Norwegian University of Life Sciences

Master's Thesis 2021 30 ECTS
Faculty of Landscape and Society

For the Love of Nature: Outdoor Recreation and Greenhouse Gas Emissions in Norway

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International Environmental Studies

Acknowledgements

This study would not have been possible without the help of countless individuals, especially my main adviser, Ola Westengen, and secondary advisers, Øystein Aas and Avi Chomsky. The work and comments of many scholars, particularly John Rønnevik, Carlo Aall, Torill Brandal Berg, and Kjartan Steen-Olsen, were also invaluable in shaping the current study. I would also like to thank those who helped to distribute the survey and provided comments which helped to improve the study, along with all those who took the time to respond to the survey. All faults are my own.

Abstract

The environmental impacts of leisure consumption have emerged as key factors that must be addressed in order to meet climate targets agreed upon by most nations. Outdoor recreation is a popular leisure activity which is considered to be an environmentally friendly practice that promotes care for the natural world. In Norway, outdoor life is a 26,000 million Kroner industry which accounts for 17,000 terajoules of energy use per year, more than any other leisure activity apart from holiday journeys by air. Meanwhile, the government continues to push for an increase in business development and value creation from nature. This points to a paradox between a strong valuation of pristine nature and high levels of consumption which characterize outdoor recreation in Norway. In this study we use a survey to investigate transportation use and gear purchasing habits among students pursuing a degree in outdoor recreation at select Norwegian universities and social media users who frequent groups related to Norwegian outdoor life. Using a hybrid life-cycle assessment it was estimated that the average participant releases between 3.4 (social media group) and 4.7 (student group) tons of carbon dioxide equivalent emissions per year in relation to outdoor recreation activities, with around 65% of these emissions coming from transportation and the remaining 35% coming from gear purchases in both groups. This is equal to around one fifth of the average Norwegian's yearly greenhouse gas emissions and is, by itself, more than double the per capita boundary required to limit global temperature rise to 2 degrees Celsius. In addition, regression analysis showed that personal beliefs and self-evaluated motivating factors did not play a significant role in mediating consumption behavior among the participant groups. Instead, level of disposable income was the best predictor of environmental load. This indicates that the facade of a green lifestyle based on ecological values masks the global environmental consequences of excessive consumption related to outdoor recreation activities.

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1. Introduction

Consumption associated with leisure activities is an increasingly important driver of greenhouse gas (GHG) emissions. As economies grow, so does the share of household consumption devoted to leisure. In Norway, household consumption increased by 26% between 1999-2012 (Steen-Olsen et al., 2016). During this period the carbon footprint of Norwegian households increased by a similar amount, while production-based emissions of GHG in Norway remained stable (Westskog et al., 2018). Furthermore, emissions from households increased in a proportional way to expenditures, implying no decoupling of consumption from environmental impact (Isaksen and Narbel, 2017). As larger segments of the world's population gain access to disposable wealth, it will become increasingly important to endorse recreational activities which promote human well-being without harming the planet's life support systems.

Leisure consumption is growing more rapidly than private consumption in general, particularly energy intensive forms of leisure consumption (Hille et al., 2007). Energy use and economic expenditures associated with Norwegian leisure consumption are dominated by holiday journeys by air followed by outdoor recreation (OR) and second homes (Aall, 2011). These categories represent around half of the environmental load related to Norwegian leisure consumption, and impacts mainly stem from transportation, equipment purchases, and the construction and maintenance of infrastructure. In total, leisure consumption accounts for more than ¼ of household energy use in Norway, while OR accounts for around 10% of all leisure consumption (Aall, 2011). In 2012 OR was estimated to account for over 26,000 million Norwegian Kroner (NOK) and 17,000 terajoules of energy (Rønnevik, 2019). This is greater than the total primary energy use of over 30 countries, many of which have populations far surpassing Norway.

These observations stand in contradiction with a long-held Scandinavian ideal which holds that more time spent participating in OR will lead to fewer environmental problems (Sandell and Sorlin, 2000; Faarlund et al., 2007). In reality, OR in Norway has a notably high energy use per unit of time (48 MJ/hour), more than double that of times spent in cafes and restaurants (23 MJ/hour) or on computers (20 MJ/hour) including embodied energy and recycling costs of all material inputs (Aall, 2011). This has led some researchers to suggest that a shift in leisure consumption from OR to internet-based activities could lead to a decrease in the environmental load of leisure activities in Norway (Rønnevik, 2019). This reflection seems paradoxical when paired with a cultural expectation of *friluftsliv* as an environmentally benign activity which promotes care for nature.

Whereas traditional narratives surrounding friluftsliv harken back to a simple life, getting back to nature, and escaping modernity (Dahle, 2003; Isberg and Isberg, 2007), today interactions with nature include diverse modes of transportation, gear, and infrastructure, leading to unseen global environmental consequences (Rønnevik, 2019). In spite of this, most studies continue to describe OR as 1) an environmentally friendly practice, which will 2) lead to care for the environment (Gelter, 2000; Pederson, 2008; Winter et al., 2020). In Norway, friluftsliv, or outdoor life, is considered to be part of a "value-based green life philosophy" which promotes harmonious living with nature (Pedersen, 2008; Faarlund et al., 2007; Repp, 2007). Climate change is

generally regarded as a factor which can impact OR, with little consideration of the possibility that OR activities may be influencing climate change (Askew et al., 2018; Hewer et al., 2018; Winter et al. 2020) apart from Aall (2014). While many studies focus on the direct local environmental consequences of OR activities, few consider the overall use of energy and material resources – the total ecological footprint of friluftsliv – a practice considered to be an integral part of sustainable Scandinavian living.

The Norwegian government plays an active role in sponsoring OR as a means to "promote growth…by stimulating profitable business development", especially in rural areas (Innovation Norway, 2021a). *Visit Norway*, a branch of the government funded *Innovation Norway*, boasts that Norway is "a natural playground" and sells package tours promising that "spending time in remote locations…can make you a happier person" (Innovation Norway, 2021b). Friluftsliv is marketed as "a simple life in nature without destroying or disturbing it", with "physical and mental benefits…reducing anxiety and improving cognition". By purchasing the proper gear, one can enjoy friluftsliv "regardless of the season"; the organization trumpets a well-known Norwegian proverb, "there is no such thing as bad weather, only bad clothing". These government sponsored advertisements target both foreign and domestic tourists and the website is available in over ten languages. There is no mention of the environmental impacts of the transportation, gear, and infrastructure which characterize Norwegian friluftsliv. Instead, these activities are branded as "green travel" to "sustainable destinations".

In this study we use a survey of consumption practices to investigate transportation use and gear purchasing habits among students pursuing a degree in OR at select Norwegian universities and social media users who frequent groups related to Norwegian friluftsliv. We use a hybrid life-cycle assessment (Scientific Applications International Corporation, 2006) to estimate GHG emissions associated with OR activities among the target groups related to transportation and gear, as well as ordinary least squares regression analysis to investigate the role of demographic information and personal beliefs regarding consumption in mediating actual consumption behavior. The objective is to better understand what steps can be taken to mitigate the environmental load associated with these activities while contributing to the literature on sustainable leisure consumption. The study proceeds with a theoretical framing of sustainable consumption in general and expounds upon the main drivers of GHG emissions associated with OR. This is followed by a description of the survey instrument and analysis methods before a presentation of results and a discussion of the main findings in light of relevant literature.

