

Impact of Climate Change on Agriculture and Aquaculture: A Risk Communication Approach

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Abstract

Climate change poses significant challenges for agriculture and aquaculture, affecting food production and global food security. This article analyzes the impact of climate change on these sectors, highlighting the importance of risk communication to mitigate its effects. A bibliographic and case study analysis was carried out, evaluating the communication strategies implemented between 2018 and 2023. The results reveal a gap in public understanding and the adoption of adaptive measures, underscoring the need for inclusive policies and effective information campaigns. This study offers recommendations for strengthening resilience in rural and coastal communities.

Keywords: climate change, agriculture, aquaculture, risk communication, sustainability, food security.

Introduction

Climate change is one of the most pressing challenges of the twenty-first century, the consequences of which affect not only the environment, but also the social and economic systems that depend on it (IPCC, 2021). Agriculture and aquaculture are sectors that are particularly vulnerable to these changes, as they depend directly on climatic factors such as temperature, rainfall and water availability. According to the Food and Agriculture Organization of the United Nations (FAO, 2022), the adverse impacts of climate change on these sectors have generated growing concerns about global food security, especially in regions where communities mostly depend on these activities for their livelihoods.

In the case of agriculture, changes in weather patterns have altered growing seasons, decreased soil fertility, and increased the incidence of pests and diseases, resulting in significant productivity losses (Smith & Brown, 2020). For its part, aquaculture faces challenges such as ocean acidification, warming waters, and harmful algal blooms, factors that have negatively impacted the production of key species such as molluscs and salmon (Smith et al., 2021). These effects not only threaten the sustainability of food systems, but also increase the economic and social vulnerability of rural and coastal communities.

Against this backdrop, risk communication emerges as a crucial strategy to mitigate the impacts of climate change and build resilience in affected communities (Moser, 2020). Risk communication is not limited to the transmission of information, but also seeks to promote collective action and behaviour change through awareness raising and education. However, its effectiveness depends on multiple factors, including access to information, the level of climate literacy, and cultural or economic barriers that limit the adoption of adaptive measures (Figueroa et al., 2021).

In many regions, particularly in developing countries, a significant gap persists in the understanding and management of climate risks, highlighting the need for more inclusive communication approaches adapted to local contexts (FAO, 2022). In addition, the lack of funding for communication initiatives and the limited integration of communities in decision-making processes exacerbate this problem (Lundgren &McMakin, 2018). This article seeks to analyze how the impacts of climate change affect agriculture and aquaculture, and to explore the role of risk communication as a tool to reduce vulnerabilities and promote long-term sustainability.

This approach is critical not only to understand the dynamics of affected systems, but also to design strategies that allow communities to effectively adapt and contribute to the mitigation of climate impacts. By addressing these issues, this study contributes to the global debate on the need to strengthen communication and resilience policies in the face of climate risks.

Theoretical Framework

1. Climate Change and its Effects on Agriculture and Aquaculture

Climate change is redefining global weather patterns, negatively affecting the agriculture and aquaculture sectors that depend on stable conditions for their functioning. According to the IPCC (2021), the increase in global temperature has intensified extreme weather events such as droughts, floods, and cyclones, leading to a reduction in agricultural and aquaculture productivity. These events affect both crop yields and the ability to maintain healthy aquatic ecosystems.

In agriculture, the alteration of seasonal cycles has generated imbalances in planting and harvesting times, increasing the vulnerability of staple crops such as maize, wheat, and rice (FAO, 2022). Similarly, in aquaculture, rising water temperatures and ocean acidification have negatively impacted the reproduction and growth of key species such as molluscs and cold-water fish (Smith et al., 2021).

Impact of Climate Change on Agriculture and Aquaculture	Description
Reduction of agricultural yields	10%-20% decrease in crops such as rice and maize (FAO, 2022).
Alteration of aquatic ecosystems	Ocean acidification and decreased oxygen in water (Smith et al., 2021).
Increase in pests and diseases	Increased spread of heat-resistant pests (Moser, 2020).

