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Exploring the Gender-Specific Adaptive Responses to Climate Variability: Application of Grazing Game in the Semi-Arid Region of Ghana [†]

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Abstract: Regional climate change assessments show a likely temperature increase that is higher than the global average for all seasons in Africa, which would have extreme negative implications for ecosystem health and productivity. Most extreme climate change effects in West Africa are predicted to occur in desert and grassland areas. It is important for smallholder farmers in this region to understand the implications of these projections to their livelihood and to identify appropriate adaptation strategies. A grazing game was used to explore gender-specific adaptive responses to climate variability in the semiarid region of Ghana. The game was designed to understand the decision-making processes that result in the overgrazing of animals, leading to desertification based on the players' interactions with the environment. A total of 44 grazing games comprising 22 games for male-headed households (HH) and 22 games for female-HH were played from August to December 2014 from 14 communities within the Bolgatanga Municipality and the Bongo district. The study revealed that males migrate to the southern part of the country to work on other people's farms during the dry season as an adaptation strategy, while females engage in off-farm activities such as shea-butter production and basketry. Results of the game showed that males produced the highest number of cattle but created the largest desert patches. Females, on the other hand, were more conscious about the environment (long-term condition of the rangeland) than the short-term income benefits from the sale of cattle; hence, they created fewer desert patches. Strategies such as reducing the number of cattle to allow for the re-growth of vegetation in periods of feed scarcity, ploughing for one another using bulls, and family support using income from the sale of livestock were employed by both gender groups. The involvement of female farmers in decision-making is crucial to improve natural resource management.

Keywords: grazing game; natural resources; men; women; climate variability; adaptation

1. Introduction

Regional assessments of climate change show likely temperature increases that are higher than those of the global mean for all seasons in Africa [1,2], which would have extreme negative implications for ecosystem health and productivity. Among the key ecosystem properties identified as experiencing notable climatic impacts are freshwater resources and their management, food, fibre, and forest products [3]. These impacts are evident in the changing ranges of some plants and animals, the extinction of species, and the alteration of biomass, with predictions of increased desertification in West African

desert and grassland areas [4,5]. In climate-sensitive economies, these changes are expected to exacerbate the vulnerabilities of rural populations that depend on livelihoods such as agriculture and that have high poverty levels and limited social safety nets as the yields of major staples as well as the extent of the area that is suitable for the crop cultivation shrink [3,6,7].

In Ghana, the majority of the livelihood activities are heavily dependent on agro-ecosystems, with 90% of agricultural production dominated by smallholders [8]. In the five semi-arid northern regions that have higher proportions of rural dwellers, more than 70% of the economically active population are engaged in agricultural activities [9], producing crops such as millet, guinea corn, maize, groundnut, beans, sorghum, tomatoes, and onions, with livestock such as cattle, sheep, and goats, forming an essential component of the agricultural production. This semi-arid area experiences low rainfall, less than 700 mm per annum, which has become increasingly erratic, followed by a long dry season (November to May); thus, climate change and variability contributes to the challenges of smallholder farmers in the form of water stress and the availability of feed for animals, especially in the dry season. The dependences of so many livelihoods on rainfall and natural resources means that climatic and non-climatic stressors are threats to these livelihoods [10,11].

To improve the adaptive capabilities of these populations and their livelihoods, some interventions have focused on the promotion of livestock farming as a way to help farmers cope with the dry spells while producing a steady income, with some of these interventions being specifically targeted at women. However, there is a concern that farmers facing the challenge of feed shortages cause overgrazing of the limited grasslands, leading to loss of land cover and the threat of desertification. The situation calls for urgent attention to the conservation of functional ecosystems such as grasslands to achieve maximum benefits while enhancing positive adaptation outcomes [4]. To ensure that livestock farmers understand the need for a balance between livestock numbers and the availability of rangeland requires innovativeness and decisions with foresight. However, the successful adoption of adaptation options in sub-Saharan Africa are largely household based and are influenced by socio-cultural factors including gender barriers [12]. Therefore, it is important to explore the gender dimensions of climate adaptation practices, as climate variability adaptation is not gender neutral. Alhasan et al. [13] and Mersha and Laerhoven [14] reported differences in climate variability adaptation between male and female groups. Alhasan et al. [13] reported significant differences in the vulnerability level between male and female-headed households, with the females being more vulnerable to climate variability but with the least adaptive capacity. Mersha and Laerhoven [14] reported that gender-specific differences in climate change and variability adaptation are attributed to gender barriers and not on the basis of preference. Owing to the important role of gender in development, it is crucial to address gender issues when dealing with climate change-related research [15]. It is therefore imperative to identify the effective adaptation strategies of gender groups to climate change and variability [16]. The need for gender-specific adaptation and the focus on women stems from the existence of empirical data confirming differential vulnerability between males and females [15]. Research report by Mensah [17] and Wrigley-Asante et al. [18] indicate that while male farmers plant hybrid drought-resistant crop varieties as an adaptation strategy, their female counterparts cultivate traditional crops. In addition, Wrigley-Asante et al. [18] reported that while male farmers prefer to migrate to other parts of the country to work on other people's farms as an adaptation strategy, the females are interested in off-farm jobs such as trading.