Three results stand out from the study. 1) It is estimated that the average participant releases between 3.4 (social media group) and 4.7 (student group) tons of carbon dioxide equivalent (CO_2eq) emissions per year associated with OR activities, with around 65% of these emissions coming from transportation and the remaining 35% coming from gear purchases in both groups. Meanwhile, 2) personal beliefs and self-evaluated motivating factors did not play a significant role in mediating consumption behavior among the participant groups. Instead, 3) level of disposable income was the best predictor of consumption behavior and associated environmental load. This indicates that the facade of a green lifestyle based on ecological values masks the global environmental consequences of excessive consumption related to OR activities.

2. Greenhouse Gas Emissions and Sustainable Consumption

GHG emissions associated with household consumption, particularly in wealthy countries, are the primary cause of global warming (Dubois et al., 2019). Norwegian GHG emissions measured using consumption-based accounts are typically 40-70% higher than estimates based of territorial emissions, or those that occur within the nation's borders (Kanemoto et al., 2016; Steen-Olsen et al., 2016; Westskog et al., 2018). This trend occurs as economies financialize and production is shifted abroad, leading to the illusion of a relative decoupling of emissions from economic growth (Hickel and Kallis, 2019). From a perspective of environmental justice and global equality, per capita consumption based emissions must be used when considering possibilities for reductions. If this is to be effective, consumption-based inventories which include emissions embodied in international trade and travel are required (Hille and Aall, 2010). This is particularly true for measures of leisure consumption and the case of Norway, where people travel extensively and import large amounts of consumer goods (Thoring, 2017; Æra, 2017).

A recent study estimates consumption-based emission of GHG in Norway to be 17.2 tons per person per year (O'Neill et al., 2018). The same article estimates a per capita yearly budget of no more than 1.6 tons of GHG emissions per person per year (pppy) is necessary to limit global temperature rise to 2 degrees Celsius above preindustrial levels. Norway's per capita consumption based emissions need to be cut by over 90% to cease transgressing this boundary. This is unlikely to be achieved by increasing efficiency without drastic cuts in overall levels of consumption. Historically, efficiency gains are outweighed by increases in overall consumption, a phenomenon known as the rebound effect. Evidence is mounting that an absolute reduction in consumption will be necessary to avoid surpassing planetary boundaries associated with growing energy and material throughput (Ivanova et al., 2015; Isaksen, 2017; Bjelle et al., 2018; Hickel and Kallis, 2019). Meanwhile, the basic needs of large segments of the world population remain unmet, underscoring the importance of prioritizing those most in need when considering the remaining carbon budget.

Fulfilling basic needs requires some level of material and energy consumption. Beyond certain limits, excessive individual or group consumption can be seen compromising the ability of others to reach minimum consumption levels. This is a burden placed on other countries or future generations. Lorek and Fuchs (2019) describes sustainable consumption corridors as existing between an upper limit of planetary boundaries and lower threshold of human well-being. Although a decrease in working hours can help to reduce emissions, a recent study concluded that it is the reduced income from working less hours that is the is responsible for the decrease (Nässén and Larsson, 2015). The authors also found that time spent at work in general is less energy and carbon intensive than other activities. Furthermore, weekends and vacations are often considered as breaks, both from work and from sustainable consumption, and individuals often treat themselves to more luxuries during these times (Nässén and Larsson, 2015).

Achieving sustainable consumption will require changes in individual action to be combined with more largescale societal change (Lorek and Fuchs, 2019). Power structures in political economy and media promote the pursuit of economic growth as fundamental to human well-

being. A focus in all levels of society and economy needs to move from pursuit of a better life based on constant growth towards achievement of a good life and contentedness. Although there have been some positive movements building awareness of environmental concerns and the impact of consumption habits, there is a troubling trend towards viewing frequent travel (e.g. weekend trips) and technical equipment as status symbols. Making consumption sustainable will require changes not only in personal choice, but across the entire economy, in the infrastructure servicing daily life as well as in the dominant culture, institutions, and power relations (Lorek, 2016).

While OR is an activity associated with good health and environmental stewardship, the consumption practices of most outdoor enthusiasts entail the use of significant energy and material resources leading to unseen environmental consequences.

2.1 The Environmental Load of Outdoor Recreation in Norway: Transportation, Gear, and Infrastructure

Transportation accounts for a large share of the energy use associated with OR in Norway, and close to 40% of Norway's total GHG emissions (Aamaas and Peters, 2017). In general, close to 70% of these emissions come from infrequent trips over 100 kilometers (km) in distance, and high-income individuals are disproportionately responsible for these emissions. Only 4% of emissions come from public transportation, while 55% comes from air transport and 36% from private road transport. Norwegians drive more on average than any other European country and use public transportation less frequently. Km driven and private car ownership increased by 17% and 20% respectively between 2005-2015. Norwegians also fly far more frequently on average than citizens of the European Union (Rønnevik, 2019). These trends are reflected in transportation habits related to friluftsliv, as public transportation accounts for just 3% of Norwegian expenditure on transportation related to OR.

Previous studies concluded that outdoor gear consumption requires even more energy than transportation to and from OR activities (Aall, 2011; Rønnevik, 2019). Both energy-use and economic expenditures associated with outdoor gear are increasing rapidly. Expenditures on sporting and outdoor equipment equaled 15 billion NOK in 2016, with the average Norwegian spending three times as much on such goods as average European (Æra, 2017). Previously minimalist activities such as hiking, biking, and skiing, have seen an extreme diversification of sub-genres, each requiring its own specialized clothing and equipment (Rønnevik, 2019). There is a trend towards newer, lighter, more technically advanced gear made from an ever-expanding array of difficult to source and energy intensive materials, often employing hazardous chemicals in order to make outdoor life more comfortable. In addition, gear which could last for many years is often discarded only to be replaced with the newest style.

While this study focused on transportation and gear, infrastructure used in conjunction with OR represents a third major source of environmental impacts. This infrastructure ranges from ski tracks and boating marinas to shared or private accommodation. Owning a nonprimary dwelling associated with leisure activities in general and OR in particular "is a mass phenomenon with a long tradition in Norway", and around 70% of the population has access to at least one cabin

(Xue et al., 2020). These second homes account for nearly as much energy as OR itself, around 16,000 TJ per year (Aall, 2011). The size and construction standards of infrastructure related to second homes as well as OR in general has increased dramatically in past decades (Xue et al., 2020). These cabins are increasingly utilized more frequently with a decreasing average length of stay, resulting in more emissions from travel.

Communal infrastructure can be equally energy and carbon intensive. In order to promote safety and the healthy lifestyle associated with OR, large sums of money are dedicated to the maintenance of outdoor spaces. A popular construction practice, *Sherpasteps*, involves moving boulders with helicopters to construct footpaths. These large rocks are then put in place by migrant workers flown halfway around the world. In Norway, Nepalis learn to use helicopters to move stones, while in their home country they build similar trails using draft power. DNT, the largest domestic trekking organization, currently owns over 500 huts in all corners of the country, some of which are constructed, supplied, and maintained exclusively by helicopter or snowmobile. Fortunately, DNT has begun to take emissions from overconsumption associated with OR seriously. A yet to be released sustainability plan promises to phase out the use of diesel generators to power huts by 2030 (Falck et al., 2021). It also encourages members to buy less gear and take part in OR near home while giving discounts to those who use public transportation.

