Article

Farmers' Perception of Water Quality and Risks in the Mashavera River Basin, Georgia: Analyzing the Vulnerability of the Social-Ecological System through Community Perceptions

Sisira S. Withanachchi [1],* , Ilia Kunchulia [2] , Giorgi Ghambashidze [3], Rami Al Sidawi [1], Teo Urushadze [3] and Angelika Ploeger [1]

[1] Specialized Partnerships in Sustainable Food Systems and Food Sovereignty, Faculty of Organic Agricultural Sciences, University of Kassel, 37213 Witzenhausen, Germany; rami.alsidawi@uni-kassel.de (R.A.S.); a.ploeger@uni-kassel.de (A.P.)

[2] Michail Sabashvili Institute of Soil Science, Agrochemistry and Melioration, Agricultural University of Georgia, 0159 Tbilisi, Georgia; iliakunchulia@gmail.com

[3] School of Agricultural and Natural Sciences, Agricultural University of Georgia, 0159 Tbilisi, Georgia; g.ghambashidze@agruni.edu.ge (G.G.); t.urushadze@agruni.edu.ge (T.U.)

* Correspondence: sisirawitha@uni-kassel.de; Tel.: +49-055-42981627

check for updates

Abstract: Competing natural resources usage that leads to dramatic land use changes can threaten the balance of a social-ecological system. When this is the case, communities are directly exposed to the negative consequences of those land use changes. The Mashavera River Basin is considered one of the hotspots of environmental pollution in Georgia. This is of importance for public health because the food production from this basin meets a substantial proportion of the country's food demand. The farmers' perception of the water quality and their perceived risks to the economy, health, and lifestyle reflect the status of the environmental and social conditions. The inclusion of farmers' risk perceptions is an important stage of water quality governance that could enable active civic participation. The approach of this research study was the convergence model in the triangular design of the mixed method approach. As part of the social data, the research study was conducted with a survey of 177 households, for which agriculture was either a main or partial source of income. A few focus group discussions were also conducted. A binary logistic regression analysis was employed as the main method for the analysis. The results from the pollution load index (PLI) were used as the supportive data to verify some geospatial hypotheses. We found that aesthetic attributes (i.e., color changes observed in the river) and the source of the water contamination (i.e., mining sites) were the main predictor variables for a perceived risk to water quality, health, and livelihoods. The people who work in agriculture as the main income source had more concern about their ability to sell their agricultural products as a result of water contamination in the river, compared with people for whom agriculture is a secondary source of income or for self-consumption. Age, amount of land, years of agricultural experience, and the source of water supply for agriculture did not have a significant effect on any of the risk perception or water quality perception models. The results indicate that the health risk is perceived more strongly in areas with more heavily contaminated water compared to less polluted areas. We propose that conducting a public risk perception assessment is an ideal means to detect people's concerns regarding water quality governance for future risk analysis in Georgia. Another recommendation of this study is an integrated model of risk assessment that combines the results from a public risk perception assessment and a technical assessment. The benefits of such an integrated assessment include finding new hazard-sensitive areas for further analysis, the possibility to cross-check data for verification, communal communication of hazardous conditions by utilizing local knowledge, and the direct participation of the community in monitoring risks.

1. Introduction

Water contamination is as an alarming form of environmental degradation because of its direct and immediate effects on human health, social and economic circumstances, and lifestyle activities [1]. How people perceive water quality and the types of risks that people perceive in a water contaminated situation are important factors in water quality governance. People's concerns about water quality are considered as an essential part of water resource management [2]. Based on the European Union (EU) Water Framework Directive (WFD), people's active participation in water resource management is one of the governance principles in order to identify issues by monitoring water bodies and applying regulatory measures [3,4]. The inclusion of people's risk perception in the governance approach is a possible means of stakeholder involvement [5].

In general, there is limited focus on people's perceptions in environmental management procedures. Environmental managers and policymakers have a greater tendency to ratify the policies and management principles based only on the environmental risk assessment on the grounds of 'technical rationality' [6,7]. The concerns of the people who are the direct recipients of the impacts caused by environmental degradation need to be recognized and scrutinized systematically [8–10]. Risk perception and the perception of environmental quality are interconnected [11–13]. Public risk perception assessments are as important as the experts' technical assessments, in order to obtain complementary policy decisions that organize responses to degradation, alleviate risks, allocate resources, and implement risk management policies [9,14,15]. The way that society perceives risk is crucial to understanding the existing vulnerabilities to an event [16]. A deliberate consideration of the people's observations and appraisals of environmental risks and how people covenant those risks is an integral part of environmental sustainability [17]. The analysis of environmental risk is a vital governance element for a country's prospective economic and social development, as well as for sustainability [18]. Moreover, the local people are one of the primary parties affected by environmental issues. Regarding water pollution in particular, the local level is the most vulnerable to risks, where the source of the pollution is born in the region or another area [19,20].

The environmental risks are complex, with scientific uncertainties and socio-political controversies contributing to this complexity [21]. Within the scientific or policy communities, the environmental risk is identified based on the thematic areas, indices, or parameters that are used to measure the risk [18]. Environmental risk is recognized as a unique type of risk characterized by a high level of uncertainty, delayed consequences, and far-reaching effects [17]. This risk is multifaceted, inconstant, and challenging to examine [7]. Environmental risks emerge from anthropogenic activities as well as from natural hazards [16,22]. On the other hand, the people who encounter an environmental risk may not be the people who are directly responsible for causing it [16]. Thus, environmental policy at a global, regional, national, and local level should asses, examine, communicate, and collaborate to mitigate or manage risk [23–25].

Discovering farmers' perceptions regarding the quality of their water sources is critical in order to understand the perceived risk and in integrating this information into the policymaking process and, finally, the application of water management policies [26]. The farmers' health perceptions could arise from concern over the health effects of their own food or the possible negative impacts that poor water quality could have on their ability to sell their food and make economic profits at the market [27]. Moreover, swimming and direct access to the rivers or lakes with other recreational activities demonstrates the level of trust people must have in their water sources, and this is affected by their perception of the quality of water [23,28]. People who are reluctant to access the water source perceive swimming as being linked to health risks [28]. Therefore, an assessment of the farmers'

perceptions of water quality and health-related risks, risks related to the social and economic impacts on their sale of agricultural products, and lifestyle disturbance (e.g., swimming) is important in order to evaluate the farmers' awareness of the environmental risks and to integrate their opinions into policy decisions.

The research was conducted in the Mashavera River Basin, Georgia, which has been identified as a hotspot of water quality deterioration, which is one of the key natural resource management issues and public health issues in Georgia [29]. People in the river basin have been exposed to prolonged environmental pollution due to opencast mining extraction [30,31]. Since 1975, the 'Madneuli' mining plants have been operating in Kazreti, Bolnisi Municipality [32]. In 2014, a new open-pit mining site was started in Sakdrisi, Dmanisi Municipality, by the company RMG Gold [33], and they are continuing preliminary studies for new mining sites in the Kvemo Bolnisi region [34]. Farmers can be identified as the most vulnerable group who encounter this environmental pollution. The Kvemo Kartli region in the Mashavera River Basin is a leading provider of vegetables, fruits, and dairy products to the national food system [35]. Some locals are even fishing in the Mashavera River for their own consumption or supply to neighbors. Any negative effects on agriculture will therefore have an effect on the public health in the region, as well as on the whole country [29]. Some local organizations and non-governmental organizations are working to ease farmers' anxieties regarding these issues. However, a systematic study of the farmers' risk perceptions and their perceptions of water quality has not been conducted yet. Thus, the existing channels for policymakers and other responsible authorities to obtain information about farmers' opinions regarding environmental pollution is limited. In this research study, we examine the following two research questions: (a) What factors influence farmers' perception of water quality? (b) In an area affected by water contamination, which factors influence farmers' perceived risks in the economic, social, lifestyle, and health domains? Georgia is in a phase of transforming their water resource management systems so as to comply with the framework of the WFD. People's participation and a consideration of the people's concerns regarding water quality is therefore an essential governance element [36]. Thus, this study concludes by briefly explaining the policy implications of analyzing risk perceptions in the context of water quality.

1.1. Factors Affecting People's Perception of Water Quality and Risks

There are several studies that analyse people's perception of water quality in the context of, for example, drinking water [11,13,37–40], lifestyle disruption and recreational activities [28,41], surface water sources in different water usage situations [4,42–44], and agricultural water usage [26,45–47]. Water-related risk perception and the perception of water quality are integrally connected [11,13]. People's perceptions of risk and water quality are both subjective [11]. The construction of the perception of a specific environmental quality depends on multiple socioeconomic factors, individual experiences, interests, and sociodemographic characteristics [42,48].

1.1.1. Sociocultural Factors

Peoples' risk perceptions and judgments regarding environmental conditions depend on their beliefs, attitudes, and feelings, which are formed by sociocultural circumstances [4,10] and certain values and interests of societal groups [49,50]. According to Berry et al. [51], the awareness and impression of water quality could also be a part of the values and knowledge a community links with water. The rooted sociocultural practices and political dynamics of a society that frame the knowledge about water and the characteristics of water sources that people feel or respond to determine the level of water quality in certain ontologies [51]. Cultural symbols and certain ecosystem-oriented values indicate the quality of water. As an example, traditional Mongolian society believes that fish are a symbol of the gift of nature, indicating pure water, and 'Naga', a snake lord, protects the purity of water in the rivers [52]. Communities could set the criteria for managing water and water quality perceptions based on their generational experiences and customs. David and Ploeger [53] observed adaptable indigenous water resource management practices under micro-climate changes in Sumatra,

Indonesia, which were rooted in their longstanding knowledge and social trust among communities. This indigenous farming society tries to harmonize demanding food production and limited water resources by protecting the water quality, biodiversity, and other ecosystems. Dare and Mohtar [47] point out that religious beliefs could constrain access to wastewater for the irrigation. Not only cultural influences but also formal and informal flows of information strongly affect risk perception at the community level, as well as individually [7].

1.1.2. Sociodemographic and Agri-Hydrological Factors

Sociodemographic factors such as gender, age, family composition, education, employment, income, and locality or living area are identified as vital factors in people's perception studies [14,43,54,55]. Nauges and van den Berg [56] emphasize that demographic factors may strongly affect the perception of water quality. Social control, power relations, the role in the family or society, and trust can alter the understanding and identification of risk situations by gender [57,58]. Risk perception studies have identified that women may have more concern about risk or be more vulnerable to risk or perceived risk in the environmental context [59,60]. In the literature regarding food risk, some research has found that females are more concerned about food-related risks [61,62]. The gendered division of labor in the public and private sphere regarding water usage or activities related to water access, such a fetching water, could lead to dissimilar concerns over water quality and quantity [63,64]. Similarly, age, as a reflection of the span of the experiences an individual has acquired, is a critical factor influencing risk perception, which could be correlated with the duration of exposure to an issue [43,65]. The people who have experienced a hazardous situation may have less concern about risk [66]. There is a strong relationship between past experiences, risk perception, and decision-making [67]. However, differences between individual and group experiences could depend on the time-framework or the proximity to the hazard areas or with the peer-effect [65].

The family composition can affect certain aspects of perceived risk, either because of the division of labour or because of the shared responsibilities of the family in an agricultural society [68]. The family, either big or small, may have more concern over risk as their responsibilities increase. The economic activities or the nature of the occupation could be associated with the means of recognizing a risk [10] and the perception of water quality [69]. The study of certain occupation-oriented groups or communities could explain risk perception due to their specific circumstances, which society at large is not exposed to [70]. The scale of the response may depend on the nature of the occupational relationship, which can be positive or negative. The farmers' water quality perceptions are embedded in their regular exposure to water conditions while carrying out their agricultural duties [71]. Woldetsadik et al. [26] examined how farmers react to the contamination of irrigation water in a wastewater-irrigated area in Addis Ababa, Ethiopia. The perceived health risk and perception of water quality showed a strong relationship with irrigation water quality perception. In research conducted in Morogoro, Tanzania, to investigate the farmers' perceptions of applying low-quality irrigation water in vegetable production, Mayilla et al. [46] mentioned that farmers' experiences, size of the farmland, and concerns are decisive factors in water quality perception. Furthermore, the farmers' perceived economic benefits stemming from the use of low-quality irrigation water are determined by the degree of intention to the use wastewater, regardless of the level of water quality.

