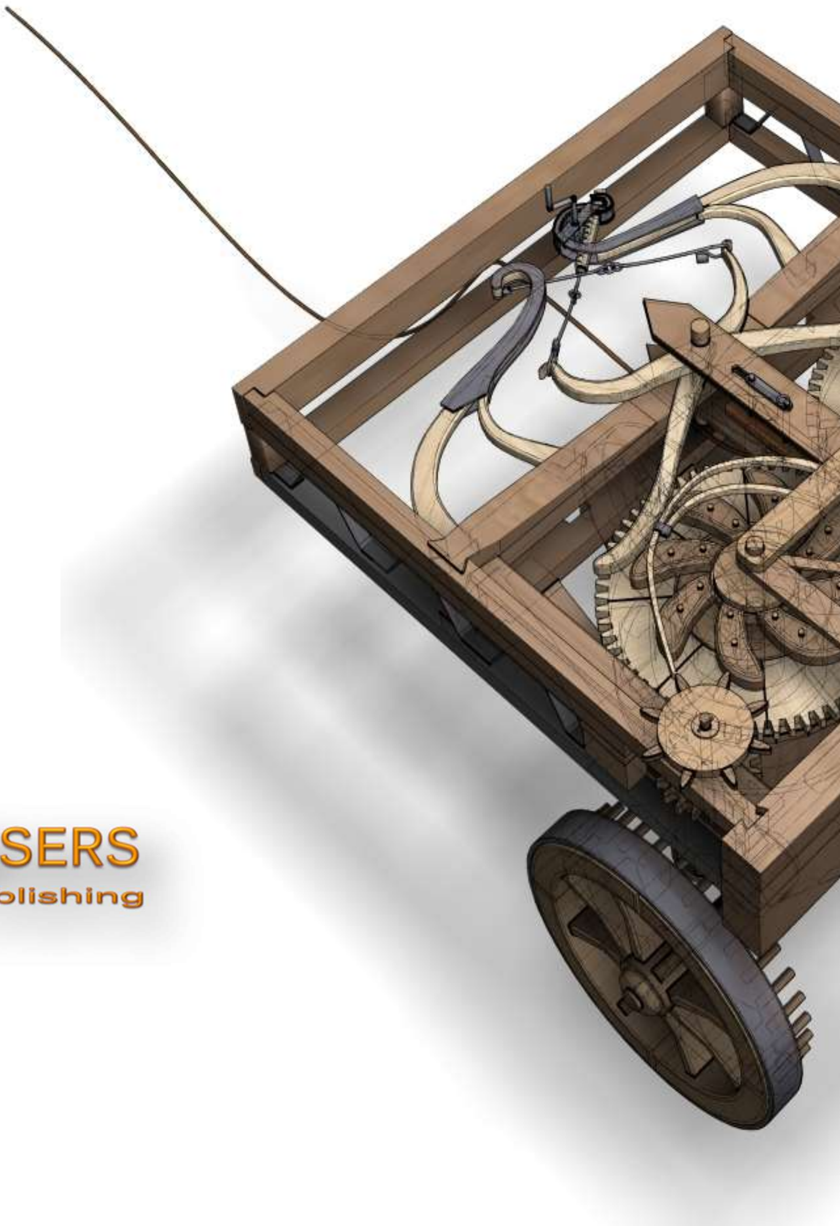
ASERS

Journal of Environmental Management and Tourism



Quarterly
Volume XV
Issue 2(74)
Summer 2024
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

Summer 2024
Volume XV
Issue 2(74)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

Table of Contents:

Call for Papers
Fall Issue 2024
Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is an open access, peer-reviewed interdisciplinary research journal, aimed to publish articles and original research papers that contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences. The Journal publishes original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modelling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in Environmental Management.

Also, this journal is committed to a broad range of topics regarding Tourism and Travel Management, leisure and recreation studies and the emerging field of event management. It contains both theoretical and applied research papers and encourages obtaining results through collaboration between researchers and those working in the tourism industry.

The journal takes an interdisciplinary approach and includes planning and policy aspects of international, national and regional tourism as well as specific management studies. Case studies are welcomed when the authors indicate the wider applications of their insights or techniques, emphasizing the global perspective of the problem they address.

Journal of Environmental Management and Tourism is indexed in RePEc, CEEOL, ProQuest, EBSCO, DOAJ and Cabell Directory databases.

Details regarding the publication in this journal are here: https://journals.aserspublishing.eu/jemt/about

Deadline for submission:	15st July 2024
Expected publication date:	August 2024
Website:	https://journals.aserspublishing.eu/jemt
E-mail:	jemt@aserspublishing.eu

DOI: https://doi.org/10.14505/jemt.v15.2(74).01

An Approach to Assessing Farm-Scale Adaptation to Climate Change: The Case Study of Prespa Park

Dorina GRAZHDANI
Department of Agribusiness Management
Faculty of Economy and Agribusiness
Agricultural University of Tirana, Albania
d.grazhdani@yahoo.com

Article info: Received 15 March 2024; Received in revised form 4 April 2024; Accepted for publication 26 April 2024; Published 31 May 2024.

Abstract: Developing appropriate adaptation practices and coping mechanisms for climate change and evaluating the variables affecting households' choices are critical for ensuring sustainable agricultural production. In addressing the above issues, this paper presents the results of a multi-method approach at the farm level conducted in the case study of Prespa Park. The data collected by a participatory process were analyzed using descriptive statistics, the 5-point Likert scale, the Delphi method, and a multinomial logit model. The typology of coping and adaptation practices to climate change preferred by households and the reasons for those who failed to adapt are presented. Results revealed that improving technologies for increasing soil health was the most preferred adaptation practice, followed by planting early maturing and drought-tolerant food crop varieties, practicing water-saving irrigation methods or technologies, planting agroforestry systems, and finally perennial agriculture. In terms of coping mechanisms, engaging in off-farm activities was the most used, followed by collecting fuel wood for sale, selling assets like livestock, increasing water storage capacity, and changing farming structure. Small farm holdings, financial constraints, limited off-farm employment opportunities, inadequate infrastructure and technology, and a lack of information about adaptation practices were identified as the main barriers to undertaking adaptation. Performing the multinomial logit analysis, the variables that positively and significantly improve households' ability to adapt to climate change were identified and evaluated. The results of this study should help policymakers and climate change planners come up with better practices for the agricultural sector to adapt to the effects of climate change.

Keywords: climate change; Delphi method; households' adaptation practices; multi-method approach; multinomial Logit model and Prespa Park.

JEL Classification: Q19; Q50; Q54; R29; R11.

Introduction

The problem of climate change has grown in importance during the last few decades. One of the sectors most vulnerable to climate change is agriculture, since agricultural productivity is weather- and climate-related and, as De Frutos *et al.* (2018) claim, is so sensitive to climatic changes. Many studies (Tol *et al.* 2004; Mozny *et al.* 2009; Krishnan *et al.* 2011; Shrestha *et al.* 2013; IPCC, 2014; Mandryk 2016; Niles *et al.* 2016; Lane *et al.* 2018; Elias *et al.* 2019; Aryal *et al.* 2020) are undertaken as concerns about climate change and how it may affect agriculture grow.

The most effective way for developing countries to confront the threats caused by climate change, as Adger *et al.* (2003) point out, is adaptation. Climate change adaptation efforts in agriculture, according to Mandryk *et al.* (2017), van Dijl *et al.* (2015), and Roesch-McNally *et al.* (2020), encompass a wide range of activities at various scales connected to decreasing agricultural exposure and vulnerability to changes, such as developments in technology or changes in production practices. According to Schattman *et al.* (2021), this is required to protect farmers' and rural communities' means of livelihood and provide food security for households. It is critical to comprehend the coping and adaptation measures used by smallholder farmers in climate vulnerability hotspots to mitigate climate hazards. This issue is addressed in this study.

Iglesias *et al.* (2012) say that climate change adaptation happens on two main levels: (a) the farm level, which, as Nicholas and Durham (2012) say, is based on the reasonable individual interests of farmers and looks at the small decisions that farmers make; and (b) the macro-level, which is also called policy-driven adaptation with government involvement and is based on collective needs. It looks at agricultural production at the regional and national levels. Adaptation at the farm level is the most important because local actors are the first to recognize the seriousness of climate change. This study's research was conducted at the farm level.

One main goal of this study was to provide an answer to the following: What are the variables that affect the choices made by farmers about adaptation practices to the changing climate in Presoa Park? Deressa *et al.* (2009) demonstrated that understanding these variables helps policymakers strengthen adaptation by investing in them. To do this, many modeling methods have been employed in literature. Because of its well-established theory and accessible procedures, regression analysis is commonly employed in climate change adaptation. So, for this study, descriptive statistics were used to look at information from 358 households in the basins of Prespa Park in 2023 about household characteristics, institutional variables, and agro-ecological parameters. A multinomial logit model was employed then to assess the variables that affect households' decisions on adaptation practices.

Given the aforementioned, a two-step empirical analysis was used in this study. The first empirical analysis identified and ranked the coping and adaptation practices adopted by farmers to reduce the effects of climate change. The second used a multinomial logit model to evaluate the relationship between each adaptation strategy that farmers identified and the factors that affected it.

The contribution of this study is related to the use of an approach based on an integrated and participatory process (a field survey, more than 40 in-depth interviews with stakeholders and authorities, a one-day workshop, and a Delphi survey) developed and employed to identify the adaptation practices and coping mechanisms and the variables affecting households' choices.

