

UNDERSTANDING THE ADOPTION AND IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON CLIMATE CHANGE AWARENESS: EVIDENCE FROM UNIVERSITY GRADUATES IN PAKISTAN

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ABSTRACT

Climate change is a pressing issue that significantly impacts agriculture, health, biodiversity, water resources, forests, and the socioeconomic well-being of populations, particularly in developing and least developed nations. Raising public awareness of climate change through accurate knowledge is a key strategy to encourage proactive mitigation and adaptation efforts. This study investigates the use of Information and Communication Technologies (ICTs) by university graduates to enhance climate change awareness, focusing on the role of both educators and students in knowledge transfer within academic environments. The research was conducted across 15 major universities in Pakistan, using a structured questionnaire to collect data on demographic, socio-cultural, technological, and economic factors influencing graduates' awareness and perceptions of climate change. A binary logistic regression analysis was used to assess the impact of ICTs on climate change awareness. The results indicate that access to smartphones, agricultural magazines, news bulletins, newspapers, television, and internet connectivity significantly enhances climate change awareness. However, access to radio and computers or laptops did not show a significant impact. Universities should integrate ICT-based training and outreach activities into their curricula, promoting technological solutions that address climate change challenges. Furthermore, collaboration between technological solution providers, environmental departments, and academic institutions is recommended to design ICT-driven strategies for raising climate change awareness among the youth.

Keywords: ICTs adoption, biodiversity, learning environment, climate change awareness.

Citation: Aslam M, Li Z, Naeem M, Al-Ghamdi AA, Ahmad S, Alisher K, Rapat A, Ozodbek A. 2024. Understanding the adoption and impact of information and communication technologies on climate change awareness: Evidence from university graduates in Pakistan. *Agrociencia*. <https://doi.org/10.47163/agrociencia.v58i8.3091>

Editor in Chief:
Dr. Fernando C. Gómez Merino

Received: October 18, 2023.
Approved: October 23, 2024.
Published in Agrociencia:
December 05, 2024.

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INTRODUCTION

Climate change represents a significant obstacle to global development in the 21st century (Naylor and Ford, 2023). Rising global temperatures are outpacing the natural rate of climate change (Aslam and Li, 2024), driven by a variety of natural processes over time. However, over the past 200 years, human activities have also contributed significantly to global warming. Despite ongoing debates, there is a broad consensus among researchers that human actions, such as deforestation, fossil fuel combustion, industrial processes, and water, air, and land pollution, play a critical role in accelerating climate change (IPCC, 2022). This has led many scholars to describe climate change as a human-induced alteration of the environment, primarily due to the increased concentration of greenhouse gases (Dwivedi *et al.*, 2022; Santos *et al.*, 2022; Malik and Ford, 2024).

During the 20th century, the average global temperature rose by approximately 0.6 °C, and it is expected to increase by an additional 2–3 °C by the end of the 21st century (IPCC, 2022). Like many other Asian nations, the majority of Pakistan's population remains unaware of the implications of climate change. However, the country faces critical challenges such as food shortages and frequent flooding, exacerbating its already struggling economy (Ahmad *et al.*, 2024; Shakoor *et al.*, 2011; Rahman *et al.*, 2023; Aslam and Li, 2024). The global impact of climate change has become more evident with its increasing frequency and intensity (Lilavanichakul and Pathak, 2024; Rahman *et al.*, 2023). Despite this, climate change is still not perceived as a critical issue in many developing nations (Leiserowitz *et al.*, 2015).

Educating the public on the consequences of climate change and its effects on investments and livelihoods becomes essential (Meath *et al.*, 2016; Thinda *et al.*, 2020; Stelvia *et al.*, 2022). According to empirical findings from the latest climate change index, Pakistan ranks fifth among the countries most vulnerable to climate change (Adnan *et al.*, 2024). The Pakistani government has recognized climate change as a critical threat to the nation's development. In 2002, the Global Climate-Change Impact Studies Centre (GCISC) was established to analyze both global and national climate trends. GCISC is also responsible for informing the public and evaluating the impact of climate change on Pakistan's key socioeconomic sectors (Shahid and Piracha, 2010; Rasul, 2011).

