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Carbon Budget Analysis for the Olympic Peninsula, Washington

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PENINSULA COLLEGE

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Based upon contributions from the students of Dr. Gerald Estberg's ESCI 492: Global Climate Change
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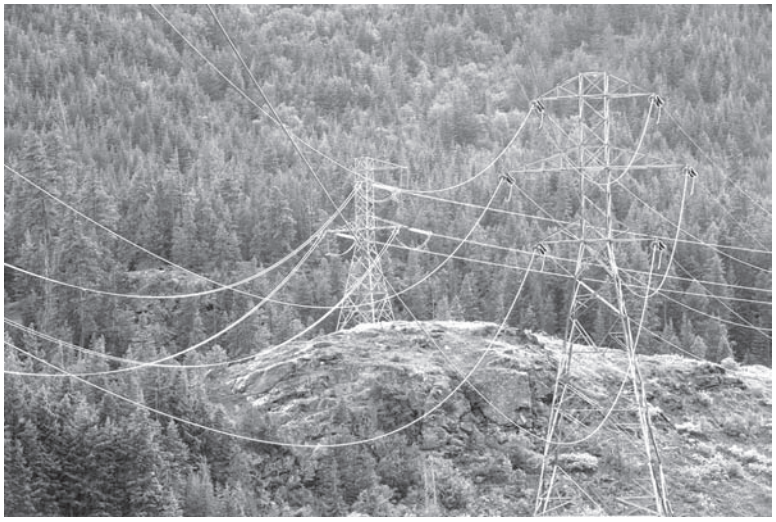
Abstract

While potent messages of climate change are found in such sources as *An Inconvenient Truth*, there is still not enough being done in such countries as the United States to reduce contributions to greenhouse gas emissions. The primary greenhouse gas of concern is carbon dioxide, and the two largest anthropogenic sources are due to the burning of fossil fuels and rapid changes in land use. A starting point for assessing future impacts of global climate change is to construct a carbon budget to assess where pools and sources exist for a particular region. This paper represents such an inventory of carbon sources and sinks for the Olympic Peninsula region of Western Washington, prepared by students of Huxley College on the Peninsula with Western Washington University. It is modeled after a similar accounting scheme written for King County in 2003. The hypothesis for this study was to assess whether there was enough forest cover in the wilderness regions of the Peninsula to contribute to carbon sequestration and result in the study area being an overall carbon sink. Seven students contributed to the research for the project by collecting data on the following categories: forests, transportation, electrical generation for homes and businesses, landfills, propane, and smokestack emissions. Results showed that overall the Olympic Peninsula is a source for carbon dioxide emissions at 2,299,174 MgCO2/year. The three largest emitters for this region are forests (1,710,000 MgCO2/year), transportation (262,335 MgCO2/year), and electrical generation (240,006 MgCO2/year). Forest emissions dominated the carbon budget analysis, and a possible reason to explain this large contribution is due to actions of the logging industry, particularly on state and private lands. Impacts from increased development in urban areas also have and will continue in the future to alter the traditional landscape of the Peninsula. Such results, while surprising, are supported by research undertaken in forested regions of Oregon. These results underscore the importance of preserving wilderness areas, as well as taking proactive initiatives to reduce destructive land-use patterns and lead by example to confront global issues. This study represents initial results for a carbon budget of the Olympic Peninsula, and due to the uncertainties inherent in the science of climate change, further research is needed to refine calculations and target specific areas of concern.



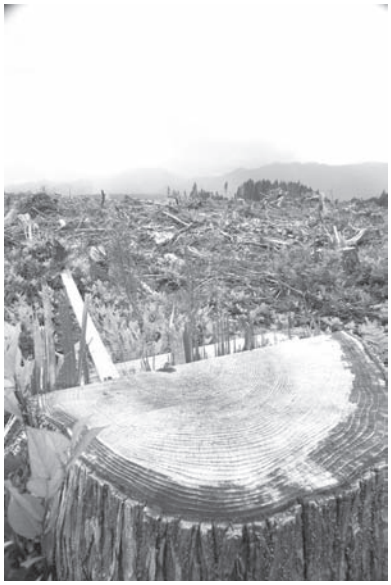
Introduction

While there seems to be a growing awareness in regard to the consequences of climate change, in part due to effective messages found in such sources as *An Inconvenient Truth,* a greater amount of action is still needed. The global warming debate has shifted somewhat from that of questioning the existence, severity, and source of climate change to more of an examination of potential solutions. However, not enough is being done in countries such as the United States to actively encourage the changes that need to happen among citizens. Recent observations of global warming are primarily driven by concentrations of carbon dioxide in the atmosphere, which have increased by approximately 25% since the Industrial Revolution. Two of the largest anthropogenic sources which contribute to an enhanced greenhouse effect include the burning of fossil fuels and rapid changes to the land from deforestation and other such actions (Cohen et al. 1996).

