Green America® GOLD certified Green Business, and a California Certified Organic Farmers member. They scored a 134 on their 2014 B Impact Report while the median score of all businesses that had gone through the vetting system was 80. On the environment category of this same report they scored 39 while the median score of other businesses equaled 9 (TMs Sustainability and Benefit Corporation Annual Report, FY2014). As evidenced in this data, TMs is an environmentally and socially progressive company.

3.1 Traditional Medicinals and sustainability:

Stated simply, TM and has literally infused sustainability into its culture and operations and is outperforming most of its competitors on the grounds of sustainability. The company's mission is to make herbal medicines affordable and effective while balancing sustainability, committing to the highest quality ingredients, and simultaneously promoting social and environmental justice. TMs CEO Blair Kellison wrote the following in a letter included in the company's 2014 Sustainability and Benefit Corporation Annual Report, "...we believe the actions we take today around sustainability will on day simply be the norm or the law and that we are just a little ahead of our time". Co-founder Drake Sadler wrote "...really we are in the business of change" in his letter prefacing the same report. These are leaders who understand the importance of ecological and social sustainability and are willing to promote it within their organization.

How does TMs practice sustainability? A more difficult question is where do they not act sustainably? The TMs Sustainability and Benefit Corporation Annual Report from 2014 was denser and more data driven than any other similar corporate sustainability or social responsibility report I had ever read. The report is wide ranging in its themes, and attacks sustainability concerns from all different angles which is something I can attest to doing.

Amazingly, the company has considered, or is planning to consider most every commonsensical sustainability approach appropriate to their business model. That being said sustainability is a moving target and no company can prove itself fully sustainable until it becomes restorative in the environment, society, and economy.

3.1.1. Sourcing practices:

TMs source botanical ingredients that are obtained under verifiable and certifiable sustainability standards that comprise of criteria considering the ecological, economic, and social effects. On top of this, over 40 percent of species collected are from the wild. The company collaborates with stakeholders in these locations to ensure that the botanicals are being obtained in a responsible way that adheres to organic practices. To do so they pursue "organic wild" certification through the United States Department of Agriculture National Organic Program Wild Crop Harvesting Practice Standard.

Social impacts of sourcing are important to sustainability as well because people are such an important part of achieving global sustainability. If communities where ingredients are sourced are not treated fairly they are less likely to lead healthy, positive lives and respect their environment. TMs uses Fair Trade and Fair Wild certifications to ensure third party farmers are treated well. The company also has a policy that sources botanical ingredients from native ecosystems whenever possible. Additionally, no GMOs are used in the production of TMs products or packaging and the company purchases 98.9 percent organic botanical raw materials so land used in the production of TMs supply chain is kept as close to its natural state as possible. Despite all of these efforts TMs is not completely satisfied with its accomplishments in sourcing and plans to achieve 100 percent of its ingredients as fair trade, organically certified,

and non-GMO Project verified by 2024 (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.2. Distribution of products and vehicle emissions:

TMs chooses to buy or lease only environmentally friendly vehicles such as hybrid electric vehicles or alternative fuel vehicles instead of conventional vehicles with internal combustion engines. Though the company does not control its own distribution system it does own a couple trucks that use alternative fuels of biodiesel and diesel. 99 percent of its products are distributed by trucks whereas only 1 percent are flown by airplanes. Because of the nature of the business the company receives approximately 85 percent of botanical ingredients from other countries. However, it does receive 86 percent of packing materials from within the region (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.3 Energy:

TMs practices energy efficiency and conservation. The company reached 100 percent renewable energy in 2014 by combining efficiency and conservation efforts with on-site solar energy production, purchasing off-site renewable energy, and renewable energy certificates. They also are interested in going above and beyond this achievement by setting a goal of obtaining all of electricity from renewable energy sources on-site or locally produced renewable electricity generation in the future (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.4. Climate change and emissions:

TMs recognizes that its business releases climate change inducing greenhouse gases outside the confines of its own facilities. As a result they have a companywide carbon footprint calculated by a third party company. Commuting and other business travel is one of the largest

sources of emissions, creating around 60 percent of the firms CO_2 equivalent emissions. To mitigate this, TMs encourages employees to reduce their carbon footprints by providing with $5 per day to those that carpool, walk, use public transport, or take a bicycle to work. A newer, and very important goal adopted is to prioritize video conferencing before of traveling for meetings when appropriate (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.5. Water:

Water is a resource of utmost importance, especially in the state of California which has faced extreme drought in recent time. TMs successfully reduced well water usage by using water saving faucets, toilets, dishwashing, and encouraging water conservation via employees, among other practices. The company is currently looking into additional water conservation and reuse practices such as rainwater collection and black water purification (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.6. Solid waste:

TMs has a goal in place to be zero waste and divert all waste streams from landfills or incinerators. This plan is to be met by combining multiple policies and programs within the company. Primarily the company will rely on composting all food and plant waste, eliminating all disposable products in its facilities (eg. dishes, cups, etc.), recycling, and reusing waste when appropriate. Over the course of just two fiscal years the company has been able to divert close to 50 percent of its landfill output but it has a ways to go to reach zero waste (TMs Sustainability and Benefit Corporation Annual Report, FY2014). The goal of attaining zero waste relates to the concepts of industrial ecology which stresses the elimination of waste, and the reuse of outputs as new inputs in separate production systems.

3.1.7. Packaging materials:

TMs is delivering their products in more efficient and environmentally responsible packaging over time. Their policy is to use “sustainable and responsible packaging materials” whenever available. TMs even exclude GMOs from packaging. Though the company shipped close to 22 percent more product by weight in 2014 compared to 2013, they only increased the weight of packaging materials by around 11 percent. The Operation Department is in the process of looking into additional means of reducing packaging weight and waste by eventually phasing out tea bags with string and tags (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

3.1.8. Labor:

Labor is extremely important to the pursuit of sustainability within any organization. Sustainability practices often require the full engagement and support of employees. A labor force that is happy and finds work to be financially and personally rewarding is beneficial in any company, especially one with ambitious sustainability goals. All but 2 percent of workers received a living wage in 2014, benefit packages are fairly generous and include medical and dental benefits, paid holidays, paid time off for full time employees, and other financial incentives. The company stresses the health and safety of its employees as it is a part of what the company culture (TMs Sustainability and Benefit Corporation Annual Report, FY2014). One could also imagine that work would be rewarding becauase many sustainability initiatives and goals are in place.

3.1.9. Education:

Education is an integral part of the sustainability revolution. TMs policy is to educate its own employees about environmental issues, and what related company policies exist. Externally the company also takes responsibility to provide the public with information about what

sustainability practices the company is pursuing, and why they are important in the grander scheme of global climate change and environmental problems. Social media platforms and the company website are important outlets used to reach the company's customers. An aspect of education that is not stressed enough on consumer products are clear sustainability statements on product packaging. In the case of TMs products, the company provides recycling logos, information on renewable energy that was used to produce the herbal medicine, and information on composting of tea bags to spur behavior change (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

4. Tactical recommendations:

Despite the long and yet incomplete list of sustainability practices and policies listed here, TMs could benefit from additional tactical changes to their business operation.