In a society, there are many different groups with contrasting or competing interests [19]. For example, farmers competing for land for crop production and the grazing of animals by pastoralists. This can result in conflict if there is no engagement of these stakeholders. Conflict prevention as a result of land-use can be achieved when stakeholders learn amongst themselves through participatory approaches and negotiations to observe how their decisions on land use impact their livelihoods [20,21] and how to manage the natural resources for the benefit of all.

Role playing games (RPGs) are important tools for participatory and joint learning. RPGs are tools that also support teaching, planning, analyses, and negotiation processes, among other things. As a learning tool, RPGs aim to provide either the players or game organizers with better knowledge of a given situation [22]. Games are also seen as appropriate tools for stimulating the active participation of stakeholders in a collective process with regard to resource management. Speelman et al. [23], for instance, employed RE-SORTES, a land use board, game and showed that the game sessions created an open and active discussion on land-use among the participants where the farmers expressed their actual views on and responses to multifunctional agricultural landscape planning and land sharing vs. land sparing dilemmas. Another study by [24] integrated an RPG with several modelling approaches (multi-criteria evaluation model and a machine learning base tool) to observe the complex land-dynamics influencing a land-adjudication process.

RPGs help stakeholders understand how to manage resources well without conflict and land degradation. Anticipatory learning is therefore important to build resilience [25] and decision making in a changing environment. This study assessed the gender-specific adaptive responses to climate variability in a semi-arid region of Ghana using grazing game.

2. Materials and Methods

2.1. Study Area

The research was conducted in the Veia catchment located within Bolgatanga municipality and the Bongo district of the Upper East Region (UER) of Ghana (Figure 1). The Veia Catchment has a total land area of about 301 km² and is bordered to the north by Burkina Faso and to the east by Togo. A larger portion of the region is situated within the semiarid West African savannah belt, with the exception of a small stretch of land in the north-eastern part of the catchment that belongs to the Sudan savannah [26]. The UER falls within the White Volta basin, which has an estimated land area of about 8842 km² and represents 3.7% of the entire land mass of Ghana. The region is made up of nine administrative districts, namely Kassena-Nankana East, Kassena Nankana West, Bawku Municipality, Talensi-Nabdam, Bawku West, Bongo, Garu Tempane, Bolgatanga municipality, and the Builsa Districts [8]. A report by GSS [9] estimated the population to be 1,301,221 (631,258 males and 669,963 females), representing 4.2% of Ghana's population, with a density of 147.2 km⁻² and an annual growth rate of 1.2%. The region is about 79% rural, with an average household size of 5.8 people. Agriculture, forestry, and hunting are the main economic activities in the region, with agriculture employing about 80% of the economically active population [9]. Cereals (maize, guinea-corn, and sorghum) are the main crops that are cultivated in this region; however, groundnuts, beans and dry season tomatoes and onions are also cultivated. There are two main irrigation projects in the region for dry season farming. These are the Tono and Veia irrigation projects, which have a catchment area of 850 and 2490 hectares, respectively. Small scale agro-processing (rice and groundnut) and handicrafts are income generating activities for the active population. Similarly, farmers also produce livestock (sheep, goats, cattle and pig) and poultry, which serve as a source of security, income, and nutritional needs of the household. In most cases, livestock are kept under three main management systems, which comprise intensive, extensive, and semi-intensive systems. However, the greater percentage of the livestock are kept under an extensive management system.

