Assessment of a Course Group Research Project – *Quantifying the Greenhouse Gas Emissions in the Counties of Washington State*

BIS 242 – Environmental Geography: Maps and Climatology
Winter Quarter 2010

Abstract

During winter quarter 2010, the students in an Environmental Geography course at the University of Washington Bothell worked as a team to quantify and map the variability in greenhouse gas emissions from county to county in Washington State. The results of an anonymous survey indicate that a majority of the students felt working on the project gave them more confidence in their abilities to: 1) make sense of a formula and generate one of their own, 2) critically evaluate quantitative data and information; 3) generate useful products with quantitative data. Thus, this project provided an especially significant learning experience for those students who had avoided courses emphasizing quantitative thinking and methods. Furthermore, 84% of the students agreed or strongly agreed that the project expanded their knowledge of the sources of greenhouse gases, while 93% agreed or strongly agreed that the project increased their understanding of the challenges in estimating greenhouse gas emissions. The project therefore expanded their environmental literacy while also activating their critical thinking skills.

About the Course

Environmental Geography investigates geographic variability in the interplay between people and natural systems. The content focus of the 2010 version of the course is apparent in the subtitle of course – Maps and Climatology. Map literacy and introductory climatology was addressed via an interdisciplinary analysis of concepts from meteorology, climatology, physical geography, and oceanography. Specific course objectives include advancing student ability to:

1) Characterize the natural processes and human activities important in controlling climate.
2) Discuss the sources of uncertainty in models used to predict climate change and the likelihood of projected impacts on ecosystems and people.
3) Apply geographic techniques in the analysis of environmental variability, including enhanced ability to read, interpret, and create maps, as well as read, interpret, and create graphs and charts.
4) Articulate learning gains in critical thinking and quantitative reasoning, particularly in abilities to evaluate and work with quantitative data.
5) Demonstrate facility in collaborating with a partner by producing quality work on time and in a professional manner.
6) Articulate how they have improved in their ability to conduct research.

Description of Group Research Project

I designed a collaborative research project to help students advance in their abilities in the learning objectives listed above, particularly numbers 2, 4, and 5. The general assignment was for all the students to work as a team to quantify the variability in greenhouse gas emissions from county to county in Washington State. To accomplish this, students worked in pairs throughout the quarter, sharing their findings on Blackboard along the way. Each pair was assigned a specific parameter (for example cattle emissions) and it was their task to: 1) determine how to calculate the carbon dioxide equivalent emissions for their parameter; 2) find the data to plug into their formula; 3) list the sources of their information; 4) generate maps comparing the emissions of their parameter in each WA county; and 5) assess the assumptions and sources of uncertainty in their calculations. Near the end of the quarter all students were challenged to evaluate the work of all student pairs and decide which student data sets to use in calculating total emissions for each counties. Aside from having to critically evaluate the data available to them, the students also had to justify the choices they made in generating their total emissions per county and how they displayed the data on a map. A list of the various greenhouse gas emission parameters that student pairs were challenged to work with can be found in Appendix 1.

Student Demographics

The winter 2010 offering of BIS 242 had 47 students. 34 (72%) were women, 13 (28%) were men. 6 (13%) were sophomores, 16 (34%) were juniors, and 24 (51%) were seniors, and one (2%) was a graduate student. Most of the majors in the Interdisciplinary Arts and Sciences program were represented in the student body. Only 7 students were in natural science-oriented majors (2 STE, 2 ENV, 2 ENSCI, 1 STS).

Survey Information

I generated a survey to assess what the students felt they gained from working through the research project. The survey was distributed on the last day of class. 44 of the surveys were completed and handed in. The survey was anonymous and did not include typical demographic questions. Because questions 11-14 were on the back of the survey form, several students did not respond to those questions. As a consequence, n = 37 for questions 11-14. A copy of the survey is included as Appendix 2 at the end of this report.