4.1. Introduction of electric vehicles:

One of the only straightforward sustainability initiatives that TMs is missing in its current operation is in its small fleet of vehicles. Although the company has a policy to purchase or lease vehicles that are environmentally friendly, the company does not own a single all-electric vehicle as part of its fleet. Over time, as its diesel, hybrid electric, and petroleum based vehicles come upon their end of life TMs should investigate replacing them with all-electric vehicles. The company could utilize electric vehicles to decrease air pollution, carbon emissions, and costs of operating their fleet. All-electric vehicle technology is rapidly improving along with the batteries it depends on. All-electric vehicles typically cost less to operate over their lifetimes compared to conventional internal combustion vehicles because relatively little maintenance is required to keep them in operation, and the electricity it takes to power them costs less per unit of energy than does liquid fuels (Alternative Fuels Data Center). Since the company is already striving to

obtain all its energy from on-site and local renewable energy sources, the introduction of electric vehicles over time could significantly reduce greenhouse gas emissions from travel. Electric vehicle charging stations also could be installed on the three facility sites to provide carbon free energy to an electric vehicle fleet free of tailpipe emissions. Providing electric vehicle charging stations at the facilities also would encourage employees who commute to work via car to consider purchasing plug-in electric vehicles to decrease their environmental footprints.

4.2. Rethinking single serve product cups:

Based on the description provided of TMs you might be surprised to learn that the company sells a selection of its product offerings in the infamous Keurig® K-Cup®. These single serve teas are designed to be used to create one drink at a time, and the single serve cup with which the tea is brewed is discarded and assumed to end up in landfill because it is not biodegradable, recyclable, or compostable. The inventor of the original product, John Sylvan, has even denounced his own invention after the technology that he designed to be used primarily in office settings became much more popular than he had ever anticipated and responsible for huge amounts of waste (Hamblin, 2015). The company goes against its own environmental ethics in selling these products to customers, but justifies the production and sale of them by assuming their non-GMO and organic teas reach new customers that normally would not buy them. Additionally, TMs internal policy is to not use any single serve coffee makers within their own facilities or use any landfill disposable products at all for the consumption of food or beverages (TMs Sustainability and Benefit Corporation Annual Report, FY2014).

TMs has claimed that a compostable single serve product does not exist to serve their needs yet. Although this may have been the case, companies are currently racing to create biodegradable cups for use in Keurig® K-Cup® brewers. According to the company website,

Canadian coffee roaster Club Coffee has announced the invention of PõrPod100™, and has claimed their product is the first fully compostable single serve coffee cup ever. With this product, Club Coffee is targeting the 25 million single serve brewers in operation in North America and hoping to increase this number to include some customers who used to be against the convenient single serve coffee because of environmental impacts. Club Coffee also sells a product line of teas as well in single serve cups, though they do not advertise these as being compostable.

TMs should partner with Club Coffee, or other promising manufacturers of single serve cups to create a fully compostable single serve tea cup if they plan to continue serving their own single serve products. The single serve tea product line goes against everything else the company stands for, so either investing in research and development to aid the creation of a suitable alternative, or halting production are the most appropriate means of advancing while maintaining true to their mission and values.

5. Conclusions:

TMs has made sustainability part of its normal operations. Though the company is investing a significant amount of effort and resources in sustainable initiatives, they are chasing a moving target and cannot account for and predict every possible best practice within their sector of herbal remedies. Like myself, TMs considers sustainability more as a means of maintaining a healthy business, planet, and society, rather than an end to be attained. In order to become an even more sustainable organization TMs could invest in purchasing a fleet of electric vehicles and development of compostable single serve cups. Electric vehicles could curb the company's emissions of greenhouse gases greatly, especially if they also invest in electric vehicle charging stations which be powered from their renewable energy sources. Innovating the next

compostable single serve cup for tea is a goal that would help TMs pursue zero waste and also have global benefits if the product was adopted by other coffee brewers around the world. Single serve cups and brewers are very popular and compostable cups would limit the waste that owning and operating these machines generates.

TMs sustainable practices mirror the way that I try to live my own life. I always am taking into account everything within my power to reduce the environmental impact I have on the earth. I respect TMs for their commitment to all aspects of sustainability and think that other companies could serve to benefit from imitating their sustainable practices. TMs are truly a sustainability infusion!

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Title:

IDCE Internship Report

Course:

IDCE 398 – Internship

Description and notes:

The following IDCE Internship Report was completed after I had spent a summer working for National Grid, Inc. as an intern. It outlines a description of the company itself, my role and responsibilities, as well as some lessons learned.

IDCE Internship Report

Please answer the following questions and submit your report to the IDCE Career Development Office, not more than four weeks after the internship is completed (by October 15 for summer internships). For GISDE students who will graduate in December under the internship option, this exact date should be coordinated with your advisor and the final project's deadline.

Student Name: Nathaniel Lapides

I. Description of the sponsoring organization

- What is the organization's mission?

National Grid's mission is to provide electricity and gas safely, reliably, and efficiently to its customers.

- What are its main areas of work and expertise, and where does it carry out its mission (in the U.S., other countries)?

National Grid US specializes in delivering electricity and Natural Gas to its customers in the northeastern United States. National Grid also operates in the United Kingdom where it is headquartered.

- What is the organizational structure (e.g., staff composition, gender, cultures, etc.)?

The organizational structure of National Grid is mixed because it is a large company. There are a number of people with varying backgrounds that work for the company. Over the course of my internship I worked with five other interns from Worcester Polytechnic Institute who were entering their third year of undergraduate studies. Our group was mixed terms of our academic backgrounds. Two of the interns were international students. I worked under the supervision of one experienced intern from Clark University who had spent a couple of years as an intern with the company and had already graduated with an M.S. in Environmental Science and Policy. I reported to the manager of the Sustainability Hub, Colleen Gardner, who has a many years of experience in a number of functions within National Grid.

- What are the organization's strengths? What areas need attention?

It is difficult for me to speak on the behalf of the entire organization of National Grid, Inc. I can more accurately comment on what I observed at the Sustainability Hub. The hub is an incredible space that was well designed and thought out. Its strengths include the fact that it is staffed by university interns, it is located near a university, and is meant

to address the needs of customers and other community stakeholders. The advertisement and overall presence of the Sustainability Hub could be improved to increase its effectiveness in achieving its goals.

- How effectively does it accomplish its mission?

National Grid effectively accomplishes its mission by adhering to certain company guidelines. It is an extremely safety conscious organization that prides itself in employee and customer safety. It also effectively delivers electricity to its customers by following regulatory oversight. The company is investing in ways to deliver electricity more efficiently to its customers as well as is evidenced by the Smart Energy Solutions smart grid pilot program in the city of Worcester.

II. Description of the Internship Responsibilities

- Describe your responsibilities in the internship.