The Intergovernmental Panel on Climate Change (IPCC) is a global entity that was created jointly through the World Meteorological Organization and the United Nations Environment Program. It is meant to be policy relevant, not policy prescriptive, meaning that the role of the IPCC is one of assessment for scientific, technical, and socio economic information that can be conveyed to policy makers in an objective manner (Intergovernmental Panel on Climate Change 2007). While the latest assessment report from the IPCC is expected in 2007, the report from 2001

has represented the most current information as a basis in climate change discussions. A central starting point in assessing future impacts of climate change is the construction of a global carbon budget where pools and fluxes are examined and accounted. It has been acknowledged in scientific literature that there is much variation among measurements for carbon sinks and sources, however, in the IPCC assessment reports and other publications the undisturbed tropical forests have received attention as areas of high carbon sequestration. An issue that has spurred new scientific research since the end of the last century in regard to a global carbon budget has been the possible existence of a "missing sink" in the biosphere based upon scientific calculations. Substantial evidence has shown that one of the more plausible areas for this "missing sink" may be in northern, mid-latitude forests (Wallin et al. 1996).

The focus of this paper is upon the possibility that the northern forests, such as those found in the Pacific Northwest, could represent a large sink for the sequestration of carbon, therefore balancing out carbon dioxide emissions that lead to an enhanced greenhouse effect. Various carbon accounting studies have been conducted, and the seminal one for this particular region has been the 2003 Inventory of King County Air Emissions (Hammerschlag 2004; Howell 2006). The purpose of this report was to evaluate contributions of greenhouse gas emissions and common air pollutants from the county, including a detailed examination of county government contributions (Hammerschlag 2004). Using the paper from King County as a model, the study group set out to compile a carbon budget for the Olympic Peninsula in Western Washington. Students from Huxley College associated with Western Washington University (WWU) completed research papers for a Global Climate Change course where each contributed a particular sector of the carbon budget for the Olympic Peninsula study area. One of the findings from the inventory conducted by King County was that while there are many sources of carbon dioxide due largely to the presence of Seattle, Tacoma, and other urban areas, the forests in that region are classified as a carbon sink. Due to the large amount of wilderness found on the Olympic Peninsula resulting from the presence of Olympic National Park, the goal of the Western Washington University study was to assess whether the entire Olympic Peninsula region could be considered a carbon sink due to the large amount of forest cover. Forests are typically chosen as a focus for carbon budget analyzes as they contain approximately 60% of the terrestrial stock of carbon on a global scale (Wallin et al. 1996). Therefore, the hypothesis that guided this study was to ask whether there was enough forest cover in the wilderness of this region to contribute to carbon sequestration. If so, the message that this study hopes to convey is an emphasis on the importance of retaining wilderness, the preservation of forests on a variety of land types throughout the Olympic Peninsula, and the wise use and management of land for the future, as from a climate change perspective such actions may balance high carbon emission sources near urban areas.



Methods

The seven students in the Global Climate Change course each were assigned a particular topic to research that represented a category of the carbon budget. The categories covered in this study are: forests (which includes natural areas, as well as forest industry and burning), transportation, electrical generation for homes and businesses, landfills, propane, and smokestack emissions. Carbon dioxide emissions from average households were also analyzed separately (Livesey 2006). The students were asked to calculate carbon emission or sink concentrations for their topic and report them in units of metric tons (MgCO2), which is a conventional means of conveying carbon accounting. For other greenhouse gases, such as methane, data is presented in metric ton units of carbon equivalents as determined by the Global Warming Potential of the gas (U.S. Environmental Protection Agency 2006; Puget Sound Clean Air Agency 2007). The only exception to the use of metric tons is for the data related to individual households, as it was believed that these results may be best understood by a variety of individuals if the information was conveyed in English units. There was one student in the course who had the responsibility of assisting class members with research and compiling all of the separate reports into a final comprehensive study.