Reflections on the Project

Although this project was challenging for everyone involved, I believe the payoff was well worth it. For most students in the course, this effort constituted the first time they had been asked to determine how to calculate an original data set. Specifically, 70% of the students reported that they had “rarely” or “never” been asked to generate a formula for a class project. Doing so required a new kind of critical thinking and quantitative reasoning. 70% of the students agreed or strongly agreed that the project gave them more confidence in their ability to make sense of a formula and generate one of their own. Meanwhile, 66% of the

students agreed or strongly agreed that the project gave them more confidence in their ability to critically evaluate quantitative data and information. 75% of the students agreed or strongly agreed that the project gave them more confidence in their ability to generate useful products with quantitative data.

The project also had significant benefits in terms of getting students to really appreciate the many sources and geographic variability of greenhouse gas emissions, the difficulties in quantifying them, the relative warming effects of different greenhouse gases, and the complexity of modeling emissions and their impacts. Accordingly, 84% of the students agreed or strongly agreed that the project expanded their knowledge of the sources of greenhouse gases, while 93% agreed or strongly agreed that the project increased their understanding of the challenges in estimating greenhouse gas emissions.

A detailed breakdown of the survey results, along with responses to questions not mentioned in the paragraphs above can be seen in the next section.

This project also gave the students the opportunities to create original maps and collaborate with each other, both in pairs and as an entire class, to generate and evaluate a big data set. Working through this process fostered a number of valuable discussions in class on these topics. In addition, an enhanced ability to make and interpret maps, as well as to work in a productive collaboration, were primary learning objectives of the course.

An example of the kind of map produced by all of the students can be seen in Figure 1 below. The software that the students used to produce this map can be found here: http://monarch.tamu.edu/~maps2/wa.htm.

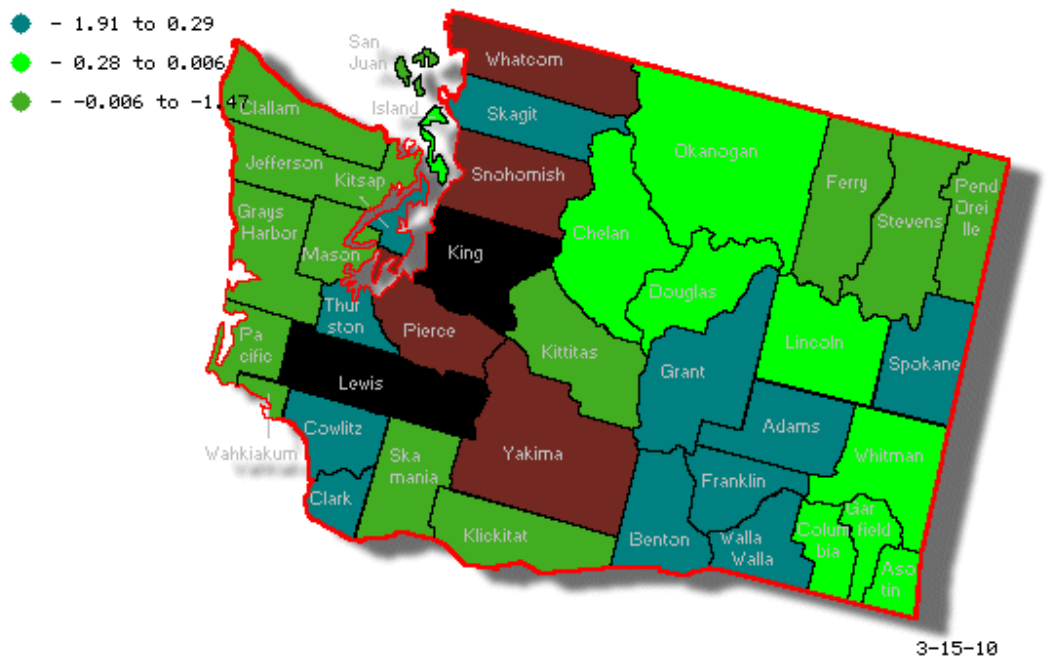


Figure 1. Example map displaying estimated variability in annual CO2 equivalent emissions in Washington State by county. From Tidwell, S and Bower, T (2010). Evaluating Emission Calculations in Washington State. Final report for BIS 242.

