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The Impact of Environmental Awareness on Personal Carbon Footprint Values of Biology Department Students, Faculty of Science, El-Mergib University, Al-Khums, Libya

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ABSTRACT

This study aims to determine, explicate, and comprehend the impact of environmental awareness on the personal carbon footprint values of Biology Department students, Faculty of Science, El-Mergib University, Al-Khums. Libya. The study population was divided into two groups: 1). a group that underwent and passed the general ecology course and 2(. a group that did not undergo any environmental-related courses. Findings have revealed an inverse proportion between students' environmental consciousness and carbon footprint; the more environmentally conscious students are, the lower their carbon footprint values. Results have also shown that the mean value of the personal carbon footprint of the study population's first and most environmentally aware group is 5.6 ± 1.7 (t/yr). Meanwhile, the second group scored an average personal carbon footprint of 11.7 ± 2.3 (t/yr).

Keywords: Environmental Awareness; Personal Carbon Footprint; CO_2e; GHGs; Global Warming; Climate Change

INTRODUCTION

The term carbon footprint was first introduced to the scientific community by William Reese and Matthias Wackernagel in the nineties of the twentieth century. However, it became prevalent during the campaign carried out by the B&B Company between 2005 and 2007. As in fingerprint and genetic footprint, each person has a carbon footprint, which is the amount of carbon dioxide CO_2 or carbon dioxide equivalents CO_2 (usually expressed in tons per year) that a particular individual releases into the atmosphere due to his various activities. The overall carbon footprint is considered one of the most significant contributors to global warming and its repercussions on climate deterioration worldwide.

There are different types of carbon footprints for instance: the carbon footprint of individuals (personal), the carbon footprint for products, services, and events (from cradle to grave), and the carbon footprint for institutions, organizations, and companies. Each type of carbon footprint has different determination methods and limits. Values of personal carbon footprint (the subject of the study) are related to the activity of individuals and the impact of their lifestyle and countless activities on the environment.

Personal carbon footprint is determined by calculating the amount of carbon dioxide CO_2 or its equivalent CO_2e that an individual releases into the atmosphere directly or indirectly. To calculate the effective carbon footprint, a global unit must be used, so that all six greenhouse gases covered by the Kyoto Protocol are converted into CO_2 equivalents. Calculating and reporting carbon footprint allows us to manage the risks of GHGs and identify opportunities to reduce them. On the other hand, voluntary actions can be taken to reduce our footprint and show commitment to climate change mitigation and global warming. The carbon footprint determines the direct emissions of carbon dioxide gas resulting from burning fossil fuels, which is represented in our consumption of electric energy and our exploitation of various means of transportation (cars, planes, and trains). Through this footprint, we can directly control the amount of our emissions.

Conventionally, carbon dioxide (CO_2) is not the only gas that is heating our planet, as the total personal carbon footprint comprises the six greenhouse gases (GHGs): CO_2, CH_4, N_2O, PFCs, HFCs, and SF_6. Methane (CH_4) molecules are the most effective in warming the planet, as carbon dioxide gas accounts for only approximately 20% of total emissions. Based on findings reported by [6] it is estimated that CH_4 accounts for more than a third of the global warming gases emitted into the atmosphere from various sources such as grazing cattle, landfill gases, and fossil fuel extraction.

Table 1: The Primary Greenhouse Gases and their CO_2 Equivalents.

Gas	Name	CO_2 Equivalents (GWP)
CO_2	Carbon dioxide	**1**
CH_4	Methane	**21**

N_2O	Nitrous oxide	**310**
PFCs	Perfluorocarbons	**6500**
HFCs	Hydrofluorocarbons	**11700**
SF_6	Sulfur hexafluoride	**23900**

***Source:** [1].*

Nitrous Oxide (N_2O) and the fluorinated gases (PFCs & HFCs) used in refrigeration equipment are also crucial greenhouse gases, as the effect of one ton of nitrous oxide on atmospheric warming is approximately 300 times greater than one ton of carbon dioxide CO_2. The global warming potential (GWP) of PFCs and HFCs reaches 6500 and 11700 respectively as indicated in Table 1 [1]. Furthermore, Sulphur Hexafluoride (SF_6) employed in the electrical industries is one of the most potent greenhouse gases as it is estimated that 1 ton of SF_6 is 23900 times more effective than the same amount of CO_2, meaning that 1 ton of SF_6 has the same impact as 23900 tons of CO_2 as reported by [13].

