

Adaptation to climate change in indigenous food systems of the Teribe in Panama: a training based on CRISTAL 2.0

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Recibido: 13 de noviembre de 2019, Aceptado: 27 de abril de 2020, Actualizado: 24 de junio de 2020

Doi: 10.17151/luaz.2020.51.10

ABSTRACT

In this didactic experience, a training workshop about an innovative tool called CRISTAL 2.0 (Community-based Risk Screening Tool - Adaptation and Livelihoods) was implemented in the Panamanian indigenous context with the objective of developing abilities in the local actors responsible for making decisions, namely students, teachers, and members of the San San Tigra and San San Druy communities of the Teribe, Panama. The impact of qualitative and quantitative training was described through the Simple Correspondence Analysis. The training carried out showed differences between the groups of participants and the impact of learning, which would help establish measures that strengthen climate resilience and identify indicators that measure changes in the resilience of Panamanian national institutions.

Keywords: adaptation; farming; learning; training; food safety.

Adaptación al cambio climático en sistemas alimentarios indígenas del Teribe en Panamá: una capacitación basada en CRISTAL 2.0

RESUMEN

En esta experiencia didáctica se implementó un taller de capacitación acerca de una herramienta denominada CRISTAL 2.0 (Community-based Risk Screening Tool - Adaptation and Livelihoods), innovadora en el contexto indígena panameño con el objetivo de desarrollar capacidades en los actores locales responsables de la toma de decisiones; estudiantes, profesores e integrantes de las comunidades San San Tigra y San San Druy del Teribe, Panamá. Se describió el impacto de la capacitación a nivel cualitativo y cuantitativo a través del Análisis de Correspondencia Simple. La capacitación ejecutada presentó diferencias entre los grupos de participantes y el impacto del aprendizaje, la cual ayudaría a establecer medidas que fortalezcan la resiliencia climática y a

identificar indicadores que midan los cambios en la resiliencia de instituciones nacionales panameñas.

Palabras clave: adaptación; agricultura; aprendizaje; formación; seguridad alimentaria.

Introduction

Currently, the increasingly severe effects of climate change on agriculture and livestock in Latin America are evident; they also generate various challenges to local agriculture such as productivity, inclusion and competitiveness (Santamaría and González, 2015). In the case of Teribe of Panama, one of the main challenges is the ability to effectively integrate scientific information, projections and models of climate change impact on design processes, as well as the planning of mitigation instruments and / or adaptation (Nelson et al., 2007; Olivares *et al.*, 2016a).

Research carried out globally on the ability to forecast the degree of food insecurity in indigenous agricultural territories is based on the establishment of different early warning systems (EWS). They are represented by environmental indicators considered as the basic elements of the crises generated due to extreme weather events such as: droughts (Paredes-Trejo and Olivares, 2018; Cortez *et al.*, 2018), floods (Olivares y Hernandez, 2019), landslides and effects on agricultural areas (Olivares *et al.*, 2016b; Hernández *et al.*, 2017; Olivares *et al.* 2017b) or patterns of behavior that reflect individual vulnerabilities (Olivares *et al.*, 2017a; Flores Silva, 2017).

In this regard, the initiatives related to training in the environmental education programs on climate change aimed primarily at personnel related to local management. They also aimed at promoting and raising awareness of this problem to modify attitudes and behaviors of the communities in the Teribe of Panama that are more likely to suffer the consequences of climate change.

1. Theoretical fundament

1.1. Background

In the Teribe of Panama case, there is a climate change strategy based on the creation of a sectorial adaptation plan for the agricultural sector, but it has not been completed. Likewise, it should be noted that in the Panamanian territory, actions related to the National Committee to Combat Drought and Desertification, an Intersectoral Committee for Climate Change and Comprehensive Risk Management have been developed; poverty reduction in indigenous territories has been the Top priority issue (Witkowski *et al.*, 2017). However, there is no strict line of action for the different public bodies such as ministries of agriculture, environment and institutions that define the guidelines for actively working to ensure that public policy instruments respond and provide a favorable environment for adaptation and mitigation.