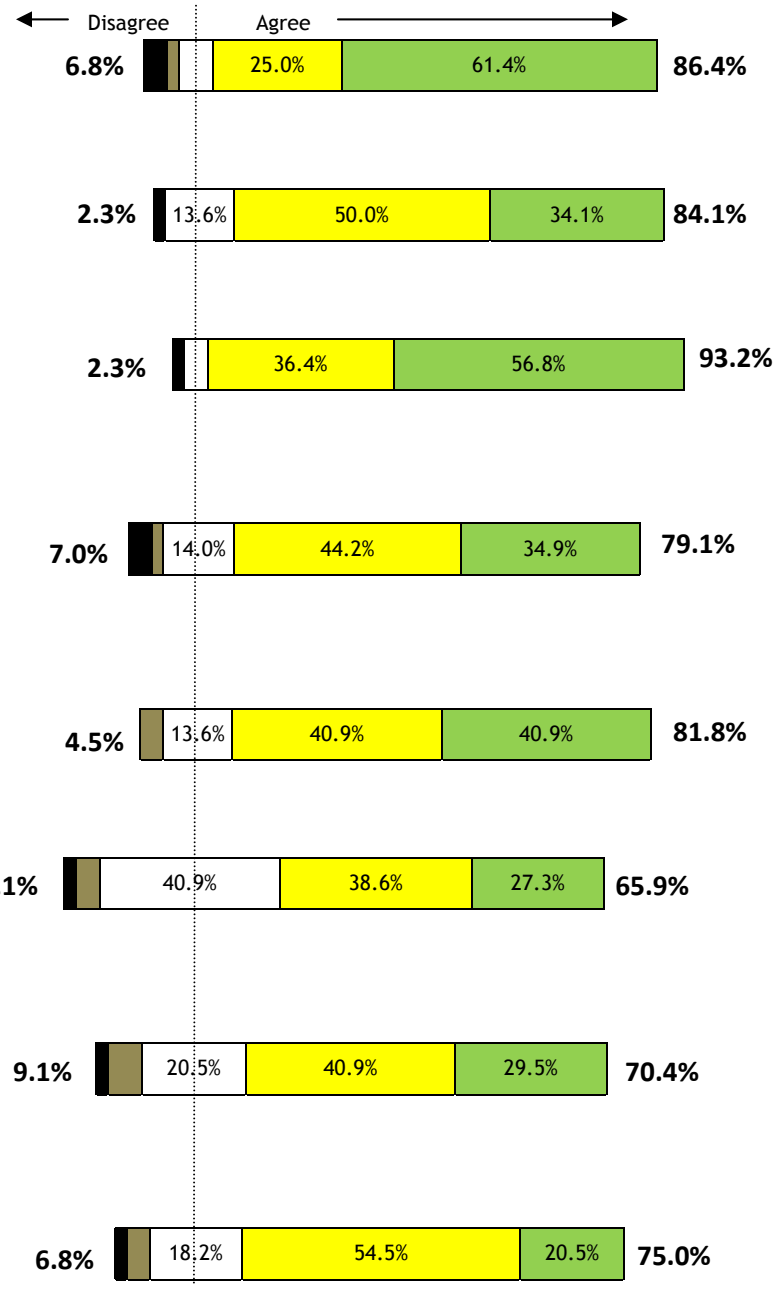
I would most definitely do this project again in a future offering of Environmental Geography. It very nicely provided a framework for students to independently dig into the subtitle of the course (Maps and Climatology). Given the groundwork that has been laid by the BIS 242 students in the winter quarter of 2010, future student efforts could concentrate on finding new data on additional parameters and more recent data on the parameters we looked at before. We could also spend more time examining the various formulas used to calculate greenhouse gas emissions for the parameters and critically evaluating the many assumptions that went into each one. As far as I know, this analysis of determining the variability in greenhouse emissions by county has not been done in the state of Washington. So, with further research and quality control, our data sets and map products could be publishable and of interest to state and county government agencies.