The world's reliance on energy resources in the Middle East and North African (MENA) region has caused the region to have some of the largest carbon footprints per capita worldwide. The oil and gas industry, electricity production, transportation, industrial heating, and air conditioning are responsible for most of the carbon emissions from the region. Qatar, Kuwait, UAE, Bahrain, and Saudi Arabia are among the top 10 per capita carbon emissions countries. In 2019, Qatar's carbon emissions recorded 50 tons per capita, which is more than double the US's per capita of 19 tons per year [9]. Likewise, the monthly rate of per capita emissions in rich countries is much higher than the annual per capita emissions of poor countries. This remarkable difference depends on the manufacturing methods of goods and services, the consumption patterns, and the lifestyle of developed societies and world elites.

Many factors control the per capita emissions, the most important of which are environmental awareness, population size, and the nature of urban and economic activity in the country. It is worth mentioning that the international average volume of carbon dioxide emissions per capita is about 4 tons per year. Even though the ideal rate of personal carbon footprint is only about 2 tons per year. In 2020, the State of Qatar scored the highest personal carbon footprint at 37.02 tons per year. On the contrary, Yemen recorded the lowest carbon footprint at 0.33 tons annually, while Libya recorded an average of 7.38 tons annually, which is approximately four times the ideal rate of the global personal carbon footprint [5].

It must be noted that during the coming years, Libya will witness severe climatic challenges, including temperature rise, a decrease in rain levels, and a scarcity of drinking water. According to findings published by [7], rain levels will gradually decrease, and thus Libya will lose nearly 7% of its precipitation rate by 2050. Over and above, the average temperature levels will rise by 2 ºC accompanied by an increase in sandstorms, drought, scarcity of drinking water, coastal erosion, and sea level rise affecting coastal areas and low-lying cities such as Al-Khums, Benghazi, and Sirte, and a decline in agricultural production due to arable lands degradation. This does not mean that the rest of the countries or regions will be immune from the effects of climate change, as other Arab countries will also suffer from the risks of climate change, Egypt, for example, will suffer from a rise in sea levels. Equally important, Yemen and Oman will face more hurricanes coming from the Arabian Sea. Countries like Jordan and Syria will suffer from severe water scarcity and desertification, which will subsequently lead to a decline in agricultural production and food crises.

Methodology:

In this study, the calculator available on the Ecological Footprint Network website on the Internet https://www.footprintcalculator.org was chosen as it is the most accurate calculator available for calculating the personal (individual) carbon footprint. This calculator is a survey that takes each individual a few minutes and ends with a result in the form of a number that represents the personal carbon footprint of the respondent in (tons/year). The personal carbon footprint varies from one individual to another according to his environmental awareness, location, habits, and personal choices, in addition to many other factors. Through the personal carbon footprint, we can determine the direct emissions of carbon dioxide (CO_2) resulting from burning fossil fuels, consumption of electric energy, and exploitation of various means of transportation as well as the indirect emissions of carbon dioxide resulting from the life cycle of the products (from cradle to grave), which is mainly related to manufacturing processes. In other words, the more products we buy, the more we emit.

The size of the study sample was assessed utilizing the calculator available on the statistical website https://select-statistics.co.uk with a confidence level of 95%, as the total number of Biology Department students was 631 students the size of the target sample was estimated at 126 randomly chosen students. The population of the study sample was equally divided into two groups: the first group represented the students who underwent and passed the general ecology course, while the second group exemplified the students who did not undergo any environmental-related courses. The survey data obtained were analyzed using IBM SPSS Statistics 24.0 software to compare the results, while the degree of standard deviation was attained using the One-way ANOVA test.

Results & Discussion:

Survey results showed that 34.6% of the targeted students had previously heard of the term personal carbon footprint. Furthermore, the percentage of students who had heard of the term (personal carbon footprint) through their study of the general ecology course was 77.7% of the aforementioned percentage, and 22.3% of the total students had heard of it through friends, social media, and other different sources of information (Figure 1).This is solid evidence of the great significance of developing environmental awareness among students through the various means available and its effective impact in reducing their carbon footprint, which positively reflects on reducing the negative impacts of GHGs.

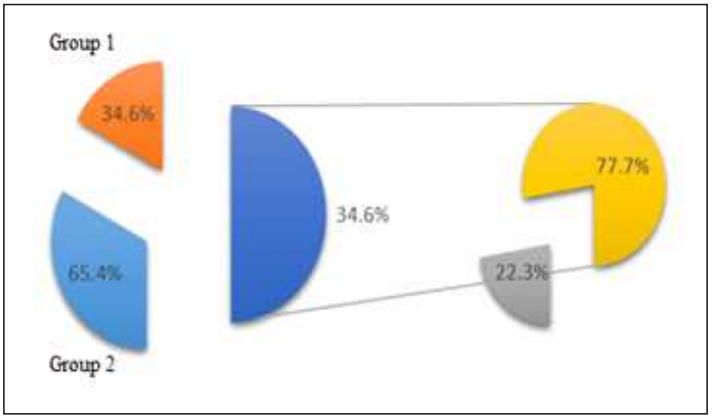

Figure 1: Percentage Explanation of Group 1.