The primary methods of research conducted by each student included direct interviews of agency or business representatives via phone calls or the Internet, as well as traditional methods of reading articles and relying upon exter-

nal data sources. There was no primary data collected for this study, all calculations are based upon other studies and information. However, this study differs from other carbon accounting methodologies, and the IPCC protocol, as it includes electricity generation found outside of the Olympic Peninsula study area. The rationale for this is that while technically the electricity is generated elsewhere and not directly contributing to emissions in this region, the demand by local citizens drives the overall need for the electricity to be generated. Therefore, it seemed important to account for this end-point usage and to address the issue of moral responsibility for consumption of fossil fuels (Washington State Department of Community, Trade, and Economic Development 2006). For specific information on the methodology pertaining to a particular category please contact those names listed at the beginning of this document following the abstract.

The study area comprised the greater part of the Olympic Peninsula, including all major urban regions. The east to west boundaries extended from the Pacific Ocean in the west to Hood Canal in the east. For the south to north boundaries, the Strait of Juan de Fuca represented the northern border and extended down to the southern border of the United States Forest Service land (excluding the Skokomish Reservation to the east, but including the Quinault Reservation to the west). Consequently, all of Clallam and Jefferson counties were included in the study, along with portions of Mason and Grays Harbor counties. In regard to the hypothesis for this analysis, the study boundaries encompass a wide variety of forest lands, including federally protected areas, state forests, public trusts and other protected wilderness, city and county holdings, and privately owned parcels (Licari 2006).

Results

In displaying the results obtained by WWU students for this study, it is important to note that these calculations represent a first attempt at constructing a carbon budget analysis for the Olympic Peninsula. Climate change science is extremely challenging as there are multiple variables and uncertainties to contend with, making precise results difficult, if not impossible, to achieve (Cohen et al. 1996). One example of uncertainty can be seen with results for transportation in this study. When compared with results from the King County inventory for a cross-reference check, it is seen that their per capita numbers were significantly higher, particularly for the diesel sector of highway fuel use. While there do not appear to be any flaws in the calculations for our study, one of the conjectures made is that the large number of diesel trucks which utilize the Interstate-5 corridor in King County may be a substantial contributor to transportation emissions for that region (Denson 2006). However, it is difficult to determine a single reason for this discrepancy. Other discrepancies discovered through research include the disproportionate carbon emissions resulting from electricity use between the Port Townsend Paper Mill and Nippon Plant in Port Angeles (Kawal 2006; Mollerstuen 2006). Therefore, further research is always helpful, and often a necessity, in order to refine results and target specific issues of concern.

Table 1. Overall Carbon Budget Analysis for the Olympic Peninsula:

Category	$MgCO_2$/year
Landfill	1,002
Propane [1]	24,930
Transportation	262,335
Electricity [2]	240,007
Forests	1,710,000
Smokestacks (Industry) [3]	61,000

Total emissions for Olympic Peninsula region= 2,299,174 MgCO2/year
1 Olson 1997
2 Coughenour 2006; Payne 2006; Kawal 2006; Mollerstuen 2006
3 Olympic Region Clean Air Agency 2007