I had a number of responsibilities during the internship. I had to become comfortable and well versed with all aspects of the Sustainability Hub and the tour that is offered to visitors. This included learning about the history of the Sustainability Hub, background on the company, and detailed knowledge of all of the technology. I also had to create learning modules to present to schoolchildren to help teach them about themes relating to sustainability. These modules contained two parts: a presentation and interactive activity. I learned and performed presentations and activities at for children at the Worcester Parks and Recreation Series summer camps throughout the city. This included leading a similar oral presentation with a visual poster aid, followed by a hands on activity. I proctored the Sustainability Hub during meetings and help internal and external groups set up media for their needs. I worked at a number of outreach events throughout the summer including Worcester Bravehearts college baseball games and farmer's markets at Beaver Brook and the Main South YMCA in Worcester. I completed weekly visitor summaries to keep records of operations and all that happened throughout the week.

- How was your internship connected to the organization's mission?

My internship was directly connected to the organization's mission regarding electricity distribution and transmission. My role supported the success of the Smart Energy Solutions smart grid pilot program in the city which is an effort to modernize the antiquated electric grid and provide customers more control over their energy management. I was able to support this effort which directly relates to the ability for the company to more safely, reliably, and efficiently provide electricity to its customers.

III. Assessment of Your Internship

- What did you learn during this internship?

I learned a great deal about the culture and operations of National Grid as a whole. I also learned about the smart grid technology in the city and its benefits to customers and to the company. I learned to take initiative of responsibilities at the hub.

- How well did the internship relate to your course of studies and/or overall career goals?

This internship related directly to my course of studies as well as my overall career goals in that I dealt with energy and sustainability. Someday I hope to help facilitate the expansion of renewable energies and other technology that will expand sustainability efforts. I am interested in pursuing a career that helps to mitigate the human effects on climate change and reduce our overall impact on the earth. National Grid's goal to modernize the electric grid means energy will be transmitted and distributed to customers more efficiently. Since I was able to help work towards this mission I was also striving towards the career goals mentioned.

- Would you recommend this internship for other IDCE students? Please explain.

I would recommend this internship to other IDCE students because it offers multiple opportunities to expand important professional skills. Interns are asked to work on a number of different tasks relating to outreach, education, and customer service. Despite the diverse type of work that interns are tasked with (outreach, administrative, operations, customer service, etc.) I did not feel overwhelmed with what I was asked to do. In addition, I always knew I had the support of peers within the company if I needed guidance.

Title:

Determinants of National Football League ticket prices

Course:

GEOG 247 – Intermediate Quantitative Methods

Description and notes:

This Intermediate Quantitative Methods final project focused on using multivariate regression analysis to determine what factors are most influential in determining ticket prices at National Football League franchises.

Determinants of National Football League ticket prices

Nathaniel K. Lapides
Intermediate Quantitative Methods
Clark University
16 December 2014

Introduction

The National Football League (NFL) is a massive business. The league as we know it today has formally existed since the year 1970 when the National Football League and the American Football League merged. Recent estimates have cited that the league generates nearly $10 billion yearly, $1 billion in operating profit, and its 32 franchises combined are worth more than $30 billion (Quinn, 2012). The NFL is much more massive than the next largest sporting league in North America, Major League Baseball (MLB). The revenue of the NFL is approximately 50% greater than that of the MLB. A smaller portion of the leagues' revenue has been coming from ticket sales recently. However, ticket sales still make up a significant portion of the revenue (Quinn, 2012).

Despite all of the success of the NFL and other professional sporting leagues, little research has been conducted with the purpose of determining the factors most heavily influencing ticket prices. According to Drayer and Rasher (2013), sport pricing in general is underrepresented in sports marketing literature and journals. It is well known that ticket prices and consumer demand influence one another and are strongly correlated (Drayer and Rasher, 2013). However, what is not well understood is how other factors such as team performance, and demographics of the teams' fan base influence consumer demand and how the tickets are priced by professional sports organizations such as teams in the NFL.

The purpose of this study is to use multivariate linear regressions to analyze NFL ticket price and attempt to quantify what variables, relating to team performance or fan demographics, most heavily influence the prices of NFL tickets. A number of independent variables related to both NFL teams' performance and socio-economic fan information is used to determine which variables are the best indicators for the dependent variable, average NFL ticket price.

Data and Methods

Data

Multiple data were needed to conduct this statistical study. Data regarding NFL teams' fan base at the county level, average ticket price for the 2014 season, team performance indicators, and socio-economic indicators were all obtained. The dependent variable, average ticket price in

2014 was obtained for each one of the 32 NFL teams from the Team Marketing Report 2014 NFL report (see Table 1 below).

Table 1. Displays 2014 average NFL ticket prices for all 32 NFL teams. Sorted by ticket price from high to low.

NFL_TEAM	TEAM_ID	Avg_Tix _Price [USD]
New England	NE	122
San Francisco	SF	117
N.Y. Giants	NYG	111.69
Dallas	DAL	110.2
Chicago	CHI	108.44
N.Y. Jets	NYJ	105.66
Washington	WAS	102
Baltimore	BAL	100.19
Philadelphia	PHI	98.69
Houston	HOU	88.98
Minnesota	MIN	88.53
Denver	DEN	87.96
Indianapolis	IND	86.32
Green Bay	GB	85.61
New Orleans	NO	84.87
San Diego	SD	84.55
Pittsburgh	PIT	83.97
Arizona	ARI	82.15
Seattle	SEA	80.77
Atlanta	ATL	78.58
St. Louis	STL	73.86
Detroit	DET	72.98
Carolina	CAR	72.44
Cincinnati	CIN	71.26
Kansas City	KC	68.38
Tennessee	TEN	67.15
Miami	MIA	65.16
Oakland	OAK	64.8
Tampa Bay	TB	63.59
Buffalo	BUF	62.01
Jacksonville	JAC	57.65
Cleveland	CLE	54.2

Source: Team Marketing Report

The average ticket price for 2014 variable is defined by Team Marketing Report as "a weighted average of season ticket prices for general seating categories, determined by factoring the tickets in each price range as a percentage of the total number of seats in each ballpark". "Premium seating (tickets that come with at least one added amenity)", and luxury suites are not included in the ticket average (Team Marketing Report, 2014).

Socio-economic data was obtained from the United States Census Bureau American Community Survey website. The "Selected Economic Characteristics" data are from the 2013 American Community Survey 5 Year Estimate and are based on a sample which is subject to sampling variability. These data represent different economic estimates for a period from 2009-2013. The data are at the county level for all of the 3,144 counties (or county equivalents) in the contiguous United States, Washington D.C., Alaska, and Hawai'i. Some states use geographical delineators other than counties, such as boroughs, or parishes. These cases in which other geographical delineators are used are included in the data set as well.

The specific socio-economic variables chosen for analysis from within the "Selected Economic Characteristics" data are the following: "Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force – Unemployed", "Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)", "Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families". A number of other potentially appropriate socio-economic data exists in the data set, other additional economic indicators were not included in addition to the ones already stated in an attempt to run the analysis without redundant variables.