1.1.3. Geospatial Factors

The location, place, or area of living that decides the spatial proximity to the water source or the contamination source may shape the perception of the risk [14] and the environmental perception [12,23]. Thus, the analysis of the geographical distribution of risk perception could bring more depth of understanding regarding the spatial dimension of risk, which is advantageous for operational reasons and is necessary in order to construct comprehensive knowledge about the field [14,72,73]. The residential distance or the proximity to the water source as a geospatial factor has a considerable effect on the perception of water quality [12,23]. Also, the hydrological interactions and

anthropogenic activities upstream influence the downstream conditions [74]. The farmers are one the core stakeholders who encounter water pollution as a result of the industrial activities upstream [75]. The distance from the irrigation channel or river to the farmland may alter the water quality perception as well as the health risks [23]. Research conducted in Denmark indicates that farmers who have their farm close to water sources form a stronger perception about water quality [45].

1.1.4. Issue Attribute Factors

Water organoleptic factors (i.e., taste, smell, color, and clarity) are decisive in the water quality perception of humans, as well as the judgment of perceived health risks related to water [37,41,42,56,64]. These factors are considered aesthetic attributes [43] that indicate the instant perception of water quality [40]. For drinking water, all of the aesthetic attributes are taken into consideration in order to examine how people identify whether water has good quality or not [40,56]. Color-related risk judgments are combined with the psychological effects that are constructed through experiences and the cognitive reaction to hazards [76]. In particular, the clarity of the water is a vital decision-making factor that connects either suitability or satisfaction. When people want to utilize a river, lake, or sea for leisure, bathing, or swimming, clarity and color-based perceptions indicate the level of water quality [41]. Some technical water quality measurement thresholds also acknowledge the aesthetic attributes of water in order to evaluate water quality. The United States Environmental Protection Agency listed odor as the secondary water quality measurement attribute. The noticeable odor can be described as a 'rotten-egg', musty, or chemical smell that measures as three threshold odor number (TON) [77]. However, for farmers, with their routine passive and active observation of the adjacent environmental status, the color and smell of the irrigation water sources are fundamental issue attributes that influence their view of water quality [26].

Moreover, perceptions can differ from person to person in relation to the factors mentioned above. An individual perception of risk should be carefully scrutinized in the analysis, or generalization of the community perception [15,78,79]. The risk perceptions could be diverse among individuals, depending on their political orientations and sociocultural, sociodemographic, and socio-geographic factors [78,80]. These individual systemic differences are challenging in a risk perception study [78]. A concrete and comprehensive understanding of the risk perception is a difficult task in research studies, as multiple and dissimilar factors could connect with each other [81].

2. Hypothesis

Based on the literature review, the following seven hypotheses have been constructed:

- Farmers who are familiar with regional environmental issues are concerned about the quality of the environment.
- Farmers who have long-term experiences in agriculture are more concerned about the water quality deterioration, health issues, and economic impacts as a result of the environmental pollution.
- Women perceive relatively more risk and have more concern for the lifestyle disturbances due to water quality.
- Larger families have more concerns regarding water quality, health risks, lifestyle disturbances, and their ability to sell their agricultural products.
- Regarding geospatial factors, the farmers who have their farmland near agricultural water sources and live near the river are more concerned about water quality and the risk of health issues and swimming.
- Compared to those from upstream and middle zones of the river, the downstream farmers and their family members do not swim in the river because of the water contamination.
- The farmers who use irrigation and river water together have a negative perception of water quality and perceive that their health and ability to market their agricultural products are at risk.

3. Methodology

3.1. Study Area

The research study was conducted from 2015 to 2017 in the Kvemo Kartli region of southeastern Georgia (Figure 1). This research is part of a collaborative project investigating the multiple impacts of water quality on food security in Georgia [29]. Parallel to a heavy metal analysis in the Mashavera River, its tributaries and main irrigation canals, a survey of farmers' risk perceptions was conducted in 19 villages in the Bolnisi and Dmanisi municipalities. The total population in the Bolnisi and Dmanisi municipalities is 53,590 and 19,141, respectively [82].
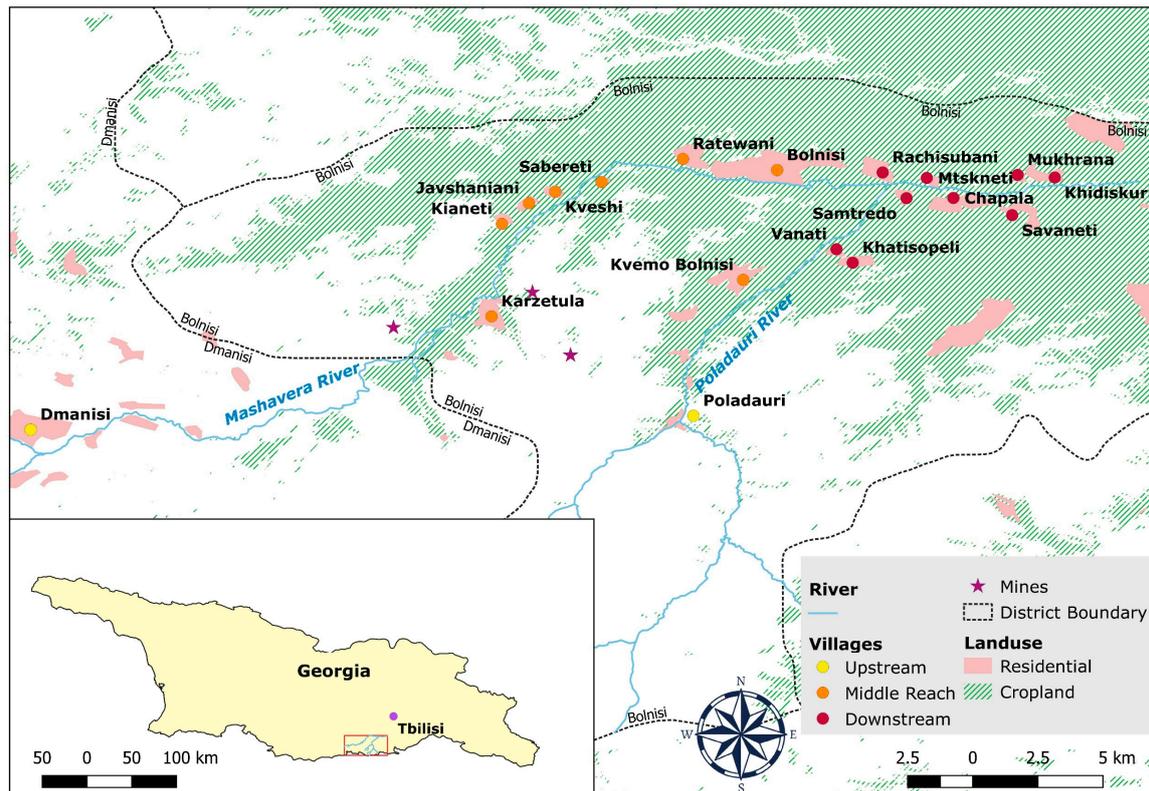

Figure 1. Map of the study area (authors' illustration).

Environmental pollution in the Mashavera River Basin has been a key natural resource governance problem in Georgia. The open-pit mining sites have been identified as a major cause of environmental pollution in the region (Figure 2a) [30,32]. The sediment rock extraction is another cause of river pollution. Road construction projects and other large and small-scale building construction projects are extracting sedimentary rocks and sand from the river banks [29]. Truck-driving through the river and bank erosion both affect the environment in the river basin (Figure 2b). The outflows from the agricultural fields and the untreated wastewater from the urban areas transport pollutants to the river and tributaries (Figure 2c).

The main occupation of the local population in Kvemo Kartli in the Mashavera River Basin is agriculture [83]. Most farmers are small-holders owning less than two hectares. In Georgia, in 2004, the average land ownership was about 1.2 hectares [84]. About 80–90% of landowners are small-holder farmers who became actively engaged in subsistence land use in the country after the land reformation in 1992 [85,86]. The workers in the mining sites are also a considerable work-force in the region, mainly in Kazretula Village.

(**a**)　　　　　　　　　　　　(**b**)　　　　　　　　　　　　(**c**)

Figure 2. (**a**) Open-pit mining sites in Sakdrisi, Dmanisi Municipality. (**b**) Sediment extraction in the Mashavera River in Bolnisi Municipality. (**c**) Untreated wastewater (photo credits: Sisira Withanachchi, Nika Kostava, and Giorgi Gabedava).

3.2. Mixed Method Approach

This study followed the convergence model in the triangular design of the mixed method approach [87]. In mixed method research design, questionnaires or surveys and interviews are proceed together [88]. Figure 3 indicates the methodological steps in this study, whereby the qualitative and quantitative surveys and interviews served as the primary data, and the water quality assessment was utilized as the supportive data to verify geospatial hypotheses.
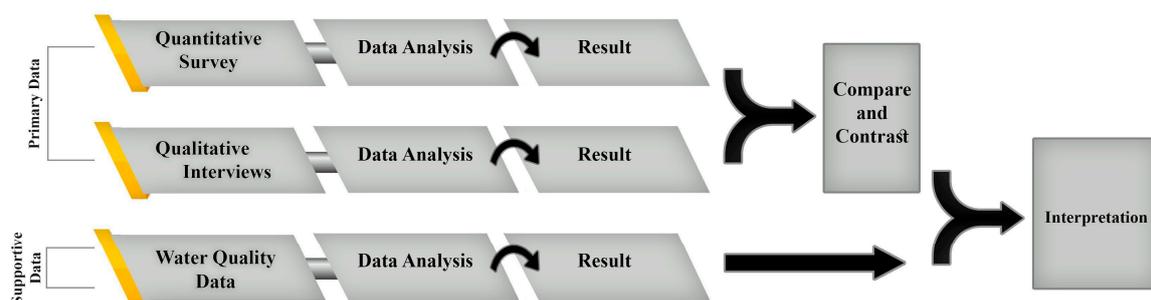
Figure 3. Methodological design (Adaption from Creswell and Clark [87]).

3.3. Survey and Data Collection

The questionnaire-based survey was conducted with open-ended and closed-ended questions. The participants in the survey, interviews, and focus group discussions (FGD) were people who use agriculture as a sole or secondary source of income. The preliminary study showed that most households are active in agriculture, either as the main income, secondary income, or only as subsistence agriculture. The main survey was developed based on the fulfillment of multiple purposes within the main project, which facilitate the calculation of diverse statistical data regarding several subjects that are focused in the same direction [89,90]. The order of the questions was logical and interconnected regarding the content. All of the questionnaires were filled out during face-to-face interviews. Some of the participants took part in the framework of the group discussions, depending on the social setting of the situation. The total sample included 177 households (N = 177). Among them, 113 were male participants and 64 were female participants. The interviews and FGDs were conducted on the farm, in common local shops, or at the community hall. Apart from that, local political representatives and the amelioration officers in Tbilisi were interviewed. The interviews were conducted in Georgian, Russian, and Armenian, and then translated into English. The interview and the FGD data were finally transferred to the descriptive excel data sheet. The transcripts of the interviews and the FGDs were used as qualitative data in the analysis. MAXQDA 2018 was used

for coding the interviews. The questionnaire data were also transferred to the datasheet before the quantitative statistical analysis. The questionnaire was formulated based on five domains, including socio-demography and geography, agro-socioeconomic, agro-hydrology, issue attributes and the perception of the water quality, and risk perceptions (Table 1) [26,43,46]. The questions under these domains were interconnected and rationally combined with the research hypotheses and the findings from the literature review. The pollution load index (PLI) results from the heavy metal analysis data collected in the parallel study were used as supportive data to verify some geospatial hypotheses.

Table 1. Domains and questions of the survey and the open-ended interviews.