Figure 1. Map of the study area.

2.2. Conceptual Model of the Role-Playing Game (Grazing Game)

The “over-grazing game”, which was developed by Van Noordwijk [27] and that had the main purpose of teaching university students the processes that lead to overgrazing and desert conditions in savannah ecological zones, was modified and used for the current study. The game was created to enable students to gain knowledge on the processes that lead to desertification in order to influence extension practices in natural resource management. In this study, the game aimed to demonstrate the activities of local farmers that result in land degradation through overgrazing and desertification as well as to better understand their indigenous knowledge, farmer behaviours, and adaptive strategies in the study area (Veia catchment). The game was modified to understand the coping strategies of individual farmers and to reflect the existing situation of the upper east region. The modified version of the grazing game (Figure 2) combined the conditions of low rainfall, on which agriculture production is dependent, with other determinants that bring flexibility and complexity into the game [5]. The key assumptions were based on prior research that was conducted in the study area in terms of erratic rainfall, inter-annual variability distribution, and amount [5,28]. The game was modified by disaggregating participants according to gender and by creating more room to accommodate additional crops and a simplified score sheet. The score sheet represents actors, such as farmers and markets; processes, such as the reproduction and regrowth of grass; resources, such as grass, patches of land, and rainfall; and strategies, such as keeping cattle, selling cattle, or relocating the animals to a valley where more feed is available during the dry season or to an upland area in the rainy season. Crop production and cattle rearing on a subsistence basis within the area is a major source of economic activities for the local farmers. The game process entails grass development cycles based on rainfall: i.e., more rainfall promotes grass, shrubs or bush development/growth, and increases cattle reproduction, and less rainfall inhibits grass growth, thus reducing cattle reproduction. The indicators in the conceptualized model that are monitored include the total number of cattle that are produced, the total number sold, and the increase in the number of herds after reproduction. The arrows in Figure 2 represent decision strategies regarding the grazing management, marketing, and maintenance of cattle. The term “cattle” was used throughout the game, with the assumption that bulls were always available for reproduction purposes.

Figure 2. Conceptual framework of the grazing game (adopted from [5]).

2.3. Specifications of the Ghana RPG (Grazing Game)

A total of 44 games were played by 245 male-headed households and 237 female-headed households between August and December 2014. In all, 482 farmers (household-heads) participated in the game. In this study, the definition of female-headed household is households that are headed by females who are mainly responsible for decision making. The number of participants per game varied based on interest in participating in the game and gender without taking other demographic characteristics into consideration. No participation incentive was provided. The participants of the game were subdivided into 22 women and 22 men groups in the catchment. Each game was played once by a participant. The game employed an 8×8 grid board, with each patch measuring $5 \text{ cm} \times 5 \text{ cm}$, representing the entire farming landscape (Figure 3). The centre of the game board denoting a valley constituted a total of 16 patches, and this was assumed to contain water all year round. The amount of rainfall and grass growth was determined prior to every round of the game using the dice. The amount of grass and crops available were represented by coloured pins. Three pebbles were used to represent the herds. The land patches were differentiated using coloured codes according to the type of land cover, with green patches representing bush, and red patches denoting desert. Score sheets were used to document the performance of individual players. The number of cattle produced at the end of the season as well as the number sold were recorded using the score sheets.

Figure 3. Game board for the role-playing game.

2.3.1. Vegetation and Rainfall

The amount of rainfall and thus the availability of grazing land in every year for each land patch in the game was determined using the dice. The amount of grass growth ranged between 1 and 6 markers (units). In an instance where the dice show five (5), every patch on the game board will be represented with 5 units of grass in that particular year of play. Every round of the grazing game constitutes a year. Each year comprised of dry and rainy seasons (two seasons per year).