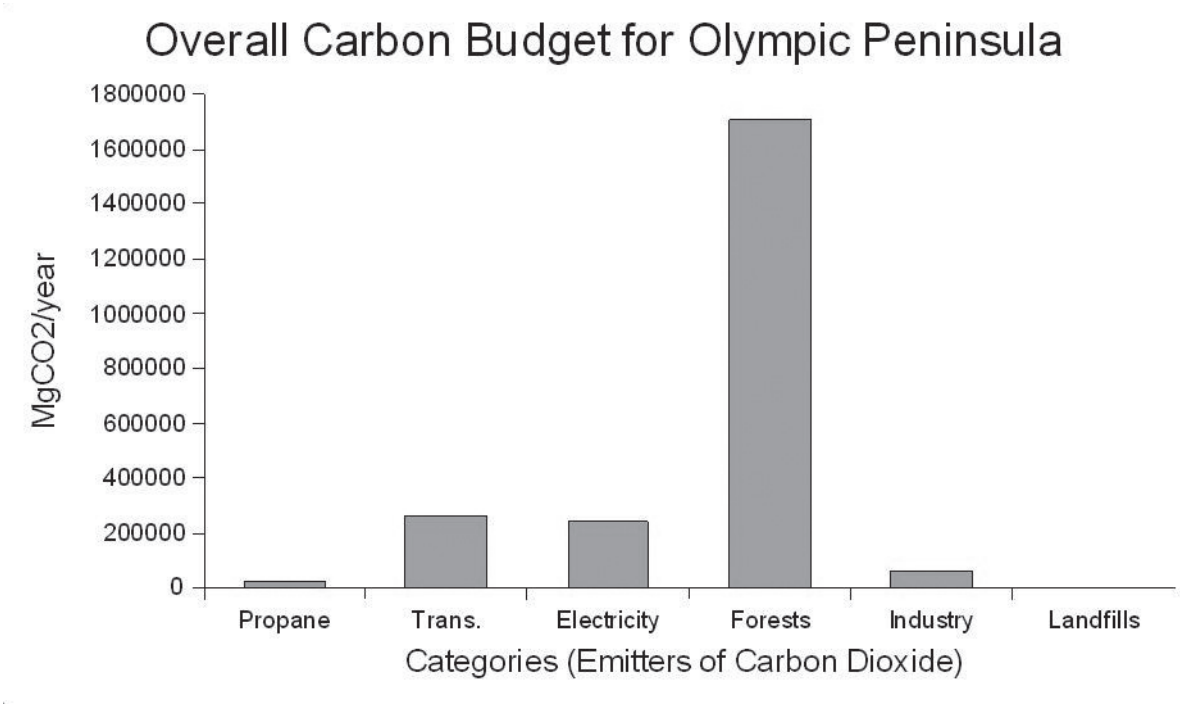
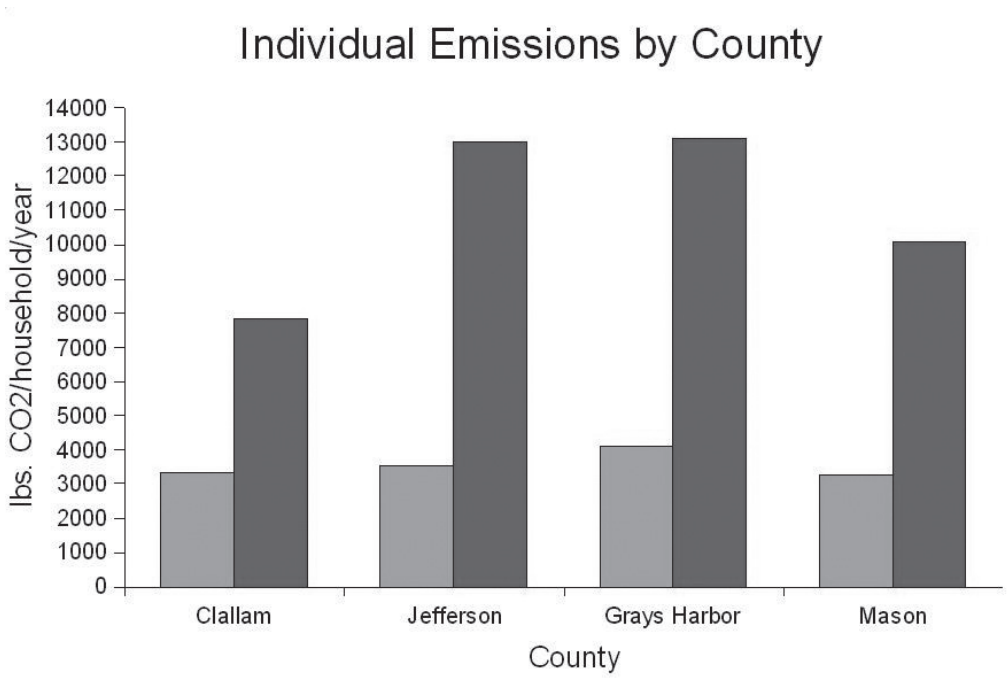


Table 2. Household Emissions by County[1]

County	Population (for study area)	lbs. of CO_2/year/household (electric)	lbs. of CO_2/year/household (auto)
Clallam County	69,689	3,333	7,848
Jefferson County	28,666	3,562	13,020
Grays Harbor County	4,073	4,125	13,092
Mason County	1,602	3,279	10,068

Average Yearly Carbon Emissions for Households on Olympic Peninsula (Electric and Auto combined) = 14,582 lbs