Data obtained from the second and most detailed part of the survey showed that relying on various livestock products especially cows such as meat, milk, and its derivatives as a main food source plays a fundamental role in increasing the values of the personal carbon footprint. The number of students from group 2 who (always) rely on livestock products daily is quite huge as it almost hits the roof of 40 students out of 63 (62%) as illustrated in Figure 2. On the contrary, number of students who (never) rely on such products is relatively small (only 3). [4] indicated that cows are considered a significant source of methane gas released through their digestive tracts (farting) into the atmosphere. A 2014 study carried out by [8] revealed that a cow is 21 times more jeopardous to the environment than a car, as the methane gas (CH_4) that leaks from the cow's digestive tract is 21 times more dangerous to the environment than carbon dioxide CO_2. Additionally, the responsibility of methane (CH_4) for environmental pollution and global warming approximately represents 30% of all known sources of pollution as 200 cows' methane gas release is equivalent to the amount released by a town of a population between 5 and 10 thousand people with all its homes, utilities, and factories [3].

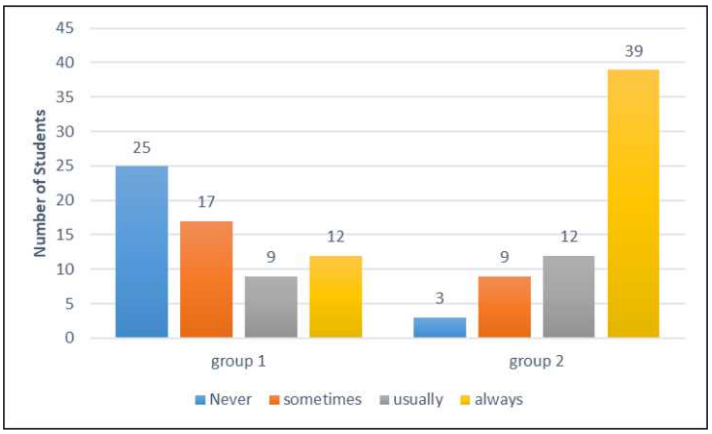

Figure 2: Relying on Livestock Products.

In this study, the consumption rates of unpackaged and unprocessed local foods (natural products) for both targeted groups were relatively high. These results are attributed to the fact that the culture of Libyan society, in general, is often represented in eating the local product that the Libyan individual prefers over its imported counterpart for both cultural and health reasons, which positively reflects on reducing the values of the personal carbon footprint of the study community (Figure 3).

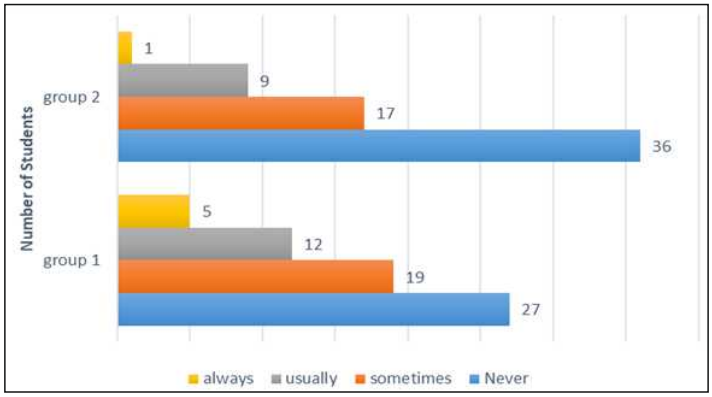

Figure 3: Local Products Consumption.

It is axiomatic in the environmental community that local products have a much lower carbon footprint than their imported counterparts, as imported products require different means of transportation (ships, planes, cars, etc.) to deliver to consumers, which requires huge amounts of fuel to complete the process. The transportation processes and delivery of these products to store shelves, and the packaging of the products (packaged goods) result in a lot of waste that is unintentionally imported as a part of the product, which results in raising the value of the individual's carbon footprint.