Survey Response Statistics

Response Options

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree

Survey Questions

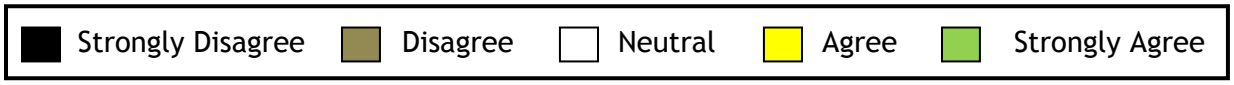


1. My partner and I both contributed an equivalent amount of effort to the group project work.
2. Conducting the group project research expanded my knowledge of the sources of greenhouse gases.
3. Conducting the group project research increased my understanding of the challenges in estimating greenhouse gas emissions.
4.* Conducting the group project has given me practice in comparing the relative merits of different sources of information on the same topic.
5. Conducting the group project has given me practice in working with quantitative data.
6. Conducting the group project has given me more confidence in my ability to critically evaluate quantitative data and information.
7. Conducting the group project has given me more confidence in my ability to make sense of a formula and generate one of my own.
8. Conducting the group project has given me more confidence in my ability to generate useful products with quantitative data.

* N=43 on question 4.

Survey Response Statistics

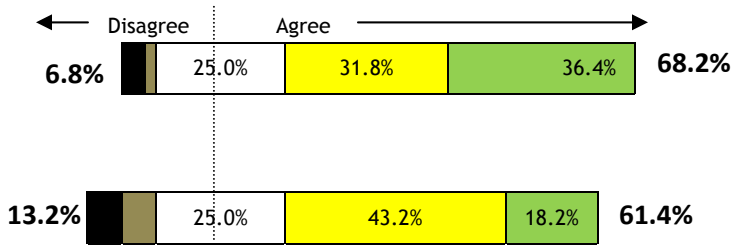
Response Options



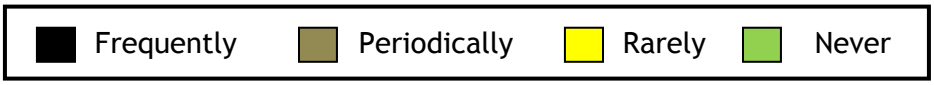
Survey Questions

9. Conducting the group project has enhanced my abilities to use Microsoft Excel.

10. I think that the collaborative class research project yielded worthwhile results.



Response Options

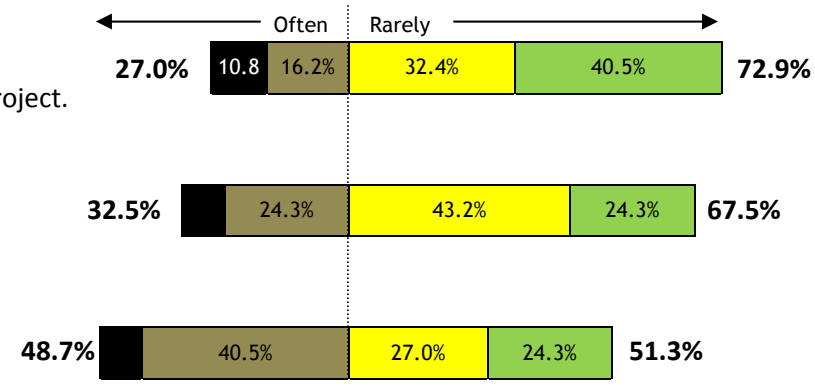


Survey Questions **

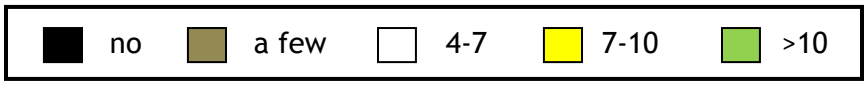
11. I have _____ been asked to generate a formula for a class project.