Domains and Variables	Questions
Socio-demography and geography	Village Gender Age Total members in the household
Agro-socioeconomic	
Role of agriculture as a means of income	How important is agricultural income to your total income? (Agriculture is the main occupation or agriculture is a side occupation)
Years of farming experience (if farming is a means of income)	If you are a farmer, how long have you been in agriculture?
Area of land ownership	How much land do you use for agriculture (in hectare)?
Agro-hydrology	
Source of the water supply	How do you supply water to your farmland (main water source)?
	If you take water from a river, what is the name of the river?
Distance to the water sources	How far is your farmland from the nearest water source?
	How many meters is your farmland from the river?
Satisfaction of the water quantity for agricultural needs	Are you satisfied with the quantity of water in your water source for your agricultural needs?
Issue attributes and perception of the water quality	
Observable attributes of the water source (e.g., color or smell)	Have you observed a change of color or other changes to the water in the river/irrigation channel?
Source of water contamination	If you think the water has been contaminated, what is the main source for this water contamination (e.g., mining industry, gravel industry, urban waste, or farmland)
People's perception of water pollution	What is your general observation of the water quality of the river (Mashavera/Poladauri/Kazretula) next to you?
Perceived risk	
Lifestyle disruption	What is the reason that you or your family members swim/do not swim in the river next to you?
Severity of the consequences (health risks)	What kinds of feelings do you have regarding your health (and any health risks) due to water pollution, if any?
	Do you think the quality of the water sources in the region has importance for your health?
Problems selling agricultural products at the market	Do you have any difficulties when you are selling you agricultural products at the market due to water or soil quality issues? (Are consumers asking?)

3.4. Data Analysis

The data in the descriptive excel sheet were transferred as coded data. Table 2 illustrates the descriptive statistical results for each category of the predictor and criterion variables. Except for the age group variable, other all of the variables were assigned binary responses. The perception of water quality in the river was categorized as "polluted" if the description of the water quality was "poor" in the survey. The responses that the water quality was "fair" or "very good" were categorized as an indication that the rivers were "not polluted". Regarding the variable "village", the middle reach and upstream areas were considered as one category in the dummy variable. For the source of the water supply for agriculture, the target group was the farmers who used both a river and an irrigation canal. Thus, only irrigation canal, only river, and other source were considered as one category in the dummy variable. These formulations of the binary responses, without any influence of the actual

data, were important to the binary logistic regression analysis [43]. All of the statistical analyses were conducted with SPSS version 24.0 (IBM, USA). Q-GIS was used to map the study area. The overall comparison between all of the perceived risks and the water quality perception was firstly calculated with Spearman correlations (*rs*).

Table 2. The coded data and descriptive statistical analysis (N = 177).

Domains and Variables	Category (Coded)	%
Sociodemographic/socio-geographic	Upstream	12.4
	Middle reach	45.2
Village *	Downstream	42.4
Gender	Male	63.8
	Female	36.2
Age	Under 35	9.6
	36–65	63.8
	Above 66	16.9
Total members in the household	Less than 4 members	40.1
	More than 4 members	59.9
Agro-socioeconomic	Full-time agriculture	78
Role of agriculture as a means of income	Agriculture as a side job	22
Years of farming experience (if farming is a means of income)	Less than 10 years	9.6
	More than 10 years	90.4
Area of land ownership	Less than 2 hectares	88.7
	More than 2 hectares	11.3
Agro-hydrological information	Irrigation canal only	47.5
	River only	10.7
Source of the water supply **	River and irrigation canal	40.7
	Other source	1.1
Distance to the irrigation water sources	Less than 200 m	52
	More than 200 m	48
Distance to the adjacent river	Less than 200 m	13
	More than 200 m	87
Satisfaction of the water quantity for agricultural needs	Satisfied	37.9
	Not satisfied	62.1
Issue attributes	Yes, color changes are visible	37.9
Observable attributes of the water sources (color)	No, there is no visible color change	62.1
Source of the water contamination	Mining sites	60.5
	Others (e.g., gravel industry, urban waste, farmland, etc.)	39.5
People perception of water pollution	Polluted	55.4
Opinions about water quality ***	Not polluted	44.6
Perceived risk	Bad water quality is limiting the swimming activities	42.4
Lifestyle disruption: swimming possibility in the adjacent river	Water quality is not a determinant of whether people swim	57.6
The severity of the consequences: the feeling of health risks due to the water pollution	Our health is at risk	63.8
	No, there is no risk to our health	36.2
Problems selling agricultural products at the market	Yes, we have problems selling agricultural products	30.5
	There are no problems selling agricultural products or we are not selling our products	69.5

* Middle reach and upstream were considered as one category in the dummy variable. ** Irrigation canal only, river only, and other source were considered as one category in the dummy variable. *** "Poor" water quality in the river was considered polluted, "fair" and "very good" quality were categorized as not polluted.

3.5. Model Specification

The tolerance and variance inflation factor (VIF) values were the measurements used to test the degree of multicollinearity between the independent variables of this study [91]. According to statistical principles, a tolerance ≤0.10 and VIF >3 are considered as benchmarks for multicollinearity [92,93]. In conducting a multivariate logistic regression analysis, a tolerance ≥0.37 and VIF <3 are the thresholds to select the independent variables. The logistic regression analysis was applied because of the nature of the analysis and the criterion variables (either one or various criterion variables with predictor variables) [94]. As the dependent variable responses in this study were binominal, the binary logistic regression analysis was performed to analyze the three diverse risk perceptions and the perceived

water quality. Equation (1) demonstrates the model formulation to estimate the logistic coefficients for this analysis [95], as follows:

$$\text{logit} \{p(x)\} = \log\left\{\frac{p}{1-p}\right\} = c + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_i x_i \tag{1}$$

where p is the probability of the observed result, c is a constant, and β_i are the regression coefficients of the explanatory variables of x_i. The overall goodness of fit of the logistic regression models was assessed in each step of analysis utilizing the -2 log-likelihood ($-2LL$), the pseudo R-squares (Cox and Snell R^2 and Nagelkerke's R^2), and the percentage accuracy of the classification (PAC). Furthermore, the omnibus test for the model coefficients evaluated the significance of the models by analyzing the chi-square. To test the external and internal validity of the results, the statistical models were verified by conducting the holdout sample cross-validation [92,96].

4. Results

Table 3 provides the results of the binary logistic regression analysis for farmers' perception of the water quality and perceived risks concerning health, lifestyle disturbance (i.e., swimming), and threat to selling agricultural products and the key predictor variables. All the predictor variables were analyzed with the step-by-step forward selection, the likelihood ratio (LR) method. In each analysis, the final step recorded the appropriate predictor variables that significantly fit each model based on the significance of the score statistic and the maximum partial likelihood estimates. Table 4 shows the overall goodness of fit and model-fit test for each model.

Table 3. Results of the binary logistic regression analysis.

Model	Predictor	β	S.E.	Wald	df	*p*-Value	Odds Ratio
Water quality perception of farmers	Family composition (less than 4 family members)	1.314	0.636	4.271	1	0.039	3.719
	Satisfaction of water quality for agriculture (not satisfied)	2.371	0.837	8.027	1	0.005	10.713
	Aesthetic attributes (color) changes are observed in the river	3.212	0.699	21.103	1	0.001	24.832
	Source of water contamination (mining site)	2.253	0.631	12.762	1	0.001	9.520
	Constant	−4.532	0.924	24.044	1	0.001	0.011
Perceived health risk	Distance to irrigation sources (less than 200 m)	−2.793	1.246	5.024	1	0.025	0.061
	Distance to river (less than 200 m)	4.066	1.778	5.231	1	0.022	58.306
	Aesthetic attributes (color) changes are observed in the river	6.593	1.437	21.060	1	0.001	730.029
	Source of water contamination (mining site)	4.400	1.195	13.560	1	0.001	81.489
	Constant	−8.824	2.503	12.427	1	0.001	0.000
Lifestyle disturbance (perceived risk)—limitation to swimming activities	Geospatial location (upstream or middle reach)	1.318	0.453	8.474	1	0.004	3.735
	Gender Female	1.691	0.474	12.706	1	0.001	5.423
	Distance to river (less than 200 m)	1.510	0.681	4.911	1	0.027	4.526
	Aesthetic attributes (color) changes are observed in the river	2.471	0.654	14.287	1	0.001	11.829
	Source of water contamination (mining site)	2.201	0.634	12.052	1	0.001	9.037
	Constant	−3.986	0.886	20.244	1	0.001	0.019
Problems selling agricultural products (Perceived risk)	Role of agriculture as an income source Agriculture is the only income source	1.088	0.498	4.780	1	0.029	2.968
	Satisfaction of water quality for agriculture Not satisfied	1.420	0.350	16.414	1	0.001	4.136
	Constant	−0.170	0.263	0.419	1	0.518	0.844

S.E.—standard error; df—degrees of freedom.

Table 4. Results of overall goodness of fit test and model fit.

	−2 Log-Likelihood	Chi-Square	Degrees of Freedom	*p*-Value
Water quality perception of farmers	81.132	4.667	1	0.031
Health risk perception due to water quality issues	36.565	5.969	1	0.015
Limitation to swimming activities	143.211	5.406	1	0.020
Problems selling agricultural products	194.617	5.509	1	0.019

4.1. Water Quality Perception of Farmers—Factors and Dynamics

Based on Table 3, the family composition, the satisfaction of water quality for agriculture, aesthetic attributes of water (color and smell), and the identification of the source of water contamination are the key predictor variables that affect the farmers' perception of water quality in the Mashavera River Basin. The model results indicate a positive relationship between the families with less than four members and the perception of water contamination in the Mashavera River with a 3.72 odd ratio ($p < 0.05$). This relationship may emphasize that family size, as a socio-demographic factor, plays a role in forming farmers' perception about water quality. However, our hypothesis that individuals from a large family (i.e., more than four members) may have more concerns about water quality, is therefore disproved. Based on this model, the farmers who are not satisfied with their water source for agricultural purposes expressed that the water is contaminated with a 10.71 odd ratio ($p < 0.05$). Regarding color as an aesthetic attribute of the water quality, the farmers perceived water as contaminated when they observed that the color of the river had changed (24.83 odd ratio and $p < 0.01$). When the farmers identified the mining industry as the main water polluter, they also recognized that the water in the Mashavera River was polluted (9.52 odd ratio and $p < 0.01$). In the interviews and FGDs, there were some key responses that enabled us to track the farmers' perception of water quality with other related factors. One farmer stated,

> *"This whole range is changing color. We cannot cultivate with this water. The color is changing, like to orange or yellow"*. (16 September 2016, Khidishkuri).

This color or clarity-based expression outlines their cognitive responses to the water contamination of the river. Moreover, the farmer might connect his/her experiences with site-specific pollution and express his/her anxiety about agricultural water usage. In this context, the color is the dominant organoleptic property that combines with the internal and personal familiarity to define the status of water quality of the Mashavera River [69].

4.2. Farmers' Perceived Health Risk Due to Water Quality Issues—Factors and Dynamics

The regression analysis results (Table 3) express that the distance to the irrigation sources, the distance to the river, the aesthetic attributes, and the source of water contamination are the influential predictor variables for perceived health risk, as a result of the water contamination. The farmlands located less than 200 m from a water source had a negative relationship ($\beta = -2.79$) with a negative exponentiated coefficient (0.061 odd ratio, $p < 0.05$). However, the farmlands located near the river (less than 200 m) showed a positive relationship with a high odd ratio and a highly significant p-value ($\beta = 4.066$, 58.31 odd ratio, $p < 0.001$). These results show that there is a different relationship between the farmers' perceived health risks and the proximity of the farmlands to the river versus the irrigation water sources. However, we need to consider that 40.7% of farmers used an irrigation channel and river together as their agricultural water sources in the sample. The hypothesis that the farmers who have their farmland near agricultural water sources and live near the river are more concerned about health issues was therefore only partially verified. The health risk perceptions of farmers are also affected by their observation of color changes in the river. The positive relationship between the aesthetic attribute and their opinion that their health is at risk due to water contamination had a high coefficient and highly significant p-value ($\beta = 6.593$, 730.03 odd ratio, $p < 0.001$). In the interview data, the following expression indicates people's anxiety about water quality and health conditions in the area perceived through the color changes of the river,

> *"Sometimes the color of the water is yellow. I think the reason is Kazreti. Water quality affects our health badly"*. (13 May 2016, Javshaniani).