Climate change has had a significant impact in Pakistan, particularly on agriculture (Shakoor *et al.*, 2011; Rasul, 2011; Göpfert *et al.*, 2019). Changes in rainfall patterns and temperature fluctuations have impacted crop yields and farmers' incomes (Thinda *et al.*, 2020; Santos *et al.*, 2022; Lilavanichakul and Pathak, 2024). In recent years, the adoption of technological advancements has become increasingly important for enhancing economic viability and agricultural productivity. The integration of Information and Communication Technologies (ICTs) facilitates more efficient exchange of information (Aslam and Li, 2024; Lilavanichakul and Pathak, 2024). By accessing valuable information on environmental conditions, climatic patterns, and market opportunities, farmers can make informed decisions. Internet-based

technological solutions help mitigate information asymmetry by delivering reliable information rapidly and affordably (Aslam and Li, 2024).

In response to climate change, both mitigation and adaptation strategies are essential to benefit the public and minimize adverse outcomes (Jamal *et al.*, 2022). Educator capacity building is critical for increasing their subject-matter expertise, as they play a pivotal role in raising public awareness about climate change (UNDP, 2008). Raising awareness through comprehensive education and training empowers individuals at all levels of society to actively engage in climate change mitigation and adaptation efforts.

University graduates, in particular, require a solid understanding of climate change impacts, and this awareness can be influenced by the adoption of ICTs. Providing university graduates with critical knowledge about climate change increases their ability to contribute to climate action and adaptation initiatives. Therefore, this research aims to explore the impact of ICT adoption on climate change awareness among university graduates from major universities and higher educational institutions in Pakistan.

MATERIALS AND METHODS

Data collection

The study was conducted in three stages. In the first stage, 15 prominent public sector universities in Pakistan were selected from different regions (Table 1). In the second phase, data was collected through interviews with 20 graduates from each selected university, resulting in a total sample size of 300 respondents. These interviews assessed the socio-personal profiles and awareness levels of the participants. In the final phase, the study identified key ICT-based factors influencing climate change awareness among university graduates. These factors were evaluated through hypotheses designed to test their significance.

The following hypotheses were constructed to test the impact of various ICTs on climate change awareness: H1, access to television has a significant effect on climate change awareness; H2, access to smartphones significantly impacts climate change awareness; H3, access to agricultural magazines, news bulletins, and newspapers has a significant effect on climate change awareness; H4, access to radio has a significant link with climate change awareness; H5, access to computers or laptops significantly influences climate change awareness; and H6, access to internet connectivity has a strong relationship with climate change awareness.

A purposive sampling technique was used to select 300 university graduates from the selected universities. Data collection took place between August 20 and October 17, 2023, using face-to-face interviews conducted by trained enumerators. Both open-ended and close-ended questions were used to gather comprehensive data.

Table 1. Distribution of selected universities by region in Pakistan.

Region	Universities
Federal Region (3 out of 13)*	- Quaid-i-Azam University, Islamabad - National University of Sciences and Technology (NUST) - COMSATS University, Islamabad
Punjab Region (4 out of 22)*	- University of the Punjab, Lahore - MNS University of Agriculture, Multan - University of Agriculture, Faisalabad - University of Veterinary and Animal Sciences, Lahore
Sindh Region (3 out of 15)*	- Sindh Agriculture University - Mehran University of Engineering and Technology - University of Karachi
Khyber Pakhtunkhwa (KPK) Region (3 out of 16)*	- University of Agriculture, Peshawar - Ghulam Ishaq Khan Institute of Engineering Sciences and Technology (GIKI) - Military Academy, Abbottabad
Balochistan Region (3 out of 5)*	- Balochistan University of Information Technology, Engineering and Management Sciences (BUIITEMS)
Azad Jammu and Kashmir (AJK) Region (1 out of 2)*	- University of Azad Jammu and Kashmir
Gilgit Baltistan Region (1 out of 1)*	- Karakoram International University

*Number of selected universities for this study out of the total number of existing universities per region.