NFL fan data was obtained at the county level from Sean J. Taylor of the Facebook Data Science Team. Taylor published a map of the United States showing each counties' favorite NFL team (see Figure 1a in Appendix A) based on Facebook Data Science Teams' analysis of Facebook 'likes' and other social media parameters. In this data set 3,104 observations (counties) have a unique "ID" code that matches the "GEO.id2" code present in the census data. The 3,104 observations present for this data set represent all 32 NFL teams and all 50 of the states in the United States. The counties or county equivalents that are not included in the NFL fan data set

have relatively small total populations. As such, there may have not been sufficient Facebook data available to attribute these counties' loyalty to a specific NFL team.

Attendance data for each of the 32 NFL teams was obtained from http://espn.go.com/nfl/attendance/_/year/. This data is for the attendance of games when the team is considered home only. The data was compiled for the years 2010 through 2013 as these years contained complete records for all teams in the league. The specific variables used in the regression analysis from the attendance data are "Average attendance 2010-2013" and "Percent capacity 2010-2013" of the stadium.

Team performance data was also obtained from http://home.jps.net/~fos/nfl/10snfl.htm, a website that compiled historical NFL statistics and records. The data used is from the current decade (2010-present) and is complete for all 32 NFL teams. "Win percentage" was the variable used specifically in the regression analysis.

Methods

Data was obtained from the sources listed above and compiled into a Microsoft Excel workbook where it was cleaned and prepared for data analysis. Multiple worksheets were utilized to keep socio-economic, NFL team performance, and attendance data separate. A 2 or 3 letter Team ID code was added to each worksheet with NFL team data so that each one of the NFL teams had a unique identifier (i.e. "NE" for the New England Patriots). The attendance and census data required a bit more manipulation. Attendance data from 2010 through 2013 were combined to create a more robust variable. Specific columns out of the census data were chosen for analysis and are mentioned in the "Data" section.

A merge of the census data and NFL fan data by county was performed using the common county identifier variable in IBM SPSS Statistics 22. In the census data set this was called "GEO.id2" and in the NFL fan data set it was referred to simply as "ID". In both data sets this unique identifying code was renamed "GEO.id2" in order to perform the merge. Afterwards this was performed, the NFL fan data was successfully added as an additional variable to the previously existing census data worksheet in SPSS. See Table 2a. below for information regarding how many counties support each NFL team.

Table 2a. Displays the number of counties that each NFL is supported by in terms of fans. 40 observations are missing.

NFL_TEAM

		Frequency	Percent	Cumulative Percent
Valid		40	1.3	1.3
	ARI	10	.3	1.6
	ATL	165	5.2	6.8
	BAL	16	.5	7.3
	BUF	15	.5	7.8
	CAR	49	1.6	9.4
	CHI	132	4.2	13.6
	CIN	64	2.0	15.6
	CLE	28	.9	16.5
	DAL	669	21.3	37.8
	DEN	178	5.7	43.4
	DET	70	2.2	45.7
	GB	142	4.5	50.2
	HOU	10	.3	50.5
	IND	95	3.0	53.5
	JAC	11	.3	53.9
	KC	169	5.4	59.3
	MIA	25	.8	60.1
	MIN	241	7.7	67.7
	NE	70	2.2	69.9
	NO	218	6.9	76.9
	NYG	62	2.0	78.8
	NYJ	1	.0	78.9
	OAK	24	.8	79.6
	PHI	24	.8	80.4
	PIT	272	8.7	89.1
	SD	4	.1	89.2
	SEA	83	2.6	91.8
	SF	47	1.5	93.3
	STL	38	1.2	94.5
	TB	12	.4	94.9
	TEN	92	2.9	97.8
	WAS	68	2.2	100.0
	Total	3144	100.0	

Next, a number of the other variables used in the analysis were extrapolated to the county level. This was performed by using the *Compute Variable* function under *Transform*. The 2014 average ticket price variable was extrapolated for each of the 32 teams to the counties that they were assigned to. The 2010-2013 attendance data, including both the average attendance and the percent capacity, were extrapolated to the county level. The team performance data including winning percentage during the 2010s was also extrapolated to the county level.
Descriptive statistics were run on the data set to obtain information relating to the variables to be used in the analysis. See Table 2b. below for more information.

Table 2b. Descriptive Statistics table below displays the pertinent statistics of 6 independent variables and the dependent variable of interest, AVG_TIX_PRI_2014 for the linear regression analysis.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	3143	20	0	20	5.25	.037	2.1	4.3
Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	3143	114945	31654	146599	59526.5	254.8	14282	203975779.2
Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	3143	45	0	45	12.2	.1	5.6	31.7
AVG_TIX_PRI_2014	3104	67.80	54.20	122.00	90.5797	.28998	16.2	261
WINNING_%_2010s	3104	48.60	27.60	76.20	52.7115	.17607	9.8	96.230
AVG_ATTENDANCE_2010_13	3104	34700	52583	87283	71813.4	174.6	9731	94692459.2
ATTENDANCE_%_CAPACITY_2010_2013	3104	25.9	83.2	109.1	99.4	.1	6.5	42.2
Valid N (listwise)	3103							

The multivariate linear regression analyses were performed next using the Enter method. The default P-values to enter and removed were left at .05 and .10, respectively. First a linear regression was run with "AVG_TIX_PRI_2014" as the dependent variable using the performance and attendance variables only as independent variables. These independent variables included "WINNING_%_2010s, AVG_ATTENDANCE_2010_13, ATTENDANCE_%_CAPACITY_2010_2013". See Appendix B for a complete output results from this analysis.

Next a multivariate linear regression was run with "AVG_TIX_PRI_2014" as the dependent variable using the socio-economic variables only as independent variables. These independent variables included "Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force – Unemployed, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars) Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families". See Appendix C for complete output results from this analysis.

Lastly, a multivariate linear regression was run with "AVG_TIX_PRI_2014" as the dependent variable and all other socio-economic, performance, and attendance variables as the independent variables. See Results and Appendix D sections for complete output results from this analysis.

Results

The results described are from the final regression using all of the independent variables to predict the dependent variable, average NFL ticket price in 2014. The descriptive statistics (*see Table 2. in Methods above*) table provides important information related to the different variables used in the linear regression analyses. The socio-economic variables all have a greater sample size of 3,143 compared to the performance and attendance variables' sample size of 3,104. This is due to the differences in the number of observations in the census and NFL fan data. The mean household income data has the greatest Range, Std. Deviation, and Variance of the grouping of socio-economic indicators. This variable has a range of 114,945 USD, and a Std. Deviation of 14,282.01 USD. The average attendance variable has the greatest variation of the performance

and attendance variables. The range is 34,700 people, and the Std. Deviation is 9,731 people. The final listwise N for this analysis is 3,103 observations.

The Correlations table (*see Appendix D, Table 21*) displays the level of correlation among all of the variables used in the final regression analysis. The variables most highly correlated with the dependent variable average ticket price are average attendance from 2010-2013 and attendance capacity from 2010-2013. The next greatest correlation with the dependent variable is the winning percentage 2010s variable. The socioeconomic variables have a lower correlation with the dependent variable. There also exists correlations among the independent variables used in the analysis. For example, average attendance from 2010-2013 and attendance capacity from 2010-2013 have a high .correlation of .743. A relatively high negative correlation, -.646, occurs between the mean household income and percentage poverty level variables, indicating some multicollinearity.