1.2. The influence of climate change on the political agenda for development

The Sustainable Development Goals (SDGs) represent the way forward in relevant issues related to long-term global development. Consequently, the content of objective 13, which emphasizes the adoption of urgent measures to combat climate change and its effect is highlighted. That is why the UN (UNDP, 2015) urges governments to take the following actions:

- Strengthen resilience and the capacity to adapt to climate risks and natural disasters.
- Incorporate effective measures to climate change in national strategies, policies and plans.
- Improve education, awareness as well as human and institutional capacity in relation to climate change mitigation, adaptation and reduction of effects.
- Promote mechanisms to increase capacity for effective planning and management focusing on groups of women, youth, indigenous and marginalized communities.

Consequently, it is necessary to highlight that formal and non-formal education are educational tools that address the problem of climate change; they adopt innovative educational learning approaches that stimulate understanding, facing, mitigating and adapting to such phenomenon (ONU, 2011). These types of education also promote changes in attitudes and behaviors of people, which benefits the environment in different sectors (González, 2016) and make citizens sensitized and aware of this problem (Olivares *et al.*, 2020).

1.3. The need to incorporate adaptation to training projects in rural areas

In order to advance the analysis of the state of the art regarding the subject of this study, it is convenient to cite the experiences of Meira Cartea (2013) in Bolivia, Maldonado and González (2013) in Mexico, Olivares (2014a); Gómez and Moncada (2015) in Venezuela, and Gallardo (2014) in Cuba. They are some of the experiences that demonstrate the need for training in rural environments to promote the formation of pro-environmental attitudes and awareness of climate change, which require the active, conscious and sincere participation of all citizens.

The challenge of incorporating climate change adaptation activities into rural development projects is based on the translation of the problems into solutions, considering the influence that climate vulnerability imposes on small producers. It is clear that the resources allocated to adaptation are still scarce, hence the need to maximize the effects of projects and integrate them throughout rural development programs.

1.4. The role of training in climate change adaptation plans

In the potential scenarios of more severe climatic changes coupled with the persistence of highly vulnerable production systems, the contributions of Kates, Travis and Wilbanks (2012) establish that urgent measures of transformational adaptation be implemented. According to Palutikof *et al.* (2013), these measures lead to the redesign of systems, so they generally require the increase of the capacities of the various actors to deal with higher levels of risk and uncertainty.

In many Latin American countries, producers or local governments do not always have the precise and extensive knowledge or resources necessary to assume higher levels of risk and make decisions about future scenarios in vulnerable territories (Galindo *et al.*,2013).

Therefore, the objective of this article was to develop capacities and facilitate processes of integration of climate change adaptation to the institutional actors in charge of the processes and planning instruments of the food sector in the indigenous communities of the Teribe, Panama. Moreover, the purpose is that local decision makers in Bocas del Toro mobilize, in the short and medium term, respond to the drastic impacts of climate variability and thus promote sustainable development of the food sector in these vulnerable areas.

At the same time, the efforts of the University of Panama to strengthen institutional capacities in the province of Bocas del Toro are evident, including the consequences of climate change on indigenous agriculture and the application of response strategies that should be prioritized within sectoral plans.

2. Materials and methods

2.1. Conformation of the research team

To initiate this research, it was necessary to put together a team whose main function was to act as a facilitator and organizer of the workshop called: Tools for the identification of climatic risks in the Agri-food system: a look for its application. This team was made up of professors from the Faculty of Agricultural Sciences and the Faculty of Economics of the University of Panama, Changuinola headquarters and of researchers from the Campus of international excellence in Environment, Biodiversity and Global Change based in Seville, Spain. Likewise, this team acted as systematizer of the information generated during the development of the event.