1. Literature Review

In the last 30 years, two core concepts in the literature on society's reactions to climate change have emerged: coping and adaptation. Within the fields of practice, policy, and research, there has been discussion on the meaning of these concepts. In terms of elucidating social reactions to environmental stress, coping comes before adaptation. As Eriksen *et al.* (2005) outlined, coping practices are the temporary actions farmers take to mitigate the negative consequences of climate change, which typically aim to lessen exposure to the effects of socio-ecological stressors, either as forecasted or as experienced. They might not always be sustainable in terms of the economy or the environment. In the order in which they are most likely to occur, the following five main coping strategies are listed by Ellis *et al.* (2019). looking for new sources of income; relying on reciprocal obligations (sharing resources like labor and seed); temporarily moving to a smaller home; selling fixed assets (like land); and decreasing the size of movable assets (like livestock). When all other coping mechanisms have been tried, permanent distress migration is frequently the last option.

But adaptation is a more complex kind of coping. IPCC (2014) defines climate change adaptation as "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities." Many overlapping approaches have been used to define the ability to adapt. A large number of research studies (Kandlinkar and Risbey 2000; Smit and Skinner 2002; Adger *et al.* 2003; Smit and Wandel 2006; Lobell *et al.* 2008; Di Falco *et al.* 2011; Olesen *et al.* 2011; Below *et al.* 2012; Kates *et al.* 2012; Acosta *et al.* 2013; Satishkumar *et al.* 2013; Rodriguez *et al.* 2014; Wood *et al.* 2014; Aryal *et al.* 2020; Lamichhane 2020) have documented that adaptation is a crucial component of the response to climate change.

In literature of adaptation to climate change, relevant research is focused on different adaptation farm practices such as using drought-resistant crop varieties (Anik *et al.* 2021; Ponce 2020; Kebede *et al.* 2019); crop diversification (Bradshaw *et al.* 2004; McCord *et al.* 2015; De Boni *et al.* 2022); crop rotation (Wood *et al.* 2014); practicing improved irrigation (Finger *et al.* 2011; van Dijl *et al.* 2015; Roesch-McNally *et al.* 2020) and soil conservation techniques (Kahil *et al.* 2015; Ureta *et al.* 2020); adjusting planting dates (Ponce, 2020; Masud *et al.* 2017); managing land use in relation to climate change (Klein *et al.* 2013; Liu *et al.* 2016); developing technologies for adaptation in the context of climate change (Foudi and Erdlenbruch 2012; Alvi and Jamil 2018); shifting to non-farm income activities (Marie *et al.* 2020); implementing complementary policies that impact both socioeconomic issues and climate (Agrawala and Fankhauser 2008; Chimbwera 2010), and farm financial management (Smit and Skinner 2002; Berrang-Ford *et al.* 2011); using improved livestock breeds (Faisal *et al.*

2021); and micro-insurance (Brouwer and Akter 2010). For policymakers, evaluating how farming communities are dealing with the effects of climate change offers crucial information.

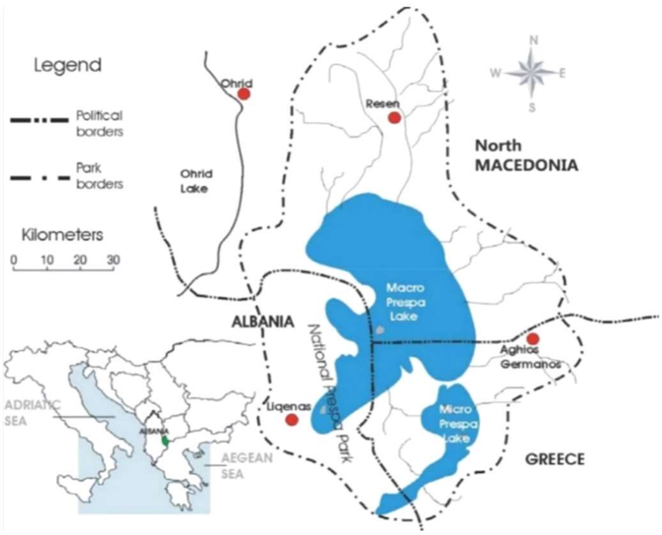
In order to develop an adaptation farm practice to climate change, according to several researchers (Norries and Batie 1987; Brooks *et al.* 2005), it is critical to identify and analyze factors that influence, in a positive or negative way, the households' decision to adopt it. Deressa *et al.* (2009) showed how having a solid understanding of these variables might serve as a suitable foundation for developing proposals for policies in reaction to climate change. The reviewed literature (Deressa *et al.* 2009; Obayelu *et al.* 2014; van Dijl *et al.* 2015; Marie *et al.* 2020) indicates that the variables that affect farmers' adoption practices across regions include socioeconomic factors, household head characteristics, services and resources or existing inputs, institutional factors, agro-ecological parameters, and cultural factors.

2. Methodology

2.1. An Overview of the Study Area

Prespa Park, the subject of this case study, became the first transboundary protected area in the Balkans, southeast Europe, after the Prime Ministers of the three nearby nations (Albania, Greece, and North Macedonia) signed a Joint Declaration in February 2000 (Grazhdani 2024). According to Grazhdani (2014a), it is a high-altitude basin within a 2,500 km^2 basin that includes two interconnected tectonic lakes, the Macro Prespa (259.4 km^2) and Micro Prespa (47.4 km^2), located at roughly 850 m above sea level in a karstic system with no natural surface outlet, as well as mountains that rise above 2,600 m above sea level. Prespa Park is a unitary area with a rich common natural and cultural heritage, despite being situated at a three-way border intersection. In each of the three states, national protected areas have been established. Nearly 30,000 people live in 12 villages on the Albanian side, 13 villages on the Greek side, and 43 villages on the North Macedonian side (Grazhdani 2016).

Figure 1. Prespa Park area



Agriculture is the primary source of revenue for residents on all three sides of Prespa Park, where about 70% of the labor force is employed (Grazhdani *et al.* 2010). In most cases, stock-breeding, fishing, and forestry provide complementary income. The secondary sector is relatively developed in North Macedonia (primarily in apple processing), whereas a bean packaging unit has been operational in Greece since 2007. The tertiary sector has grown rapidly in recent years, primarily through tourism service enterprises (Grazhdani 2014b).

As outlined by Grazhdani (2014c), there are roughly 1,450 agricultural holdings in the Albanian part of Prespa Park, all of which are mixed crop and stock-breeding with 2,185 hectares of land, only 160 of which are irrigated (7.3% of the total), and there is a small percentage of mechanization. With very little access to the organized market, the main crops are cereals, corn, vegetables, alfalfa, and vines, intended primarily to meet household requirements.

There are about 4,500 agricultural crop properties on the side of North Macedonia, with 11,000 hectares of agricultural land in total, 80% of which is irrigated in some way, although only about half of the land is actually irrigated. The most important crop in the area is the cultivation of fruit trees, mainly apples (3,000 ha). The main crop, in addition to fruits (apples, other fruit, and vines), is wheat (1,200 ha). Although the level of mechanization appears to be high, most machinery is old and of low horsepower.

The cultivation of the white-seed dry "beans of Prespa" in an area of around 1,000 ha of irrigated land near the two lakes, which provides 75% of the total agricultural income, occupies the majority of the approximately 370 agricultural holdings in the Greek Prespa. Another 150 ha are planted with other irrigated crops (corn, alfalfa).

According to the Köppen climate classification, the park's climate is primarily Mediterranean, with influences from the continent, and, as Markovic *et al.* (2017) argue, the Prespa basin is one of Europe's most vulnerable regions to climate change. In Prespa Park, climate change is already present and accelerating, highlighting the need for quick, medium-term, and long-term solutions that can assist everyone involved in agriculture in minimizing its negative effects. People are being forced to confront these effects in novel and creative ways.

Adaptation to current climate variability is occurring, but there has been little action to mitigate the effects of climate change. These local adaptations, however, have not been valued or documented to date; thus, recognizing and documenting local adaptation strategies is an important first step in strengthening local people's resilience to climate change. In general, there isn't any ongoing regional or local research examining strategies for adaptation to climate change in the Prespa Park cross-border region. Given the potential for serious agricultural consequences, practical adaptation strategies for climate change are critical.

The findings of this paper can help policymakers and decision-makers develop short- and long-term integrated policies and measures for climate change adaptation strategies in Prespa Park and other similar areas.

2.2. Data Collection and Data Analysis

Operationally, the data used in this study came from a field household questionnaire survey conducted in the Prespa Park region between September and October of 2023, more than 30 individual interviews with local stakeholders and authorities, and a one-day participation workshop.

A wide variety of questions were needed to be included in the questionnaire items of the survey in order to evaluate farmers' coping mechanisms and practices for adapting to climate change and analyze the factors influencing farmers' decisions to do so. Thus, the household questionnaire, which was developed in accordance with the research's objectives, contained a number of questions that could provide information about the socioeconomic characteristics of the study farm households as well as their perceptions of climate change, how it has affected their way of life, and what adaptation practices and coping mechanisms they have developed or those they believe to have been used to lessen its effects. The questions dealing with factors affecting farmers' choices of adaptation practices to climate change were also included.

A team of three researchers who are experts in survey design and construction accurately wrote the first version of the questionnaire items. Then, a panel of experts, including survey researchers, economists, experts in climate change, and designers of non-market approaches, reviewed the questionnaire items to make sure they were valid in terms of both content and construct. The questionnaire was adjusted as appropriate in accordance with the expert panel's views and recommendations. In order to clarify the questionnaire's comprehensiveness, content validity, and any potential areas of ambiguity, a pilot field test was conducted (Fink 2013; Nardi 2013). To get comments on the questionnaire's clarity and usability, 25 farm households were selected as a sample. In the final version of the questionnaire, the changes suggested by the expert panel and the pilot field test have been made.