The Model Summary table provides important information related to the overall success of the regression analysis (*see Table 23 below*). The R Square value of .559 indicates that 55.9% of the variation in the dependent variable "AVG_TIX_PRI_2014" is explained by the predictor variables. The Durbin-Watson statistic of .857 specifies the level of positive autocorrelation in the data. This value indicates that there exists some correlation between the residuals of the variables.

Table 23. Displays the Model Summary from the final regression output.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.748[a]	.559	.558	10.74175	.559	653.753	6	3096	.000	.857

a. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, WINNING_%_2010s, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, AVG_ATTENDANCE_2010_13

b. Dependent Variable: AVG_TIX_PRI_2014

The ANOVA table (*see Table 24 below*) displays the sum of squares of the regression and of the residuals. The associated F statistic of the regression is 653.753 and the Sig. value is .000, meaning the regression is strong and there is essentially no possibility that the independent variables do not have an effect on the dependent variable, "AVG_TIX_PRI_2014".

Table 24. Displays ANOVA from final regression output.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	452600.247	6	75433.375	653.753	.000[b]
	Residual	357232.242	3096	115.385		
	Total	809832.489	3102			

a. Dependent Variable: AVG_TIX_PRI_2014

b. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, WINNING_%_2010s, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, AVG_ATTENDANCE_2010_13

The final regression equation that can be used to predict the dependent variable is generated using the Coefficients table (*see Table 25. in Appendix D*). This table provides the equation constant, and the associated standardized and unstandardized coefficients. The only variable that was found to not be significant was the "Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families" variable. When considering the other variables, the equation $Y_p = -85.417 - .326x + .248x_2 + 1.77x_3$ predicts the dependent variable. In this equation x = "Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force – Unemployed", x_2 = "WINNING_%_2010s", and x_3 = "ATTENDANCE_%_CAPACITY_2010_2013". The other variables not included in this regression equation have an unstandardized coefficient value of .000. The Collinearity Statistics also included in the Coefficients table provide information relating to the degree of multicollinearity present in the data. The average attendance 2010-2013, attendance capacity

2010-2013, and poverty percentage variables all have VIF values greater than 2 indicating that they have relatively high degrees of multicollinearity.

Discussion

This linear regression analysis indicates that of the six variables used to attempt to predict the dependent variable, average ticket price during the 2014 NFL season, three are useful in the creation of a final multivariate linear regression equation. The three variables that are used in the equation are percentage of adults in the labor force who are unemployed, winning percentage in the 2010s, and attendance capacity from 2010-2013. The winning percentage in the 2010s and attendance capacity from 2010-2013 variables both increase ticket prices as they increase. The percentage of adults unemployed variable has the opposite effect, it decreases ticket price as it increases. Other variables have an impact on determining ticket price as well, however they have unstandardized coefficients of .000. These include the mean household income and average attendance variables. The Standardized Beta Coefficients of these variables indicate that they have some impact on average ticket price. The mean household income variable has a .232 Beta coefficient and the average attendance variable has a .262 Beta coefficient but both have unstandardized coefficient values of .000.

Limitations

There are a number of limitations to this quantitative study of the determinants of NFL ticket prices. One of the most obvious limitations is the lack of prior knowledge regarding the topic in academia. This analysis had to be an exploratory because there is very little academic literature on how sports ticket prices are determined (Drayer and Rascher, 2013). The selection of indicator variables was based mostly off of intuition rather than the findings of other studies. The ticket price variable also has some limitations, one being that it does not take into account premium seating or luxury suites (TMR, 2014). Although these tickets probably only make up a small portion of the attendees at NFL games, including these ticket categories would likely alter the average ticket prices at games. Another downfall of the ticket price variable is that it fails to take into account the tickets that are resold at above the original price points set by NFL organizations. The original price points set by NFL organizations is not accurate as to what NFL fans actually are willing to pay for tickets. Some teams that are constantly selling out their tickets

to games not only have a higher ticket price point set by the organization, but also have a greater demand for tickets on the internet marketplace, consequently driving ticket prices much higher above their original price points.

Other parts of this analysis had limitations as well. There only was one performance variable, winning percentage during the 2010s. It may have been beneficial to include a variable or two related to the longer term history and record of success of the NFL teams, such as playoff appearances, or Super Bowl Championships.

In terms of the attendance variables, the percentage capacity variable was not defined by the data source, http://espn.go.com/nfl/attendance/_/year/. Logically, percent capacity should not be above 100%. However this was not this case, a number of stadiums and NFL teams had average percent capacities that exceeded 100%. Additional investigation into this variable is warranted. Also, it was not specified whether the average attendance variable was representative of actual attendance figures or paid attendance figures. Actual attendance is often less than the paid attendance for sporting events. This is likely only a minor discrepancy and probably would not affect the outcome of the quantitative analysis.

Future directions

This research was very exploratory and there are a number of avenues that future studies could investigate to get a better idea of the factors influencing pricing in the NFL. Researchers could take a look into the "Fan Cost Index" published by the Team Marketing Report (TMR, 2014). This variable takes into account other costs generally associated with attending a NFL game, such as parking and the cost of a soft drink or beer.

Also, it might be worthwhile to look into additional socio-economic factors to see if another type of income variable explains a greater amount of the variation in average NFL ticket price. Variables such as per capita income, median household income, median family income, median male earnings, and others could potentially be important in setting NFL ticket prices. These variables were not included in this analysis specifically because they would have been redundant and caused the analysis to become statistically not significant.

Conclusion

The quantitative linear regression analyses performed in this study indicates that the factors most influential in determining NFL ticket prices are the percent capacity of stadiums, percentage of the county adult fan base that is unemployed, and winning percentage during the 2010s. These factors, along with the remaining indicator variables explained .559 of the variation in the dependent variable, average NFL ticket price. The multivariate regression analysis statistical technique used in the study was appropriate for attempting to address the research objective of identifying the factors that most heavily influence NFL ticket prices.