2.2. Selection of participants

Since it was a collective-analysis event, the participants selection was fundamental in the workshop development process. In all instances, different personal consultations were conducted from the Faculty of Agricultural Sciences of the University of Panama to government institutions of Bocas del Toro such as: Ministry of Agricultural Development (MIDA), Ministry of Environment of Panama (MIAMBIENTE) and other educational institutions linked with the agri-food sector in order to identify the most suitable participants.

Subsequently, 26 participants were directly involved in the implementation and evaluation of instruments or projects in the food, economic and environmental sectors. Most of the participants in the workshop were public or technical officials of the government institutions, who work in the environmental, agri-food or climate change units in their respective institutions. Coordinators and / or professors from other faculties of the University of Panama, Changuinola headquarters, as well as senior students from the Faculty of Agricultural Sciences participated.

2.3. Description of the tool CRISTAL Food Safety 2.0

The tool called CRISTAL Food Security 2.0 (Community-based Risk Screening Tool - Adaptation and Livelihoods) was developed by four international non-governmental organizations. They propose a logical process, easy to follow, to help better understand the links between climate-related risks, people's livelihoods and project activities. Therefore, the CRISTAL Food Security 2.0 tool represents a specialized version for community risk identification: adaptation and livelihoods (IISD, 2014).

CRISTAL is aimed at decision makers of a community or at a local level, namely municipal, provincial, and municipal government, project managers of development organizations and leaders of indigenous communities. The tool has a series of linked Microsoft Excel spreadsheets, which automatically generate a succession of reports based on the information completed.

2.4. Phases of the training

The training workshop was designed under the framework whose phases are shown in [Table 1](#). The training lasted 40 hours; it combined several work dynamics: the first one was related to diagnosing through brainstorming ideas. expectations of the participants in the training. The second one was the theoretical part developed through presentations about the conceptual basis of climate change, the main characteristics and livelihoods of the community and the influence of climate context, resilience, and the economic performance of agricultural production systems. All of them for the understanding and management of the CRISTAL Food Security tool 2.0.

Subsequently, the group dynamics were carried out with hypothetical case studies for vulnerability analysis and the application of CRISTAL 2.0 modules in the cabinet. They focused on the following content according to IISD (2013):

- a. Introduction: the objectives, the approach, the concepts and the structure of the tool and details about the use that will be given to the tool called: CRISTAL 2.0.
- b. The analysis of the climate context: main characteristics and livelihoods of the community, as well as the climate context, respectively.
- c. The analysis of the food system: description of the five dimensions described in the conceptual framework (utilization and consumption, access, food availability, resources and support services, and support organizations and policies). Determination of the sensitivity of the key elements of the food system within each dimension to current and future climate threats.
- d. Resilience: the same five dimensions are used, and the user analyzes the resilience of the food system through questions specific to each dimension.
- e. Indicators: main orientations in the identification of specific, measurable, attainable, realistic, and time-constrained resilience indicators (SMART) based on the analysis performed in the previous step.
- f. Economic analysis: theoretical-conceptual and methodological approaches related to the field of economy knowledge, to analyze the economic problems and the relevant relationships with the social, political and environmental processes that produce them.
- g. Assessment: Interpretation of a series of reports summarizing the key parts of the analysis and summarizing the teaching strategies for the final report.

Table 1. Phases developed in the training workshop on the CRISTAL tool 2.0.

Phases	Objective	Activity	Strategy
I Approach	Identify the expectations of the participants, main agricultural problems due to climate and the local perception of climate	Participatory Diagnosis	Brainstorming
II Interactive theoretical	Describe and recognize the importance of climate in the food system in the dimensions: utilization and consumption, access, availability of food, resources and support services, and support organizations or policies; the resilience and economic performance of agricultural production systems	Exposure of issues related to climate, agricultural and economic area of Panama	Oral presentation of collective participation
III Collective knowledge construction	Address the five dimensions described in the conceptual framework of the tool	Work tables	Socialized discussion and focused interviews
IV Assessment of knowledge	Rescue and Value local knowledge of indigenous communities for agricultural planning and decision making in the field of climate change adaptation	Assembly of citizens in indigenous farming communities of Bocas del Toro	Conversation and reflection of the result of the activity

Note: Compiled by authors

Finally, a field visit was made to the indigenous communities of San San Druy and San San Tigra in the Teribe of Panama to collect information on the climate context and livelihoods considered in the first module of the CRISTAL tool 2.0. Likewise, both visits were concluded with plenaries that served as a basis to express the multidisciplinary capacity of the participants and thus enrich the debate and joint learning.