The sample size for this investigation was determined using the Dillman *et al.* (2007) method. 300 households should be included in the sample. In September 2023, 550 questionnaires were distributed to randomly selected households in Prespa Park due to the low response rate and high number of undeliverable addresses. After completion, the questionnaires were returned. 358 questionnaires, or 65.1% of the total, were usable.

Each questionnaire was reviewed to make sure it was appropriate for the study before being included in the database. Due to their incompleteness, certain questionnaires were not included in the final data analysis. After variables and data transformations, a sample of the data was produced for data analysis. After entering all of the data into a database file, the necessary calculations, formatting changes, and the creation of dummy variables were performed. After that, the database file was imported into the STATA: Release 18 (StataCorp 2023) program, which was used to compute descriptive statistics and perform all estimation procedures.

Following the field survey, there were 30 individual interviews with local stakeholders and authorities as well as a one-day workshop.

2.3. Variable Explanations and Multicollinearity Analysis

This study employed a multinomial logit model to examine the factors that influence households' decisions on a particular practice of climate change adaptation. To do this, in the first stage, the dependent and independent variables are selected. In this study, as dependent variables, the following most important adaptation practices were used: (1) improved crop varieties; (2) increased soil health; (3) efficient irrigation management; (4) shifting from crop production to plant agroforestry systems; and (5) perennial agriculture. The dependent variables (practices for adapting to climate change) were binary. The number 1 records a yes vote, and the number 0 records a no vote.

The choice of independent variables for model estimation is the most subjective and controversial issue. A preliminary list of variables affecting households' decisions on adaptation practices was first established based on (1) a review of the literature, (2) the availability of data, and (3) correlations between the identified variables of interest. Then, it was presented to the participants of a one-day workshop where the participants were asked to give their opinion on it. Next, at the end of the workshop, a final list was made. The following categories represent the selected independent variables employed in this study's multinomial logit model: sociodemographic household characteristics, institutional factors, and agro-ecological parameters. In the first category were included independent variables like household age, education, farming experience, off-farm employment, wealth status, household size, off-farm employment, and farm size. The availability of credit, the ease with which information about climate change is accessible, and the level of social capital, such as farmer-to-farmer extension services, were also included in institutional variables. Awareness of rainfall decline and temperature increases were included in the model as agro-ecological variables.

Regression analysis is frequently associated with issues of multicollinearity among independent variables. Multicollinearity in multiple regression is when an independent variable has a strong correlation with one or more other variables in the model. In this study, in order to avoid multi-collinearity, in the second stage, correlation tests were performed among all independent variables. The variance inflation factor (VIF) (Belsley *et al.* 1980) and Pearson's product moment correlation coefficient (r) (Walford 1995) were used in this study to determine if multicollinearity was present in the model and to eliminate it by screening and removing some of the independent variables. A good "rule of thumb" when using a correlation matrix to determine if multicollinearity exists in a model is to remove variables that have a Pearson correlation value of 0.7 or higher (Park 2009; AcaStat 2014; Grazhdani 2015). Regarding the *VIF* values, the higher the value of *VIF,* the higher the possibility of multicolinearity. It is accepted that a *VIF* value greater than 4 indicates multicollinearity (Miles and Shevlin 2001; Grazhdani 2016). Grazhdani (2016) provides more details about the procedure we used for variable multicollinearity analysis.

Independent variables were removed through an iterative process. The procedure was employed through the following sequential steps: First, the *VIF* value for each independent variable was calculated. The explanatory variable with the highest *VIF* was then excluded. The iterative elimination process was terminated when the threshold *VIF* value of 4 was reached. At this time, additional eliminations based on *r* values were carried out. Therefore, using STATA's corr command (Park 2009), a bivariate correlation study was carried out. The final selected variables are presented in Table 1.

2.4. Data Analysis Methods Applied

2.4.1. Delphi Method

According to Skulmoski *et al.* (2007), the Delphi method is one of the most common methods, which entails a group of experts coming to an acceptable level of agreement on the attributes of interest. The Delphi method, which seeks the most acceptable agreement among the opinions of a "group of experts," is described as a series of sequential questionnaires or "rounds" interspersed with controlled feedback. In order to arrive at a consensus, data from surveys is administered and then applied iteratively, with highly ranked items from one questionnaire being utilized to formulate the next. This iterative process starts by identifying areas of agreement and disagreement, then moves on to changes based on previous questionnaire responses.

For the present study, fifteen experts were selected to participate in the Delphi process and provide email responses to the questionnaires. Through successive rounds, participants created a list of coping mechanisms, the relevant adaptation practices needed to adapt to climate change, and the main barriers to undertaking adaptation.

2.4.2. Multinomial Logit Regression Model

The Logit and Probit models are the two most used models in the literature. A multinomial logit (MNL) or multinomial probit (MNP) regression model would be the ideal econometric model, given that several adaptation options are evaluated. In this study, a MNL model was used to analyze the determinants of farmers' decisions because it is widely used in adaptation decision studies involving multiple choices. The model has a major flaw that comes from the independence of irrelevant alternative (IIA) property. This property says that the ratio of the odds of choosing any two options is not affected by the properties of any other option in the decision set (Hausman and McFadden 1984; Tse 1987).

The MNL model was first run and checked to see if the independence of the irrelevant alternatives (IIA) assumption was true using both the Hausman specification test and the seemingly unrelated post-estimation procedure (SUEST). Both tests failed to disprove the null hypothesis that the practices for adapting to climate change are independent, indicating that there is no evidence to refute the appropriate specification of the adaptation model. So, it made sense to use the MNL specification on the data set to model how farmers will adapt to climate change.

In the MNL model, the question is how changes in the elements of *x*, which represent a set of conditioning variables, affect the response probabilities (P(y = **j**|**x**), j = 1, 2,..., J), where *y* represents a random variable with the values 1, 2,..., J. The MNL model has the following response probabilities (Green 2008):

$$P(y = j|x) = \frac{\exp(x\beta_j)}{\left[1+\sum_{h=1}^{J}\exp(x\beta_h)+\varepsilon,\ \ j=1,\dots,J\right]} \tag{1}$$

In this study, *y* represents adaptation practices, *x* represents various household, institutional, and agro-ecological attributes, and *β* is a vector of estimated attributes. Differentiating Equation (1) with regard to each independent variable yields Equation (2). This allows one to determine the marginal effects (ME) of the pertinent variable:

$$ME = \frac{\partial P_j}{\partial x_k} = P_j(\beta_{jk} - \sum_{j=1}^{J-1} P_j\,\beta_{jk}) \tag{2}$$

The following econometric model function was estimated to perform the multinomial logit analysis:

$$\text{Adaptation practice} = \beta_0 + \beta_1\text{Gender} + \beta_2\text{Age} + \beta_3\text{Edu} + \beta_4\text{FarmExp} + \beta_5\text{HouseholdSize} + \beta_6\text{WealthStatus} + \beta_7\text{FarmSize} + \beta_8\text{OffFarmEmploy} + \beta_9\text{InfToClimChange} + \beta_{10}\text{FarmToFarmExten} + \beta_{11}\text{AccessToCredit} + \beta_{12}\text{RainDecline} + \beta_{13}\text{TempIncrease} + \varepsilon \tag{3}$$

where: *Gender*: the respondent's sex (male or female); *Age*: the respondent's age in years; *Edu*: the respondent's degree of education; *FarmExp*: the number of years spent by the respondent making decisions related to farming; *HouseholdSize*: the number of the respondent's household members; *WealthStatus*: the financial standing of the respondent; *FarmSize*: the size (in ha) of the respondent's farm; *OffFarmEmploy*: possibilities for employment outside of the farm; *AccessToCredit*: access to credit; *InfToClimChange*: access to climate change information; *FarmToFarmExten*: farmer-to-farmer extension service; *RainDecrease*: Keep in mind that rainfall is decreasing. *TempIncrease*: recognition that the temperature is rising; and ε: the error term.

3. Results and Discussions

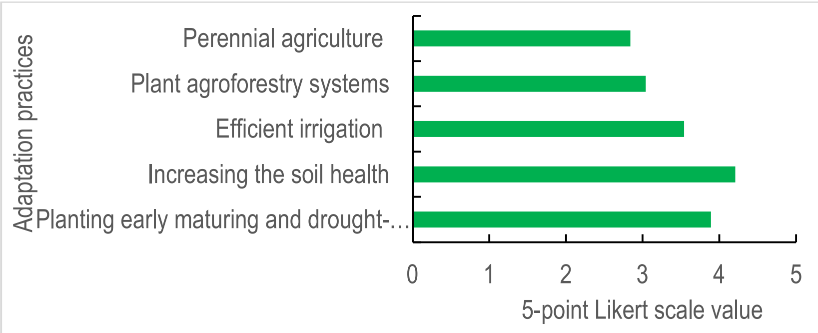
3.1. Typology of Households' Adaptation Practices and Coping Mechanisms to Climate Change in Prespa Park

The main adaptation strategies and coping mechanisms for climate change that Prespa Park households offer are defined in this section. In the selection and evaluation process, the following four sequential phases were conducted: During the first phase, a comprehensive list of adaptation practices and coping mechanisms for climate change was established. This is done using information gathered from household responses to the survey questionnaire part dealing with adaptation practices and coping mechanisms that they have implemented or those they believe to have been used to lessen the negative effects of climate change, as well as the findings of individual interviews with local stakeholders and authorities.

During the second phase, a one-day workshop was organized and attended by about 30 participants who had a good knowledge of the problems under investigation, including climate change experts, economists, academicians, representatives from agriculture, and protected area management authorities who work directly or indirectly on the study area. In this workshop, a series of brief presentations and panel discussions were presented to inform participants about the key principles of climate change, potential farmers' coping and adaptation practices to climate change, and their features in Prespa Park. Then, the list of adaptation practices and coping mechanisms developed during the first phase was presented to the participants of the workshop. Next, the participants were asked to create a preliminary list of key coping and adaptation practices that households in Prespa Park may develop, as well as the reasons why they may fail to adopt them. The meeting was characterized by intense debate among the participants. Finally, at the end of the workshop, a preliminary list of 12 adaptation practices and 10 coping mechanisms for climate change was made.