Furthermore, the identification of the mining industry as the key source of water contamination by farmers also had a positive relationship with the perceived health risk.

4.3. Farmers' Perceived Risk Causing a Limitation of Swimming Activities—Factors and Dynamics

Lifestyle disturbance was tested in this study by analyzing the swimming limitations due to the perception of poor water quality of the River. In the logistic analysis (Table 3), the geospatial location, gender, distance to the river, aesthetic attributes, and the source of water contamination were the influential predictor variables for the perception of the limitation of swimming activities due to water quality deterioration in the river. Farmers living upstream or in the middle reach of the rivers (Mashavera or Poladauri River) mentioned that the water quality deterioration of the river limited their swimming activities (β = 1.318, 3.735 odd ratio, $p < 0.05$). The hypothesis, "downstream farmers or their family members compared to upstream and middle reach farmers or their family members do not swim in the river due to the water contamination of the river" was therefore rejected. The female interviewees were more concerned about swimming and water quality compared with the males (5.42 odd ratio, $p < 0.001$). The distance of the farmland from the river (less than 200 m) had a positive relationship with the limitation, due to the water quality of the river with an odd ratio of 4.53 ($p < 0.05$). The farmers who observed the color change in the river and who identified the mining industry as the main water polluter were more likely to report a positive relationship with the lifestyle disturbance risk perception. Based on the exponentiated coefficient (odd ratio) of the aesthetic attributes, there was a 11.83 times greater ($p < 0.01$) likelihood for the limitation of swimming, due to water contamination, for people who noticed color changes in rivers.

The farmers or their family members were interviewed to understand this relationship. One of the interviewees in Bolnisi city area noted, when asked about swimming in the river,

"Yes, sometimes [we swim in the river]. But when we see another color of water, we don't. In the summer, the color of the water is good, but in the winter the color is very bad". (12 May 2016, Bolnisi).

This statement synthesizes two perspectives on this issue. Firstly, the interviewee identified the color change as the signifier of the risk associated with swimming in the river. Secondly, the interviewee noted that this color fluctuation has a seasonal character, although this statement does not mention the exact cause of the water pollution.

4.4. Farmers' Perceived Risk of Their Inability to Sell Agricultural Products—Factors and Dynamics

Two predictor variables were found to have a positive relationship with the problem of selling agricultural products (Table 3), the role of agriculture as a source of income and the satisfaction of water quality for agriculture. The people for whom agriculture is the main income source are more concerned about the food selling issue (β = 1.088, 2.97 odd ratio, $p < 0.05$) than those who have other income sources apart from agriculture. The farmers who are not satisfied with the water quality in the agricultural water sources also tend to perceive the problem of selling their products as a risk (β = 1.420, 4.13 odd ratio, $p < 0.001$). The following two statements, one from a farmer who also works as a wholesale buyer and the other from a farmer in Mukhrana, demonstrate the relationship between water contamination and the sale of agricultural products from the region:

(a) Interviewer: *Do you have any difficulties at the market when you are selling your agricultural products due to water or soil quality issues?* Respondent: *We have a big issue if we say we are from Bolnisi. We tell lies because people do not want a product from Bolnisi. We do not say the product is from Bolnisi. We are the first buyer (Wholesale). We keep it as a secret*. (focus group discussion in Mukhrana, 19 May 2016).

(b) Interviewer: *Do you have any difficulties at the market when you are selling your agricultural products due to water or soil quality issues?* Respondent: *We do not tell that our vegetables are from Bolnisi to Tbilisi customers. Mostly wholesale buyers in the field keep it a secret; therefore, we do not have any issue at the market*. (focus group discussion in Mukhrana, 19 May 2016).

The main outcome from these two statements is that the farmers and buyers worry about revealing the place of origin of their products at the market. The first opinion was from the wholesale buyers and the second interviewees were farmers. The consumers' awareness of the environmental pollution issue in the Mashavera River Basin is also revealed in this comment. The interviews conducted with people in the Tbilisi food markets and with the Marneuli vegetables and fruit retailers reveal that there is a social awareness in Georgia about the connectivity between the health risk and the consumption of contaminated food [97,98]. To build such a community perception in Georgia, the risk communication methods such as the media, leaders expressing their opinions, the efforts to raise awareness by Non-governmental organization (NGOs), and individual interactions and observations regarding this issue must play a vital role. Food markets are a common place where people meet each other and share individual ideas in Georgia [97].

4.5. Overall Comparison between Perceived Risks and Water Quality Perception

The correlation matrix is employed in risk perception studies to compute the dimension of various risks in an analysis [99–101]. The Spearman correlations (*rs*) were applied because of the asymmetric distribution within criterion variables [100]. Table 5 illustrates the results of the analysis. All of the criterion variables show a significant correlation with a positive relationship. This indicates that the perceived risk to health, lifestyle disturbances, risks to the sale of agricultural products, and the perception of water quality are correlated with each other.

Table 5. Correlation matrix of perceived risks (criterion variables) (Spearman correlations, *rs*).

	Any Risk to Agri-Product Selling	Perceived Health Risk	Swimming is Limited Due to Water Contamination	Water Quality Perception of Farmers
Any risk to agri-product selling	1.000			
Perceived health risk	0.167 *	1.000		
Swimming is limited due to water contamination	0.351 **	0.574 **	1.000	
Water quality perception of farmers	0.274 **	0.838 **	0.632 **	1.000

** The correlation is significant at the 0.01 level (two-sided). * The correlation is significant at the 0.05 level (two-sided).

Secondly, the radar chart in Figure 4 compares all of the perceived risks and the water quality perception across the total sample. The farmers who perceived that there was a risk in selling their products, the farmers who perceived that there was a health risk, and the farmers who perceived there was a limitation of swimming activities were analyzed against all of the positive responses in each category. The number of farmers who perceived their health is at risk and that the water is contaminated in the river was larger compared with the numbers of farmers who perceived risk to their ability to sell their products and lifestyle disturbance (i.e., swimming) as a result of water pollution in the river.

4.6. Other Causes for Averting Behaviors of Farmers with Water Quality Perception

In the survey, we tried to find other associations between key predictors that may indicate farmer aversion to the use of water, depending on their location along the river and the source of the agricultural water supply. For that, a cross-tab analysis was conducted to test the association between the satisfaction level and the agricultural water supply sources, geospatial location of villages, and the aesthetic attributes (color change). According to Figure 5, the farmers who use only irrigation channels as a water source for agriculture are relatively satisfied with the water quality, compared with the farmers who use only the river or who use both. The farmers who use both may be influenced by their opinion of the river water. The farmers who live in upstream areas of the rivers do not have noticeable color changes in the rivers, compared to the farmers who have their farmlands in the middle reaches and downstream areas of the rivers (Figure 6).
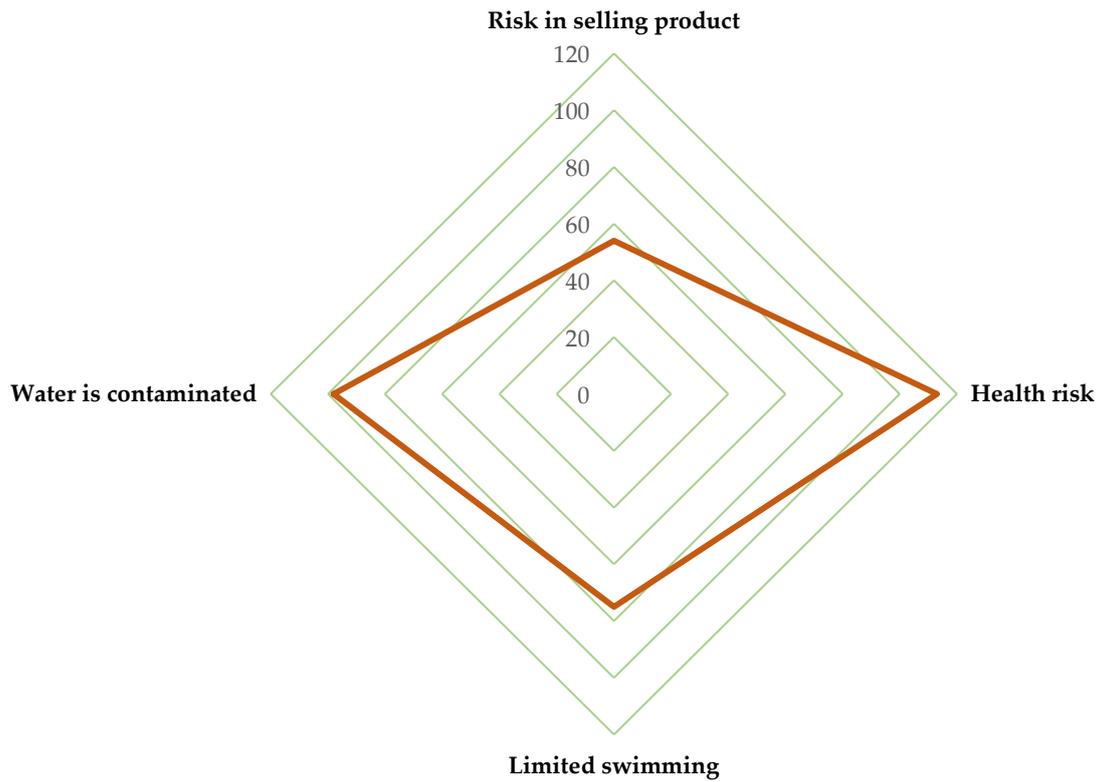
Figure 4. The comparison between all of the perceived risks and water quality perception (N = 177).
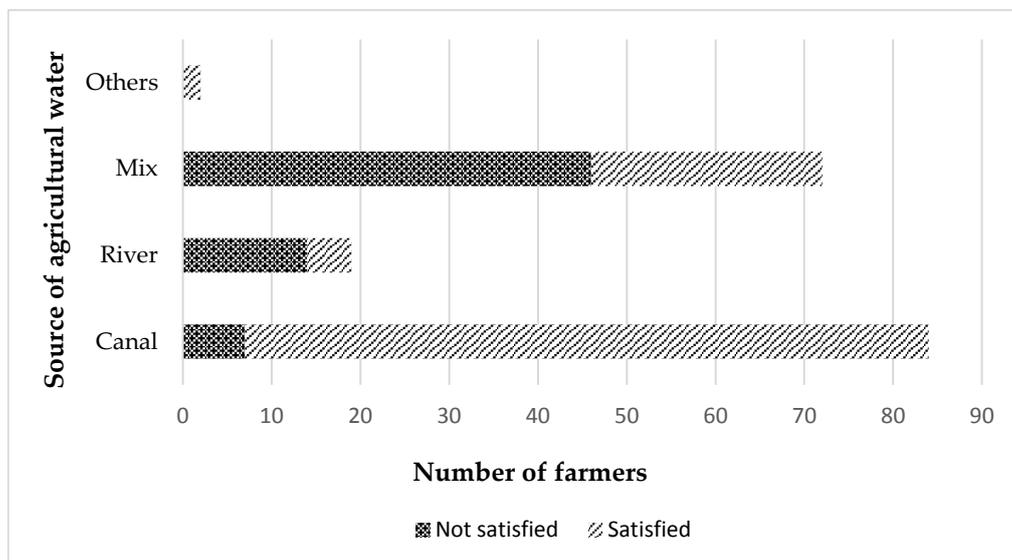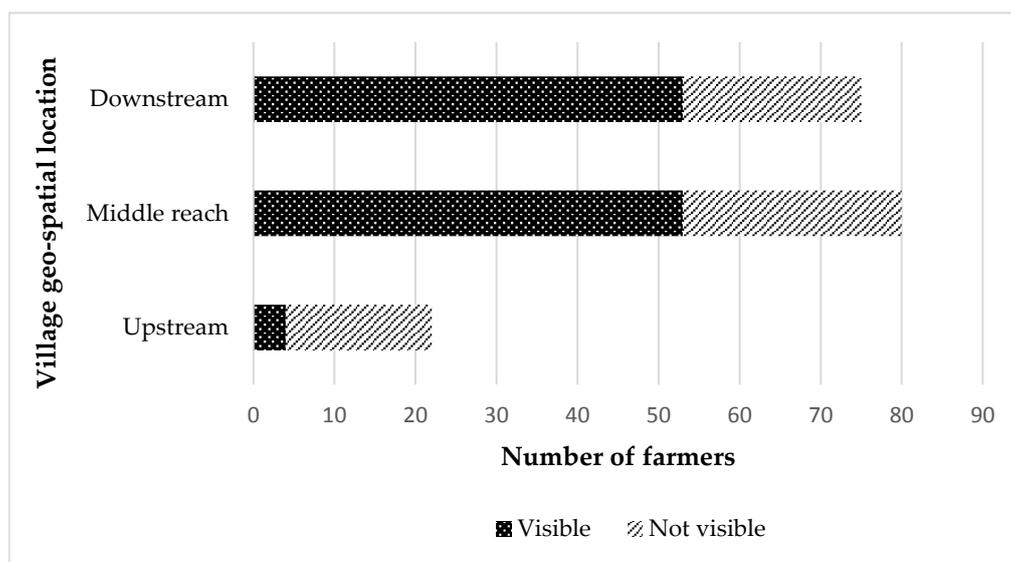

Figure 5. The satisfaction of farmers with their agricultural water source (N = 177). Chi-square value = 63.45, *p* < 0.001.