2.5. Training Assessment

The individual written evaluations of the modules that were used in CRISTAL 2.0 made by the participants were synthesized; three open questions were posed: a description of positive aspects (to be repeated), negative aspects (to be modified) and lessons to be learned from the training. Also, for the direct assessment of the perception of the impact of training with the tool, a scale with a Likert format of 10 levels and 6 items ([Table 2](#)) was designed following the guidelines of Landini *et al.*, (2013) and Olivares (2014b). It was used at the end of the training with the delivery of the report in order to identify the usefulness of the learning obtained.

Table 2. Description of the Items about the impact of training learning.**Table 2.** Description of the Items about the impact of training learning.

N	Items	Symbol
1	The training offered extensive knowledge in my academic background	F_aca
2	The event allowed to strengthen institutional capacities	F_ins
3	The training allowed to respond to the impacts of climate variability	R_imp
4	The event facilitated the processes of integration of adaptation to climate change in the plans of the institution	I_cc
5	The training generated a theoretical contribution with little use in the communities	A_sin
6	The training generated a relevant theoretical and practical contribution	A_com

Note: Compiled by authors

The simple correspondence analysis (SCA) was applied through the statistical software Infostat (Di Rienzo *et al.*, 2011), which is an exploratory technique that allows to graphically represent rows and columns of a contingency table (Balzarini *et al.*, 2015). The ACS was on a single two-way table, considering the group variable to which the participant belongs (student, technicians and teachers); and the variable: use of learning obtained in training. The SCA technique also constitutes a tool of main importance for the analysis of textual data where contingency tables are constructed relating the use of several words among different discourse texts.

3. Results and Discussion

3.1. Participatory evaluation of the modules

Among the modules addressed in the training, the great interest generated by the analysis of the climate context is highlighted, rather than that of agri-food systems in indigenous territories of Teribe of Panama. Likewise, the interest in the CRISTAL tool 2.0 is also mentioned, which results from an innovative character for Panamanian agricultural communities. Finally, different practical implications of the discussion, such as the importance of climate change adaptation and mitigation measures in food systems were noted. Regarding the aspects to be improved, six attendees indicated the need to replace topics as general as those associated with the characteristics of the food systems because these topics are already immersed in academic courses.

Regarding the implementation of the tool during the training, a group of participating technicians stressed that the implementation of the tool in the workshop takes time and is part of a process that can hardly be resolved in the short term. That is to say, the processes of adaptation to climate change tend to be oriented in the long term, which represents a challenge to give continuity to the

actions beyond the political cycles or deadlines of the projects and to empower public sector technicians in the face of this reality.

Other actors who participate in the planning of climate change adaptation instruments in the agri-food sector of Panama were identified: private sector and unions, academic institutions and research, local governments, the Food and Agriculture Organization of the United Nations (FAO), the Inter-American Institute for Cooperation on Agriculture (IICA), the Tropical Agronomic Research Center and Education (CATIE), non-governmental organizations, indigenous groups and the Ministry of Economy and Finance.

Regarding the issue of adaptation to climate change within the framework of national programs in Panama, government institutions have had more opportunity to get to know the issue, in relation to the rest and civil society. It is necessary that both governmental organizations and universities improve scientific and technical knowledge in the field of climate change and promote technological tools such as CRISTAL 2.0 to counteract its effects.