1 Livesey 2006



Discussion

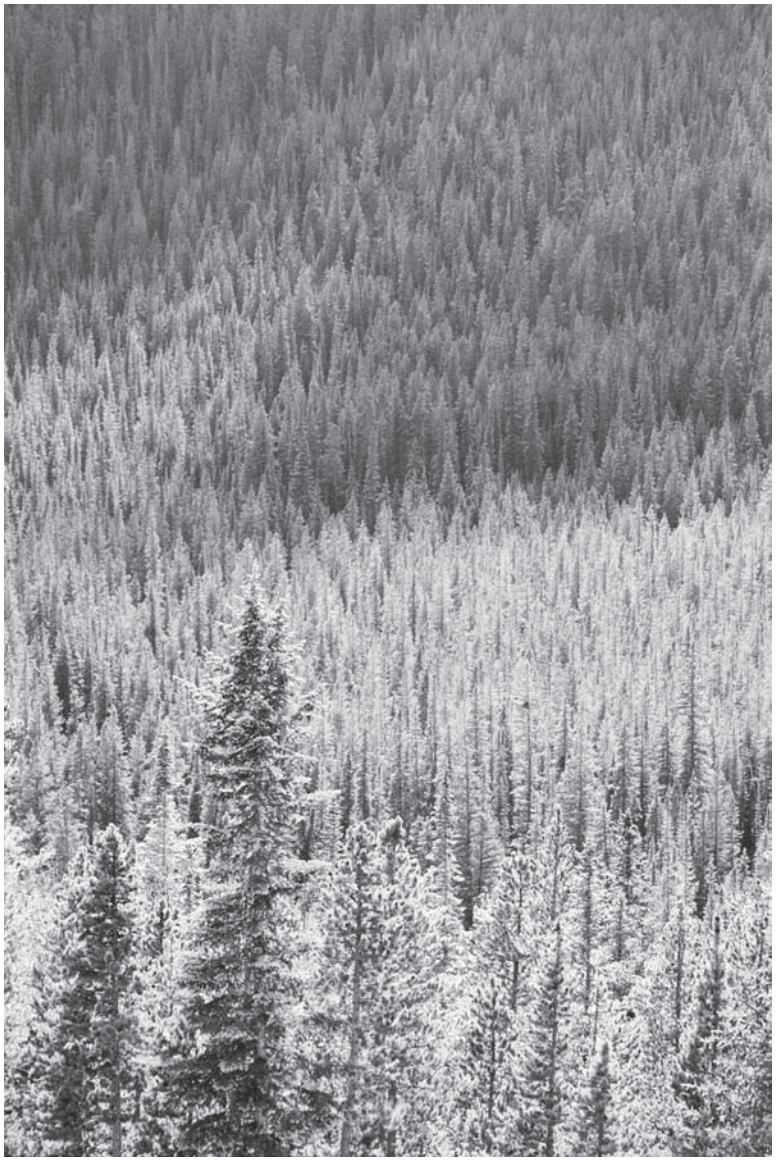
In assessing the results from the Western Washington University study, it is shown that the Olympic Peninsula is a source for carbon dioxide emissions. Overall, the forests, rather than sequestrating carbon dioxide, were the dominant source in the region. This result differs from the hypothesis that guided this study, which had proposed that the region would be a carbon sink due to the large amount of forested wilderness. The three highest sources of emissions on the Olympic Peninsula are those associated with forests, electrical generation, and transportation. Emissions from forests represent the land-use component of anthropogenic influences on the environment, while the electricity and transportation show the impacts from fossil fuels. When looking at individual data representing households in the various counties, it is possible to see what a large carbon footprint humans create on a daily basis with the staggering result that on average each household in this study area emits 14,582 pounds of carbon dioxide per year.

The finding that the hypothesis for this study was disproved is extremely interesting, especially since the forest category resulted in the largest source of emissions. As part of many ecosystem services, undisturbed forests absorb and sequester carbon dioxide from the atmosphere, but this study demonstrated what can happen when natural processes are interrupted due to human management. However, while these results are surprising, they can be supported by studies conducted on the west slope of the Oregon Cascade Mountain Range where a particular study area was found to be a significant net source of carbon dioxide to the atmosphere between the years of 1972 and 1991. Further extrapolation of this study was applied to the entire Pacific Northwest region (Wallin et al. 1996; Cohen et al. 1996). As mentioned, humans have the potential to be very destructive to the atmosphere based upon how the land is used and how rapid changes to the land are made. Impacts from land use include the loss of living biomass in forests, an increase in the amount of decaying matter on the forest floor, fossil fuel emissions related to transportation and industry, and the burning of land patches and debris. Due to these impacts, a plausible explanation for the Olympic Peninsula is that impacts from the logging industry, particularly on state and private lands, are a substantial causal factor for the region being an overall source of carbon dioxide emissions. On the Olympic Peninsula between 1971 and 2002, clearcutting reduced all forest cover in the area by 29%, with 36% of this occurring in forests without federal management oversight (Licari 2006). Therefore, the active logging and the decay of carbon pools from earlier forests on these lands has overwhelmed the absorption occurring in trees found within protected wilderness lands due to the removal of old-growth forests and the replacement with young plantations (Wallin et al. 1996; Cohen et al. 1996). This conjecture is consistent with results from the study completed in Oregon, which found that the harvesting of timber impacts the regional budget of carbon dioxide by changing the overall frequency distribution of age classes in a stand, as well as their distribution across the landscape (Wallin et al 1996). It is possible that if logging practices were to change then the overall region could become a sink for carbon dioxide emissions. It has been noted in the scientific literature, particularly by Wallin et al (1996), that some changes to logging practices have occurred and have reduced the emissions contributed by the forest industry. However, it appears that if the land is continuously being logged in various parts of the region, and is being lost too rapidly, there is not enough time to attain a balance between carbon emitted and carbon absorbed.