Statistical Analysis

Descriptive statistics were used to analyze the socio-personal characteristics of the respondents. To assess the impact of ICTs on climate change awareness, binary logistic regression was applied. The data were analyzed using SPSS 26.0 (IBM Statistics). The probability of adopting ICTs to understand the impacts of climate change was modeled using a logistic regression framework. The adoption probability, denoted by P_i , and the odds of adoption, represented by:

$$Y = \left(\frac{P_i}{1 - P_i} \right)$$

where P_i is the probability of a respondent adopting ICTs to become aware of climate change, and $1 - P_i$ is the probability of not adopting ICTs.

The odds ratio for ICT adoption is given by:

$$\ln(Odds) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_i$$

where β_0 is the intercept, and β_i represents the coefficients of the independent variables.

The odds ratio in this equation represents the probability that an individual will use ICTs to understand climate change versus the likelihood that they will not. If the odds ratio is greater than one, it means that increasing a continuous variable or categorizing an independent variable increases the likelihood of ICT adoption.

ICT adoption is measured as a binary outcome:

$P = 1$ if a university graduate utilizes ICTs to learn about climate change, and
 $P = 0$ if the individual does not use ICTs for this purpose.

The specific logistic regression model used to estimate the odds of ICT adoption is:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1W_1 + \beta_2W_2 + \beta_3W_3 + \beta_4W_4 + \beta_5W_5 + \beta_6W_6 + \varepsilon$$

where W_1 denotes access to television; W_2 access to smartphones; W_3 access to agricultural bulletins, magazines, or newspapers; W_4 access to radio; W_5 access to computers; and W_6 access to the internet. In the model, β_0 serves as the intercept term, while β_1 to β_6 are the coefficients for the independent variables (W_1 to W_6). Finally, ε represents the error term in the equation, accounting for the variation not explained by the independent variables.

The independent variables were measured using a five-point Likert scale: strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). These variables measure access to various ICT tools that may influence an individual's decision to adopt technologies for understanding the impacts of climate change.

RESULTS AND DISCUSSION

Awareness level of climate change

Out of the 300 individuals surveyed, 230 graduates (77 %) had a minimal level of awareness about climate change. A smaller group of 30 graduates (10 %) had medium knowledge or awareness, while 40 graduates (13 %) exhibited the highest level of awareness on the subject. This distribution reveals a significant gap in climate change awareness among the sample population (Table 2).

Table 2. Respondent distribution based on climate change awareness levels.

Awareness level of climate change	Frequency	Percentage
Low	230	77
Medium	30	10
High	40	13
Total	300	100

Importance of climate change for respondents

To make well-informed decisions, the general public must be aware of the issue. When asked about the importance of climate change, 160 graduates (53 %) expressed that climate change is highly important, while 20 graduates (7 %) stated it was fairly important. On the other hand, 50 graduates (17 %) considered it not highly important, and 70 graduates (23 %) felt it was not important at all (Table 3). This indicates that while a majority are concerned, there is still a notable proportion of the population that does not recognize the severity of the issue.

Table 3. Respondent distribution based on the significance of climate change.

Climate change importance	Frequency	Percentage
Highly important	160	53
Fairly important	20	7
Not highly important	50	17
Not important at all	70	23
Total	300	100

Climate change as a threat

Climate change is expected to have a significant impact on both sustainable incomes and livelihoods. Among the respondents, 200 graduates (66 %) viewed climate change as a significant threat to sustainable livelihoods and global development. A total of 50 graduates (17 %) expressed neutrality, while another 50 (17 %) did not see climate change as a concern (Table 4). These results are consistent with the findings of Aslam and Li (2024), showing a general consensus on the dangers of climate change, although some graduates remain indifferent.

Table 4. Distribution of respondents regarding climate change as a threat.

Climate change is perceived as a threat	Frequency	Percentage
Yes	200	66
No	50	17
In-between	50	17
Total	300	100

Binary logistic regression for ICTs adoption and climate change awareness

A binary logistic regression model was employed to examine the influence of ICT adoption on climate change awareness. The Cox and Snell R^2 value of 0.689 indicates that 69 % of the variation in climate change awareness can be explained by the factors studied, while the Nagelkerke R^2 value of 0.813 shows that 81.3 % of the variation is explained by the model (Table 5).