2.3.2. Grazing Rules

The game commences with one herd of cattle, which is made up of a total of 5 cattle. Every cow requires 1 unit of pasture for every month for good growth, development, and reproduction. Herds can pass through two neighbouring fields each month. Animal grazing usually starts in April and takes place in the middle (valley) of the board being used for the game, which denotes a naturally moist environment in the study area. The next grazing period takes place between the months of May and October in the upland area, and grazing on crop lands is only allowed in November. Grazing in the dry season lasts from November to April. Cattle could be fed on a half ration if the grazing requirement was not met but the reproduction and sales value would be affected. Crop residues such as groundnut, millet, rice, and maize could be used to supplement the ration after harvesting.

2.3.3. Reproduction and Sale

Cattle that received full rations for at least 6 months reproduced a new calf when the dry season was over. Players were allowed to sell their cattle when the rainy season was over and if they were willing to do so. The value of cattle that had not been fed on one unit of grass in the past 6 months depreciated in value by half or 50%. Cattle that were not fully fed over the previous 6 months had their value diminished by one half. Herds with six cattle or more could be split into two sub herds to enable them to graze independently. If sub herds were reduced to less than three cattle, then they had to be regrouped.

2.3.4. Regrowth of Vegetation

At the end of the first year, new rules were introduced to determine how the vegetation was influenced by rainfall:

- There is no vegetation growth on a patch if no vegetation remained after every round of the game played;
- Patches of land with 1 unit of vegetation at the end of the round grew slowly and took time to recover. The value of available grass under this circumstance was depreciated by half or 50%. For example, 1 is equivalent to 0 markers or unit, 2 and 3 are equal to 1 marker, 4 and 5 are equal to 2 markers, and 6 is equal to 3 markers. These units grass markers were determined by throwing the dice;
- Vegetation changed from grass to bush if 6 units of vegetation already existed on a land patch and if the next throw of the dice recorded another 6.

2.3.5. Players

There was no fixed number of participants for each game, but the number per game was based on the availability of participants. However, each game was played by a minimum of 5 and a maximum of 15 players. Participants were selected from 14 communities out of which seven was from Bolgatanga municipality (Sumbrungru, Sherigu, Yikene, Zaare, Nyarega, Ve and Gowrie) and seven from Bongo district (Lungu, Bongo, Balungu, Bongo Soe, Amanga, Feo and Boko). The number was based on earlier survey that was conducted [29]. Data collected during the survey covered the socio-economic and demographic attributes of the farmers. The game required support from three people for effective and successful management. These people included a game master, an observer who took notes regarding the conversation in each round (one year) of the game, and a game recorder to keep records of the event and to serve as a moderator. Three research assistants who were native speakers and who came from the area were engaged to facilitate the game, two men for monitoring the male-headed games and one woman and a man for the female-headed games. One woman was used for the monitoring due to the unavailability of the needed number of female monitors.

2.3.6. Session, Steps and Reflection of the Game

A game comprised of five sessions, with each session or round constituting a year. This means that the duration of each game is 5 years. At the onset, farmers (Figures 4 and 5) could select four patches of land with respect to their choice of crops. This entails, for example, 1 unit of groundnut, 1 unit of maize, 1 unit of millet, and 1 unit of rice. Players can graze animals on the other patches of their choice, apart from the four patches that they selected for crops. The animals are only allowed to feed on the stover after harvesting in November. The purpose of the game is to increase cattle production through good management practices while avoiding desertification. The rules and objectives of the game were spelt out by the game master before the beginning of each session (one year). Each game was pretested, or a test run was conducted to educate the players and to enable them to familiarize themselves with the rules before the commencement of the game. Cattle grazing begins inside the valley for the first month of the year or round one and subsequently moves to the uplands. The game master announces the start and the end of both seasons (rain and dry season) of each game. The game master also announces the scores of all players to account for the number of bush and desert patches as well as the number of young cattle that have been reproduced. Players are given the opportunity to sell cattle when the year ends, as there is feed scarcity during this period. At the end of each game, a structured questionnaire (game- reflection guide) was administered to the participants to assess the game and to understand the strategies and decisions that were made. The questionnaire was administered using a native interpreter after each game. The questions that were asked entailed the suitability of the game, if the game depicted a real-life situation, coping strategies under rainfall variability, what local ecological knowledge

can be acquired, the responsibility of the government toward farmers, and how to improve on the game to reflect reality.

Figure 4. Some selected female players.

Figure 5. Some selected male players.