As for the quality of electricity use (conservative - moderate - bad) for the study sample, the results revealed that the students who underwent the general ecology course were the most conservative compared to the second group of the targeted sample who did not study the aforementioned course (Figure 4). The quality of electricity consumption is a clear indicator of the carbon footprint of an individual, the more a person uses energy sources in an immoral or irresponsible way, the higher the value of his carbon footprint and vice versa.

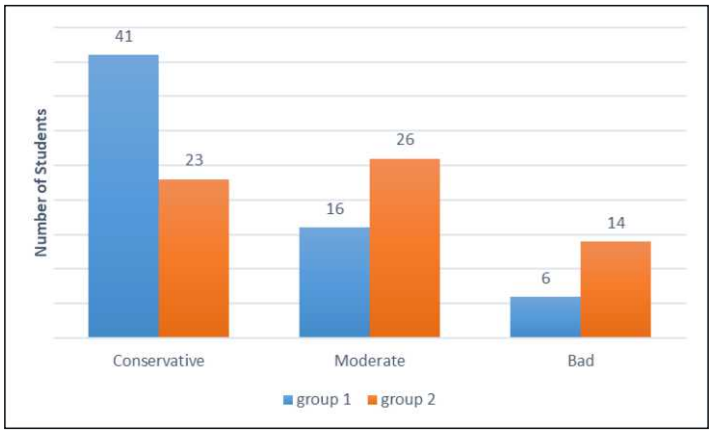

Figure 4: Electricity Consumption Quality.

Regarding alternative (renewable) energy use, survey results showed that respondents barely use it or do not use it at all (Figure 5). This is due to circumstances beyond the consumer's control, as the Libyan government has not supported the renewable (clean) energy sector in one way or another. On the other hand, the high solar luminosity rates in the Libyan Desert, which constitutes a wide geographical area of Libya, were not exploited to encourage the solar energy sector, like other countries, to solve the electricity crisis that worsens every day. This is primarily reflected in the high values of the personal carbon footprint, as the latter is inversely proportional to the use of alternative energies. Most African countries are

characterized by a high rate of annual solar radiation, especially in deserts and plains, which allows governments to establish solar farms in most areas without the need to use advanced technologies to concentrate and collect solar radiation. The rates of solar radiation in African countries are close to a large percentage of about 85% to receive about 2000 kWh/m2 per year. However, if Africa exploited only 0.3% of the area of North African countries; it would generate enough energy to cover the consumption of European Union countries, a study finds [12].

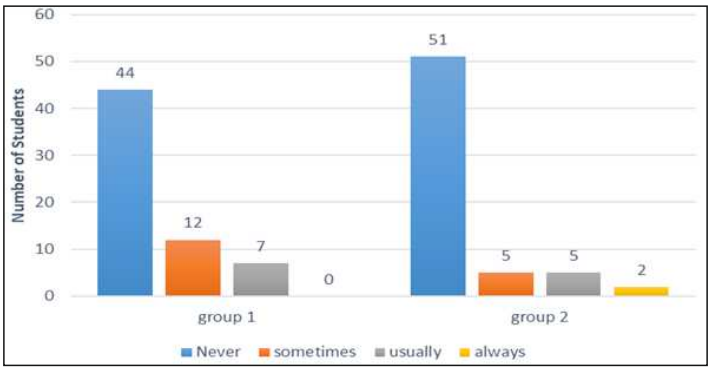

Figure 5: Clean Energy Consumption.

Concerning the amount of solid waste discarded by the respondents, results showed that the amount of waste generated compared to the neighbors was relatively less for the students who took the general ecology course (the most environmentally aware), while it was equal or more compared to the quantities thrown by the neighbors for the second group (Figure 5). It is logically known that the amount of garbage produced by individuals is directly proportional to their carbon footprint. According to a Taqarub project launched in 2019 at the municipal level and funded by the United States Agency for Development (USAID), the Libyan individual generates 1.5 kg of waste daily. Organic materials constitute 65% of the aforementioned number, while recyclable materials (paper, plastic, glass, and wood) constitute 29% [11].

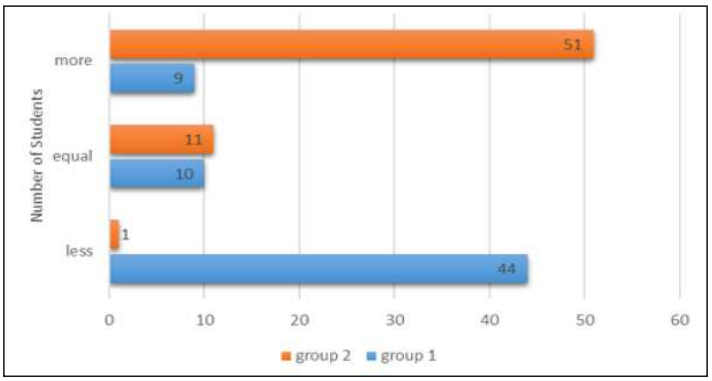

Figure 6: Solid Waste Generation Compared to Neighbors.