3. Methods

In the current study we use a survey to estimate the carbon footprint of transportation and gear related to OR activities among two target populations. In addition to global warming potential we also determine GHG emissions per unit of time spent on OR activities. We employ a hybrid life-cycle assessment (LCA) approach combining statistical estimations with prior investigations of related activities (Scientific Applications International Corporation, 2006). This involves breaking a given activity into components, estimating consumption levels for each component based on the original survey data, and combining this with data from LCAs and other statistical sources. In this case, components include 1) transportation, measured in passenger km (PKM) using different forms of transportation, and 2) gear, measured in monetary expenditures directed towards different types of equipment. Next, regression analysis is used to search for correlations between dependent variables: yearly km traveled and monetary expenditures for OR equipment, and independent variables: participant-evaluated factors motivating consumption and demographic information. Finally, open-ended questions regarding possibilities for reductions are analyzed in light of results of the current study and previous research.

3.1 Transportation for Outdoor Recreation

Transportation was divided into 5 categories: walking/human powered, electric car, gasoline powered car, public transportation, and airplanes. Human powered transport was given no environmental impact while all estimates of carbon intensity are taken from Vestlandsforsking (2016), excluding long distance flights which come from Cox et al. (2019). GHG emissions per PKM are provided in carbon dioxide equivalents (CO_2eq).

Categories were assigned according to distance from home: <50 km from home (covers most daily activity), 50-300 km from home (covers most multi-day and cabin activities), 300-3000 km from home (covers activity within Europe), and 3000+ km from home (covers activity in the rest of the world). Distances travelled for trips in the first two categories were estimated using the average distance in each category. For example, one trip less than 50 km from home using motorized transport was estimated to be a 25 PKM trip one way, or 50 PKM round trip, while a trip 50-300 km from home was estimated to be a 150 PKM trip one way or 300 PKM round trip. Distances traveled by air were estimated in a similar way for trips further from home; one trip by air 300-3000 km from home was assigned a round trip distance of 3000 km while a trip of 3000+ km was assigned a round trip distance of 15,000 km. Meanwhile trips by road 300-3000 and 3000 + km from home were estimated to include 1500 PKM and 10,000 PKM of travel respectively. These estimates correspond well with data from the most recent National Transport Survey (Hjorthol et al., 2014) and data on holidays and leisure activities from Statistics Norway (SSB, 2021).

In general, travel further from home is less energy and carbon intensive per km traveled than activities near home. For trips by public transportation we used the average for short-distance bus, train, tram, and subway to provide an aggregate emission multiplier for journeys less than 50 km, and long-distance bus and train only for trips over 50 km. For airline travel we opted to use data for a large narrow body aircraft for trips under 3000 km and a large wide body aircraft for trips over 3000 km following Rønnevik (2019) based on data from Cox et al. (2019). This will likely give underestimates as no short distance flights are included. The majority of energy expenditure and GHG emissions from flights come from take-off and landing, meaning short haul flights can create more than double the emissions and require twice as much energy per PKM when compared to long-distance flights. In addition, for trips by plane, additional means of transportation are generally used in order to reach outdoor destinations. This was not included for practicality and because these emissions are likely dwarfed by the comparatively longer distances traveled by air.

3.2 Equipment for Outdoor Recreation

Calculating energy use and carbon emissions for equipment purchases relies on prior input-output analysis of Steen-Olsen et al (2016). Economic activity was distributed between Categories of Individual Consumption According to Purpose (COICOP) 031 Clothing, 032 Footwear, 0713 Bicycles, 0912 Major durables for Outdoor Recreation, and 0922 Equipment for Sports, Camping, and Open-air Recreation. Using survey responses, we were able to calculate the percentage of total economic activity devoted to each of these subcategories. WRAP (2012) provides the most comprehensive original LCA of GHG emissions from textiles, while Rønnevik (2019) gives estimates of energy use per NOK for equipment purchases related to OR. Bjelle et al. (2018) provide emission multipliers in g/CO_2eq per NOK spent related to a range of COICOP categories following the methodology developed by Steen-Olsen et al. (2016). Combining these sources, it is possible to give estimates for GHG emissions related to gear for OR among participant groups.

3.3 Statistical Tests

Welch's t-tests were used to assess statistically significant differences between the two target populations, while ordinary least squares regression analysis was used to identify correlations between dependent variables (DV) and independent variables (IV). DV included yearly km traveled for OR activities and monetary expenditures on OR equipment, while IV included demographic information like age, annual income, and years of education, as well as participant-evaluated factors motivating consumption and statements regarding personal beliefs about consumption and the environment. Participants ranked how much factors like price, time, and comfort influence their consumption practices related to OR transportation and gear purchasing respectively using a 1-5 Likert scale with 1 being strongly disagree, 3 being neutral, and 5 being strongly agree. Statements regarding personal beliefs about consumption and the environment were also evaluated using the same Likert scale. T-tests were performed on the number of trips taken pppy in different distance categories and with different modes of transport, monetary expenditures pppy on different types of gear, and responses to the statements and motivating factors described above.

3.4 Survey Populations and Distribution Methods

The survey was distributed to two populations of interest during the month of February 2021, including users of social media groups related to friluftsliv and students in master's (MA) and bachelor's (BA) programs related to friluftsliv. While previous studies have focused on the general population, this investigation targeted groups expected to have a relatively high (social media group) to very high (student group) level of participation in OR activities.

The survey was first posted on 6 social media groups focused on general friluftsliv in Norway with 10,000-50,000 members per group for a total of around 150,000 members. A short description of the survey was included with the offer of one free night at a DNT hut to one lucky winner who participated in the survey. Over the course of 1 week 168 responses were received, of which 8 were identified as outliers and removed, leaving 160 useable responses.

Secondly, 7 Norwegian universities with MA or BA programs related to friluftsliv were identified and contacted. Shortly after, the survey link, description and offer of the chance to win a free night at a DNT hut, were shared by 6 of the 7 universities through Canvas or email by professors or academic administrators. The survey reached approximately 250 students with this method. Over the course of one week 61 responses were received, of which 2 were identified as outliers, leaving 59 useable responses.

In both cases the participants were self-selected and are therefore samples of convenience rather than truly random samples. Unfortunately, it is not possible to determine how many individuals were exposed to the social media group posts, making it impossible to estimate a response rate. We know that the survey was taken by around .1% of the target population. For the student group the response rate was around 25%. While this is average for surveys, in this case it also represents around 25% of the entire target population.

3.5 Limitations

While yielding numerous interesting results the study suffers from the following limitations. Firstly, GHG emissions associated with infrastructure and food systems are beyond the scope of this study. In addition, the number of km traveled is an estimate based on a division between four distance categories rather than a participant-reported number of km traveled. This is due to the fact that asking participants to calculate the actual number of km traveled and would have led to the survey taking an unacceptable amount of time to complete. In certain instances, participants also chose between a range when selecting the number of trips or monetary expenditures, for example between 4-6 trips per month by car less than 50 km from home, or 5,000-10,000 NOK spent on trekking gear in the past two years. This data was then used to estimate km traveled or NOK spent as described above. While this may mean that for one individual the estimate may be too low or high, with 60-160 responses per group the margin of error decreases, and we believe the results are reasonable indicators which can be used to spot trends and draw useful conclusions.