The rapid loss of land is also prevalent in another aspect on the Olympic Peninsula as new construction and land clearing for housing developments is becoming extremely common. This change to the land through the loss of trees and burning of the land will alter the landscape of the region drastically in the next decade, in ways that are not yet fully understood by scientists in terms of successional mechanisms, and the implications of this in regards to climate change needs to be assessed concurrently with actions of the logging industry (Cohen et al 1996). Burning of the land for development may also create amplified impacts in the future as the fire suppression policies change for federal lands on the Peninsula. As more acres of the current wilderness area are allowed to burn freely when a natural forest fire occurs, which could be as much as 1,000 acres per year, this will result in emissions from an area that is currently calculated to be a carbon sink. Therefore, as burning occurs in the lowlands for development and in the mountains from forest fires, this could potentially be a substantial amount of carbon dioxide emitted to the atmosphere. In ad-

dition, climate scientists are projecting that as consequences from global warming become more apparent, there is an increased likelihood of hotter, drier summers in the Pacific Northwest, creating above average conditions for forest fires to ignite (Westerling et al. 2003). Therefore, it is the hope that such carbon budget inventories as the one created by Western Washington University for the Olympic Peninsula will be instrumental for initiating the types of discussions that need to happen amongst policy makers, and to underscore the important point that it is no longer possible or sustainable for business to occur as it has in the past.

It is also essential that residents of the Olympic Peninsula realize the crucial environmental services that are provided by wilderness, such as the absorption of carbon dioxide from the atmosphere, and give priority to these services over short-term economic gain. While this may prove difficult at the outset, it will ensure an aggressive approach to a global issue. Given the large amount of land protection found on the Olympic Peninsula, it is achievable through proactive and creative means for this area to become a sink for carbon dioxide presenting an opportunity to lead by example for the preservation of similar areas throughout the world. While the forest category was the largest emitter of carbon dioxides for this study, it is hard to ignore that transportation and electrical generation were the next largest categories, and while it may be hard for citizens to have a direct impact on logging actions it is possible for individuals to monitor their personal uses of fossil fuels. In regard to transportation, which constitutes the largest impacts by an individual, residents need to petition policy makers to create more opportunities for public transportation on the Olympic Peninsula as it is difficult for people to change their lifestyles if the proper infrastructure is not in place. Also, expedient development can help reduce emissions from transportation while making dwelling units more energy efficient and allowing for increased open space by the use of urban villages and the proliferation of cluster developments for housing units, which allow more opportunities for walking. By reducing the pounds of carbon dioxide emitted by a household on an annual basis this can help reduce the carbon dioxide concentrations in the localized area, and can help foster momentum allowing citizens to capitalize upon successes in this realm in order to confront larger issues, such as land-use and forestry practices and the goals for the entire Olympic Peninsula in the next ten years.



In regard to this study and assessing a carbon budget for the Olympic Peninsula, the next steps include more research in order to refine calculations and target specific areas of question, such as reasons for the differences in results for transportation sectors between this area and King County. Similarly, only by fully understanding carbon production and decomposition processes can management goals be achieved (Cohen et al. 1996). Therefore, in addition to further work for the purpose of obtaining clarity in data, it is important that land-use practices are scrutinized on the Olympic Peninsula and that incremental changes are initiated in the present. The work of Western Washington University students for this study represented the first step in addressing greenhouse gas emissions accounting for this region, and will hopefully be used as a foundation for continued future work and to help ensure that the Olympic Peninsula can become an area of carbon sequestration in subsequent years.

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