During the third phase, the most important adaptation practices provided by the Prespa Lakes households were identified using a Delphi survey. In the first run of the Delphi survey, a questionnaire of 12 adaptation practices identified by the workshop was emailed to fifteen different experts (Delphi members) to be filled out. A direct ranking technique was used: each Delphi expert gave a value using a 5-point Likert scale (from 1 = not important to 5 = extremely important). At the end of the first Delphi round, excluding less-significant adaptation practices, the former list was shortlisted. To accomplish this, the Cronbach alpha α statistics were used. The second round's questionnaire was created using the nine adaptation practices that were chosen during the first round. At the end of the second Delphi round, four assessment items were deleted, leaving five (Figure 2).

Figure 2. Five more important adaptation practices



Source: The author's collected and elaborated survey data for 2023

Improved technologies for increasing soil health are the main adaptation practices used by respondents. It is a key component in assisting farmers in dealing with drought. Cropping rotations, the use of cover crops and crop residues to protect soils from wind and water erosion, reduced tillage, the cultivation of cover crops with legumes, adding manure and compost, and fallow techniques are all tried-and-true methods that farmers may use right now. These practices, as De Gryze *et al.* (2009) highlight, make soils richer in organic matter, better able to retain soil moisture once it gets there, prevent erosion, improve soil structure, and increase biodiversity in the system. According to Rosenzweig and Tubiello (2007), in addition to strengthening stability and resilience to additional droughts and/or floods soon, they also assist in reducing climate change by sequestering carbon in the soil.

Planting early maturing and drought-tolerant food crop varieties is another of the main adaptation practices employed by smallholder farmers in Prespa Park. This practice helps to reduce the impact of climate change on farming activities impacted by reduced rainfall patterns, irregular rainfalls, or drought and, as De Boni *et al.* (2022) outline, may contribute to improving biodiversity, solving the problems of water scarcity, and making the agroecosystems more resilient. The fundamental advantage of this adaptation practice is that it enables farmers to grow crops with higher and more stable yields, as well as early maturity, disease resistance, and higher nutritional value.

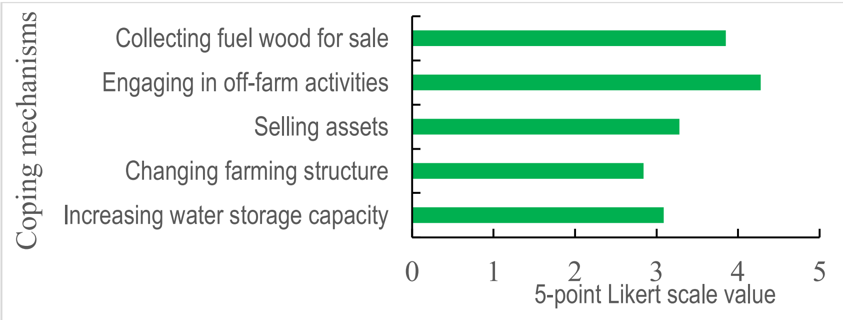
The next most important adaptation practice is practicing water-saving irrigation and water-management methods or technologies, including advanced irrigation systems like drip and deficit irrigation. Luquet *et al.* (2005) claim that the most water-efficient irrigation technology is drip irrigation, which can significantly reduce a farm's water use by controlling the precise moisture requirements for each plant while improving crop yields and quality. According to Al-Ghobari and Dewidar (2018), deficit irrigation (DI) is the practice of watering plants less frequently but more precisely. This method tries to maximize water productivity and stabilize yields, as opposed to maximizing them by restricting water applications to drought-sensitive growth stages. DI has received a lot of attention as a valuable and sustainable production strategy in dry or semi-arid areas.

Shifting from crop production to plant agroforestry systems is one of the most significant adaptation practices chosen by households. Agroforestry is simply the planned integration of trees and agriculture. It has been shown in numerous studies to provide numerous economic and environmental benefits (Oelbermann and Smith 2011; Zoysa and Inoue 2014). Every plant in an agroforestry system is chosen for a specific function; species are chosen so that plants will cooperate rather than compete (Luedeling *et al.* 2016). In line with this, Zoysa and Inoue (2014), indicted that agroforestry, which increases resiliency to climate impacts on farming systems, plays a significant role in climate change adaptation, such as reducing the impact of extreme weather events (drought, heatwaves, cold waves, heavy rain, and floods). It also improves soil and water availability, attracts pollinators, and increases biodiversity. Aside from its socioeconomic benefits, Murthy *et al.* (2016) have well documented that agroforestry is the most sustainable strategy due to its effects on soil conservation, biodiversity protection, and carbon sequestration.

Among the major adaptation practices found in the Prespa Park basin, perennial agriculture is the one that was least used. Previous studies have shown that perennial crops have the capacity to sequester carbon, improve erosion control, soil health, pest management, and biodiversity (Reynolds *et al.* 2021; Glover and Reganold 2010), as well as potentially increasing food security (Ertl *et al.* 2015; Glover *et al.* 2012; Karlsson *et al.* 2018) and sovereignty (Holt-Giménez and Altieri 2013).

Households in the study region have also employed a variety of coping mechanisms to deal with the natural dangers in order to avoid years with unfavorable weather conditions. As with adaptation practices, the preliminary list of coping mechanisms was similarly reduced during the fourth phase. Figure 3 shows the five crucial coping mechanisms that experts identified in the second round of the Delphi survey, in descending order: engaging in off-farm activities, collecting fuel wood for sale, selling assets like livestock, increasing water storage capacity, and changing farming structure.

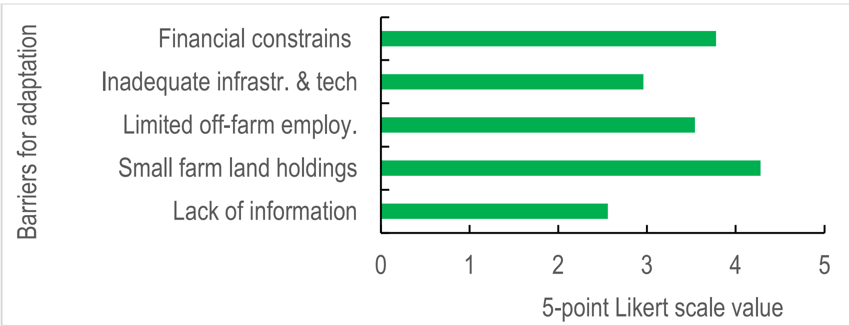
Figure 3. Five more important coping mechanisms



Source: The author's collected and elaborated survey data for 2023

Many reasons are cited by those who failed to adapt, including small farm holdings, financial constraints on using any of the adaptation methods, limited off-farm employment opportunities, inadequate infrastructure and technology, and a lack of information about adaptation practices (Fig. 4).

Figure 4. Five more important barriers for adaptation



Source: The author's collected and elaborated survey data for 2023

3.2 Analysis of the Variables Affecting Households' Decision to Adapt to Climate Change

Table 1 presents the values of the estimated MNL model coefficients as well as the standard errors (in parentheses). The likelihood ratio statistics as indicated by ch2 statistics (LR chi-square = 706.57 and Pseudo-R^2 = 0.4876) are highly significant ($P < 0.0001$), explaining that the model has strong explanatory power. In all cases, the estimated coefficients were compared with the base category of no adaptation. Table 2 shows the marginal effects as well as the standard errors (in parentheses).

The findings revealed that the majority of the explanatory variables are statistically significant at 10% or less, as described and discussed below.

Table 1. Statistics of MNL regression model for the variables affecting farmers' decision to adapt to climate change

Independent variable	Practices of climate change adaptation				
	Improved crop varieties	Improved soil health	Efficient irrigation methods	Plant agroforestry systems	Perennial agriculture
Gender	1.432***	1.325***	1.521***	1.055**	1.052*
	(0.008)	(0.0*7)	(0.501)	(0.037)	(0.579)
Age	0.042**	0.078**	0.354***	0.035*	0.084**
	(0.011)	(0.048)	(0.078)	(0.014)	(0.048)
Education	0.192***	0.165**	0.112***	0.209**	0.209**
	(0.012)	(0.084)	(0.065)	(0.049)	(0.042)
FarmExp	1.321	0.954	0.845	0.789	1.003
	(0.052)	(0.321)	(0.213)	(0.302)	(0.634)
HouseholdSize	-0.019	-0.010	-0.015	-0.018	-0.021
	(0.006)	(0.006)	(0.006)	(0.009)	(0.006)
OffFarmEmploy	0.549***	0.489***	0.274***	0.548***	0.607***
	(0.023)	(0.078)	(0.063)	(0.153)	(0.094)
WealthStatus	0.046	0.049	0.038	0.044	0.044
	(0.047)	(0.028)	(0.014)	(0.041)	(0.017)
FarmSize	0.179***	0.186***	1.199***	1.825***	1.118***
	(0.029)	(0.026)	(0.034)	(0.869)	(0.537)
FarmToFarmExten	1.879**	1.675**	1.557***	1.689***	1.432***
	(0.644)	(0.642)	(0.408)	(0.586)	(0.085)
AccessToCredit	1.236***	1.003***	0.875***	0.901***	1.021***
	(0.703)	(0.805)	(0.522)	(0.401)	(0.004)
InfToClimChange	0.153**	0.264**	0.935***	0.166**	0.204**
	(0.632)	(0.074)	(0.607)	(0.046)	(0.016)
RainDecline	0.062***	0.058**	0.065**	0.098**	-0.077**
	(0.013)	(0.047)	(0.044)	(0.022)	(0.014)
TempIncrease	0.452***	0.509***	0.512***	0.541**	0.554**
	(0.058)	(0.157)	(0.204)	(0.019)	(0.024)
Base category	No adaptation				
N	358				
LR chi-square	706.57***				
Log likelihood	- 987.16				
Prob > chi-square	0.0001				
Pseudo-R^2	0.4876				

***. **, * = significant at 1%, 5 % and 10 % probability level of significance, respectively.

Source: The author's collected and elaborated survey data for 2023

The multinomial logit analysis results of Table 1 reveal that the gender of household heads has a significant and positive influence on all climate change adaptations. The results of Table 2 show, for instance, that gender has a significant impact on the likelihood of adopting efficient irrigation methods (male households were 12.5% more likely to adopt them) as well as plant agroforestry systems (male households were 10.9% more likely to adopt them). This demonstrates that households headed by men may be more likely than households headed by women to have access to adaptation practices and information on climate change. This result is in agreement with the study by Belay *et al.* (2017). McNamara *et al.* (1991) and Deressa *et al.* (2009) discovered the opposite result in their study.