2.3.7. Game Scenarios

The game scenarios that were introduced by the game master included the following: First, an additional household with one herd constituting a total of 5 cattle was introduced at the beginning of the third year in order to increase the population of the cattle. This was to understand the responses of the farmers in terms of increasing population in an environment with limited natural resources coupled with the negative impacts of climate change. According to the rules of the game, the additional household was expected to choose 4 new units out of 64 for rice, millet, maize, and groundnut cultivation. The population increase scenario was aimed to investigate the responses of the farmers to competition for scarce resources (i.e., patches of grass). A fertilizer subsidy was introduced at the start of year 4 to rejuvenate the grass in the desert patches on condition that farmers reduced their stock (number of cattle) by at least one cow. The purpose of the fertilizer subsidy was to explore how farmers responded (accessing the subsidized fertilizer) to local government initiatives (fertilizer subsidy) of increasing crop productivity in a sustainable way and to reduce the pressure on the grass to allow for re-growth. According to [30], a fertilizer subsidy in the region was introduced in 2008 to motivate local farmers to adopt improved maize varieties. The game reverts to the original scenario (the same scenario as in rounds 1 and 2) at the start of year 5, where no subsidy is given (such as in round 1 and 2), and all farmers (both old and newcomers) can participate in the game.

2.4. Data Analysis

The data were analysed using a Microsoft spread sheet. The following indicators were considered: (I) the total number of livestock produced, (II) the number of degraded patches, (III) the number of cropland patches, (IV) the number of fallow or bush patches, (V) income from the sale of livestock, (VI) the total number of livestock lost. The average rainfall generated by the dice per year were categorized into very dry, dry, wet, and very wet, where very low values represented very dry, and high values denoted very wet conditions.

3. Results

3.1. Overall Gender-Specific Response

Figures 6 and 7 present rainfall and the average number of cattle produced by both gender groups from 44 grazing games. The distribution of very dry, dry, wet, and very wet years as determined by the throw of the dice was different for the male- and female-headed households. The male players simulated higher wet and very wet years, whereas the female-headed households simulated higher drier and very dry years. For cattle production, the males produced a higher number of cattle than the females under all rainfall categories, with the exception of the very wet category. The highest number of cattle (75) produced by the males was observed under the wet category, while females had the highest number of cattle (72) under the very wet category. However, the difference in the number of cattle produced by both gender groups was only significant under the “very dry” and “very wet” categories, where the males produced 46% more cattle and females produced 26% more cattle, respectively.

Figure 6. Percentage of games in annual rainfall categories among male- and female-headed household grazing game players in UER ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Figure 7. Annual average yield of cattle produced by male- and female-headed household grazing game players in UER ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Figure 8 presents the number of desert patches created under various rainfall categories. Males created desert conditions under all rainfall categories, whereas females recorded no desert patch under the wet and very wet rainfall categories, signifying that they are more conscious about the state of their land. Males recorded a higher percentage of desert patches despite the high amount of rainfall recorded during the game, suggesting that desertification can also be caused by factors other than climate.

Figure 8. Prevalence of desertification among male and female grazing game players in UER ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Figure 9 presents the annual average production of cattle and the amount of desert patches created. The males produced the highest number of cattle and created the largest number of desert patches (degradation) compared to the females. The males produced 10% more cattle than the females but created about 85% more desert patches (degradation) than the females for the number of cattle produced. Results from Figures 8 and 9 (Case 3 of both figures) show that some of the games played by both gender groups ended with high percentages of desert patches in spite of the high amount of rainfall recorded during the game, which again suggests that desertification could also be caused by factors other than climate.

Figure 9. Average number of cattle produced and desert patches created by male- and female-headed households ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

A total of three games each from male- and female-headed households showing the rainfall patterns in the Vea catchment were selected. Figures 10 and 11 depict land use patterns in response to rainfall in the game (Figures 10B and 11B) as well as cattle production levels (Figures 10C and 11C). For both genders, Case 1 reveals a decreasing trend in the rainfall patterns (Figures 10A and 11A), whereas Case 2 shows a moving average rainfall with an increasing rainfall pattern, and Case 3 depicts a galloping moving average rainfall pattern. The land-use patterns and cattle production trends in Cases 1 and 2 revealed that a reduction in rainfall increases the rate of desertification and decreases cattle production due to low amounts of feedstuff. On the contrary, in Case 3, the amount of desert patches went up marginally despite the increasing rainfall trend, which might be due to over grazing.