Impact of Climate Change on Agriculture and Aquaculture	Description
Loss of biodiversity	Disappearance of aquatic species vulnerable to climate change (IPCC, 2021).

2. Risk Communication

Risk communication plays a crucial role in mitigating the impacts of climate change, especially in vulnerable sectors such as agriculture and aquaculture. According to Lundgren and McMakin (2018), this process involves not only the transmission of information about risks, but also the promotion of adaptive measures and the generation of trust among affected communities.

The effectiveness of risk communication depends on factors such as:

- The clarity of the message.
- Access to relevant information.
- The capacity of communities to implement adaptive measures (Moser, 2020).

A study by Figueroa et al. (2021) highlights that participatory strategies, where local communities are integrated into the planning and execution of communication campaigns, have proven to be more effective in raising awareness and encouraging collective action.

Principles of Risk Communication	Example
Clarity and precision	Use of simple messages about agricultural adaptation techniques (Lundgren & McMakin, 2018).
Community Engagement	Climate change workshops for farmers and fishermen (Figueroa et al., 2021).
Access to technological resources	Mobile applications that report on local climate changes (Moser, 2020).

3. Communication Models in Vulnerable Contexts

In rural and coastal contexts, risk communication models need to adapt to the cultural, economic, and technological barriers faced by communities. Moser (2020) proposes an approach based on co-creation, in which communities not only receive information, but also actively participate in the design of communication strategies.

An analysis of campaigns in Latin America reveals that initiatives that combine traditional media, such as community radio, with modern technologies, such as mobile applications, have a greater reach and effectiveness (Figueroa et al., 2021). These campaigns have also demonstrated a positive impact on the adoption of sustainable practices, such as crop diversification and the use of low-impact technology.

Communication Strategies in Vulnerable Contexts	Example
Community Radio	Dissemination of climate adaptation messages in local languages (FAO, 2022).
Mobile Apps	Early warnings on climate risks (Smith et al., 2021).
Participatory workshops	Training on climate-resilient cropping techniques (Moser, 2020).

The theoretical framework developed shows how climate change profoundly affects the agricultural and aquaculture sectors, highlighting the need for risk communication strategies adapted to local realities. The inclusion of tables provides a visual summary of the main findings, facilitating their understanding and critical analysis.

Methodology

The methodology used in this research combines a qualitative-descriptive approach with documentary analysis and case study techniques, allowing a comprehensive understanding of the impacts of climate change on agriculture and aquaculture from the perspective of risk communication. The methodological design includes three main stages: data collection, qualitative analysis, and validation of results.

1. Data Collection

Data collection focused on secondary sources, including academic articles, reports from international organizations, and case studies published between 2018 and 2023. The criteria for selecting the sources were:

- Thematic relevance: studies that explore climate change and its impact on agriculture, aquaculture or risk communication.
- Recent publication: documents published in the last five years.
- Academic quality: peer-reviewed articles or reports from recognized bodies such as FAO and IPCC (FAO, 2022; IPCC, 2021).

In addition, empirical data from communication campaigns implemented in vulnerable regions of Latin America, Asia and Africa, selected for their relevance and availability of documentation, were included.

Source Selection Criteria	Description
Recent Post	Sources published between 2018 and 2023.
Thematic relevance	Studies related to agriculture, aquaculture and risk communication.
Academic quality	Peer-reviewed articles and reports from international organizations.

2. Qualitative Analysis

The qualitative analysis was carried out using the thematic coding technique, which allows the identification of relevant patterns and categories within the collected data (Nowell et al., 2017). The main categories included:

- **Impacts of climate change on agriculture.**
- **Impacts of climate change on aquaculture.**
- **Risk communication strategies.**
- **Limiting factors in communication.**

NVivo software was used to manage and analyze textual data, making it easier to organize information and establish connections between categories (Bazeley & Jackson, 2019).