It is worth noting that the literature on the impact of household age on adaptation is mixed. Age is not related, according to Wegayehu and Drake (2003), but it is significantly and negatively related, according to Dolisca *et al.* (2006), to households' decisions to adopt. The age of the household head in this study had a positive impact on adaptation to climate change due to his or her stock of experience. The result of marginal effects (Table 2) shows, for instance, a higher age of the head of the household was linked to a 9.8% higher probability of using efficient irrigation methods, a 4.2% higher probability of using improved crop varieties, and a 7.8% higher probability of improving the soil's health.

The results also showed that the education level of the household head had a significant influence on the choice of all adaptation practices, indicating a positive relationship between education and climate change adaptation. This indicates that farmers seem to be more prone to dealing with climate change if they have greater education. Higher educational levels are probably going to result in farmers having better information and understanding about climate change and their choices for adapting. Dolisca *et al.* (2006) and Patnaik and Das (2017) have all reported similar findings. On average, a household with one more year of education would be 2.8% more likely to use improved crop varieties, 3.9% more likely to improve soil health, 4.6% more likely to use efficient irrigation methods, 5.2% more likely to set up plant agroforestry systems, and 2.5% more likely to practice perennial agriculture to accommodate climate change. Meanwhile, Aymone (2009) found that the level of education didn't influence the likelihood of choosing any adaptation practices.

Table 2. Statistics of marginal effects for multinomial Logit climate change adaptation model

Independent variable	Practices of climate change adaptation					
	Improved crop varieties	Improved soil health	Efficient irrigation methods	Plant agroforestry systems	Perennial agriculture	No adaptation
Gender	0.089**	0.057**	0.125***	0.109***	0.045	0.258*
	(0.018)	(0.045)	(0.007)	(0.006)	(0.168)	(0.077)
Age	0.042***	0.078***	0.098***	0.073*	0.084*	-0.005**
	(0.027)	(0.000)	(0.008)	(0.041)	(0.094)	(0.048)
Education	0.028**	0.039**	0.046**	0.052**	0.025**	0.033**
	(0.014)	(0.038)	(0.046)	(0.027)	(0.038)	(0.033)
FarmingExp	0.059**	0.044**	-0.062**	-0.078*	0.088**	0.066*
	(0.033)	(0.044)	(0.043)	(0.068)	(0.031)	(0.122)
FamilySize	0.004	0.005	0.003	0.006	0.002	0.005
	(0.002)	(0.167)	(0.108)	(0.188)	(0.166)	(0.178)
OffFarmEmploy	0.350**	0.350**	0.350***	0.350***	0.350**	0.350***
	(0.049)	(0.035)	(0.000)	(0.000)	(0.034)	(0.000)
WealthStatus	0.008	0.004	0.009	0.005	0.003	0.007
	(0.001)	(0.233)	(0.257)	(0.304)	(0.219)	(0.268)
FarmSize	0.132**	0.108**	0.122***	0.087***	0.098***	0.154***
	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FarmerToFarmerExten	0.033*	0. 108**	0.021*	0.048***	0.018	-0.032***
	(0.010)	(0.048)	(0.087)	(0.002)	(0.270)	(0.007)
AccessToCredit	0.126***	0.088***	0.047***	0.126***	0.077***	0.111***
	(0.006)	(0.009)	(0.003)	(0.008)	(0.004)	(0.005)
InfToClimeChange	0.042**	0.135***	0.087***	0.022**	0.055**	0.057**
	(0.021)	(0.053)	(0.028)	(0.018)	(0.033)	(0.033)
RainfallDecline	0.014***	0.053***	0.091***	0.072**	-0.082**	-0.007***
	(0.08)	(0.031)	(0.035)	(0.062)	(0.049)	(0.003)
TempIncrease	0.032***	0.042***	0.055***	0.029**	0.071**	0.074**
	(0.017)	(0.022)	(0.034)	(0.011)	(0.035)	(0.061)

***. **, * = significant at 1%, 5 % and 10 % probability level of significance, respectively.

Source: The author's collected and elaborated survey data for 2023

The findings in Table 2 demonstrate that a household's farming experience has a different impact on their likelihood of adopting adaptation practices. Farming experience encourages farmers to use improved crop varieties, improve the soil's health, and practice perennial agriculture. For instance, farmers with more farming experience are more likely to improve crop varieties, improve soil health, and practice perennial agriculture, respectively, by 5.9%, 4.4%, and 8.8%. This result is consistent with earlier research by Obayelu *et al.* (2014). Meanwhile, the household's years of farming experience had a negative impact on using efficient irrigation methods (6.2%) as well as plant agroforestry systems (7.8%). This contradicts previous research findings by Sani and Chalchisa (2016).

Farm size has both negative and positive effects on adoption, according to research on agricultural technology adoption by Bradshaw *et al.* (2004). This study revealed a significant and positive relationship between farm holding size and all climate change adaptations. The likelihood of a farmer implementing crop diversification, drought-tolerant crops, soil and water management, date-changing planting, and small-scale irrigation increases with the size of their landholding. Based on marginal effects (Table 2), the chances of using improved crop varieties, improved soil health, efficient irrigation methods, plant agroforestry systems, and perennial agriculture could rise by 13.5%, 10.8%, 12.2%, 8.7%, and 9.7% for every unit increase in farm size. The size of the farm influences the decision to combine multiple climate change adaptation practices. As a result, if farmers do not have enough land, they will be unable to adapt to climate change. Sani and Chalchisa (2016) also concur with this.

All practices of climate change adaptation in this study are significantly and positively correlated with variable off-farm employment. This result shows that many resource-poor farm households can reduce their financial limitations through off-farm employment, which will encourage them to adopt climate change adaptation practices. Giannakis *et al.* (2018) came to the identical conclusion.

Farmer-to-farmer extension, which served as a proxy for social capital in this study, has a positive impact on climate change adaptation. A marginal effect analysis shows that farmers who have access to farmer-to-farmer extension services are 3.3%, 10.8%, 2.1%, 4.8%, and 1.8% more likely to use improved crop varieties, improve soil health, use efficient irrigation methods, set up plant agroforestry systems, and practice perennial agriculture than farmers who don't have access to these services.

In order for households to close their financial gap and buy the farm inputs and technologies necessary to increase agricultural production as well as engage in income-generating activities outside of farming, access to credit services is a crucial factor. This study's variable has a significant and positive impact on households' attempts to adapt to climate change. The findings of this study are comparable to those that Pattanayak *et al.* (2003) reported. When credit is readily available, it is frequently evident that farmers attempt to implement capital-intensive strategies for implementing improved agricultural technologies, such as plant agroforestry systems, efficient irrigation methods, and small-scale irrigation technologies like drip irrigation, improving the soil's health, and purchasing drought-tolerant and crop-diversification varieties.

The findings also show that the household's information about climate change has a significant and positive impact on the likelihood of adopting all types of adaptation practices. Farmers who have access to information about climate change are more likely to choose drought-tolerant cultivars and to use soil and water management as adaptation strategies to slow down or even reverse climate change. On the other hand, as a result of marginal effects, increasing climate information could increase the likelihood of improving soil health by 13.5% with information about climate change, while the likelihood of using efficient irrigation methods increases by 8.7%. Deressa *et al. (2009)* also revealed a solidly favorable relationship between information and climate change access and adaptation.

Additionally, it was discovered that variables influencing the adoption of alternative practices that could improve resilience against the effects of climate change include awareness of declining rainfall. The results of this study show that a one-millimeter decrease in rainfall decreases the likelihood of using improved crop varieties by 3.8%, improving soil health by 5.3%, using efficient irrigation methods by 9.1%, using plant agroforestry systems by 7.2%, and doing perennial agriculture by 8.2%.

As shown in Table 2, a 1 degree rise above the average annual temperature on the household's farm makes it 3.2% more likely that they will use improved crop varieties, 4.2% more likely that they will improve the health of the soil, 5.5% more likely that they will use efficient irrigation methods, 2.9% more likely that they will plant agroforestry systems, and 7.1% more likely that they will practice perennial agriculture. Other empirical research, for example, by Ureta *et al.* (2020), shows that a slight increase in temperature negatively affects important cereal crops like maize and wheat.

Conclusions

This study evaluated by two empirical analyses conducted using the methodology described in the present article how smallholder farmers in Prespa Park coped with short-term climate changes, how they adapted for future climate change, and identified the main barriers impeding smallholder farmers from successfully using coping and adaptation practices. Additionally, a multinomial logistic regression model was employed to analyze the factors influencing smallholder farmers' choice of adaptation practices to climate change.