References

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Team Marketing Report. (2014). https://www.teammarketing.com/public/uploadedPDFs/FOOTBALL_FCI_TWENTYFOURTEEN.pdf

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U.S. Census Bureau, 2009-2013 5-Year American Community Survey

Appendices

Appendix A – NFL Fan Data maps

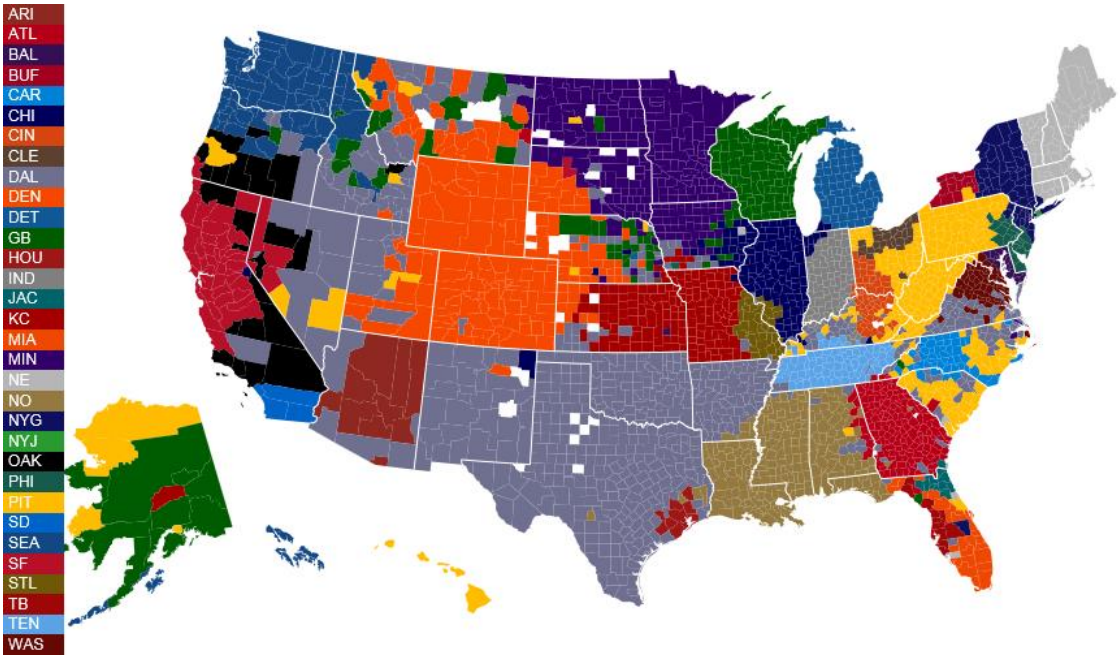

Figure 1a. Displays the 2013 Facebook fans of NFL teams map (used in this study).

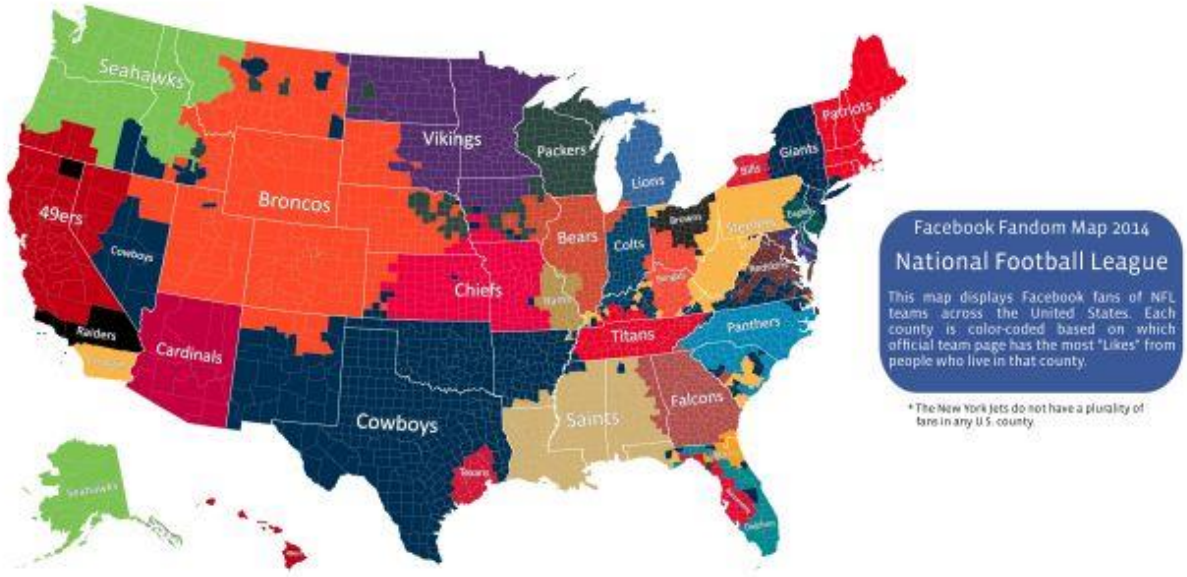

Figure 1b. Displays the 2014 Facebook fans of NFL teams map (not used in this study). *According to this map the New York Jets do not control the majority of the fan base in any county in the United States.

Appendix B – Contains the resulting outputs from the regression analysis using only performance and attendance data to predict the dependent variable.

Table 3. Displays the Descriptive Statistics for the variables used in the performance and attendance regression analysis.

Descriptive Statistics

	Mean	Std. Deviation	N
AVG_TIX_PRI_2014	90.5797	16.15595	3104
WINNING_%_2010s	52.7115	9.80967	3104
AVG_ATTENDANCE_2010_13	71813.4285	9731.00505	3104
ATTENDANCE_%_CAPACITY_2010_2013	99.4372	6.49586	3104

Table 4. Displays the Correlations for the variables used in the performance and attendance regression analysis.

Correlations

		AVG_TIX_PRI_2014	WINNING_%_2010s	AVG_ATTENDANCE_2010_13	ATTENDANCE_%_CAPACITY_2010_2013
Pearson Correlation	AVG_TIX_PRI_2014	1.000	.221	.619	.673
	WINNING_%_2010s	.221	1.000	.015	.157
	AVG_ATTENDANCE_2010_13	.619	.015	1.000	.743
	ATTENDANCE_%_CAPACITY_2010_2013	.673	.157	.743	1.000
Sig. (1-tailed)	AVG_TIX_PRI_2014	.	.000	.000	.000
	WINNING_%_2010s	.000	.	.200	.000
	AVG_ATTENDANCE_2010_13	.000	.200	.	.000
	ATTENDANCE_%_CAPACITY_2010_2013	.000	.000	.000	.
N	AVG_TIX_PRI_2014	3104	3104	3104	3104
	WINNING_%_2010s	3104	3104	3104	3104
	AVG_ATTENDANCE_2010_13	3104	3104	3104	3104

ATTENDANCE_%_CAPACITY_2010_2013	3104	3104	3104	3104

Table 5. Displays the Variables Entered/Removed from the performance and attendance regression analysis.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	ATTENDANCE_%_CAPACITY_2010_2013, WINNING_%_2010s, AVG_ATTENDANCE_2010_13[b]	.	Enter

a. Dependent Variable: AVG_TIX_PRI_2014

b. All requested variables entered.