Categories Analyzed	Description
Impacts on agriculture	Changes in yields, soil quality and pest appearance.
Impacts on aquaculture	Alterations in marine and productive ecosystems.
Communication strategies	Methods of dissemination and community participation.
Limiting factors	Technological and cultural gaps.

3. Case Studies

To complement the theoretical analysis, three representative case studies were selected:

- **Climate Resilience Campaign in Latin America:** Implemented by FAO, this campaign used traditional and technological means to train farmers in sustainable practices (FAO, 2022).
- **Aquaculture Adaptation Program in Asia:** Project that combined scientific research with community communication to mitigate the effects of climate change on aquaculture (Smith et al., 2021).
- **Climate Literacy Initiative in Africa:** Focused on improving public understanding of climate change through participatory workshops (Figueroa et al., 2021).

4. Validation of Results

To ensure the validity and reliability of the findings, two strategies were employed:

- **Data triangulation:** The results obtained from different sources and methods were compared to corroborate their consistency (Nowell et al., 2017).
- **Peer review:** Climate change and risk communication practitioners reviewed preliminary results and provided constructive feedback.

ValidationStages	Description
Data triangulation	Comparison between documentary analysis, case studies and literature.
Expert Review	Evaluation of the results by specialists in risk communication.

5. Limitations of the Study

Among the main limitations are the dependence on secondary sources and the heterogeneity of data between the regions studied, which can influence the generalizability of the results. However, these limitations were addressed through a robust methodological approach and data triangulation.

Results

The results of this research allow us to identify the specific impacts of climate change on agriculture and aquaculture, as well as to evaluate the effectiveness of risk communication strategies implemented in different regions. Below are the most relevant findings organized into key categories.

1. Impacts of Climate Change on Agriculture

Climate change has led to significant changes in agricultural productivity, exacerbating existing challenges to global food security. According to recent FAO data (2022), variations in rainfall and rising temperatures have reduced yields of staple crops in various regions of the world. Forexample:

- In Latin America, maize yields declined by 12% due to recurrent droughts (FAO, 2022).
- In Asia, rice production fell by 15% as a result of prolonged floods (Smith & Brown, 2020).
- In sub-Saharan Africa, farmers reported a 30% increase in heat-resistant pests, affecting crops such as sorghum and millet (Moser, 2020).

Impacts on Agriculture by Region	CropAffected	Reduction in Yield (%)	Mainspring
Latin America	Corn	12%	Droughts
Asia	Rice	15%	Floods
Sub-Saharan Africa	Sorghum and millet	30%	Heat-resistant pests

2. Impacts of Climate Change on Aquaculture

In the aquaculture sector, impacts are mainly manifested through rising water temperatures, ocean acidification, and toxic algal blooms. These factors have resulted in the decline of

marine species that are key to the food security and economy of coastal communities. According to a study by Smith et al. (2021), the following effects were observed:

- Salmon production declined by 20% in Norway due to heat stress.
- In Southeast Asia, water acidification reduced mollusc survival by 18%.
- Harmful algal blooms in North America caused economic losses of more than \$2 billion between 2018 and 2022.

Impacts on Aquaculture by Region	SpeciesAffected	Reduction (%)	Mainspring
Norway	Salmon	20%	Heat stress
Southeast Asia	Molluscs	18%	Water acidification
North America	Various species	N/A	Toxic algae blooms

3. Effectiveness of Risk Communication Strategies

Risk communication strategies have shown mixed results in terms of their effectiveness. While some campaigns have succeeded in increasing the adoption of resilient practices, others face challenges due to cultural, technological, and economic barriers. Key findings are highlighted below:

- **Successful campaigns:** In Latin America, an FAO-led campaign increased the adoption of sustainable agricultural practices, such as the use of drought-resistant crops and efficient irrigation systems, by 35% (FAO, 2022).
- **Persistent challenges:** In Africa, limited access to technologies and low climate literacy restricted the effectiveness of training programs by 50% (Figuroa et al., 2021).
- **Effect of technology:** Mobile applications and early warning systems implemented in Asia managed to reduce losses in aquaculture during extreme weather events by 25% (Moser, 2020).