The typology of climate change adaptation strategies and coping mechanisms employed by Prespa Park region farmers at the household level was established in the first empirical investigation. Findings showed that future policies that assist in addressing the issues of improving soil health, planting drought-tolerant and early-maturing food crop varieties, utilizing tried-and-true methods of conserving water in agriculture (such as controlled deficit irrigation and drip irrigation systems), and enhancing the resilience of agroecosystems, as well as agroforestry and perennial plantations, which align with the most significant adaptation practices adopted by households, can assist households, local governments, or any other concerned body in addressing these issues of both current and future climate changes by giving them more attention.

The empirical investigation also revealed several significant coping mechanisms used in the research area's households. They entail selling animals and other assets, engaging in off-farm activities, gathering fuel wood for sale, increasing the capacity of the soil to store water, and changing farming structures. The empirical investigation also identified the main barriers to the adoption of coping strategies and behaviors for adapting to climate change. Small farm holdings, financial restrictions on utilizing any of the adaptation strategies, a lack of off-farm work options, poor infrastructure and technology, and a lack of knowledge about adaptation practices were some of the barriers.

The following variables were identified and evaluated in the second empirical analysis, which was carried out using a multinomial logit model: gender, education, off-farm employment, farm size, farming experience, farmer-to-farmer extension, access to credit, information about climate change, awareness of declining rainfall, and recognition of temperature increases. These variables have the potential to influence households' decisions to use a particular practice of climate change adaptation that climate change planners should focus on. Consequently, strengthening adaptations at the farm level will come from creating policies and practices that improve these variables.

The results of the current study are expected to be useful in guiding local government agencies and policymakers and helping to build sustainable adaptation strategies to climate change at the household level in Prespa Park and other areas with similar conditions.

Acknowledgment

I would like to extend my appreciation to those individuals who made substantial contributions to the successful completion of this research. I greatly value the assistance provided by my co-workers, including both emotional encouragement and tangible resources.

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

References

[1] Acosta, L.A., *et al.* 2013. A Spatially Explicit Scenario-Driven Model of Adaptive Capacity to Global Change in Europe. *Global Environmental Change*, *23*(5): 1211–1224. DOI:10.1016/j.gloenvcha.2013.03.008

[2] Adger, W.N., Huq, S., Brown, K., Conway, D., and Hulme, M. 2003. Adaptation to climate change in the developing world. *Progress in Development Studies*, 3: 179–195. DOI: 10.1191/1464993403ps060oa

[3] Agrawala, S., and Fankhauser, S. 2008. Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments. Paris, France: OECD, 138 pp.

[4] Al-Ghobari, M.H., and Dewidar, Z.A. 2018. Deficit irrigation and irrigation methods as on-farm strategies to maximize crop water productivity in dry areas. *Journal of Water and Climate Change*, 9(2): 399–409. DOI:https://doi.org/10.2166/wcc.2017.014

[5] Alvi, S., and Jamil, F. 2018. Impact of Climate Change and Technology Adoption on Cereal Yields in South Asian Countries. *European Journal of Sustainable Development*, 7(3): 237–246. DOI:https://doi.org/10.14207/ejsd.2018.v7n3p237

[6] Anik, A.R., Rahman, S., Sarker, J.R., and Hasan, M.A. 2021. Farmers' adaptation strategies to combat climate change in drought prone areas in Bangladesh. *International Journal of Disaster Risk Reduction*, 65: 102562. DOI: https://doi.org/10.1016/j.ijdrr.2021.102562

[7] Aryal, J.P., *et al.* 2020. Climate change and agriculture in South Asia: adaptation options in smallholder production systems. *Environ Dev Sustain*, 22: 5045–5075. DOI: https://doi.org/10.1007/s10668-019-00414-4

[8] Aymone, G.G. 2009. Understanding farmers' perceptions and adaptation to climate change and variability: The case of the Limpopo basin, South Africa. IFPRI Discussion paper 00849, Washington DC.: International Food Policy Research Institute, USA, 36 pp.

[9] Belay, A., Recha, J.W., Woldeamanuel, T., and Morton, J.F. 2017. Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. *Agriculture & Food Security*, 6(1): 24.

[10] Below, T. B., *et al.* 2012. Can farmers' adaptation to climate change be explained by socio-economic household-level variables? *Global Environmental Change*, 22: 223-235. DOI:https://doi.org/10.1016/j.gloenvcha.2011.11.012

[11] Belsley, D.A., Kuh, E., and Welsch, R.E. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York, USA: John Wiley & Sons, 298 pp.

[12] Berrang-Ford, L., Ford, J.D., and Paterson, J. 2011. Are we adapting to climate change? *Global Environmental Change*, 21: 25–33. DOI: https://doi.org/10.1016/j.gloenvcha.2010.09.012

[13] Bradshaw, B., Dolan, H., and Smit, B. 2004. Farm-level adaptation to climatic variability and change: Crop diversification in the Canadian Prairies. *Climate Change*, 67: 119–141. DOI: 10.1007/s10584-004-0710-z

[14] Brooks, N.W., Adger, N., and Kelly, P.M. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Envron. Change*, 15: 151–163. DOI:https://doi.org/10.1016/j.gloenvcha.2004.12.006

[15] Brouwer, R., and Akter, S. 2010. Informing micro insurance contract design to mitigate climate change catastrophe risks using choice experiments. *Environ. Hazards*, 9(1): 74–88.

[16] Chimbwera, M. 2010. *Climate change adaptation in developing countries: Issues and Perspectives for Economic Analysis*. London, UK: IIED, 40 pp.

[17] De Boni, A., D'Amico, A., Acciani, C., and Roma, R. 2022. Crop Diversification and Resilience of Drought-Resistant Species in Semi-Arid Areas: An Economic and Environmental Analysis. *Sustainability*, 14(15): 9552. DOI: https://doi.org/10.3390/su14159552

[18] De Frutos, C.J., Gobin, A., and Buysse, J. 2018. Farm-level adaptation to climate change: the case of the Loam region in Belgium. *Agricultural Systems,* 165: 164–176. DOI:https://doi.org/10.1016/j.agsy.2018.06.007

[19] De Gryze, S., Albarracin, M.V., Català-Luque, R., Howitt, R.E., and Six, J. 2009. Modelling shows that alternative soil management can decrease greenhouse gases. *California Agriculture*, 63: 84–90.

[20] Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T., and Yesuf, M. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, 19(2): 248–255. DOI: https://doi.org/10.1016/j.gloenvcha.2009.01.002

[21] Di Falco, S., Veronesi, M., and Yesuf, M. 2011. Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. *American Journal of Agricultural Economics*, 93: 829–846. DOI:https://doi.org/10.1093/ajae/aar006

[22] Dillman, D.A., Smyth, J.D., and Christian, L.M. 2007. *Mail and Internet Survey – The Tailored Design Method* (second ed). New York, USA: John Wiley & Sons Inc., 512 pp.

[23] Dolisca, F., Carter, R.D., McDaniel, J.M., Shannon, D.A., and Jolly, C.M. 2006. Factors influencing farmers' participation in forestry management programs: A case study from Haiti. *Forest Ecology and Management*, 236: 324–31. DOI: https://doi.org/10.1016/j.foreco.2006.09.017

[24] Elias, E.H., *et al.* 2019. Crop vulnerability to weather and climate risk: analysis of interacting systems and adaptation efficacy for sustainable crop production. *Sustainability*, 11(23): 6619. DOI:https://doi.org/10.3390/su11236619

[25] Eriksen, S.H., Brown, K., and Kelly, P.M. 2005. The dynamics of vulnerability: Locating coping strategies in Kenya and Tanzania. *Geographical Journal*, 171: 287–305. DOI: 10.1111/j.1475-4959.2005.00174.x

[26] Ertl, P., Klocker, H., Hörtenhuber, S., Knaus, W., and Zollitsch, W. 2015. The net contribution of dairy production to human food supply: The case of Austrian dairy farms. *Agricultural Systems*, 137: 19–25. DOI:10.1016/j.agsy.2015.04.004

[27] Faisal, M., *et al.* 2021. Assessing small livestock herders' adaptation to climate variability and its impact on livestock losses and poverty. *Climate Risk Management*, 34: 100358. DOI:https://doi.org/10.1016/j.crm.2021.100358

[28] Finger, R., Hediger, W., and Schmid, S. 2011. Irrigation as adaptation strategy to climate change - a biophysical and economic appraisal for Swiss maize production. *Climatic Change*, 105: 509–528. DOI:10.1007/S10584-010-9931-5

[29] Fink, A. 2013. *How to Conduct Surveys: A Step-by-Step Guide* (sixth ed.). Thousand Oaks, CA. USA: Sage Publications Inc., 224 pp.

[30] Foudi, S., and Erdlenbruch, K. 2012. The Role of Irrigation in Farmers' Risk Management Strategies in France. *European Review of Agricultural Economics*, 39(3). DOI:https://doi.org/10.1093/erae/jbr024

[31] Giannakis, E., Efstratoglou, S., and Antoniades, A. 2018. Off-Farm Employment and Economic Crisis: Evidence from Cyprus. *Agriculture,* 8(3): 41. DOI: https://doi.org/10.3390/agriculture8030041

[32] Glover, J.D., and Reganold, J.P. 2010. Perennial grains: Food security for the future. *Issues in Science and Technology*, 26(2): 41–47.