4. Results

The results are divided into three main sections following a brief description of demographic information for participants in both groups. The first uses descriptive statistics combined with a hybrid LCA to gain insight into the typical consumption patterns of OR practitioners who encountered the survey through a social media group or study program related to friluftsliv. The second examines the role of independent variables in mediating the carbon intensity of these consumption practices. Finally, responses to open-ended questions regarding what could influence participants to change their consumption practices are examined in detail.

4.1 Descriptive Statistics of Participant Demographic Information

Students range in age from 16-59, with 81% between the ages of 20-29. A similar number of men and women responded to the survey, and 85% of respondents described themselves as Norwegian with the remainder identifying as European. There were participants from every major political party in Norway, with a significant number of respondents from the Center (15%), Socialist (13.5%), Labor (13.5%) and Green (12%) parties. Two thirds of students have been participating in friluftsliv for more than 10 years and 70% have between 1-4 family members who regularly participate in friluftsliv. All students are currently studying or have recently completed BA or MA programs related to friluftsliv. Over 60% of students report a total monthly spending of less than 9,999 NOK per month, with 30% spending between 10,000-20,000 NOK per month. Students devoted around 10% of their total monthly spending to friluftsliv, with 59% spending less than 1,000 NOK per month on these activities.

Social Media users varied in age from 16-80+ with 74% falling between the ages of 40-69. A similar number of men and women responded to the survey, and 91% of respondents describe themselves as Norwegian with the remainder identifying as European. There were representatives of every major political party, with most respondents aligning with the Labor (17%), Conservative (16%), and Center (15%) parties. Three quarters of social media users have

been participating in friluftsliv for more than 20 years, and the majority (74%) have between 1-4 family members who regularly participate in friluftsliv. Around 29% have completed 1-3 years of postsecondary education, 24% have completed 4-5 years of postsecondary education, and 28% have completed 6-9 years of postsecondary education. Close to 50% of respondents earn under 600,000 NOK per year, with 41% earning between 600,000-120,000 NOK per year. On average respondents reported spending around 5% of their income on friluftsliv, with 47% using between 3-8% of their yearly salary on these activities.

4.2 Transportation and Emissions Associated with Outdoor Recreation

*Table 1 Average number of trips taken by participants in both groups divided by mode of transportation and distance from home. Trips less than 50 km from home were reported per month, while trips further from home were reported per 6, 12, and 24 months respectively. T-tests show level of significance of differences between groups, with * p<.1, ** p<.01, *** p<.001.*

	Social Media Group				Student Group			
Mode of Transportation / Distance from Home	<50 km / per month	50-300 km / per 6 months	300-3000 km / per 12 months	3000+km / per 24 months	<50 km / per month	50-300 km / per 6 months	300-3000 km / per 12 months	3000+km / per 24 months
Private car (fossil fuel)	5.88	6.01**	1.42	0.22	6.15	9.40**	1.31	0.16
Private Car (electric)	1.79*	0.65	0.19*	X	0.85*	0.31	0*	X
Public Transportation	1.49*	1.22*	0.19*	0.08*	2.86*	2.66*	0.95*	0.31*
Airplane	X	0.26	0.53	0.49	0	0.24	0.90	0.74
Biking or walking	10.24	0.03*	X	X	10.66	0.37*	X	X

Table 1 shows mean participant responses to questions regarding frequency of travel in different distance categories and by what mode of transportation in order to engage in OR activities. T-tests confirmed significant differences between the number trips using public transport in all four distance categories, electric car in two of three distances categories, and trips by bike or foot and fossil fuel car in one of two distance categories. While these were the only categories that can be classified as statistically significant, others did have notably low p-values, such as trips by plane 300-3000 km from home (p=.120) and 3000+ km from home (p=.158). This suggests that with a larger sample size observed differences in means may become significant.

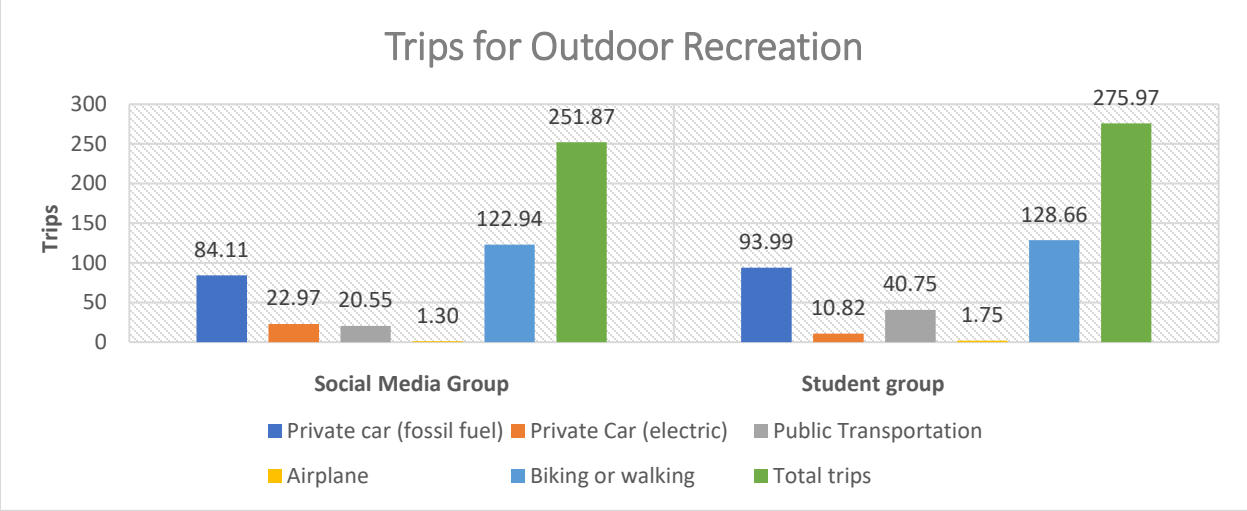

Figure 1 Average number of trips taken per person per year for OR divided by mode of transport for both groups.

Figure 1 shows the average numbers of trips pppy for OR using different modes of transportation. Both groups engage in OR frequently, around five times per week on average. Over 40% of these trips take place without the use of motorized transport (walking or biking directly from home). Trips by fossil fuel car are a close second, accounting for around one third of trips for both groups. Close to 15% of trips by students utilized public transportation, compared to just 8% of trips by social media users. Electric car use follows the opposite pattern, accounting for around 4% of trips taken by students but 9% of trips taken by social media users. Finally, the average respondent from both groups takes between one and two trips by airplane each year for OR.