Fuel consumption of the vehicle carrying the respondent and the distance the car travels per week, we could not get precise data from the respondents, as most of them are not aware of these details. However, the researchers tend to believe that the fuel consumption and the distances traveled weekly are relatively high compared to neighboring countries due to the lack of awareness of the dangers of fuel combustion and fuel cheapness approximately ($0.03).

When looking at the most prominent challenges facing carbon neutrality, transportation emissions come to the fore, given the heavy dependence on fossil fuels, and world governments are working to reduce transportation sector emissions through several methods, such as stimulating the shift to electric cars and supporting low-carbon technologies such as biofuels and hydrogen. According to a report by the World Economic Forum, even if the current policies and commitments by countries succeed, carbon emissions in the transportation sector will continue to grow by nearly 20% by 2050. Therefore, the behavior of individuals can play a significant role in supporting faster reductions in carbon emissions, with the carbon footprint of the modes of transportation people use differing.

Based on a study conducted by [2] gases emitted from car exhausts are the largest source of pollution in the State of Libya followed by the industrial sector, and urban development respectively. One of the most disturbing phenomena that recently surfaced is the phenomenon of selling the environmental can (the Catalyseur) due to its high price, which is designed to convert harmful gases into other less harmful gases by filtering 90% of these gases. In fairness, selling the environmental cans is one of the worst manifestations of the low environmental awareness of Libyan citizens where the contents of these cans are exported to China, which imposes fines and penalties on cars that do not contain these cans.

The distances traveled by the respondent on public transportation every week, are almost non-existent due to the lack of widespread public transportation culture (buses, trains, etc.), especially in areas far from the capital, where these means are relatively present (except trains). This harms the personal carbon footprint of the respondents, as the more the culture of public transportation spreads, the less the personal carbon footprint decreases. This is also the case with the number of hours traveled by plane annually as most of the respondents recorded zero (they do not travel at all) except for one respondent who said that he travels 3 and a half hours annually with his family members to perform Umrah rituals. Moreover, this contributes to significantly reducing the personal carbon footprint of the respondents, as [10] reported that one plane can produce energy equivalent to 3,500 cars, and the numbers indicate to carry one passenger by air, the plane needs the power of 6 cars combined.

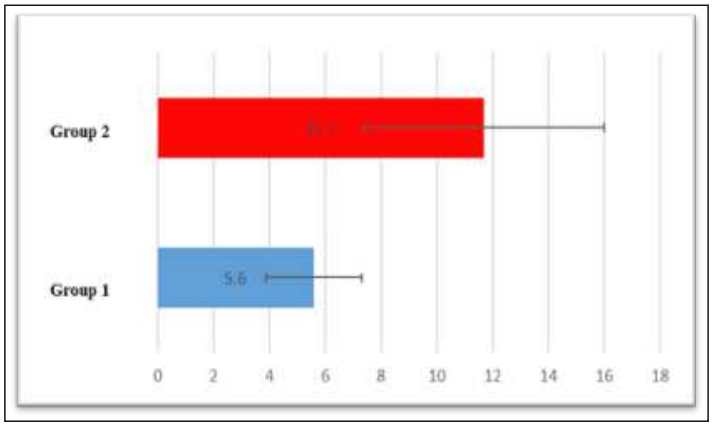

Figure 7: Personal Carbon Footprints Values for both Study Groups.

Conclusion:

This study concludes that the average personal carbon footprint of the first group of respondents scored (5.6 ± 1.7 t/yr), while it was more than double (11.7 ± 2.3 t/yr) for the second studying group (Figure 7). Findings confirmed the importance of environmental awareness represented personal habits and choices of individuals in reducing the personal

carbon footprint and thus reducing the emissions of greenhouse gases. T-test readings demonstrate that the mean personal carbon footprint for both study groups was not significantly different (P value > 0.05). Despite these results, the personal carbon footprint values for the first category remain relatively high compared to the ideal carbon footprint (2 t/yr) due to many considerations emphasized earlier.

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The authors of this work would express their gratefulness to the Biology Department students, Faculty of Science, El-Mergib University for their unconditional cooperation, patience, and understanding of the importance of the study.

Recommendation:
The authors of this work would highly recommend scholars to conduct similar studies to confirm findings and would strongly encourage public authorities to support such research materially and morally.

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