Figure 10. Results of female grazing game depicting rainfall patterns under dry conditions with decreasing rainfall (Case 1), dry conditions with ascending rainfall (Case 2), and wet conditions with ascending rainfall (Case 3): (A) pattern of average rainfall, (B) land use patterns, and (C) cattle production trends ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Figure 11. Results of male grazing game depicting rainfall patterns under dry conditions with decreasing rainfall (Case 1), dry conditions with ascending rainfall (Case 2) and wet conditions with ascending rainfall (Case 3): (A) pattern of average rainfall, (B) land use patterns, and (C) cattle production trends ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

3.2. Coping Strategies and the Nature of the Game

The various strategies adopted by male and female players under the erratic rainfall conditions during the game were observed (Table 1). Common strategies were adopted by male and female players. The decision to sell or keep a cow was taken after the rainfall

amount was determined by the dice and was thus an informed decision. The most common coping strategy by both gender groups against unpredictable and erratic rainfall (Table 2) was the selling of cattle (30% men and 22% women) to minimize losses. The study also revealed that majority of the farmers opted for the cultivation of early maturing crops (millet) and to some extent maize due to their ability to withstand drought conditions. The above choice is partly because early millet and maize mature before the end of the rainy season. The main difference between the strategies undertaken by the men and women is the preference to migrate to other parts of the country for menial jobs by men and engagement in off-farm jobs such as basketry, trading, and labour for road and house construction by women.

Table 1. Strategies identified from observations of the best performers of both gender groups during the grazing game ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Strategies of Best Performers during Low Rainfall by Both Gender Group	
	Cattle are fed on half ration
	The dice are thrown before a decision is taken to sell a cow
	Cattle are only sold in the dry season when there is shortage of feed
	Fertilizer is purchased to ameliorate soil fertility
	Herds are usually divided and sent to feed on different patches
	Cooperation among players to maintain a limited number of cattle

Table 2. Gender-specific coping strategies to cope with rainfall variability during the grazing game ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Coping Strategy	Men (%)	Women (%)
Off-farm jobs	8	20
Application of inorganic fertilizer to degraded land	3	3
Migration	15	4
Cultivate early maturing crops	20	17
Renovate irrigation canals	4	8
Ask for government support	10	11
Sell cattle	30	22
Move close to fallow and forest areas	2	3
Cultivate more trees	5	6
Move close to dam	3	6
TOTAL	100	100

3.3. Observed Gender-Specific Behaviour and Perception

Based on the game reflection, 97% and 96% of the male and female players, respectively, indicated that the game is a true reflection of reality. The game board was designed to reflect the exact landscape of farmers' fields. The patches at the centre of the game board represented the valley where there was available water throughout the year and the outer patches denoted the uplands. Rice cultivation in a valley is a normal practice of farmers in the study area due to the water sensitive nature of the plants. Other crops such as millet, maize, and groundnut are located in the uplands since their water requirements are low. The reason for inter-cropping cereals with groundnut is to improve the nitrogen level of the soil through the nitrogen fixing ability of the groundnut. The size of the valley on the game board is 4 centimetres square and 8 centimetres for the upland area. Players could position their crops on the game board based on their traditional practices in order to reflect reality. The introduction of new farmers and the fertilizer subsidy scenarios in years 3 and 4 of the game was meant to observe the farmers' reactions and coping strategies to change. There was anxiety among players due to the fear of the unknown as far as the future is concern. In reaction to the addition of a new household with a new herd, the game players began to compete for the limited resources, as might be the case in a real-life situation when there is resource scarcity. In response to the increase in the player population, the farmers were

willing to cooperate with each other for a better solution. Some of the statements made by the male farmers include:

“To rejuvenate the pasture, we can reduce the number of cattle so the grazing area can regenerate.” and “we can plough for each other using our bulls.” Some of the direct statements made by the female players were “We can support each other with money and food.”, “we can assist each other in planting and harvesting of crops.”, and “we could appeal to the government to repair irrigation canals to allow us to cultivate crops all year round”.