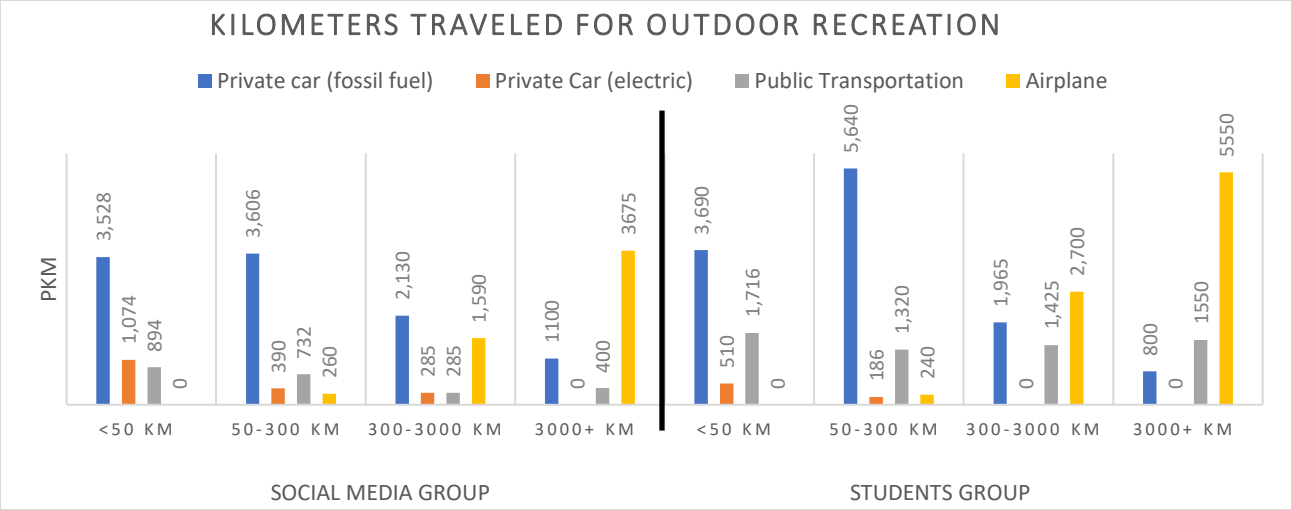

Figure 2 Estimated average number of passenger kilometers traveled per person per year for OR divided by distance from home and mode of transport for both groups.

Figure 2 shows the estimated average number of PKM traveled by both participant groups divided into categories according to both distance from home and modes of transport. Fossil fuel cars account for the largest share of PKM traveled for OR in both groups, around 44% for

students and over 50% for social media users. The number of km traveled with this form of transportation is similar for the two groups in all distance categories with the exception of trips 50-300 km from home, where students travel 60% more PKM by fossil fuel car than social media users. While trips by plane accounted for less than 1% of total trips (figure 1), they do contribute a significant share of PKM, 31% and 28% for students and social media users respectively (figure 2). There is also a clear trend of increasing use of airplane as distance from home increases, and students cover 54% more PKM by air than social media users on average. PKM traveled by public transportation are more uniform across distance categories, especially in the case of students, where this mode of transportation accounts for close to a quarter of total PKM traveled. Although electric cars accounted for the fewest number of PKM traveled for OR in both groups, they are used more frequently than public transportation by social media users for trips less than 50 km from home.

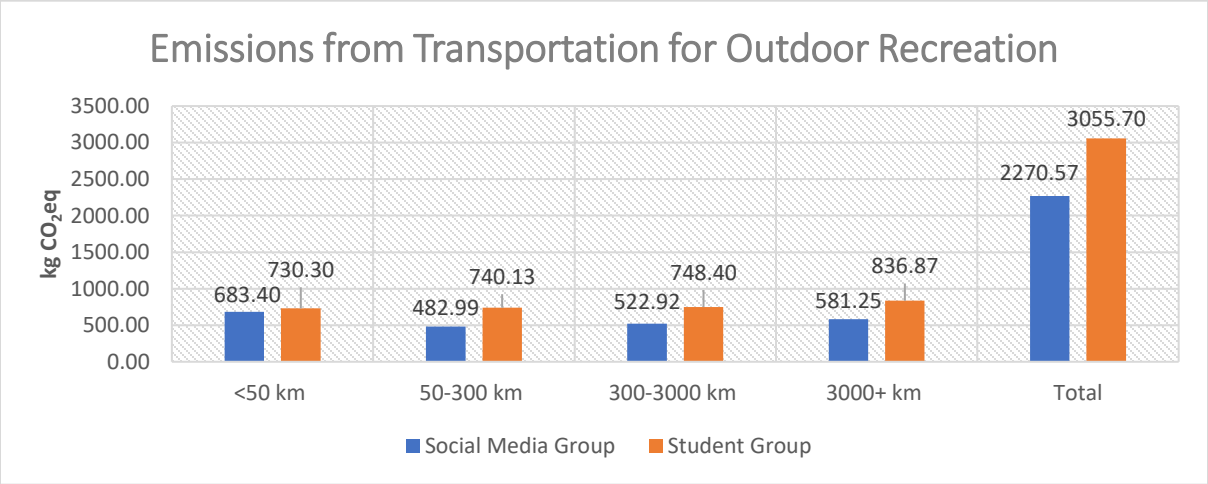

Figure 3 Estimated average kilograms of CO_2eq released per person per year for transportation related to OR divided by distance from home for both groups.

Figure 3 shows the estimated average number of kilograms (kg) of CO_2eq that are released by transportation for OR in each distance category for both groups. The numbers are remarkably similar in each distance category; while more participants travel more frequently at distances closer to home, this is offset by the fact that the trips taken further from home cover a larger number of km per trip. While this means that the impact for the average user is similar in each distance category, this is not the case for each individual respondent. Although nearly 100% of respondents in both groups participate in OR in the first two categories (less than 50 km and 50-300 km from home) around 47% of social media users and 42% of students do not engage in OR more than 300 km from home, while only slightly over a quarter of social media users and a third of students participate in OR more than 3000 km from home. Participants who engage in OR in only the first two categories are still estimated to release over 1000 kg of GHG pppy on average, while those who engage in OR in all 4 categories likely emit well over the 2000-3000 kg pppy estimate show in figure 3. For comparison, the yearly carbon footprint related to food consumption for the average Norwegian is estimated at 1550 kg of GHG pppy including food waste, transportation, storage, and preparation (Stamm 2015 cited in Wood et al 2019).

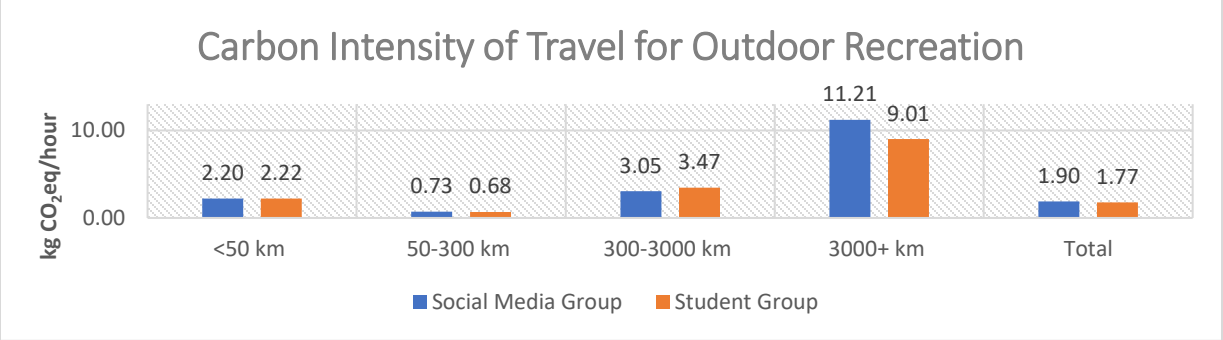

Figure 4 Carbon Intensity (emissions per unit of time) of travel related to OR divided by distance from home for both groups. Results are presented in kilogram of CO_2eq per hour of OR.