Figure 6. Identification of river color changes and the location of villages along the river (N = 177). Chi-square value = 20.89, *p* < 0.001.

5. Discussion

5.1. Overall Outlook of the Binary Logistic Regression Analysis

The logistic regression analysis is the most common analysis model in the risk perception assessment because of the skewed distribution of the data [102]. In the context of exposure to environmental pollution or other risk situations, peoples' views on risk more often can be grouped into only selected opinion variance [43]. In this analysis, the age, years of farming experience, area of land ownership, and source of the water supply (predictor variables) did not contribute significantly to the model. The reason for the non-statistically significant effect of age on the observed criterion variables may be due to the lack of distinct differences within the sample group. The age group of 36–65 years old represented 63.8% of the sample group. Such a lack of variation may impact the relationships between the variables, and thus the age group was not included as a significant factor in the regression model of the risk perception analysis [43,58]. The relationships between the long-term experience in agriculture and the risk perception and water quality perception were also not statistically significant in this study. Thus, our hypothesis was disproved. Rather, a lack of variation between the perceptions of the farmers based on farming experience is the result. In this study, the farmers with more than 10 years of experience were regarded as the most-experienced farmers, and this group represented 90.4% of the sample population. Our findings did not support the theoretical argument that experienced farmers have less concern over risks. For a deep understanding of the influence of individual or group experiences on the risk perception, indexing the risk experiences that measure the root causes and other sociocultural factors would be necessary [65]. In the Mashavera River Basin, agriculture is the primary occupation [83]. Thus, the main income source is either mixed farming with crops and livestock, or only crop production. Family members are the main source of labor on agricultural holdings with less than two hectares of farmland. In the sample, 88.7% of the farmers own less than two hectares. This skewed distribution affected the area of land ownership variable, which also did not show a significant relationship with the risk perceptions. Although the source of the water supply predictor did not indicate a skewed distribution, it was also not statistically significant within the model. In the research study, the farmers using both an irrigation canal and river water were considered as one group, with the hypothesis that farmers may have double exposure to contaminated water. This hypothesis is based on the water quality data that was collected in the second phase of this research study. However, the survey data did not show that the source of water had a statistically

significant effect on the model. Some other studies show that the source of water is a key factor influencing the risk perception of the farmers or customers [26,103]. However, this hypothesis was not supported by our findings. Therefore, risk perception cannot be determined based on the source of water for agriculture. As the Mashavera River Basin is located in a semi-arid region, the farmers tend to use irrigation canals more for their farmlands. In the sample, 40.7% used both irrigational canals and river water for agriculture. The river water is a supplementary water source during the dry months (July and August), as indicated by the survey responses. The farmers who use an irrigation canal or river water exclusively made up 47.5% and 10.7% of the study sample, respectively. The farmers who use both water sources (irrigation canal and river) have a rather negative perception about the water quality.

The study strongly demonstrates that the aesthetic attributes (i.e., color changes observed in the river) and the source of water contamination (i.e., mining sites) are the main predictor variables for the perceived risk to water quality, health, and livelihoods. As other studies mention, the visual aspect strongly modifies people's perceptions [43,76]. The color-related judgments in a hazardous environment could shape the mental reactions regarding risk [76]. The general knowledge or understanding of the main source of pollution in the Mashavera River Basin is the mining industry. Thus, the configuration of risk perceptions related to the environmental quality noticeably connect with this knowledge. A long-term exposure to environmental pollution in the region and, on the other hand, anxiety about the protection of agriculture, are the pivotal factors impacting the local peoples' decisions. Our hypothesis that farmers' who are familiar with the regional environmental issues are concerned about the quality of the environment was proven with a positive relationship. Particularly, the health impact on the region has an influential role on the local people. The way that people perceive a certain public health risk could mirror the public perception of the water quality [37].

The socioeconomic well-being of the farmers directly connects with their selling capabilities of agricultural products. According to the Food and Agriculture Organization of the United Nations (FAO), a strong marketing capability of the products of small-holder farmers could reduce poverty [104]. However, different factors could curb their selling competencies, with low returns and high production costs that arise because of financial and credit issues [105], and environmental hazards or natural phenomena that affect the product quality [106]. As Figure 4 demonstrates, the farmers in the Mashavera River Basin do not have more concern about selling their agricultural products, relative to other health and lifestyle disturbance risks. The satisfaction level with water quality in the agricultural water sources and role of the agriculture as the main income are the only two predictor variables that impact risk perception regarding selling their products.

5.2. Comparison between Pollution Load Index Data and Survey Data

Eiser [107] outlines risk as a property of the human activities with a spatial quality. Thus, a comparison between the peoples' risk perceptions and the water quality data could assist in creating a spatial view of the issue [43]. The results of the parallel physical research study [29], which examined water quality in the Mashavera River and its tributaries and irrigation canals by focusing on heavy metal analysis, can be compared to the survey findings of this study. Table 6 shows the pollution load index (PLI), one of the key index analyses regarding heavy metal pollution, for each sample site along the Mashavera River Basin for the high precipitation season (HPS) and low precipitation season (LPS). The PLI indicates the overall pollution condition by referring to the toxicity level of the examined heavy metals [108]. The threshold for classification as a polluted site is PLI ≥ 1 [109]. The PLI results were derived from sediment analyses for heavy metals, namely, Cu, Cd, Zn, Pb, Fe, Mn, Ni, and Cr [29]. Table 6 indicates the villages where the survey was conducted and the adjacent sample site or sites. Some of the farmers from Dmanisi have their farmland near sample site three, which was classified as contaminated. Figure 1 illustrates the seventeen villages located within the Bolnisi and Dmanisi Municipalities.

Table 6. The pollution load index (PLI) at samples sites and corresponding villages.

Sample Site	Villages	HPS [+]	LPS [++]
1	Dmanisi	0.8	0.7
2	Dmanisi	0.7	0.7
3	Dmanisi	1.1	1.1
4	Kazretula	1.2	1.1
5	Kazretula	0.9	0.7
6	Kianeti, Javshaniani, and Kvesha	0.8	0.6
7	Kianeti, Javshaniani, and Kvesha	0.9	0.9
8	Sabereti and Ratevani	1.1	1.0
9	Kevmo-Bolnisi	1.0	1.2
10	Poladauri	0.6	0.6
11	Poladauri	0.6	0.7
12	Vaneti and Khatisopheli	1.4	1.3
13	Vaneti and Khatisopheli	1.1	1.0
14	Mtskneti, Bolnisi, and Rachisubani	1.0	0.8
15	Chapala and Savaneti	1.0	0.9
16	Savaneti and Khidishkuri	1.1	1.0
17	Mukhrana	1.2	1.2

[+] and [++] These values indicate the PLI values. Values >1 indicate a polluted status according to the PLI index. HPS is high precipitation season and LPS is low precipitation season. For more details on the PLI analysis, see Withanachchi et al. [29].

A farmers' group expressed their perception of water quality and the new mining site in Sakdrisi, Dmanisi Municipality as a reason for changing their water source,

"previously (before the new mining site), we used a small water flow from Sakdrisi mountain. Now, we are using the irrigation channel. We observed a bad influence of the new mining site and their transport lorries (dust)". (focus group discussion, Dmanisi, 14 May 2016).

According to the PLI, the middle reach and downstream villages mostly encounter water contamination issues. Figure 6 also discloses that the farmers in the middle reach and downstream areas are more alert to color changes in the river. However, the regression model of the limitation of the swimming activities showed that the middle reach farmers and their families are more concerned than the downstream villages regarding the water quality deterioration as a reason to avoid swimming in the river. This information and the PLI data can be compared.

5.3. Policy Implications of Farmers' Risk Perception Analysis for Water Quality Governance

An analysis of the public risk perception and the consideration of their concerns over water quality have been identified as crucial factors for an operative water quality governance system [36,37,44]. Within this survey, we also asked about the existing mechanisms for farmers to participate in water quality governance. Because of many missing data, we did not include the responses in the logistic analysis. The survey questions were as follows:

1. Do you complain about this water quality issue to the local government agency?
2. If yes, how?
3. Do you participate in any formal/informal association/meetings in the village?
4. If yes, what?
5. Are you discussing your concern about water quality or food production-related issues there? If yes, what are they?

We received only a few responses to these questions in the survey. 23.7% of the participants mentioned that they complained about the water quality issue to the local authorities and 9.6% of the participants mentioned that they participate in formal or informal meetings among communities

or neighbors to discuss common issues, such as environmental issues or farming matters. From the received responses, the following main findings can be highlighted:

- Farmers who complained about water quality issues to the local government agency either talked to their village representative council (Sakrebulo) members, handed over a petition to the municipality, or spoke with the amelioration company staff members (who only focus on the construction of irrigation canals).
- There were minimal cases reported where farmers organized an informal meeting to talk about water-related issues.

The field study clearly showed that the social setting in this region still lacks community consensus about how to handle water quality issues, which hinders collective actions. As Ostrom mentioned [110], collective actions depend on the operational rules of the social setting, which correspond to the local conditions. The farmers are not prepared to discuss their perceived risks with other farmers, or to complain to governmental organizations. The local government and amelioration officers pointed out that the few farmers' associations that exist are only working towards getting grants; they are not participating in the governance process. Some of the farmers' associations were banned because of financial mismanagement and corruption [111,112]. The language barrier between the different ethnic groups could also be a factor making it hard to build strong social participation, in which people demonstrate active, voluntary engagement [113]. In Georgia, cooperation can be observed particularly among the farmers engaged in organic agriculture. The interview with the Biological Farmers' Association, Elkana, Georgia, revealed that they serve as a platform for farmers to communicate with each other and work together with democratic principles at the grassroots level [114]. Future research could examine the root causes for the lack of a 'community-feeling' in the region, with the clear exception of the community of organic farmers.

5.4. Integrated Model of Risk Assessment: the Combination of the Public Risk Perception and the Technical Assessment

Generally, the local community views were neglected in the technical risk assessments [7,115]. The main critiques against the analysis of the people's risk perceptions are that they are biased, illogical, incompatible, and inconsistent. Moreover, they are instead based on prejudiced attitudes, which are known to be manipulated by external agencies. Thus, these lobbies argue that people's risk perception cannot precisely measure the risks as a result of an inadequate knowledge of the issues [9,10,115]. However, some scholars strongly support the acknowledgment of risk perceptions in order to create an inclusive environmental risk assessment [9]. In water quality studies, an inclusive assessment of the water quality identifies the socio-technical dynamics [116,117]. In water quality governance, risk assessment is an important element in the mitigation of water pollution and the protection of water sources [36].