EvaluatedCommunicationStrategies	Region	Impact (%)	Barriers Identified
Workshops on sustainable agriculture	Latin America	+35% adoption of practices	Low initial participation
Climate literacy	Africa	-50% expected effectiveness	Low climate literacy
Early warning systems	Asia	-25% losses in aquaculture	Limited access to advanced

Evaluated Communication Strategies	Region	Impact (%)	Barriers Identified
			technologies

4. Limiting Factors in Risk Communication

Despite advances in communication strategies, significant limitations persist that hinder their effective implementation. These include:

- **Technological gaps:** In many rural regions, the lack of access to the internet and mobile devices limits the effectiveness of technology-based campaigns (Figuerola et al., 2021).
- **Cultural barriers:** Language differences and traditional practices can make it difficult to accept new adaptation strategies (Moser, 2020).
- **Lack of financial resources:** Insufficient funding for communication initiatives in developing countries restricts the reach of campaigns (FAO, 2022).

Conclusions

The analysis of the impacts of climate change on agriculture and aquaculture, together with the evaluation of risk communication strategies, allows for the identification of key findings and practical recommendations to mitigate adverse effects and strengthen the resilience of vulnerable communities.

Climate Change Impacts

Climate change continues to pose a significant threat to agricultural and aquaculture systems around the world, affecting food security and local economies. Alterations in agricultural cycles, increased incidence of pests and diseases, and changes in aquatic ecosystems underscore the urgency of implementing adaptive measures (FAO, 2022; Smith et al., 2021). In regions such as Africa and Asia, where economies rely heavily on these sectors, losses in productivity exacerbate social and economic inequalities (Moser, 2020).

On the other hand, in aquaculture, ocean acidification and warming waters are decreasing the availability of keystone species, impacting not only environmental sustainability, but also the incomes and food security of coastal communities (Smith & Brown, 2020). These effects demonstrate that mitigation and adaptation strategies must be a priority on global policy agendas.

Effectiveness of Risk Communication

Risk communication has established itself as a fundamental tool to face climate change, but its effectiveness continues to be limited by technological, cultural and financial barriers. The results show that communication strategies adapted to local contexts, such as participatory workshops and the use of accessible technologies, are more successful in encouraging the adoption of sustainable practices (Figuerola et al., 2021).

However, significant gaps in climate literacy and access to information persist in rural and coastal communities, limiting the effectiveness of these strategies (Moser, 2020). This highlights the need to increase investment in climate education and technology programs, especially in developing regions.

Recommendations

Based on the findings, the following recommendations are proposed to improve the resilience of the agriculture and aquaculture sectors to climate change:

1. **Encourage co-creation of strategies:** Actively engage local communities in the design and implementation of climate communication and adaptation initiatives, ensuring that they are culturally relevant (FAO, 2022).
2. **Investments in accessible technology:** Promote the development of low-cost technological tools, such as mobile apps and early warning systems, to improve access to real-time climate information (Moser, 2020).
3. **Strengthen climate literacy:** Implement climate education programs in schools and communities, prioritizing regions with low levels of knowledge about climate change (Figueroa et al., 2021).
4. **Expand international financing:** Increase resources for climate mitigation and adaptation projects in developing countries, particularly those that rely on agriculture and aquaculture as their main economic lifeline (Smith & Brown, 2020).

Final Thoughts

Climate change is a global issue that requires comprehensive and collaborative actions to mitigate its impacts and ensure the sustainability of agricultural and aquaculture systems. Risk communication must be at the heart of these strategies, acting as a bridge between science, public policy and affected communities. While significant progress has been made, efforts must be intensified to ensure that no community is left behind in the fight against climate change.

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