Similarly, both gender groups alluded to the fact that the erratic rainfall simulation in the game reflects the existing rainfall pattern in the study area. According to them, rainfall is unpredictable and it usually delay, leading to the season being shortened. The farmers perceived desert conditions during the game as a major threat to food production and their livelihood. Additionally, male and female farmers fed their animals with crop residues to allow for grass regrowth. Table 3 presents the gender-specific observed coping strategies identified under extreme rainfall variability in the Vea catchment. Other gender-specific behaviours observed from the games are presented in Table 4.

Table 3. Gender-specific observed coping strategies identified under extreme rainfall variability in UER ($n_{\text{female games}} = 22$; $n_{\text{male games}} = 22$).

Observed Behaviour	Situation	Strategies	
		Men	Women
Competition	Insufficient grass	Clearing of entire patches to prevent the new household from grazing animals	Making fence to keep some portion of rangeland
Leadership	Insufficient grass	Grazing pattern determined by more experience farmers.	Grazing pattern determined by experience farmers
Cooperation	Limited rainfall	Agreement to plough land for each other using bulls.	Strong agreement to sell cattle by all players
Ecological awareness	Wet seasons	Abundance of guinea fowl signifies more available grass. Land fallow to ameliorate soil.	More guinea fowl is an indicator for fresh grass. Regrowth of vegetation to ameliorate soil fertility. Application of organic residue to improve soil.
Ego and reputation	Pressure from colleagues	Older farmers exhibited strong dominance. Desert creation is considered bad luck by male players.	Older farmers had more influence.

Table 4. Grazing game as a social learning tool.

Forms of Learning [31]	Case: Grazing Game	Some Examples
Instrumental: Does the game promote knowledge and skill acquisition among farmers and game facilitators?	The game helped the famers to gain knowledge and skills for good farm management practices. This was evaluated through observation of on-going discussion among players as the game progressed. The outcome is the decision to sell livestock in times of feed (grass) scarcity	Upland and lowland patches represented on the game board reflect a real-life situation in the study area
Communicative: Does the game promote exchange of ideas through communication	Game promotes exchange of information and ideas on best farming practices.	Male and female players together with game facilitators share ideas on team work and how to solicit external support from government
Transformative: Acquisition of new skills based on reflection. Single loop: New knowledge based on personal actions and reflection. Adopt new ideas to enhance productivity.	New ideas to improve existing farming practices	Both male and female players agree to sell some number of cattle during the dry season where there is scarcity of feed.

Table 4. Cont.

Forms of Learning [31]	Case: Grazing Game	Some Examples
Double loop: Reflecting on the assumptions behind certain actions	Review of policies and farming practices to enhance farming practices and systems.	Use of improved crop varieties (early maturing millet and maize)
Triple loop: Advance learning based on assumptions and specific actions capable of improving some values and norms.	This calls for integrated landscape planning	

Adopted and modified from [5].

4. Discussion

The results from the game show that male and female were aware of climate variability in the study area. Both male and female groups attest to the low and erratic patterns of rainfall and the impact on food security. Similarly, they both agreed that rainfall was decreasing and was becoming more erratic while temperatures were increasing, which agrees with data from the period 1985 to 2014 [29]. These results are in line with the findings of Dah-gbeto and Villamor [32], who reported similar perceptions of men and women on climate variability in Benin. Desertification and drought were perceived by male and female groups as the result of low rainfall and inappropriate land use management practices (overgrazing of rangelands and unsustainable agricultural activities). The erratic and low rainfall resulted in the cultivation of early maturing varieties and the planting of more trees by both gender groups. However, the males migrated to other parts of the country to work when conditions were not favorable as an adaptation strategy, while the females engaged in off-farm activities such as shea-butter production and basketry [17]. The female-headed households created less desert patches compared to the male-headed households by selling their livestock to prevent over grazing and used the income to buy inputs as well as to increase farm size. However, male-headed households were more interested in increasing their production and tended to disregard land degradation. The differences in the behavior of both gender groups show that females place more value on their land or environment and are willing to invest income from the sale of livestock, while males see livestock as a source of income for migration to other parts of the country to work. This finding is in line with the research report by Sundström and McCright [33], who in their report from Benin, stated that women are more concerned about the quality of the environment than men [32]. The current phenomenon in the upper East region of Ghana is the migration of male farmers during the dry season to the southern part of the country to work on other people's farms and to return home at the on-set of the wet season. However, female farmers engage in off-farm activities such as trading in basketry and shea-butter making. This result is in line with the findings of Wrigley-Asante et al. [18], who reported that male farmers prefer on-farm adaptation strategies compared to the off-farm adaptation strategies preferred by female farmers. The grazing game facilitated social learning for both the researchers and farmers, as it helped them understand the motives behind the farmers' responses and to evaluate their behavior and perceptions during the game at the same time [5] while enabling farmers to make informed decisions. The higher number of cattle produced by males compared to females could be partly attributed to the fact that males generally have more access to factors of production (land, labour, capital, fertilizer, etc.) compared to females [33]. In addition, gender and cultural factors influence the higher number of cattle produced by males compared to females. Cattle production is labour intensive, and livestock grazing is normally the responsibility of males in the study area. Due to women's limited access to land, they are less likely to have access to credit facilities, as land is most often used as collateral to secure credit [34–36]. Doss [37] and Bravo-Monroy et al. [38] reported that women generally have limited access to resources such as farmland, credit, information about modern technologies, extension services, and education in sub-Saharan Africa. The high number of cattle produced under wet and very wet conditions by males and females reflects the abundance of feed for the animals due