12. I have _____ been asked to critically evaluate formulas.

13. I have _____ generated an original data set for a class.

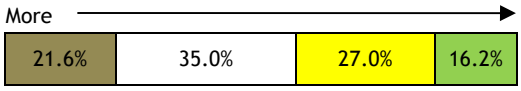


Response Options



Survey Question **

14 To complete the group project I found and read _____ articles and/or websites beyond what was provided on the course Blackboard.



****** N = 37 for questions 11-14

Appendix 1 – List of Greenhouse Gas Emission Parameters Used in the Project

The carbon dioxide equivalent emissions were calculated for the following greenhouse emission sources. Each source, or parameter, was assigned to one or two student pairs. They were responsible for finding formulas for converting emissions to (e.g., CO_2, NO_x, CO, CH_4) to CO_2 equivalents in million metric tons, along with the county-specific data to plug into the formulas.

- Cattle emissions
- Milk Production
- Sheep, Goat and Horse Emissions
- Pig and Chicken Emissions
- Manure Emissions
- Agricultural Soil Emissions
- Vehicle Emissions (based on DOT Vehicle Miles traveled)
- Vehicle Emissions (based on registered cars and the EPA CO2 equivalent calculator)
- WA State DEC Comprehensive Emissions Inventory (non-automotive)
- Household emissions
- Carbon sequestered by acres of forest
- Fuel per ton of solid waste disposed out of county
- Carbon sequestered by recycling
- Cement plant emissions*
- Large Business Inventory
- Landfills

* This parameter didn't work out for the student pair working on it. Although the formula for calculating emissions from cement plants is straightforward, we simply could not acquire the data to plug into the formula.

Appendix 2: The Survey

BIS 242 Anonymous Survey

To the right of each statement please write a checkmark in the column that best matches your response to the statement.

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
My partner and I both contributed an equivalent amount of effort to the group project work.					
Conducting the group project research expanded my knowledge of the sources of greenhouse gases.					
Conducting the group project research increased my understanding of the challenges in estimating greenhouse gas emissions.					
Conducting the group project has given me practice in comparing the relative merits of different sources of information on the same topic.					
Conducting the group project has given me practice in working with quantitative data.					
Conducting the group project has given me more confidence in my ability to critically evaluate quantitative data and information.					
Conducting the group project has given me more confidence in my ability to make sense of a formula and generate one of my own.					
Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Conducting the group project has given me more confidence in my ability to generate useful products with quantitative data.					
Conducting the group project has enhanced my abilities to use Microsoft Excel.					
I think that the collaborative class research project yielded worthwhile results.					
The course readings I did helped me to understand the course content.					
I have a better understanding of the *natural* processes that control climate now that I have completed the course.					
I have a better understanding of the relative contributions of different gases to the greenhouse effect now that I have completed the course.					
I feel more competent at interpreting and creating maps now that I have completed the course.					

Fill in the blanks of the following statements by circling the most appropriate term found in the cells to the right.

I have _____ been asked to generate a formula for a class project.	never	rarely	periodically	frequently	
I have _____ been asked to critically evaluate formulas for a class assignment.	never	rarely	periodically	frequently	
I have _____ generated an original data set for a class project.	never	rarely	periodically	frequently	
To complete the group project I found and read _____ articles and/or websites beyond what was provided on the course Blackboard.	no	a few	4-7	7-10	>10
Of the assigned course readings, I read approximately _____ percent of them.	0-10%	10-35%	35-65%	65-80%	80-100%

The following statement can be completed with the phrases in the table below.[1]

The most difficult part of the group research project was _____.

Provide your ranking of what was most to least difficult among these phrases by assigning numbers to each one in the cells above. 1 = most difficult 7= least difficult.

making sense of the assignments	working with my partner	finding good data sources	finding good formula sources	making sense of the articles related to the formulas	making sense of the work other students did	Other:

1) Results of this question are not included in the analysis as student respondents did not all do the ranking in the same way, confounding the results.