According to the information collected in the documents revised, certain limitations and gaps were determined in the subject of capacities or knowledge management on climate change, particularly about adaptation in Panama's agri-food systems. These have been grouped into several aspects of a systemic, institutional, and individual nature, which reflect the opinions expressed in the training:

- Lack of coordination and articulation between various sectors and the involvement of different disciplines mainly in local communities or indigenous groups social, economic and environmental spheres, and scientific, generated, and traditional knowledge.
- Absence in the participation of decision makers in learning platforms or knowledge management, which would enhance the skills to systematize and reflect on experiences in other countries and environments.
- Lack of incorporation of the adaptation topic in formal education curricula.

3.2. Evaluation of the impact of training from the perspective of the participants

[Figure 1](#) shows the first two dimensions of the SCA of the contingency table corresponding to the crossing of the variables group of participants and the impact of the learning obtained. The graph suggests, in its first axis (with an inertia of 62.70%), that the students associate the training with the contribution of ample knowledge in the academic formation. On the other hand, technicians link the training with the opportunity to strengthen the capacity of the institutions in the field of adaptation to climate change, as well as to respond to the possible impacts of climate variability in the area addressed. Finally, the group of participating teachers associated the impact of training with the integration of climate change adaptation to the institutions involved.

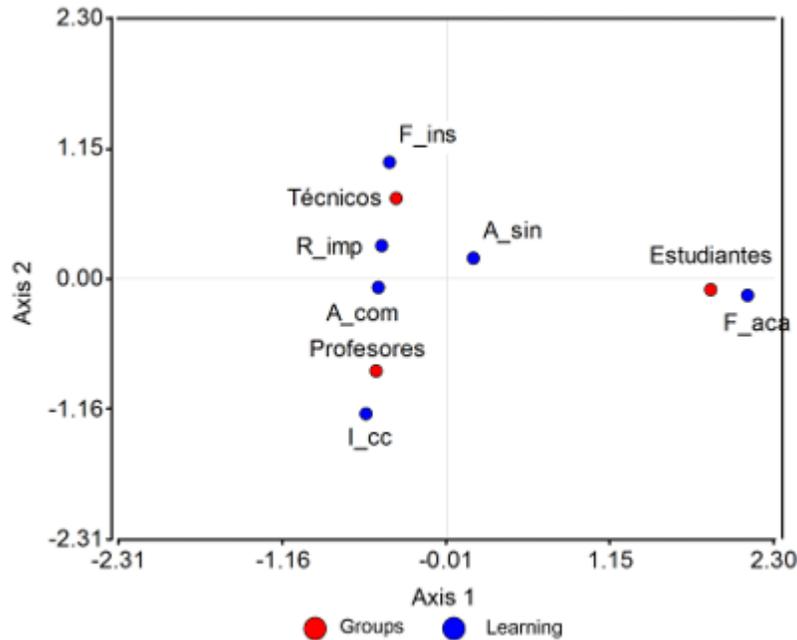


Figure 1. Biplot graph of the first two dimensions of the Simple Correspondence Analysis.

Note: Compiled by authors

The differences between the groups of participants and the impact of learning are observed; the graph suggests that there is an association between the role of the participants and the possible impact of the training. The three points that correspond to the groups of students, technicians and professors are in different quadrants and far from the center. [Table 3](#) shows the percentage of inertia of the axes.

Table 3. Contribution to the Chi square of the axes in the Simple Correspondence Analysis.

Axis	eigenvalue	Inertia	Chi- square	(%)	% Accumulated
1	0.88	0.77	16.99	62.10	62.10
2	0.69	0.47	10.37	37.90	100.00

Note: Compiled by authors

In Panama, some higher education institutions are beginning the process of incorporating topics or contents associated with climate change in the undergraduate and graduate studies curricula. For instance, the master's degree in Agricultural Sciences with emphasis on Natural Resources Management of the Regional University Center of Bocas del Toro in Changuinola and the Agronomic Engineering program incorporated contents related to climate change. The presence of certain international institutions such as IICA, FAO and CATIE offer a series of diplomas and specialization courses on the topic of risk management, vulnerability, and adaptation to climate change, providing

opportunities for those interested in participating, whether in face-to-face, distance or semi-face modalities.