Table 6. Displays the Model Summary from the performance and attendance regression analysis.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.712[a]	.506	.506	11.35553	.506	1060.349	3	3100	.000	.691

a. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, WINNING_%_2010s, AVG_ATTENDANCE_2010_13

b. Dependent Variable: AVG_TIX_PRI_2014

Table 7. Displays the ANOVA from the performance and attendance regression analysis.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	410189.852	3	136729.951	1060.349	.000[b]
	Residual	399738.898	3100	128.948		
	Total	809928.750	3103			

a. Dependent Variable: AVG_TIX_PRI_2014

b. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, WINNING_%_2010s, AVG_ATTENDANCE_2010_13

Table 8. Displays the Coefficients from the performance and regression analysis.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-63.8	3.4		-18.9	.000	-70.4	-57.151					
	WINNING_%_2010s	.247	.021	.15	11.6	.000	.2	.289	.2	.2	.1	.95	1.1
	AVG_ATTENDANCE_2010_13	.000	.000	.3	15.7	.000	.000	.001	.6	.3	.2	.44	2.3
	ATTENDANCE_%_CAPACITY_2010_2013	1.1	.04	.4	22.1	.000	.96	1.156	.7	.4	.3	.43	2.3

a. Dependent Variable: AVG_TIX_PRI_2014

Table 9. Displays the Coefficient Correlations for the performance and attendance regression analysis.

Coefficient Correlations[a]

Model			ATTENDANCE_%_CAPACITY_2010_2013	WINNING_%_2010s	AVG_ATTENDANCE_2010_13
1	Correlations	ATTENDANCE_%_CAPACITY_2010_2013	1.000	-.217	-.750
		WINNING_%_2010s	-.217	1.000	.153
		AVG_ATTENDANCE_2010_13	-.750	.153	1.000
	Covariances	ATTENDANCE_%_CAPACITY_2010_2013	.002	.000	-1.140E-6
		WINNING_%_2010s	.000	.000	1.033E-7
		AVG_ATTENDANCE_2010_13	-1.140E-6	1.033E-7	1.002E-9

a. Dependent Variable: AVG_TIX_PRI_2014

Table 10. Displays the Collinearity Diagnostics for the performance and attendance regression analysis.

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	WINNING_%_2010s	AVG_ATTENDANCE_2010_13	ATTENDANCE_%_CAPACITY_2010_2013
1	1	3.962	1.000	.00	.00	.00	.00
	2	.028	11.833	.00	.79	.06	.00
	3	.008	22.187	.21	.19	.44	.01
	4	.001	57.166	.79	.02	.50	.99

a. Dependent Variable: AVG_TIX_PRI_2014

Table 11. Displays the Residuals Statistics for the performance and attendance regression analysis.

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	59.1081	107.9030	90.5797	11.49745	3104
Residual	-21.58429	26.54758	.00000	11.35004	3104
Std. Predicted Value	-2.737	1.507	.000	1.000	3104
Std. Residual	-1.901	2.338	.000	1.000	3104

a. Dependent Variable: AVG_TIX_PRI_2014

Appendix C – Contains the resulting outputs from the regression analysis using only socioeconomic data to predict the dependent variable.

Table 12. Displays Descriptive Statistics for the socio-economic regression analysis.

Descriptive Statistics

	Mean	Std. Deviation	N
AVG_TIX_PRI_2014	90.5829	16.15759	3103
Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	5.27	2.045	3103

Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	59547.77	14284.718	3103
Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	12.26	5.581	3103

Table 13. Displays Correlations from the socio-economic regression analysis.

Correlations

		AVG_TIX_PRI_2014	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families
Pearson Correlation	AVG_TIX_PRI_2014	1.000	-.127	.173	-.056
	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	-.127	1.000	-.195	.472
	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	.173	-.195	1.000	-.646

	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	-.056	.472	-.646	1.000
Sig. (1-tailed)	AVG_TIX_PRI_2014	.	.000	.000	.001
	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	.000	.	.000	.000
	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	.000	.000	.	.000
	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	.001	.000	.000	.
N	AVG_TIX_PRI_2014	3103	3103	3103	3103
	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	3103	3103	3103	3103

	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	3103	3103	3103	3103
	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	3103	3103	3103	3103

Table 15. Displays Variables Entered/Removed for the socio-economic regression analysis.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)[b]	.	Enter

a. Dependent Variable: AVG_TIX_PRI_2014

b. All requested variables entered.

Table 16. Displays Model Summary for the socio-economic regression analysis.

Model Summary[b]

Model	R				Change Statistics	

		R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.237[a]	.056	.055	15.70316	.056	61.712	3	3099	.000	.900

a. Predictors: (Constant), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)

b. Dependent Variable: AVG_TIX_PRI_2014

Table 17. Displays ANOVA for the socio-economic regression analysis.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45652.244	3	15217.415	61.712	.000[b]
	Residual	764180.245	3099	246.589		
	Total	809832.489	3102			

a. Dependent Variable: AVG_TIX_PRI_2014

b. Predictors: (Constant), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)

Table 18. Displays Coefficients for the socio-economic regression analysis.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	72.632	2.179		33.340	.000	68.361	76.904					
	Percent Unemployed	-1.319	.159	-.167	-8.320	.000	-1.630	-1.008	-.127	-.148	-.145	.756	1.323
	Mean household income (dollars)	.000	.000	.267	11.508	.000	.000	.000	.173	.202	.201	.567	1.763

Percent poverty level	.566	.075	.195	7.580	.000	.420	.712	-.056	.135	.132	.458	2.184

a. Dependent Variable: AVG_TIX_PRI_2014

Table 19. Displays Collinearity Diagnostics for the socio-economic regression analysis.

Collinearity Diagnostics[a]

				Variance Proportions			
Model	Dimension	Eigenvalue	Condition Index	(Constant)	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families
1	1	3.724	1.000	.00	.01	.00	.01
	2	.194	4.383	.01	.03	.07	.18
	3	.071	7.229	.02	.96	.00	.25
	4	.010	18.860	.98	.00	.93	.56

a. Dependent Variable: AVG_TIX_PRI_2014

Table 20. Displays Residuals Statistics for the socio-economic regression analysis.

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	73.9111	113.4776	90.5829	3.83628	3103
Residual	-43.84124	37.82554	.00000	15.69557	3103
Std. Predicted Value	-4.346	5.968	.000	1.000	3103
Std. Residual	-2.792	2.409	.000	1.000	3103

a. Dependent Variable: AVG_TIX_PRI_2014

Appendix D – Contains the resulting outputs from the regression analysis using both the performance and attendance data, and socio-economic data to predict the dependent variable.

Table 20. Displays the Descriptive Statistics for the final regression analysis.

Descriptive Statistics

	Mean	Std. Deviation	N
AVG_TIX_PRI_2014	90.5829	16.15759	3103
Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	5.27	2.045	3103
Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	59547.77	14284.718	3103
Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	12.26	5.581	3103
WINNING_%_2010s	52.7087	9.81001	3103
AVG_ATTENDANCE_2010_13	71814.8550	9732.24882	3103
ATTENDANCE_%_CAPACITY_2010_2013	99.4368	6.49687	3103

Table 21. Displays Correlations from the final regression output.