Figure 4 shows the average carbon intensity of the transportation component of OR activities. In order to estimate the full carbon intensity, it would be necessary to incorporate emissions from gear and infrastructure, while the unit of time would remain the same. Although activities around home generally require modest amounts of infrastructure (mainly hiking trails and ski tracks), activities further from home generally require overnight accommodation. For distances over 300 km from home this infrastructure is generally rented or shared. On the other hand, it is common for Norwegians to own or have access to one or more non-primary dwellings between 50 and 300 km from home. Many days spent at these cabins explains why the emissions for transportation per unit of time is relatively low for this distance category. However, the emissions associated with the construction and maintenance of cabins is substantial, and if emissions from infrastructure were included in this estimate the category of 50-300 km from home would likely see the greatest increase due to the large number of non-primary dwellings. Meanwhile emissions from gear could be allocated to all categories equally, or proportionally depending on the percent people who participate in OR in each distance category. Regardless, the emissions per hour from transportation is substantial in all categories, but especially for trips 3000+ km from home.

4.3 Gear and Emissions Associated with Outdoor Recreation

*Table 2 Average NOK spent per person per year on various forms OR gear by both groups and estimated GHG emissions associated with these monetary expenditures. The number in parenthesis denotes what percentage of participants purchased gear in each category. T-tests show level of significance of differences between groups, with * p<.1, ** p<.01, *** p<.001.*

	Camping and hiking	Hunt-ing and fishing	Personal mobility (bicycle)	Ski and snow sport	Boat and boating gear	Beach and water sport	Climbing and high mountain	Clothing and footwear	Other OR gear	Total
Social Media Group (NOK)	3011 *** (78%)	974 (31%)	4088 (44%)	2142 *** (61%)	4850 (16%)	357 ** (14%)	376 *** (14%)	2787 ** (89%)	1123 (36%)	19,708
Emissions (kg CO_2eq)	180.36	58.34	369.09	128.30	215.97	21.38	22.52	136.98	67.24	1,200.18
Student Group (NOK)	7034 *** (95%)	776 (51%)	3411 (71%)	4365 *** (88%)	5017 (15%)	780 ** (34%)	1212 *** (68%)	3687 ** (98%)	1403 (63%)	27,685
Emissions (kg CO_2eq)	421.33	46.48	308.00	261.43	223.40	46.69	72.60	181.23	84.01	1,645.17

Table 2 shows the average amount of money spent (NOK) on gear pppy by students and social media users respectively, in addition to the number of respondents who regularly purchase items in each category and an estimation of associated GHG emissions. Most respondents in both groups buy gear related to camping and trekking, ski and snow sports, and diverse clothing or footwear related to friluftsliv. More than 50% of students also purchase gear related to hunting and fishing, personal transportation, climbing and high mountain excursions. Beach and water sports received the smallest level of expenditure per year on average, while boats and boating equipment accounted for around 20% of expenditures in both groups although less than two in ten people purchased gear in this category. Statistically significant differences were found between the two groups ($p<.01$) for yearly monetary expenditures in five out of nine categories of gear.

A total average yearly expenditure of 19,708 and 27,685 NOK for social media users and students respectively represents an estimated 1,200 and 1,645 kilograms of GHG pppy. Combined with transportation this gives social media users and students an average carbon footprint related to OR of 3,471 and 4,701 kg of GHG emissions respectively.

4.4 The Role of Independent Variables in Mediating Consumption Behavior Related to Outdoor Recreation

In addition to the demographic information discussed above, three questions and ten factors motivating consumption were evaluated as independent variables for correlations with km traveled for OR and monetary expenditure on gear respectively. These variables were ranked by participants using a 1-5 Likert scale with 1 being strongly disagree, 3 being neutral, and 5 being strongly agree.

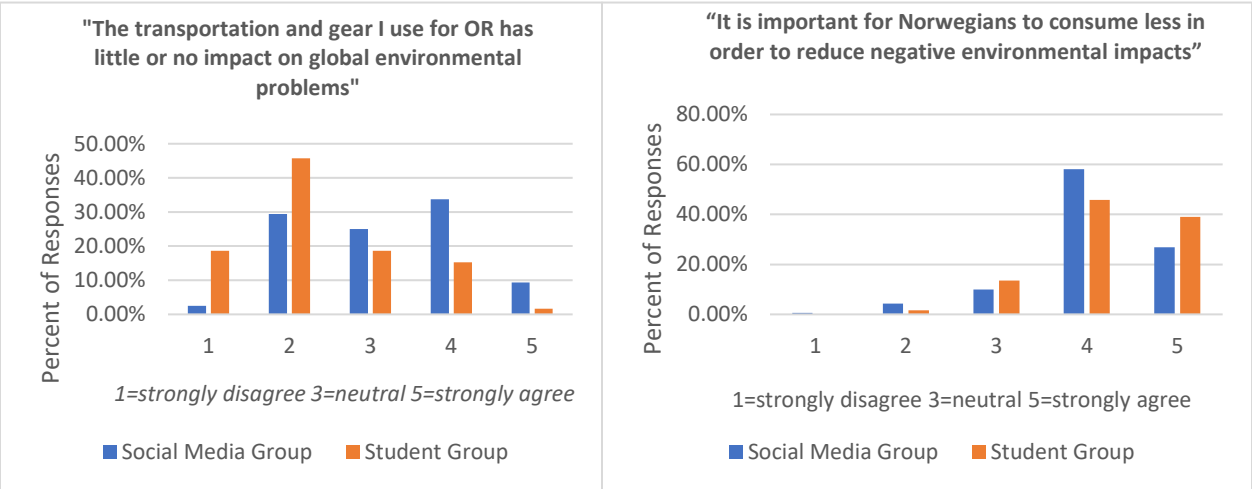

Figure 5 Participant rankings of questions regarding opinions on their own consumption patterns related to outdoor recreation and the consumption of Norwegians in general. Results are presented in percentage of participants for comparability. T-tests confirm statistically significant difference with very high confidence ($p<.001$) for question one (left) and moderate confidence ($p=.087$) question two (right).

The questions concerned participants beliefs about their own consumption patterns related to OR and Norwegian consumption in general (figure 5). Participants ranked statements like “the

transportation and gear I use for OR has little or no impact on global environmental problems", and "It is important for Norwegians to consume less in order to reduce negative environmental impacts". Over 60% of students and 30% of social media users marked disagree or strongly disagree for the first statement, while over 85% of participants from both groups marked agree or strongly agree in response to the second statement. While this could imply that a portion of participants moderate their consumption behavior in accordance with these beliefs, regression analysis showed no correlation between participant responses to these questions and actual monetary expenditures or km traveled for OR.

Participants also ranked ten factors motivating consumption twice, in relation to both travel behavior and gear purchasing (table 3). Price (mean=4.12) and time (3.88) stood out as the two factors regarded as most influencing travel behavior among students, followed by friends/family (3.51), and environmental concerns (3.47). Social media users, on the other hand, were mainly influenced by time (3.79) and healthy lifestyle (3.53) when traveling for OR. Statistically significant differences ($p<.01$) were found between the two groups in 4 of the 10 factors related to travel behavior. Responses to these questions had no correlation with the actual number of km traveled by participants in either group. The student group, who ranked environmental concerns as influencing their travel behavior related to OR significantly higher than the social media group, were estimated to be responsible for around 30% more emissions from transportation for OR.