to vigorous grass growth. Animals in the region are normally in an extensive system of production; hence, an abundance of feed is crucial to increase production.

The development of a large number of desert patches by males in all of the rainfall categories was due to the excessive production of cattle. This suggests that there is a strong correlation between cattle production and land degradation or the creation of desert patches, as shown in Figures 10 and 11. The creation of desert patches under wet and very wet conditions by male-headed households suggests that land degradation can be caused by factors other than climatic condition.

In addition, the elevated cattle production and desert patches created by males suggest that there is a threshold of cattle production that can be accommodated on a piece of land, above which significant diminishing returns set in. The results suggest that women are generally more cautious managers of natural resources compared to their male counterparts. Women are conscious of environmental degradation and would readily reduce stock (number of cattle) to prevent degradation. The game was very realistic, exposing the inability of farmers to predict the outcome of their decisions in relation to the unpredictable nature of rainfall patterns.

5. Conclusions and Policy Implications

This study assessed gender-specific adaptive responses to climate variability in a semi-arid region of Ghana using the grazing game. The game explores anticipatory learning, which enhances resilience building. Both gender groups acted as land managers under the scenario of erratic rainfall in the grazing game. The game depicted real-life situations. It showed farmers how to cooperate with each other in terms of the management of natural resources (land, grassland, or pasture). The game is thus a good learning tool, as it helped farmers to understand the consequences of a lack of cooperation in terms of natural resource use and management. Similarly, the game revealed that although both gender groups perceived and adapted to some similar strategies to climate variability, their approach to uncertainty and risks are different. The game enabled the farmers to come up with management strategies for the sustainable use of their rangelands. Males produced the highest number of cattle but created the largest number of desert patches, reflecting land degradation. Females were more concerned about the quality of the environment (long-term condition of the rangeland) than the short-term benefits of income from the sale of cattle and hence created fewer desert patches throughout the games that were played. Strategies such as reducing the number of cattle in order to allow for the re-growth of vegetation in periods of less feed, ploughing for each other using their bulls, and family support using the income from the sale of livestock were identified for both gender groups. Similarly, farmers saw the erratic rainfall scenarios as a real situation and as a threat to food security in the region. The game also helped to identify some indigenous ecological knowledge for coping with climate change and variability. Farmers use the abundance of guinea fowl at the onset of the rainy season as an indicator of a good year in terms of the amount and distribution of rainfall. The limitation of the study was the inability to repeat the game in the following year due to time and resource constraints. In addition, the results on the behavior of farmers might have changed since 2014, when the research was conducted, coupled with the current impact of the global pandemic (COVID-19). The concept of role-playing games should be extended to other areas of research and should be adopted by the government of Ghana for use in understanding and implementing climate change adaptation and mitigation strategies in various communities in the country. There is a need for further research on indigenous ecological knowledge in coping with climate change and variability in the study area. The involvement of female farmers in decision-making is crucial to improve natural resource management.

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