Correlations

		AVG_TIX_PRI_2014	Percent Unemployed	Mean household income (dollars)	Percent below poverty level	WINNING_%_2010s	AVG_ATTENDANCE_2010_13	ATTENDANCE_%_CAPACITY_2010_2013
Pearson	AVG_TIX_PRI_2014	1.000	-.127	.173	-.056	.222	.619	.673

Correlation	Percent Unemployed	-.127	1.000	-.195	.472	.101	-.109	-.075
	Mean household income (dollars)	.173	-.195	1.000	-.646	-.019	-.016	-.102
	Percent below poverty level	-.056	.472	-.646	1.000	.059	.125	.113
	WINNING_%_2010s	.222	.101	-.019	.059	1.000	.015	.157
	AVG_ATTENDANCE_2010_13	.619	-.109	-.016	.125	.015	1.000	.743
	ATTENDANCE_%_CAPACITY_2010_2013	.673	-.075	-.102	.113	.157	.743	1.000
Sig. (1-tailed)	AVG_TIX_PRI_2014	.	.000	.000	.001	.000	.000	.000
	Percent Unemployed	.000	.	.000	.000	.000	.000	.000
	Mean household income (dollars)	.000	.000	.	.000	.147	.194	.000
	Percent below poverty level	.001	.000	.000	.	.000	.000	.000
	WINNING_%_2010s	.000	.000	.147	.000	.	.198	.000
	AVG_ATTENDANCE_2010_13	.000	.000	.194	.000	.198	.	.000
	ATTENDANCE_%_CAPACITY_2010_2013	.000	.000	.000	.000	.000	.000	.
N	AVG_TIX_PRI_2014	3103	3103	3103	3103	3103	3103	3103
	Percent Unemployed	3103	3103	3103	3103	3103	3103	3103
	Mean household income (dollars)	3103	3103	3103	3103	3103	3103	3103
	Percent below poverty level	3103	3103	3103	3103	3103	3103	3103
	WINNING_%_2010s	3103	3103	3103	3103	3103	3103	3103

AVG_ATTENDANCE_2010_13	3103	3103	3103	3103	3103	3103	3103
ATTENDANCE_%_CAPACITY_2010_2013	3103	3103	3103	3103	3103	3103	3103

Table 22. Displays Variables Entered/Removed from the final regression output.

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	ATTENDANCE_%_CAPACITY_2010_2013, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, WINNING_%_2010s, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, AVG_ATTENDANCE_2010_13[b]	.	Enter

a. Dependent Variable: AVG_TIX_PRI_2014

b. All requested variables entered.

Table 23. Displays Model Summary from final regression output.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.748[a]	.559	.558	10.74175	.559	653.753	6	3096	.000	.857

a. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, WINNING_%_2010s, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, AVG_ATTENDANCE_2010_13

b. Dependent Variable: AVG_TIX_PRI_2014

Table 24. Displays ANOVA from final regression output.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	452600.247	6	75433.375	653.753	.000[b]
	Residual	357232.242	3096	115.385		
	Total	809832.489	3102			

a. Dependent Variable: AVG_TIX_PRI_2014

b. Predictors: (Constant), ATTENDANCE_%_CAPACITY_2010_2013, Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed, WINNING_%_2010s, Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars), Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families, AVG_ATTENDANCE_2010_13

Table 25. Displays Coefficients from final regression output.

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	-85.417	3.650		-23.402	.000	-92.574	-78.261					
Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	-.326	.111	-.041	-2.926	.003	-.544	-.107	-.127	-.053	-.035	.718	1.394

Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	.000	.000	.232	14.348	.000	.000	.000	.173	.250	.171	.544	1.837
Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	.054	.053	.019	1.027	.305	-.049	.157	-.056	.018	.012	.430	2.323
WINNING_%_2010s	.248	.020	.151	12.250	.000	.209	.288	.222	.215	.146	.940	1.063
AVG_ATTENDANCE_2010_13	.000	.000	.262	14.122	.000	.000	.000	.619	.246	.169	.413	2.420
ATTENDANCE_%_CAPACITY_2010_2013	1.177	.046	.473	25.576	.000	1.087	1.268	.673	.418	.305	.416	2.404

a. Dependent Variable: AVG_TIX_PRI_2014

Table 26. Displays Coefficient Correlations from the final regression output.

Coefficient Correlations[a]

Model			ATTENDANCE_%_CAPACITY_2010_2013	Percent Unemployed	WINNING_%_2010s	Mean household income (dollars)	Percent below poverty level	AVG_ATTENDANCE_2010_13
1	Correlations	ATTENDANCE_%_CAPACITY_2010_2013	1.000	-.004	-.221	.159	.083	-.746
		Percent Unemployed	-.004	1.000	-.080	-.182	-.485	.144
		WINNING_%_2010s	-.221	-.080	1.000	-.044	-.030	.150
		Mean household income (dollars)	.159	-.182	-.044	1.000	.650	-.199
		Percent below poverty level	.083	-.485	-.030	.650	1.000	-.215
		AVG_ATTENDANCE_2010_13	-.746	.144	.150	-.199	-.215	1.000
	Covariances	ATTENDANCE_%_CAPACITY_2010_2013	.002	-2.109E-5	.000	1.343E-7	.000	-1.059E-6
		Percent Unemployed	-2.109E-5	.012	.000	-3.697E-7	-.003	4.932E-7
		WINNING_%_2010s	.000	.000	.000	-1.648E-8	-3.239E-5	9.394E-8
		Mean household income (dollars)	1.343E-7	-3.697E-7	-1.648E-8	3.348E-10	6.261E-7	-1.121E-10
		Percent below poverty level	.000	-.003	-3.239E-5	6.261E-7	.003	-3.487E-7
		AVG_ATTENDANCE_2010_13	-1.059E-6	4.932E-7	9.394E-8	-1.121E-10	-3.487E-7	9.503E-10

a. Dependent Variable: AVG_TIX_PRI_2014

Table 27. Displays Collinearity Diagnostics from the final regression output.

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions						
				(Constant)	Percent; EMPLOYMENT STATUS - Population 16 years and over - In labor force - Civilian labor force - Unemployed	Estimate; INCOME AND BENEFITS (IN 2013 INFLATION-ADJUSTED DOLLARS) - Total households - Mean household income (dollars)	Percent; PERCENTAGE OF FAMILIES AND PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL - All families	WINNING_%_2010s	AVG_ATTENDANCE_2010_13	ATTENDANCE_%_CAPACITY_2010_2013
1	1	6.646	1.000	.00	.00	.00	.00	.00	.00	.00
	2	.213	5.591	.00	.07	.04	.18	.00	.00	.00
	3	.084	8.913	.00	.77	.01	.16	.00	.01	.00
	4	.031	14.668	.00	.00	.15	.08	.78	.01	.00
	5	.019	18.520	.00	.14	.58	.52	.06	.12	.01
	6	.007	31.383	.20	.02	.14	.03	.14	.38	.03
	7	.001	77.297	.79	.00	.09	.03	.02	.49	.96

a. Dependent Variable: AVG_TIX_PRI_2014

Table 28. Displays Residuals Statistics from the final regression output.

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	54.7165	128.6672	90.5829	12.07915	3103
Residual	-34.68769	32.43546	.00000	10.73135	3103
Std. Predicted Value	-2.969	3.153	.000	1.000	3103
Std. Residual	-3.229	3.020	.000	.999	3103

a. Dependent Variable: AVG_TIX_PRI_2014