[33] Glover, J.D., Reganold, J.P., and Cox, C.M. 2012. Agriculture: Plant perennials to save Africa's soils. *Nature*, 489(7416): 359–361. DOI: 10.1038/489359a

[34] Grazhdani, D. 2024. Results of two non-market valuation methods used to estimate recreational fishing in the Lakes Prespa watershed. *Journal of environment management and tourism*, 15(1): 52–68. DOI:https://doi.org/10.14505/jemt.v15.1(73).05

[35] Grazhdani, D. 2014a. Integrating ecosystem services into assessment of different management options in a protected area: a deliberate multi-criteria decision analysis approach. *Bulgarian Journal of Agricultural Science*, 20(6): 1311–1319.

[36] Grazhdani, D. 2014b. Estimating residents' willing to pay using contingent valuation for ecological restoration and recreational benefits of AL-Prespa protected area in Albania. *Journal of Food, Agriculture & Environment*, 12(3&4): 132–137.

[37] Grazhdani, D. 2014c. An approach for assessing ecosystem services with application in a protected area case study: Al-Prespa. *Bulgarian Journal of Agricultural Sciences*, 20: 118–124.

[38] Grazhdani, D. 2015. Contingent valuation of residents' attitudes and willingness-to-pay for non-point source pollution control: a case study in Prespa Park, Southeastern Albania. *Environmental Management*, 56(1): 81–93. DOI: 10.1007/s00267-015-0480-6

[39] Grazhdani, D. 2016. Assessing the variables affecting the rate of solid waste generation and recycling: An empirical analysis in Prespa Park. *Waste Management*, 48: 3–13. DOI:https://doi.org/10.1016/j.wasman.2015.09.028

[40] Grazhdani, D., Grazhdani, S., and Shehu, D. 2010. Environment, socio-economic development and sustainability in Albanian part of Prespa Park. Annals of Agriculture, Faculty of Environmental Engineering and Biotechnologies, University of Targoviste, Romania, 5: 32–41.

[41] Green, W. 2008. *Econometric Analysis* (6th ed.). New Jersey, USA: Prentice Hall, 1178 pp.

[42] Hausman, J, and McFadden, D. 1984. Specification tests for the multinomial logit model. *Econometrica*, 52(5): 1219–1240. DOI: https://doi.org/10.2307/1910997

[43] Holt-Giménez, E., and Altieri, M.A. 2013. Agroecology, food sovereignty, and the new green revolution. *Agroecology and Sustainable Food Systems*, 37 (1): 90–102. DOI:10.1080/10440046.2012.716388

[44] Iglesias, A., Garrote, L., Quiroga, S., and Moneo, M. 2012. From climate change impacts to the development of adaptation strategies: Challenges for agriculture in Europe. *Clim. Chang.*, 112: 143–168. DOI:10.1007/s10584-011-0344-x

[45] Kahil, M. T., Connor, J. D., and Albiac, J. 2015. Efficient water management policies for irrigation adaptation to climate change in Southern Europe. *Ecological Economics*, 120: 226–233. DOI:https://doi.org/10.1016/j.ecolecon.2015.11.004

[46] Kandlinkar, M., and Risbey, J. 2000. Agricultural impacts of climate change: If adaptation is the answer, what is the question? *Climate Change*, 45: 429–439.

[47] Karlsson, J., Spörndly, R., Lindberg, M., and Holtenius, K. 2018. Replacing human-edible feed ingredients with by-products increases net food production efficiency in dairy cows. *Journal of Dairy Science*, 101(8): 7146–55. DOI: https://doi.org/10.3168/jds.2017-14209

[48] Kates, R.W., Travis, W.R., and Wilbanks, T.J. 2012. Transformational adaptation when incremental adaptations to climate change are insufficient. Proc. Natl. Acad. Sci. USA, 109: 7156–7161. DOI:https://doi.org/10.1073/pnas.1115521109

[49] Kebede, A., Kang, M.S., and Bekele, E. 2019. Advances in mechanisms of drought tolerance crops, with emphasis on barley. *Advances in Agronomy*, 156: 265–314. DOI:https://doi.org/10.1016/bs.agron.2019.01.008

[50] Klein, T., Holzkämper, A., Calanca, P., Seppelt, R., and Fuhrer, J. 2013. Adapting agricultural land management to climate change: a regional multi-objective optimization approach. *Landscape Ecology*, 28(10): 2029–2047. DOI: https://doi.org/10.1007/s10980-013-9939-0

[51] Krishnan, P., Ramakrishnan, B., Reddy, K.R., and Reddy, V.R. 2011. High-temperature effects on rice growth, yield, and grain quality. In: Sparks, D.L. (ed) *Advances in Agronomy*, vol 111. Burlington, Vermont, USA: Academic Press, pp. 87–206. DOI: https://doi.org/10.1016/B978-0-12-387689-8.00004-7

[52] Lamichhane, P., Miller, K.K., Hadjikakou, M., and Bryan, B.A. 2020. Resilience of smallholder cropping to climatic variability. *Science of Total Environment*, 719: 137464. DOI:https://doi.org/10.1016/j.scitotenv.2020.137464

[53] Lane, D., *et al.* 2018. Climate change and agriculture in New York and Pennsylvania: risk perceptions, vulnerability and adaptation among farmers. *Renewable Agriculture and Food Systems,* 33(3): 197–205. DOI: https://doi.org/10.1017/S1742170517000710

[54] Liu, X., Lehtonen, H., Purola, T., Pavlova, Y., Rotter, R., and Palosuo, T. 2016. Dynamic economic modelling of crop rotations with farm management practices under future pest pressure. *Agricultural Systems*, 144: 65–76. DOI: https://doi.org/10.1016/j.agsy.2015.12.003

[55] Lobell, D., Burke, M., Tebaldi, C., Mastrandrea, M., Falcon, W., and Naylor, R. 2008. Prioritizing Climate Change Adaptation Needs for Food Security in 2030. *Science*, 319: 607–610. DOI:https://doi.org/10.1126/science.1152339

[56] Luedeling, E., *et al.* 2016. Field-scale modeling of tree–crop interactions: Challenges and development needs. *Agricultural Systems*: 51–69. DOI: https://doi.org/10.1016/j.agsy.2015.11.005

[57] Luquet, D., Vidal, A., Smith, M., and Dauzat, J. 2005. 'More crop per drop': how to make it acceptable for farmers? *Agricultural Water Management*, 76(2): 108–119. DOI: https://doi.org/10.1016/j.agwat.2005.01.011

[58] Mandryk, M. 2016. Integrated assessment of farm level adaptation to climate change in agriculture – An application to Flevoland, The Netherlands. PhD thesis, Wageningen University, 155 pp.

[59] Marie, M., Yirga, F., Haile, M., and Tquabo, F. 2020. Farmers' choices and factors affecting adoption of climate change adaptation strategies: evidence from north-western Ethiopia. *Heliyon*, 6(4): e03867.

[60] Markovic, D., Carrizo, S.F., Kärcher, O., Walz, A., and David, J.N.W. 2017. Vulnerability of European freshwater catchments to climate change. *Global Change Biology*, 23: 3567–3580. DOI:https://doi.org/10.1111/gcb.13657

[61] Masud, M.M., *et al.* 2017. Adaptation barriers and strategies towards climate change: Challenges in the agricultural sector. *Journal of Cleaner Production*, 156: 698–706. DOI:https://doi.org/10.1016/j.jclepro.2017.04.060

[62] McCord, P.F., Cox, M., Schmitt-Harsh, M., and Evans, T. 2015. Crop diversification as a smallholder livelihood strategy within semi-arid agricultural systems near Mount Kenya. *Land Use Policy*, 42: 738–750. DOI: https://doi.org/10.1016/j.landusepol.2014.10.012

[63] McNamara, K.T. Wetzstein, M.E., and Douce, G.K. 1991. Factors affecting peanut producer adoption of integrated pest management. *Review of agricultural Economics*, 13: 129–139. DOI:https://doi.org/10.2307/1349563

[64] Miles, J., and Shevlin, M. 2001. *Applying Regression and Correlation: A Guide for Students and Researchers*. London, England: Sage Publications, 253 pp.

[65] Mozny, M., Tolasz, R., Nekovar, J., Sparks, T., Trnka, M., and Zalud, Z. 2009. The impact of climate change on the yield and quality of Saaz hops in the Czech Republic. *Agric. For Meteorol*., 149: 913–919. DOI:https://doi.org/10.1016/j.agrformet.2009.02.006

[66] Murthy, I.K., Dutta, S., Varghese, V., and Kumar, P. *2016*. Impact of Agroforestry Systems on Ecological. *Glob. J. Sci. Front. Res.,* 16*:* 15–28.

[67] Nardi, P.M. 2013. *Doing Survey Research: A Guide to Quantitative Methods* (third ed.). New York, USA: Routledge, 274 pp.

[68] Nicholas, K.A., and Durham, W.H. 2012. Farm-scale adaptation and vulnerability to environmental stresses: insights from winegrowing in Northern California. *Global Environmental Change*, 22(2): 483 - 494.

[69] Niles, M.T., Brown, M., and Dynes, R. 2016. Farmer's intended and actual adoption of climate change mitigation and adaptation strategies. *Climatic Change*, 135(2): 277–295. DOI:https://doi.org/10.1007/s10584-015-1558-0

[70] Norris, E., and Batie, S. 1987. Virginia farmers' soil conservation decisions: an application of Tobit analysis. *Southern journal of Agricultural Economics*, 19(1): 89–97. DOI: 0.22004/ag.econ.29310

[71] Obayelu, O.A., Adepoju, A.O., and Idowu, T. 2014. Factors influencing farmers' choices of adaptation to climate change in Ekiti State, Nigeria. *J Agric Environ Int Dev.,* 108(1): 3–16.

[72] Oelbermann, M., and Smith, C.E. 2011. Climate Change Adaptation using Agroforestry Practices: A Case Study from Costa Rica. In: Casalegno, S., *Global Warming Impacts—Case Studies on the Economy, Human Health, and on Urban and Natural Environments*. InTech, London, UK, pp. 125–138.