This miscommunication or mistrust of people's concerns and their know-how could create a barrier between the government and society that obstructs successful policy implementation [7]. According to Beck [8], a discussion about the environmental degradation of air, water, and food should include social, cultural, and political factors in order to get a complete understanding of the social architecture and political dynamics of risk. The concerns of the people who are the direct recipients of the impacts of any environmental degradation need to be recognized and scrutinized systematically [8–10]. In the EU WFD, community participation is a mandatory governance principle [118]. In such a risk assessment, the opportunity to engage with the public at the local level is a positive factor. The local level is the proximate scale where the water quality and food production issues occur. Thus, the farmers' concerns and participation in water quality governance are decisive factors for inclusive WQG. In Georgia, there is currently limited public participation in the governance process [119]. Particularly, a consideration of the peoples' concerns over environmental pollution and their active engagement in the protection of natural resources are still underdeveloped. As the local

level is the proximate level to address water quality issues [20], the peoples' perceptions of the water quality and their local knowledge [51] are vital resources that can be used in assessments. As this study revealed, the farmers' risk perceptions and the water quality perceptions could be used to identify the current status of the environmental condition in the Mashavera River Basin. Thus, a public risk perception assessment would be a good approach to detect the people's concerns regarding water quality governance, for future risk analysis in Georgia.

People's views and observations need to be acknowledged on the grounds of including democratic principles in risk management and policymaking processes. Otherwise, the policies and governance may have negative effects on people (i.e., voters) [10]. Regarding sensitive environmental matters, such as nuclear waste [7], environmental pollution [14,39], and displacement of human settlements by large projects [120], people's perceptions of risk have to be considered, as the local people are the ones affected by the issues. Furthermore, the people's perceptions are often the first indication or signifier before hazardous events. In this way, risk communication can avoid fatality and decrease the severity of natural hazards [121]. Likewise, experts can advance their technical assessments and the output of their analysis if they work with the people's risk perceptions [10] or merge the two perspectives in their studies [122]. Each approach has its advantages and limitations. Accordingly, the people's perception of the risk also should be considered and analyzed [10,54]. Withanachchi [123] listed the following four key benefits of the integrated model of risk assessment:

- Finding new areas for further analysis that may be vulnerable to hazards;
- The possibility to cross-check data as a form of verification;
- Communal communication of hazardous condition based on local knowledge; and
- Direct participation of the public in monitoring the risk condition.

In such an assessment, the ecosystem and human vulnerabilities to environmental risk through quantified data from the technical field study, and people's concerns over the same vulnerabilities, are researched in parallel and are used as the supporting data to examine the hypotheses under a mixed-method research approach [43,124]. The local knowledge regarding the places vulnerable to hazards can be discovered. Also, the data from the technical assessment, which is an objective analysis, can be cross-checked with the people's perceptions of the risks. Moreover, the people's active engagement for frequent assessments can be obtained in this integrated model.

In this study, the farmers' risk and water quality perceptions were examined. To observe the geospatial association between the farmers' views and the current water quality situation, the pollution load index (PLI) as secondary data, based on the analysis of sediment samples of the Mashavera River and its tributaries, namely the Poladauri River, Kazretula River, and the irrigation canals, were compared with the sample sites. The comprehensive analysis of the sediment and water samples were previously published in Withanachchi et al. [29]. The samples sites and the surveyed villages can be associated based on their proximity. In the sediment sample collection, the research group integrated the local knowledge of the farmers in order to identify some of the pollution sources of the basin. The local people's ecological knowledge should be an essential input in research studies, by adding advanced and critical aspects to the existing 'top-down' natural resource management and studies [124]. In this study, the local farmers' knowledge and support were critical to the investigation of the outflow from the processing plant at the Madneuli mine site (sample site 9) in Kevmo-Bolnisi Village. Also, the results of the heavy metal analysis at certain sample sites, which normally required a few months to be completed, could be cross-checked with the interview or survey data of farmers. The farmers' feedback on the color changes of the water sources over a time period were taken into consideration when the research examined the diurnal variation of the heavy metal concentrations in water samples [29]. For example, one farmer pointed out his observation of the color changes in the river as follows:

Respondent: "Sometimes the color of the water is yellow. I think the reason is Kazreti. In the morning and late evening, the color is drastically changed. Water quality affects our health badly". (Farmer interview, 19 May 2016, Mukhrana).

This observation was useful guidance to further examine the water quality changes in the river. The active engagement of the local people would be an asset for the water quality monitoring and the continuous examination of the risk level. How farmers react or reflect on the water quality and their opinions for the causation of the contamination or lack of contamination is important information for policymakers in order to make decisions. This integrated assessment of the water quality and related risks could deliver a comprehensive interpretation of the status-quo. Under the newly drafted water law, the public participation in the preparation of river basin management plans was included (Article 6). Within that framework, this study proposes the application of an integrated model of risk assessment that combines the public risk perception and the technical assessment together.

6. Conclusions

This research study examined the factors that affect the farmers' perception of water quality and their perceived risks in the socioeconomic, lifestyle, and health domains. Hypotheses based on existing risk perception studies were tested and some of them were verified, while others were disproved. Based on the binary logistic regression analysis, age, amount of land, years of agricultural experience, and the source of the water supply to agriculture do not show a significant relationship with any of the tested risk perception domains or water quality perception in the model. In addition to the perceived risk of not being able to sell their agricultural products, the aesthetic attributes (i.e., color changes in the river) and the source of water contamination (i.e., a mining site) were the common predictor variables for the perceived risk and water quality perception. In the context that the region is known to have environmental pollution because of the mining industry and other reasons, such as gravel extraction and untreated wastewater discharge from urban areas and farmland, the farmers' perceptions of these two predictor variables have a relatively high likelihood. As far as the problem of selling agricultural products, the contribution of agricultural income to the total income and the satisfaction level with the quality of the agricultural water sources both affect perceptions. The PLI data from the heavy metal assessments also show the geospatial relationship between the pollution level and the farmers' risk perceptions. Overall, the theoretical argument of this study is that multiple factors can influence the perceptions of risk, and these perceptions may depend on the severity of the community's exposure to environmental pollution.

This study can be considered a preliminary assessment of public risk perception in the Mashavera River Basin, and can be expanded to comprehensive research by examining the people's concerns regarding water quality across Georgia. Thus, one of the recommendations of this study is to conduct a public risk perception assessment that could detect people's concerns regarding water quality, and to obtain a clear understanding of the possible risks. By enabling the people's active engagement in risk analysis, local knowledge can play a role in water quality governance. Another recommendation of this study is an integrated model of the risk assessment that combines the results from the public risk perception assessment and the technical risk assessment. The benefits of such an integrated assessment include finding new hazard-sensitive areas for further analysis, the possibility of cross-checking data for verification, communal communication of hazardous conditions by utilizing local knowledge, and the direct participation of the community in monitoring risks.

The stakeholders who use natural resources (e.g., water, soil, forest, and minerals) in the Mashavera River Basin are currently in competition. In this competition, the interests of powerful stakeholders are more profoundly established in the governance process. Their economic support to the local government authorities, as well as high-level political power, may negatively influence the other stakeholders who use river basin, particularly farmers. The mismanagement of natural resource extraction and the malpractices of agriculture contribute to the land use changes that threaten the balance of the social-ecological system in the region. As briefly noted in the research study, the social

setting in this region still lacks a community consensus about how to handle water quality issues, which hinders collective actions. However, there should be continued study in order to examine the background and specific hindrances in this particular case. Furthermore, future research could be conducted by integrating different stakeholders in the region to obtain other views regarding water quality and the risks perceptions in Mashavera River Basin.

References

1. WWAP (World Water Assessment Programme). *The United Nations World Water Development Report 2017: Wastewater: The Untapped Resource*; UNESCO: Paris, France, 2017.

2. Bohnet, I.C. Lessons learned from public participation in water quality improvement planning: A study from Australia. *Soc. Nat. Resour.* **2015**, *28*, 180–196. [CrossRef]

3. EU. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Off. J. Eur. Communities* **2000**, *L327*, 1–72.

4. Artell, J.; Ahtiainen, H.; Pouta, E. Subjective vs. objective measures in the valuation of water quality. *J. Environ. Manag.* **2013**, *130*, 288–296. [CrossRef] [PubMed]

5. Fischhoff, B. Risk perception and communication. In *Risk Analysis and Human Behavior*; Earthscan & Routledge Publication: Oxon, UK, 2013; pp. 17–46, ISBN-13 978-1849714433.

6. Hadden, S.G. Public perception of hazardous waste. *Risk Anal.* **1991**, *11*, 47–57. [CrossRef]

7. Williams, B.L.; Brown, S.; Greenberg, M.; Kahn, M.A. Risk perception in context: The Savannah River site stakeholder study. *Risk Anal.* **1999**, *19*, 1019–1035. [CrossRef] [PubMed]

8. Beck, U. *Risikogesellschaft: Auf dem Weg in Eine Andere Moderne*; Suhrkamp Verlag: Frankfurt, Germany, 1986.

9. Renn, O. The role of risk perception for risk management. *Reliab. Eng. Syst. Saf.* **1998**, *59*, 49–62. [CrossRef]

10. Pidgeon, N. Risk assessment, risk values and the social science programme: Why we do need risk perception research. *Reliab. Eng. Syst. Saf.* **1998**, *59*, 5–15. [CrossRef]

11. Anadu, E.C.; Harding, A.K. Risk perception and bottled water use. *Am. Water Works Assoc. J.* **2000**, *92*, 82. [CrossRef]

12. Brody, S.D.; Highfield, W.; Alston, L. Does location matter? Measuring environmental perceptions of creeks in two San Antonio watersheds. *Environ. Behav.* **2004**, *36*, 229–250. [CrossRef]

13. Ochoo, B.; Valcour, J.; Sarkar, A. Association between perceptions of public drinking water quality and actual drinking water quality: A community-based exploratory study in Newfoundland (Canada). *Environ. Res.* **2017**, *159*, 435–443. [CrossRef] [PubMed]

14. Bickerstaff, K. Risk perception research: Socio-cultural perspectives on the public experience of air pollution. *Environ. Int.* **2004**, *30*, 827–840. [CrossRef] [PubMed]

15. Marlon, J.R.; van der Linden, S.; Howe, P.D.; Leiserowitz, A.; Woo, S.L.; Broad, K. Detecting local environmental change: The role of experience in shaping risk judgments about global warming. *J. Risk Res.* **2018**, 1–15. [CrossRef]

16. Whyte, A.V.; Burton, I. (Eds.) *Environmental Risk Assessment*; on behalf of The Scientific Committee on Problems of the Environment of the International Council of Scientific Unions; John Wiley & Sons: Chichester, UK, 1980; ISBN 0471277010.

17. Gattig, A.; Hendrickx, L. Judgmental discounting and environmental risk perception: Dimensional similarities, domain differences, and implications for sustainability. *J. Soc. Issues* **2007**, *63*, 21–39. [CrossRef]

18. Hoti, S.; Pauwels, L.L.; McAleer, M. Measuring Environmental Risk. 2004. Available online: http://www.iemss.org/iemss2004/pdf/volatility/hotimeas.pdf (accessed on 10 May 2018).

19. Perry, J.; Vanderklein, E.L. *Water Quality: Management of a Natural Resource*; John Wiley & Sons: Chichester, UK, 1996.

20. Feldman, D.L. *Water Politics: Governing Our Most Precious Resource*; Polity Press: Cambridge, UK, 2017.

21. Karlsson, M.; Gilek, M.; Udovyk, O. Governance of complex socio-environmental risks: The case of hazardous chemicals in the Baltic Sea. *Ambio* **2011**, *40*, 144–157. [CrossRef] [PubMed]

22. Böhm, G.; Pfister, H.R. Mental representation of global environmental risks. In *Environmental Risks: Perception, Evaluation and Management*; Böm, G., Nerb, J., McDaniels, T., Spada, H., Eds.; Emerald Group Publishing Limited: Bingley, UK, 2001; pp. 1–30.