*Table 3 Mean rankings of factors influencing consumption behavior related to transportation and equipment purchases for OR by both groups with 1=strongly disagree, 3=neutral, and 5=strongly agree. T-tests show level of significance of differences between groups, with * p<.1, ** p<.01, *** p<.001.*

	Price	Time	Comfort	Safety	Environ-mental Impacts	Social / other media	Friends / Family	DNT member-ship	National identity	Healthy Life-style
Social Media / Transport	3.21***	3.79	3.10**	3.37	3.13**	2.40	3.31*	2.78***	2.71*	3.53
Social Media / Gear	3.70***	2.86	3.78	3.81***	3.19*	2.65	3.13	2.54*	2.61	3.40**
Students / Transport	4.12***	3.88	2.85**	3.22	3.47**	2.47	3.51*	2.29***	2.42*	3.39
Students / Gear	4.20***	2.90	3.81	4.25***	3.42*	2.64	3.02	2.22*	2.47	3.02**

In terms of gear purchasing, students were motivated most strongly by safety (4.25) and price (4.20), followed by comfort (3.81). Similarly, social media users were mainly motivated by safety (3.81), comfort (3.78) and then price (3.70). Statistically significant differences ($p<.01$) were found between the two groups in 3 of the 10 factors related to gear purchasing habits. Once again, responses to these questions had no correlation with actual monetary expenditures for either group.

Despite a lack of correlation, these factors may still play a role in influencing transportation and purchasing habits. These results suggest that the importance one attributes to factors such as price and time, or one's beliefs about the environmental impacts of one's own actions play little

role in mediating actual consumption behavior. While participants ranked time as highly influential in terms of motivating travel patterns, they considered it to play far less of a role in mediating gear purchasing behavior. Rather, safety is the primary concern of most participants for this type of consumption. This is in contrast to Rønnevik (2019) who posits time as the most important factor mediating general leisure consumption followed by price, mainly due to high levels of disposable income in Norway. It seems participants consider time as most important only regarding the travel behavior of the social media group, whereas safety concerns were ranked as most important for gear purchases, and students ranked price as more influential than time for both categories of consumption.

Finally, independent variables regarding demographic information were assessed for correlations with km traveled and monetary expenditures respectively. For the social media group, annual income and percent of income devoted to OR were the most powerful predictors of consumer behavior (figure 6). Annual income was highly correlation with annual spending on equipment for OR ($p<.001$, $R^2=.16$) but only weakly with km traveled for OR ($p=.06$, $R^2=.02$), while percent of income devoted to OR correlated well with both km traveled for OR ($p<.001$, $R^2=.09$) and gear purchases for OR ($p<.01$, $R^2=.06$). In lieu of annual income and percent of income dedicated to OR, the student group instead reported total monthly expenditures and monthly expenditures related to OR. While total monthly expenditure did not correlate with transportation or gear purchasing habits among students, monthly spending on OR did correlated significantly ($p=.021$, $R^2=.09$) with annual gear purchases for OR. In addition, for the social media group, age correlated weakly with km traveled for OR ($p=.066$ $R^2=.02$) but not with gear purchases.

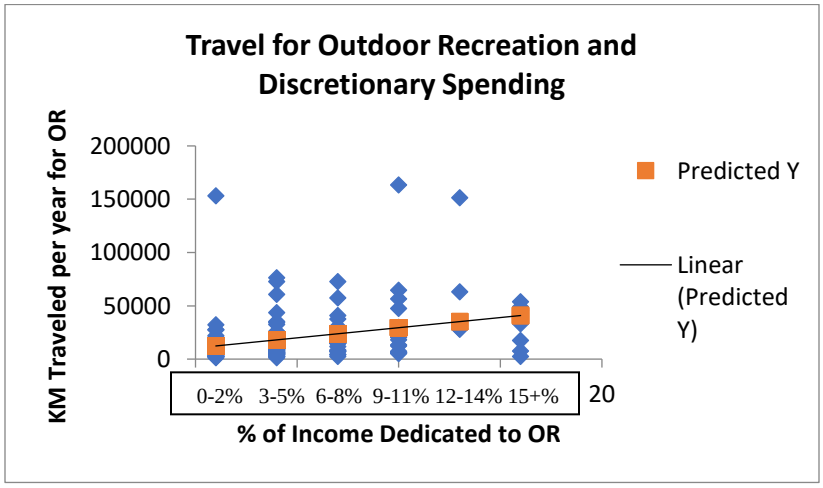

Figure 6 Ordinary least squares line produced using regression analysis showing a correlation between percent of income dedicated to OR (independent variable) and km traveled per year for OR (dependent variable) for the Social Media Group, ($p<.001$, $R^2=.09$).

4.5 Responses to Open-ended Questions

Open-ended questions include:

1) What could influence you to participate in OR around your home rather than in another region or country?
2) What could influence you to use the bus or train more often when participating in OR?
3) What could influence you to buy less clothes and equipment for outdoor activities?
4) What could influence you to rent or share more equipment with others?

A number of ideas recurred throughout participant responses to the above questions. For the first question, the most common theme discussed by both groups related to specific types of nature necessary for OR. Many described as “wild” or “untouched nature” “without other people”, for others this meant “marked trails”, “established climbing areas”, and “cabins” or other forms of infrastructure. A related theme was the need for “new” or previously “unseen places”. In both cases the type of nature that exists around the home was insufficient, leading to increases in travel for OR. Many students mentioned “information”, “knowledge”, or “descriptions of experiences” in the local areas could influence them to engage in OR in their home area more frequently. The words “price” and “time” also appeared in many responses from students, implying that with greater access to funds and free time many would increase the amount of OR near home while concurrently maintaining or increasing their levels of OR further from home. While many responses were similar between groups, some social media users explained that they already engage in activities mainly close to home or were unwilling to consider changing their travel patterns regarding destination.

In response to question two, both groups called for “cheaper, more frequent, and more diverse travel options” with “direct routes to nature areas”. Some also mentioned the ability to bring dogs and equipment on buses and trains. A number of students decried a lack of cooperation between transportation companies, for example in organizing a monthly or yearly pass or “collaborating on route planning and ticket sales”. One student suggested selling their car as the only realistic way to increase their use of public transport, and another explained that a “less busy everyday life” would allow for less use of private vehicles. A few social media users also mention the relationship between work and leisure time. In general, it seems students would be relatively open to changing their mode of transport if the price is right, they have enough time, and they can access the same destinations they do currently. On the other hand, social media users showed less willingness to switch their current mode of transport, with many writing that nothing would influence them to do so.

For questions three and four, participants from the student group mentioned the “quality and durability” of products, as well as ease of “repair services” as factors influencing them to buy more gear. One student suggested they be taught in their studies about how to repair their own gear. Many students also mentioned “versatility”, or the option to use one type of gear for different activities, while others noted the diversification of gear-intensive activities as a factor motivating consumption. Although some students called for cheaper and more accessible rental

gear or borrowing schemes, others expressed an unwillingness to share their gear, explaining that some people do not take proper care of their equipment.