Table 5. Model summary for the binary logistic regression on ICT adoption and climate change awareness.

Metric	Value
-2 log likelihood	11.59
Value of Cox and Snell R^2	0.689
Value of Nagelkerke R^2	0.813

The Hosmer and Lemeshow test yielded a chi-square value of 1.29 ($p > 0.05$), confirming that the model is a good fit for the data (Table 6). University graduates had adequate access to communication, information, and technology, which increased awareness of climate change and its consequences for society. Of the information they know, 92.9 % is correct. The overall correction estimate was 97.5 %. This classification table was most appropriate when the primary goal of our analysis was categorization; however, it should only be used in conjunction with a more precise method for determining model fitness.

Table 6. Hosmer and Lemeshow test results.

Metric	Value
Chi-square value	1.29
Degrees of freedom	9
Significance level	0.1

Access to television had an odds ratio of 1.945, suggesting that for every unit increase in television accessibility, there is a 1.945 times higher likelihood of increased climate change awareness among university graduates (Table 7). Similarly, access to smartphones, with an odds ratio of 0.584, was found to have a significant effect, indicating that smartphone use contributes to awareness at a 10 % significance level. Access to agricultural magazines, news bulletins, and newspapers also showed a positive impact on climate change awareness with an odds ratio of 1.209. This finding is consistent with the results of Naylor and Ford (2023), Rahman *et al.* (2023), Ahmad *et al.* (2024), and Karki *et al.* (2022).

The odds ratio for internet connectivity was 0.172, revealing that access to the internet has a substantial positive impact on raising climate change awareness (Table 7). This finding is consistent with Nyoni *et al.* (2024), Yang *et al.* (2024), and Jamal *et al.* (2022). In contrast, radio and computers or laptops were found to be non-significant factors in influencing awareness levels, with an odd ratio of 3.869 (Table 7). This result is in line with studies of Shakoor *et al.* (2011), Rasul (2011), and Göpfert *et al.* (2019).

Table 7. Analysis of the impact of ICT adoption on climate change awareness using binary logistic regression.

Factors	B-value	Wald test	p-value	exp(B)
Access to television	0.665	3.027	0.082**	1.945
Access to smart phone	1.257	3.221	0.073**	0.584
Access to agricultural magazine, news bulletin or newspaper	18.404	4.448	0.056*	1.209
Access to radio	0.178	0.965	0.326 NS	1.194
Access to computer/laptop	10.539	6.69	0.589 NS	3.869
Access towards internet connectivity	2.627	3.919	0.033*	0.172
Constant	24.243	0.000	1.000	3.377

*Significance level at $p \leq 0.01$; **significance level at $p \leq 0.1$.

CONCLUSION

Climate change and global warming are accelerating at an alarming rate, with consequences felt worldwide, but especially in developing economies like Pakistan. The country is dealing with both traditional and nontraditional security threats, making climate change a critical issue. Raising awareness about climate change is critical to mitigating its negative consequences. Effective awareness campaigns, which use Information and Communication Technologies (ICTs) such as social media, television, smartphones, radio, agricultural news bulletins, and other agricultural tools, are critical for educating the public, particularly university graduates, about the

climate threat. The findings of the study reveal that access to smartphones, agricultural magazines, news bulletins, newspapers, internet connectivity, and television have a significant impact on climate change awareness among university graduates. In contrast, access to radio and computers or laptops had no significant effect on raising awareness in the study area.

The public and private sectors must become more actively involved in this issue. Collaborations among research organizations, academic institutions, and other stakeholders can help to raise climate change awareness and action. Digital platforms, such as blogs, podcasts, and social media videos (such as those on TikTok), can be effective tools for informing the public about climate change and the role of ICTs in combating it. By combining these strategies and leveraging ICTs, we can not only raise awareness about climate change but also take meaningful steps to mitigate its negative effects.

ACKNOWLEDGEMENTS

The authors extend their appreciation to the Researchers Supporting Project number (RSP2024R483), King Saud University, Riyadh, Saudi Arabia.

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