23. McDaniels, T.; Axelrod, L.J.; Slovic, P. Perceived ecological risks of global change: A psychometric comparison of causes and consequences. *Glob. Environ. Chang.* **1996**, *6*, 159–171. [CrossRef]

24. Duan, H. Social Process of Environmental Risk Perception, Preferences of Risk Management and Public Participation in Decision Making: A Cross-Cultural Study between the United States and China. Ph.D. Thesis, Ohio State University, Columbus, OH, USA, 2006.

25. Zhen, N.; Barnett, J.; Webber, M. Trust and the risk of consuming polluted water in Shanghai, China. *J. Risk Res.* **2017**, 1–12. [CrossRef]

26. Woldetsadik, D.; Drechsel, P.; Keraita, B.; Itanna, F.; Gebrekidan, H. Farmers' perceptions on irrigation water contamination, health risks and risk management measures in prominent wastewater-irrigated vegetable farming sites of Addis Ababa, Ethiopia. *Environ. Syst. Decis.* **2018**, *38*, 52–64. [CrossRef]

27. Ndunda, E.N.; Mungatana, E.D. Farmers' Perception and Knowledge of Health Risks in Wastewater Irrigation. *Open Sci. Repos. Nat. Resour. Conserv.* **2013**, *2*, e70081917. [CrossRef]

28. Jones, J.; Aslan, A.; Trivedi, R.; Olivas, M.; Hoffmann, M. Water quality and the perception of risk: A study of Georgia, USA, beachgoers. *Ocean Coast. Manag.* **2018**, *158*, 116–119. [CrossRef]

29. Withanachchi, S.S.; Ghambashidze, G.; Kunchulia, I.; Urushadze, T.; Ploeger, A. Water Quality in Surface Water: A Preliminary Assessment of Heavy Metal Contamination of the Mashavera River, Georgia. *Int. J. Environ. Res. Public Health* **2018**, *15*, 621. [CrossRef] [PubMed]

30. Felix-Henningsen, P.; Urushadze, T.F.; Narimanidze, E.I.; Wichmann, L.; Steffens, D.; Kalandadze, B. Heavy metal pollution of soils and food crops due to mining wastes in an irrigation district south of Tbilisi, Eastern Georgia. *Ann. Agrar. Sci.* **2007**, *5*, 11–27.

31. Lomsadze, Z.; Makharadze, K.; Pirtskhalava, R. The ecological problems of rivers of Georgia (the Caspian Sea basin). *Ann. Agrar. Sci.* **2016**, *14*, 237–242. [CrossRef]

32. Avkopashvili, G.; Avkopashvili, M.; Gongadze, A.; Tsulukidze, M.; Shengelia, E. Determination of Cu, Zn and Cd in soil, water and food products in the vicinity of RMG gold and copper mine, Kazreti, Georgia. *Ann. Agrar. Sci.* **2017**, *15*, 269–272. [CrossRef]

33. Tsiskarishvili, O. Government Idle as Mining Companies Wreck the Environment in Georgia's 'Sustainable Development. 15 March 2017. Available online: http://oc-media.org/government-idle-as-mining-companies-wreck-the-environment-in-georgias-sustainable-development/ (accessed on 4 May 2018).

34. Georgian Mining Corporation (GMC). *Drilling Update from KB Gold Zone 2 and New Gold Discovery*; Report on 24 October 2017; GMC: London, UK, 2017.

35. Ministry of Agriculture of Georgia (MOA). Georgian Agro-Food Sector—For Your Investment. 2016. Available online: https://www.rvo.nl/sites/default/files/2016/01/Agro%20Guide%20Georgie.pdf (accessed on 10 April 2018).

36. Withanachchi, S.S.; Ghambashidze, G.; Kunchulia, I.; Urushadze, T.; Ploeger, A. A Paradigm Shift in Water Quality Governance in a Transitional Context: A Critical Study about the Empowerment of Local Governance in Georgia. *Water* **2018**, *10*, 98. [CrossRef]

37. De França Doria, M. Factors influencing public perception of drinking water quality. *Water Policy* **2010**, *12*, 1–19. [CrossRef]

38. Francis, M.R.; Nagarajan, G.; Sarkar, R.; Mohan, V.R.; Kang, G.; Balraj, V. Perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India. *BMC Public Health* **2015**, *15*, 731. [CrossRef] [PubMed]

39. Prouty, C.; Zhang, Q. How do people's perceptions of water quality influence the life cycle environmental impacts of drinking water in Uganda? *Resour. Conserv. Recycl.* **2016**, *109*, 24–33. [CrossRef]

40. Al-Khalidi, A.S. Environmental Risk Assessment of Water Pollution. In *Encyclopedia of Quantitative Risk Analysis and Assessment. II*; Melnick, E.L., Everitt, B.S., Eds.; John Wiley & Sons, Ltd.: Chichester, UK, 2008; ISBN 978-0-470-03549-8.

41. Smith, D.G.; Croker, G.F.; McFarlane, K.A.Y. Human perception of water appearance: 1. Clarity and colour for bathing and aesthetics. *N. Z. J. Mar. Freshw. Res.* **1995**, *29*, 29–43. [CrossRef]

42. Steinwender, A.; Gundacker, C.; Wittmann, K.J. Objective versus subjective assessments of environmental quality of standing and running waters in a large city. *Landsc. Urban Plan.* **2008**, *84*, 116–126. [CrossRef]

43. Dogaru, D.; Zobrist, J.; Balteanu, D.; Popescu, C.; Sima, M.; Amini, M.; Yang, H. Community perception of water quality in a mining-affected area: A case study for the Certej catchment in the Apuseni mountains in Romania. *Environ. Manag.* **2009**, *43*, 1131–1145. [CrossRef] [PubMed]

44. Tarannum, F.; Kansal, A.; Sharma, P. Understanding public perception, knowledge and behaviour for water quality management of the river Yamuna in India. *Water Policy* **2018**, *20*, 266–281. [CrossRef]

45. Gachango, F.G.; Andersen, L.M.; Pedersen, S.M. Danish farmers' perception of water quality, nutrient reduction measures and their implementation strategy. In Proceedings of the International Conference on Sustainable Water Resources Management, Coruña, Spain, 15–17 June 2015; WIT Press: Southampton, UK, 2015; pp. 435–446.

46. Mayilla, W.; Keraita, B.; Ngowi, H.; Konradsen, F.; Magayane, F. Perceptions of using low-quality irrigation water in vegetable production in Morogoro, Tanzania. *Environ. Dev. Sustain.* **2017**, *19*, 165–183. [CrossRef]

47. Dare, A.; Mohtar, R.H. Farmer perceptions regarding irrigation with treated wastewater in the West Bank, Tunisia, and Qatar. *Water Int.* **2018**, *43*, 460–471. [CrossRef]

48. White, M.J.; Hunter, L.M. Public perception of environmental issues in a developing setting: Environmental concern in coastal Ghana. *Soc. Sci. Q.* **2009**, *90*, 960–982. [CrossRef] [PubMed]

49. Aven, T.; Renn, O. *Risk Management and Governance*; Springer: New York, NY, USA, 2010.

50. Janmaimool, P.; Watanabe, T. Evaluating determinants of environmental risk perception for risk management in contaminated sites. *Int. J. Environ. Res. Public Health* **2014**, *11*, 6291–6313. [CrossRef] [PubMed]

51. Berry, K.A.; Jackson, S.; Saito, L.; Forline, L. Reconceptualising Water Quality Governance to Incorporate Knowledge and Values: Case studies from Australian and Brazilian Indigenous Communities. *Water Altern.* **2018**, *11*, 40–60.

52. Withanachchi, S.S.; Houdret, A.; Nergui, S.; Gonzalez, E.E.I.; Tsogtbayar, A.; Ploeger, A. *(Re) Configuration of Water Resources Management in Mongolia. A Critical Geopolitical Analysis*; Working Papers-ICDD; Kassel University Press: Kassel, Germany, 2014.

53. David, W.; Ploeger, A. Indigenous Knowledge (IK) of water resources management in West Sumatra, Indonesia. *Future Food J. Food, Agric. Soc.* **2014**, *2*, 52–60.

54. Slovic, P. Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Anal.* **1999**, *19*, 689–701. [CrossRef] [PubMed]

55. Leiserowitz, A. Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Clim. Chang.* **2006**, *77*, 45–72. [CrossRef]

56. Nauges, C.; Van Den Berg, C. *Perception of Health Risk and Averting Behavior: An Analysis of Household Water consumption in Southwest Sri Lanka*; Working Paper; 09-139 Toulouse School of Economics (LERNA-INRA): Toulouse, France, 2009.

57. Gustafsod, P.E. Gender Differences in risk perception: Theoretical and methodological erspectives. *Risk Anal.* **1998**, *18*, 805–811. [CrossRef]

58. Cullen, A.C.; Anderson, C.L.; Biscaye, P.; Reynolds, T.W. Variability in Cross-Domain Risk Perception among Smallholder Farmers in Mali by Gender and Other Demographic and Attitudinal Characteristics. *Risk Anal.* **2018**, *38*, 1361–1377. [CrossRef] [PubMed]

59. Davidson, D.J.; Freudenburg, W.R. Gender and environmental risk concerns: A review and analysis of available research. *Environ. Behav.* **1996**, *28*, 302–339. [CrossRef]

60. Hitchcock, J.L. Gender differences in risk perception: Broadening the contexts. *Risk* **2001**, *12*, 179.

61. Roosen, J.; Thiele, S.; Hansen, K. Food risk perceptions by different consumer groups in Germany. *Food Econ. Acta Agric. Scand. Sect. C* **2005**, *2*, 13–26. [CrossRef]

62. Yu, H.; Neal, J.A.; Sirsat, S.A. Consumers' food safety risk perceptions and willingness to pay for fresh-cut produce with lower risk of foodborne illness. *Food Control* **2018**, *86*, 83–89. [CrossRef]

63. Graham, J.P.; Hirai, M.; Kim, S.S. An analysis of water collection labor among women and children in 24 sub-Saharan African countries. *PLoS ONE* **2016**, *11*, e0155981. [CrossRef] [PubMed]

64. Ahmadi, D.; Sinclair, K.; Melgar-Quinonez, H.; Cortbaoui, P. Water Access, Women's Empowerment, Sanitation and Children's Anthropometric Status: A Study of Ethiopian Mothers with Children Under Five. *WIT Trans. Ecolo. Environ.* **2017**, *220*, 163–174. [CrossRef]

65. Barnett, J.; Breakwell, G.M. Risk perception and experience: Hazard personality profiles and individual differences. *Risk Anal.* **2001**, *21*, 171–178. [CrossRef] [PubMed]

66. MacGregor, D.; Slovic, P.; Mason, R.G.; Detweiler, J.; Binney, S.E.; Dodd, B. Perceived risks of radioactive waste transport through Oregon: Results of a statewide survey. *Risk Anal.* **1994**, *14*, 5–14. [CrossRef] [PubMed]

67. Shafi, H.; Akram, M.; Hussain, M.; Sajjad, S.I.; Rehman, K.U. Relationship between risk perception and employee investment behavior. *J. Econ. Behav. Stud.* **2001**, *3*, 345–351.

68. Ramolefhe, G.T.; Ngwenya, B.N.; Ama, N.O.; Nnyepi, M.R.; Chimbari, M.J. Perceptions of Safe Water and Accessibility by Bural Farming Communities Residing along the Fringes of the Okavango Delta. *Botsw. Notes Rec.* **2017**, *49*, 117–135.

69. Crampton, A.; Ragusa, A.T. Exploring Perceptions and Behaviors about Drinking Water in Australia and New Zealand: Is It Risky to Drink Water, When and Why? *Hydrology* **2016**, *3*, 8. [CrossRef]

70. Sjöberg, L.; Drottz-Sjöberg, B.M. Knowledge and risk perception among nuclear power plant employees. *Risk Anal.* **1991**, *11*, 607–618. [CrossRef] [PubMed]

71. Reese, M. Perception Is Reality When It Comes to Water Quality and Agriculture [Blog Post]. 23 January 2015. Available online: http://ocj.com/2015/01/perception-is-reality-when-it-comes-to-water-quality-and-agriculture/ (accessed on 12 March 2018).