Another theme discussed by students when answering questions related to gear was a strong social pressure from peers. This manifested itself in gear purchasing in order to "not feel amateurish" for not owning the correct equipment. One student referred to this as "brand / equipment pressure" and another mentioned the "shame" associated with owning "poor gear". Another refers to a "fashion pressure" associated with OR gear in Norway, and another mentioned the feeling of "having to own" a new piece of equipment. Some students suggested a decrease in advertising and social media use or an increase in environmental awareness as ways to reduce unnecessary gear purchases. "Sales" and "low prices" were also mentioned as factors motivating consumption, with one student even suggesting higher prices in order to curb consumption patterns. Many students expressed an awareness of their own impact on global environmental problems and appeared relatively open to changing their behavior.

Many in the social media group also mentioned durability, repairability, and versatility while others mentioned "lack of self-control" and the overconsumption of peers. However, many also pushed back against the premise of these questions, writing that they already only buy what they most need and the only way they could buy less would be to engage in less OR and therefore have fewer needs. One asked why it would be a goal to consume less gear, while another wrote that OR had less environmental impacts than other activities. Circumstances that participants thought might reduce their expenditures on gear included: injury, poor health, not having children, and less money, implying that some have no desire to buy less gear. Around 10% wrote that "nothing" would make them interested in reducing consumption related to OR in the ways described in questions 1-4 compared to around 1% of students.

5. Discussion

Several of the findings mentioned above warrant an extended discussion in light of relevant literature and theory. These include the carbon footprint of transportation and gear purchases related to OR among the target populations, the role of independent variables in mediating consumption practices, and the implications of these findings for our understanding of OR.

It is worthwhile to consider the average estimated carbon footprint of the target groups for these activities. Between 3.4 (social media group) and 4.7 (student group) tons of GHGs pppy stemming from transportation and gear used for OR is equal to around one fifth of the average Norwegian's yearly GHG emissions and is, by itself, more than double the per capita boundary required to achieve a good life for all within the limits of earths biocapacity (O'Neill et al., 2018). In contrast to Rønnevik (2019) and Aall (2011), this study found transportation for OR recreation to have a more substantial environmental load than gear purchases. This may be due in part to the fact that their studies focused on the average Norwegian's energy use for transportation and equipment purchases for OR, while the current study focused on GHG emissions and the survey was directed at individuals who frequently engaged in OR activities. However, it is likely also due to the fact the prior investigations excluded multi-day travel when accounting for the environmental load of transportation related to OR.

In accordance with Aamaas and Peters (2017), travel distance and GHG emissions associated with transportation were strongly linked to general income and expenditures, with wealthier individuals responsible for the majority of emissions. In addition, the social media group was found to emit around 5% of transportation related emissions with public transportation, quite similar to Aamaas and Peters (2017) estimate of 4% for general transportation among the broader population. On the other hand, emissions from public transportation accounted for 11% of the total for students. While we found emissions from transportation for OR among both target groups to come mainly from private cars followed closely by airplane, the opposite pattern was found for general transportation among the wider population (Aamaas and Peters, 2017).

In the current study, participants' personal beliefs regarding consumption and opinions related to the influence of different factors motivating consumption did not play a significant role in mediating actual consumer behavior or carbon footprint. Instead, general income and the amount of money directed towards OR activities were shown to be the best predictors of both km traveled per year of OR and monetary expenditures on gear. This supports the conclusion that with more time and disposable income, individuals are likely to emit more GHG, regardless of good intentions or the proclaimed sustainability of certain activities. It further suggests that if the Norwegian economy continues to grow it will become increasingly difficult to reduce consumption-based emissions to a level which meet per capita emission boundaries. This is in accordance with Isaksen and Narbel (2017) who found emissions from household consumption increase in a proportional way to expenditures, implying no decoupling of environmental impacts from economic activity.

These findings emphasize the need for a reevaluation of the dominant narrative surrounding OR, where OR is regarded as an environmentally friendly practice which encourages care for the environment (Gelter, 2000; Faarlund et al., 2007; Pederson, 2008; Winter et al., 2020). Flying or driving long distances to interact with nature is in part responsible for the demise of what enthusiasts claim to appreciate most. The accumulation of gear for OR is no more environmentally friendly than consumption for purposes other than spending time in nature. This raises questions of environmental justice; as some travel long distances and spend large sums of money to enjoy nature, others become refugees and lose their homes and livelihoods to the climate catastrophe. Whereas the majority of studies focus on local, technical, and managerial problems associated with OR, greater attention must be given to global environmental consequences of these activities, particularly in regard to transportation and gear purchases. Instead of encouraging unrelenting growth in the industry, it may be time to consider acceptable limits and determine which forms of OR are beneficial and which are detrimental to the biosphere.

Finally, it is important to consider structural and political forces which provide the context for individual consumption behavior. In the past three decades, purchasing power has tripled in Norway, and disposable income has been directed towards, among other things, leisure activities such as OR. At the same time, the government has been actively calling for an increase in business development and value creation from nature and cultural heritage, promoting deregulation, modernization, and market investment. From supporting cabin construction though

the sale of public or state-owned land, to requiring branding strategies for all national parks, the government's goal is growth in the industry. Generally marketed as eco- or nature-based tourism, this endorsement of commercialization has led away from simple interactions with local nature towards exclusive, equipment intensive, and expensive experiences. While other industries are targeted for change towards sustainability, the same cannot be said for OR. *Friends of the Earth Norway* recently published an article describing this as "a deliberate development, politically steered by the government and its predecessors…turning local nature areas into playgrounds for the rich" (Tordsson, 2021). With a government actively petitioning its citizens to travel and buy more in order to spur economic growth, it is unsurprising that individuals with high levels of disposable income overshoot the boundaries of sustainable consumption.

6. Conclusion

As territorial emissions stabilize in many industrialized countries, the environmental impacts of leisure consumption have emerged as key factors which must be addressed in order to meet climate targets agreed upon by most nations. This study used a survey to investigate the GHG emissions associated with transportation and gear for OR among two groups, in addition to which factors influence the carbon intensity of these activities.

Three main findings can be drawn from the investigation. The first is related to the hybrid LCA of GHG emissions, where it was estimated that the average participant releases between 3.4 (social media group) and 4.7 (student group) tons of CO_2eq emissions per year in association with OR activities, with around 65% of these emissions coming from transportation and the remaining 35% coming from gear purchases in both groups. This is in contrast with prior studies which found gear purchases to have a greater environmental load than transportation. Secondly, this study found personal beliefs and self-evaluated motivating factors to have no verifiable role in mediating consumption behavior among the participant groups. Instead, general income and expenditures for OR were the best predictors of environmental load. These findings stand in contrast with the dominant narrative surrounding OR, which fails to account for the high levels of GHG emissions associated with these practices.

We hope this study can serve as a steppingstone in our understanding of the global environmental impacts of consumption associated with OR activities. In order to address these impacts, it is likely that structural, social, and individual factors will need to coalesce to bring a shift away from the pursuit of novel and ever-greater experiences in diverse locations, and towards the revitalization and reinvestment in nature nearby the home; from buying new gear to facilitate new forms of interaction with nature towards an appreciation of what can be done in nature without any specialized equipment.

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