These types of events promote education on climate change and public awareness in environments where access to education is restricted. Similar experiences have been developed in the last decade, especially in indigenous territories (Olivares *et al.*, 2017a; Camacho *et al.*, 2018). In order to face the challenges of adaptation to climate change and, considering that Panama is one of the most vulnerable places, it is convenient to take advantage of educational opportunities such as the one developed in this study in order to strengthen capacities in climate change issues.

Therefore, there is an urgency to move in another direction, more oriented towards structural changes that transcend and also transform collective consciousness. According to Maldonado and González (2014), awareness is also urgently needed through education and communication programs that promote real changes in individual, collective, institutional, structural lifestyles and behaviors, to curb climate change.

The literature available in Latin America highlights the need to implement training of this type considering the issues of climate change in indigenous territories (Rodríguez *et al.*, 2013), adaptation and mitigation (IISD, 2013), behavior of the variability of climate (Cortez *et al.*, 2016), rescue of traditional knowledge (Olivares *et al.*, 2012), eco-entrepreneurship strategies in indigenous territories (Pitti *et al.*, 2019). The purpose of such events would be aimed at decision makers, technical experts governmental and non-governmental institutions, municipalities, community leaders, students and teachers. Consequently, the training developed allowed to:

- Systematize part of the existing information through a practical and simple technological tool, which allowed to integrate interdisciplinary elements and ensure the permanence of knowledge and capacities created in the institutions to be able to form a solid information system at the agri-food level.
- Disseminate the knowledge acquired in a simple way, accessible to different levels and actors such as producers, public management professionals, planners, researchers, professors, technicians and political decision makers. With this type of training the lessons learned were identified and innovation or participatory transfer in indigenous territories is encouraged.
- Strengthen the nexus among needs, research and extension, through coordination between the University of Panama and the ministries to execute adaptation projects in the territories. Additionally, it is important to emphasize the importance of involving agricultural research and innovation systems in the development of projects.
- Stimulate the participatory knowledge dialogue through the incorporation and validation of scientific knowledge presented in the training with local and traditional knowledge of the indigenous communities of San San Druy and San San Tigra for the design and implementation of pilot adaptation measures.

- Propose the inclusion of adaptation to climate change within the formal education system, in which different capacities and training of technicians with a new paradigm are encouraged and strengthened.
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Conclusions

The participants of the training process related the impact of the learning obtained by establishing that the CRISTAL tool 2.0 would help implement measures that strengthen the climate resilience of food systems and identify indicators that measure changes in resilience with the passing of time. It is important to highlight this point, since this work presents quantitative statistical evidence of the impact of training at the level of learning and the perceptions of the participants, something that does not seem to have been reported in the scientific literature for this type of study.

In summary, this type of training strengthens the learning and acquisition of skills, which is why there is a need for professionals and communities capable of formulating measures, strategies and policies to adapt to climate change, both at community and at the provincial, regional and national level. The aim is not only to reduce the negative impacts of the phenomena associated with this change, but also to take advantage of the possible opportunities that arise from the same changes and international agreements.

This study represented the basis for the creation of a technical and academic awareness plan through knowledge management from the university, which could expand and improve the levels of education in topics such as mitigation and adaptation to climate change in Panama.

Acknowledgments

To the members of the indigenous communities of San San Druy and San San Tigra for the contribution and the receptivity during the visits. To the Campus of International Excellence of Environment, Biodiversity and Global Change (CEI-Cambio) in Seville, Spain for promoting training and rapprochement activities in indigenous territories of Panama.

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How to cite: Montenegro-Gracia, E.J., Pitti-Rodríguez, J.E. & Olivares-Campos, B.O. (2021). Adaptation to climate change in indigenous food systems of the Teribe in Panama: a training based on CRISTAL 2.0. *Luna Azul*,51, 182-197. Doi: [10.17151/luaz.2020.51.10](https://doi.org/10.17151/luaz.2020.51.10)

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