72. Glatron, S.; Beck, E. Evaluation of socio-spatial vulnerability of citydwellers and analysis of risk perception: Industrial and seismic risks in Mulhouse. *Nat. Hazards Earth Syst. Sci.* **2008**, *8*, 1029–1040. [CrossRef]

73. Wachinger, G.; Renn, O.; Begg, C.; Kuhlicke, C. The risk perception paradox—Implications for governance and communication of natural hazards. *Risk Anal.* **2013**, *33*, 1049–1065. [CrossRef] [PubMed]

74. Molle, F. Water, politics and river basin governance: Repoliticizing approaches to river basin management. *Water Int.* **2009**, *34*, 62–70. [CrossRef]

75. Lin, C.; Tong, X.; Lu, W.; Yan, L.; Wu, Y.; Nie, C.; Long, C.J. Environmental impacts of surface mining on mined lands, affected streams and agricultural lands in the Dabaoshan mine region, southern China. *Land Degrad. Dev.* **2005**, *16*, 463–474. [CrossRef]

76. Silic, M.; Cyr, D.; Back, A.; Holzer, A. Effects of Color Appeal, Perceived Risk and Culture on User's Decision in Presence of Warning Banner Message. In Proceedings of the 50th Hawaii International Conference on System Sciences, Waikoloa, HI, USA, 4–7 January 2017; Available online: https://pdfs.semanticscholar.org/0ad4/25d6327dfc92a775a2232433913d3cb1e2ed.pdf (accessed on 10 May 2018).

77. EPA. Secondary Drinking Water Standards: Guidance for Nuisance Chemicals. Available online: https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals (accessed on 13 May 2018).

78. Kahan, D.M.; Slovic, P.; Braman, D.; Gastil, J. Fear of democracy: A cultural critique of Susskind on risk. In *The Perception of Risk*; Slovic, P., Ed.; Earthscan: London, UK, 2006; ISBN 978-1-84971-149-4.

79. Fischhoff, B. Volume 2: The methods of public health. In *Risk perception and Communication*, 5th ed.; Oxford Textbook of Public Health; Oxford University Press: Oxford, UK, 2009; pp. 940–953.

80. Sunstein, C.R. *Laws of Fear: Beyond the Precautionary Principle*; Cambridge University Press: Cambridge, UK, 2005; Volume 6.

81. Alexopoulos, E.C.; Kavadi, Z.; Bakoyannis, G.; Papantonopoulos, S. Subjective risk assessment and perception in the Greek and English bakery industries. *J. Environ. Public Health* **2009**, *2009*, 891754. [CrossRef] [PubMed]

82. Geostat. *General Population Census*; National Statistics, Office of Georgia: Tbilisi, Georgia, 2014.

83.   Ministry of Regional Development and Infrastructure of Georgia, Analysis of Regional Disparities in Georgia. 2016. Available online: http://mrdi.gov.ge/sites/default/files/updated_analysis_of_regional_disparities.pdf (accessed on 21 July 2018).

84.   Food and Agriculture Organization of the United Nations (FAO). Food Security and Agricultural Highlight Georgia—Food Security Information for Decision Making. 2011. Available online: http://www.fao.org/docrep/014/am599e/am599e00.pdf (accessed on 20 April 2018).

85.   Kan, I.; Kimhi, A.; Lerman, Z. Farm Output, Non-Farm Income, and Commercialization in Rural Georgia. *e-JADE Electron. J. Agric. Dev. Econ.* **2006**, *3*, 276–286.

86.   World Bank. *Integrating Environment into Agriculture and Forestry Progress and Prospects in Eastern Europe and Central Asia: Volume II: Georgia*; Europe and Central Asia Region Sustainable Development Department World Bank: Washington, DC, USA, 2007.

87.   Creswell, J.W.; Plano Clark, V.L. Choosing a mixed methods design. In *Designing and Conducting Mixed Methods Research*; Creswell, J.W., Plano Clark, V.L., Eds.; Sage Designing and Conducting Mixed Methods Research: Thousand Oaks, CA, USA, 2006; pp. 58–88.

88.   Harris, L.; Brown, G. Mixing interview and questionnaire methods: Practical problems in aligning data. *Pract. Assess. Res. Eval.* **2010**, *15*, 1–19. Available online: http://pareonline.net/pdf/v15n1.pdf (accessed on 17 April 2018).

89.   Kish, L. Multipurpose sample designs. *Surv. Methodol.* **1988**, *14*, 19–32.

90.   Gonzalez, J.M.; Eltinge, J.L. Optimal Survey Design: A Review. Section on Survey Research Methods–JSM. 2010. Available online: https://www.bls.gov/osmr/pdf/st100270.pdf (accessed on 15 May 2018).

91.   O'brien, R.M. A caution regarding rules of thumb for variance inflation factors. *Qual. Quant.* **2007**, *41*, 673–690. [CrossRef]

92.   Hair, J.F.; Black, W.C.; Babin, B.J.; Anderson, R.E. *Multivariate Data Analysis*; Pearson New International Edition: Harlow, UK, 2014; ISBN 10 129202190X.

93.   Knuth, D.; Kehl, D.; Hulse, L.; Spangenberg, L.; Brähler, E.; Schmidt, S. Risk perception and emergency experience: Comparing a representative German sample with German emergency survivors. *J. Risk Res.* **2015**, *18*, 581–601. [CrossRef]

94.   Reed, P.; Wu, Y. Logistic regression for risk factor modelling in stuttering research. *J. Fluen. Disord.* **2013**, *38*, 88–101. [CrossRef] [PubMed]

95.   King, J.E. Binary Logistic Regression | Chapter 24. In *Best Practices in Quantitative Methods*; Osborne, J.W., Ed.; Sage Publication: Thousand Oaks, CA, USA, 2008; ISBN 9781412940658.

96.   Arlot, S.; Celisse, A. A survey of cross-validation procedures for model selection. *Stat. Surv.* **2010**, *4*, 40–79. [CrossRef]

97.   Seebach, S. Development of Food Culture in a Multicultural Society in Georgia. Master's Thesis, University of Kassel, Kassel, Germany, 2016.

98.   Sidawi, R. Temporal and Spatial Challenges of Accessing Water Resources in Food Production by Smallholder Farmers in Kvemo Kartli, Georgia. Master's Thesis, University of Kassel, Kassel, Germany, 2016.

99.   Dholakia, U.M. An Investigation of the Relationship Between Perceived Risk and Product Involvement. In *NA—Advances in Consumer Research Volume 24*; Brucks, M., MacInnis, D.J., Provo, U.T., Eds.; MacInnis, Association for Consumer Research: Duluth, MN, USA, 1997; pp. 159–167.

100. Grothmann, T.; Reusswig, F. People at risk of flooding: Why some residents take precautionary action while others do not. *Nat. Hazards* **2006**, *38*, 101–120. [CrossRef]

101. Liao, Q.; Wong, W.S.; Fielding, R. Comparison of different risk perception measures in predicting seasonal influenza vaccination among Healthy Chinese adults in Hong Kong: A prospective longitudinal study. *PLoS ONE* **2013**, *8*, e68019. [CrossRef] [PubMed]

102. Denham, B.E. Measurement of risk perceptions in social research: A comparative analysis of ordinary least squares, ordinal and multinomial logistic regression models. *J. Risk Res.* **2010**, *13*, 571–589. [CrossRef]

103. Antwi-Agyei, P.; Peasey, A.; Biran, A.; Bruce, J.; Ensink, J. Risk perceptions of wastewater use for urban agriculture in Accra, Ghana. *PLoS ONE* **2016**, *11*, e0150603. [CrossRef] [PubMed]

104. Rapsomanikis, G. *The Economic Lives of Smallholder Farmers*; An Analysis Based on Household Surveys; Food and Agriculture Organization: Rome, Italy, 2015.

105. Abdullah, R.F.; Ahamad, R.; Ali, S.; Chandio, A.A.; Ahmad, W.; Ilyas, A.; Din, I.U. Determinants of commercialization and its impact on the welfare of smallholder rice farmers by using Heckman's two-stage approach. *J. Saudi Soc. Agric. Sci.* **2017**. [CrossRef]

106. Parmar, A.; Hensel, O.; Sturm, B. Post-harvest handling practices and associated food losses and limitations in the sweetpotato value chain of southern Ethiopia. *NJAS Wageningen J. Life Sci.* **2017**, *80*, 65–74. [CrossRef]

107. Eiser, J.R. Attitudes, decisions and perceptions of risk: A social psychological analysis. In *Environmental Risks: Perception, Evaluation and Management*; Emerald Group Publishing Limited: Bingley, UK, 2001; pp. 109–135.

108. Islam, M.S.; Ahmed, M.K.; Raknuzzaman, M.; Habibullah-Al-Mamun, M.; Islam, M.K. Heavy metal pollution in surface water and sediment: A preliminary assessment of an urban river in a developing country. *Ecol. Indic.* **2015**, *48*, 282–291. [CrossRef]

109. Goher, M.E.; Farhat, H.I.; Abdo, M.H.; Salem, S.G. Metal pollution assessment in the surface sediment of Lake Nasser, Egypt. *Egypt. J. Aquat. Res.* **2014**, *40*, 213–224. [CrossRef]

110. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990.

111. Georgian Amelioration. Tbilisi, Georgia. Personal communication, 2016.

112. Governors (Gamgebeli) and Representative Councils (Sakrebulo) Members from Bolnisi and Daminisi, Georgia. Personal communication, 2016.

113. Buetow, S. Getting the balance right: Thick and thin approaches to harmonizing state particularism and the human right to health. *Health Expect.* **2012**, *15*, 441–448. [CrossRef] [PubMed]

114. Biological Farmers' Association Elkana, Tbilisi, Georgia. Personal communication, September 2015.

115. Sansom, G.; Berke, P.; McDonald, T.; Shipp, E.; Horney, J. Confirming the Environmental Concerns of Community Members Utilizing Participatory-Based Research in the Houston Neighborhood of Manchester. *Int. J. Environ. Res. Public Health* **2016**, *13*, 839. [CrossRef] [PubMed]

116. Vighi, M.; Gramatica, P.; Consolaro, F.; Todeschini, R. QSAR and chemometric approaches for setting water quality objectives for dangerous chemicals. *Ecotoxicol. Environ. Saf.* **2001**, *49*, 206–220. [CrossRef] [PubMed]

117. Rolston, A.; Jennings, E.; Linnane, S. Water matters: An assessment of opinion on water management and community engagement in the Republic of Ireland and the United Kingdom. *PLoS ONE* **2017**, *12*, e0174957. [CrossRef] [PubMed]

118. Newig, J.; Pahl-Wostl, C.; Sigel, K. The role of public participation in managing uncertainty in the implementation of the Water Framework Directive. *Environ. Policy Gov.* **2005**, *15*, 333–343. [CrossRef]

119. Jamaspishvili, T. Community participation in local budgeting in Georgia. In *Speaking Out: Case Studies on How Poor People Influence Decision-Making*; van der Gaag, N., Rowlands, J., Eds.; Oxfam: Oxford, UK, 2009; p. 51.

120. Mteki, N.; Murayama, T.; Nishikizawa, S. Social impacts induced by a development project in Tanzania: A case of airport expansion. *Impact Assess. Proj. Apprais.* **2017**, *35*, 272–283. [CrossRef]

121. Paton, D.; Smith, L.; Daly, M.; Johnston, D. Risk perception and volcanic hazard mitigation: Individual and social perspectives. *J. Volcanol. Geotherm. Res.* **2008**, *172*, 179–188. [CrossRef]

122. European Commission (EU). *Survey on Public Perceptions of Environmental Risks. Draft Final Report (ENV.F.3/ETU/2014/0037)*; Publications Office of the European Union: Luxembour, 2015; ISBN 978-92-79-54020-2.

123. Withanachchi, S.S. Sustainable Water Resource Management for a Safe Food System in Georgia: A Study of Water Quality Governance, Focusing the Mashavera River Basin. Ph.D. Thesis, University of Kassel, Kassel, Germany, 2018.

124. Davis, A.; Wagner, J.R. Who knows? On the importance of identifying "experts" when researching local ecological knowledge. *Hum. Ecol.* **2003**, *31*, 463–489. [CrossRef]