[73] Olesen, J.E., *et al.* 2011. Impacts and adaptation of European crop production systems to climate change. *European Journal of Agronomy*, 34(2): 96–112. DOI: https://doi.org/10.1016/j.eja.2010.11.003

[74] Park, H.M. 2009. *Linear regression models for panel data using SAS, Stata, LIMDEP, and SPSS*. University Information Technology Services (UITS) Working Paper. University Information Technology Service Center for Statistical and Mathematical Computing, Indiana University, 93 pp.

[75] Patnaik, U., and Das, K.P. 2017. Do development interventions confer adaptive capacity? Insights from rural India. *World Development*, 97: 298–312. DOI: https://doi.org/10.1016/j.worlddev.2017.04.017

[76] Pattanayak, S.K., Mercer, D.E., Sills, E., and Jui-Chen, Y. 2003. Taking stock of agroforestry adoption studies. *Agroforestry Systems*, 57(3): 173–186. DOI: 10.1023/A:1024809108210

[77] Ponce, C. 2020. Inter-seasonal climate variability and crop diversification strategies in the Peruvian Andes: A word of caution on the sustainability of adaptation to climate change. *World Development*, 127: 104740. DOI:https://doi.org/10.1016/j.worlddev.2019.104740

[78] Reynolds, J., *et al.* 2021. An agroecological vision of perennial agriculture. *Agroecology and Sustainable Food Systems*, 45: 1470–1479. DOI: https://doi.org/10.1080/21683565.2021.1918313

[79] Rodriguez, D., Cox, H., deVoil, P., and Power, B. 2014. A participatory whole farm modelling approach to understand impacts and increase preparedness to climate change in Australia. *Agricultural Systems*, 126: 50–61. DOI: https://doi.org/10.1016/j.agsy.2013.04.003

[80] Roesch-McNally, G., Garrett, A., and Fery, M. 2020. Assessing perceptions of climate risk and adaptation among small farmers in Oregon's Willamette Valley. *Renewable Agriculture and Food Systems*, 35(6): 626–30. DOI: https://doi.org/10.1017/S1742170519000267

[81] Rosenzweig, C., and Tubiello, F. 2007. Adaptation and mitigation strategies in agriculture: an analysis of potential synergies. *Mitigation and Adaptation Strategies for Global Change*, 12: 855–873.

[82] Sani, S., and Chalchisa, T. 2016. Farmers' Perception, Impact and Adaptation Strategies to Climate Change among Smallholder Farmers in Sub-Saharan Africa: A Systematic Review. *J. Ressour. Dev. Manag, 26*: 1–8.

[83] Satishkumar, N., Tevari, P., and Singh, A.A. 2013. A Study on Constraints Faced by Farmers in Adapting to Climate Change in Rain fed Agriculture. *Journal of Hum. Ecology,* 44(1): 23–28.

[84] Schattman, R.E., Caswell, M., and Faulkner, J.W. 2021. Eyes on the horizon: temporal and social perspectives of climate risk and agricultural decision making among climate-informed farmers. *Society & Natural Resources*, 34: 765–84. DOI: https://doi.org/10.1080/08941920.2021.1894283

[85] Shrestha, S., Ciaian, B., Himics, M., and van Doorslaer, B. 2013. Impacts of climate change on EU agriculture. *Review of Agricultural and Applied Economics*, 16: 24–39.

[86] Skulmoski, G.J., Hartman, F.T., and Krahn, J. 2007. The Delphi method for graduate research. *J. Inf. Technol. Educ.*, 6: 1–21. DOI: https://doi.org/10.28945/199

[87] Smit, B., and Skinner, M.W. 2002. Adaptations options in agriculture to climate change: A typology. *Mitigation and Adaptation Strategies for Global Change,* 7: 85–114.

[88] Smit, B., and Wandel, J. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3): 282–92. DOI: https://doi.org/10.1016/j.gloenvcha.2006.03.008

[89] Tol, R.S.J., Downing, T.E., Kuik, O.J., and Smith, J.B. 2004. Distributional aspects of climate change impacts. *Global Environmental Change*, 14: 259–72.

[90] Tse, Y.K. 1987. A diagnostic test for the multinomial logit model. *Journal of Business and Economic Statistics*, 5 (2): 283–86.

[91] Ureta, C., *et al.* 2020. Maize yield in Mexico under climate change. *Agricultural Systems,* 177: 102697. DOI:https://doi.org/10.1016/j.agsy.2019.102697

[92] van Dijl, E.A., Grogan, K.A. and Borisova, T. 2015. Determinants of adoption of drought adaptations among vegetable growers in Florida. *Journal of Soils and Water Conservation*, 70(4): 218–31. DOI:https://doi.org/10.2489/jswc.70.4.218

[93] Walford, N. 1995. *Geographical Data Analysis*. New York, USA: John Wiley & Sons Inc., 458 pp.

[94] Wegayehu, B., and Drake, L. 2003. Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: A case study of the Hunde Lafto area. *Ecological Economics*, 46: 437–51.

[95] Wood, S.A., Jina, A.S., Jain M., Kristjanson, P., and DeFries, R.S. 2014. Smallholder farmer cropping decisions related to climate variability across multiple regions. *Glob. Environ. Chang.*, 25: 163–172. DOI:https://doi.org/10.1016/j.gloenvcha.2013.12.011

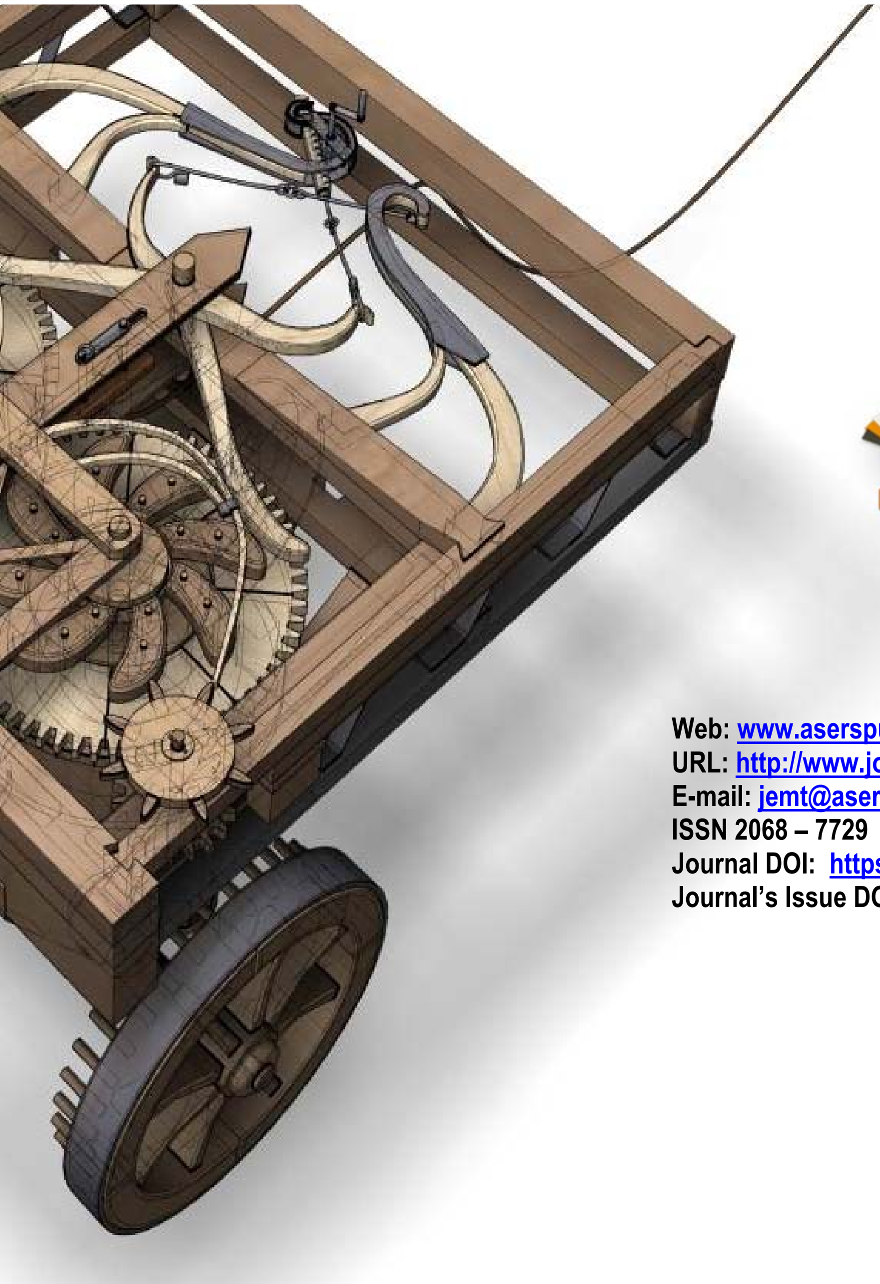
[96] Zoysa, M.D., and Inoue, M. *2014.* Climate Change Impacts, Agroforestry Adaptation and Policy Environment in Sri Lanka. *Open Journal of Forestry*, 4*:* 439–456. DOI: 10.4236/ojf.2014.45049

[97] AcaStat, Software. 2014. *Pearson Correlation. AcaStat Software*: *Research Tools and Instructional Aids*. Retrieved April 2014, from http://www.acastat.com/Statbook/correlation.htm

[98] IPCC. 2014. Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Cambridge, UK: Cambridge University Press.

[99] StataCorp. 2023. *Stata Statistical Software: Release 18*. College Station, TX, USA: StataCorp LLC.

ASERS



ASERS Publishing

Web: www.aserspublishing.eu
URL: http://www.journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v15.2(74).00