Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

https://doi.org/10.23913/ride.v14i28.1751

Scientific articles

Management plan for water security in a rural community in the state of Guerrero, Mexico

Plan de manejo para la seguridad hídrica en una comunidad rural del estado de Guerrero, México

Plano de gestão para segurança hídrica em uma comunidade rural do estado de Guerrero, México

Sirilo Suastegui Cruz
Universidad Autónoma de Guerrero
sirilo_sc@uagro.mx
https://orcid.org/0000-0001-6795-6312

Felipe Gallardo López *
Colegio De Postgraduados Campus Veracruz
felipegl@colpos.mx
https://orcid.org/0000-0003-1490-4919

*Corresponding author

Abstract

Freshwater systems provide a wide range of resources and services that are often vulnerable to climate change and other human pressures that affect millions of people who live there. The implementation of a management plan for water security in a rural community in the State of Guerrero, Mexico; contributed to the increase in water security under a Logical Framework approach with its variant of objectives nested in cascading matrices. Where workshops and meetings were developed to work on communal activities, strengthening organization, participation and care of the environment.

This approach provided a rapid and participatory way to choose options, taking into account multiple impacts, sectors, dimensions of resilience and stakeholder perspectives. The measures indicated in the projects revolve around increasing human and social capital

(organization, training and community participation) so that their implementation is expected to contribute to the improvement of water governance.

Keywords: Water security, food security, community participation, solution alternatives

Resumen

Los sistemas de agua dulce proporcionan una amplia gama de recursos y servicios que a menudo son vulnerables al cambio climático y otras presiones humanas que afectan a millones de personas que viven allí. La implementación de un plan de gestión para la seguridad hídrica en una comunidad rural del Estado de Guerrero, México; contribuyó al aumento de la seguridad hídrica bajo un enfoque de Marco Lógico con su variante de objetivos anidados en matrices en cascada. Donde se desarrollaron talleres y reuniones para trabajar las actividades comunales, fortaleciendo la organización, la participación y el cuidado del medio ambiente.

Este enfoque proporcionó una forma rápida y participativa de elegir opciones, teniendo en cuenta múltiples impactos, sectores, dimensiones de resiliencia y perspectivas de las partes interesadas. Las medidas indicadas en los proyectos giran en torno a incrementar el capital humano y social (organización, formación y participación comunitaria) por lo que se espera que su implementación contribuya a la mejora de la gobernanza del agua.

Palabras claves: Seguridad hídrica, seguridad alimentaria, participación comunitaria, alternativas de solución.

Resumo

Os sistemas de água doce fornecem uma vasta gama de recursos e serviços que são frequentemente vulneráveis às alterações climáticas e outras pressões humanas que afectam milhões de pessoas que ali vivem. A implementação de um plano de gestão para a segurança hídrica numa comunidade rural no Estado de Guerrero, México; contribuiu para o aumento da segurança hídrica sob uma abordagem de Quadro Lógico com a sua variante de objectivos aninhados em matrizes em cascata. Onde foram desenvolvidas oficinas e reuniões para trabalhar atividades comunitárias, fortalecendo a organização, a participação e o cuidado com o meio ambiente.

Esta abordagem proporcionou uma forma rápida e participativa de escolher opções, tendo em conta múltiplos impactos, setores, dimensões de resiliência e perspetivas das partes interessadas. As medidas indicadas nos projectos giram em torno do aumento do capital

humano e social (organização, formação e participação comunitária) para que se espere que a sua implementação contribua para a melhoria da governação da água.

Palavras-chave: Segurança hídrica, segurança alimentar, participação comunitária, soluções alternativas

Reception Date: June 2023 **Acceptance Date:** December 2023

Introduction

Freshwater systems provide a wide range of resources and services that are often vulnerable to climate change and other human pressures that affect millions of people who live there. This problem is observed more frequently in highly marginalized populations (Romo Aguilar and Maldonado, 2022) that lack good quality water and insufficient food. Simply put, climate change puts human security at risk by reducing access and quality of natural resources that support livelihoods (Meng *et al.*, 2016; Roque-Malo & Kumar, 2017).

Indeed, the rapid changes associated with increasing temperatures have caused socio-environmental problems where they did not exist before (Ray *et al.*, 2015) such as the change in the water cycle and in the supply and demand patterns of the resource that affect agriculture (Kang *et al.*, 2009; Wada & Bierkens, 2014), hence security must be provided in rural areas and social groups considered the most vulnerable sectors (Misselhorn & Hendriks, 2017).

For this reason, it is important to address water security as an emerging and strategic issue, since fluctuations in precipitation can cause a shortage of available water and reduce its quality due to contamination due to anthropogenic activities (Peña, 2016; Rosas -Acevedo *et al.*, 2015; Vörösmarty *et al.*, 2010). In this sense, water problems must constitute a priority of public management policy and give rise to an effective strategy to guarantee water security for human beings and for aquatic biodiversity (Rosas Acevedo *et al.*, 2016; Vörösmarty *et al.*, 2010). In fact, planners and decision makers must consider water resources as essential for agricultural and domestic activities (Turral *et al.*, 2011), as well as for activities that contribute to the development of regions (Rosas Acevedo *et al.*, 2016).

Recent research on climate change, particularly that which has applied a community-based approach and bottom-up local development, has led to the design of local proposals, programs, policies and management plans to ensure water security (Connell & Grafton, 2008). Governance practices prioritize good water management (Cook & Bakker, 2012), an essential aspect for long-term social sustainability and greater resilience to climate change.

Therefore, the objective of this research was to design a participatory community management plan for water security in the town of Las Animas Guerrero, Mexico, using the logical framework approach (EML) and its variant of cascade matrices to contribute to an efficient and sustainable management of the resource under community control.

Materials and methods

The participatory planning exercise was carried out in the community of Las Ánimas, municipality of Tecoanapa, which belongs to the Costa Chica region of the state of Guerrero, in Mexico. It is located at an altitude of 660 m asl (Suastegui Cruz, 2021; Suastegui Cruz *et al.*, 2017, 2018). The warm subhumid climate predominates (García, 1973) with an average annual temperature of 31 °C; In the coldest months (January and February) it reaches up to 24.9 °C.

Methodologically, the logical framework model was applied with five local groups (Commissioner of Communal Property, Municipal Commissioner, Surveillance Council, Health Center and Water Committee) because they all have responsibility for decisions regarding access to water.

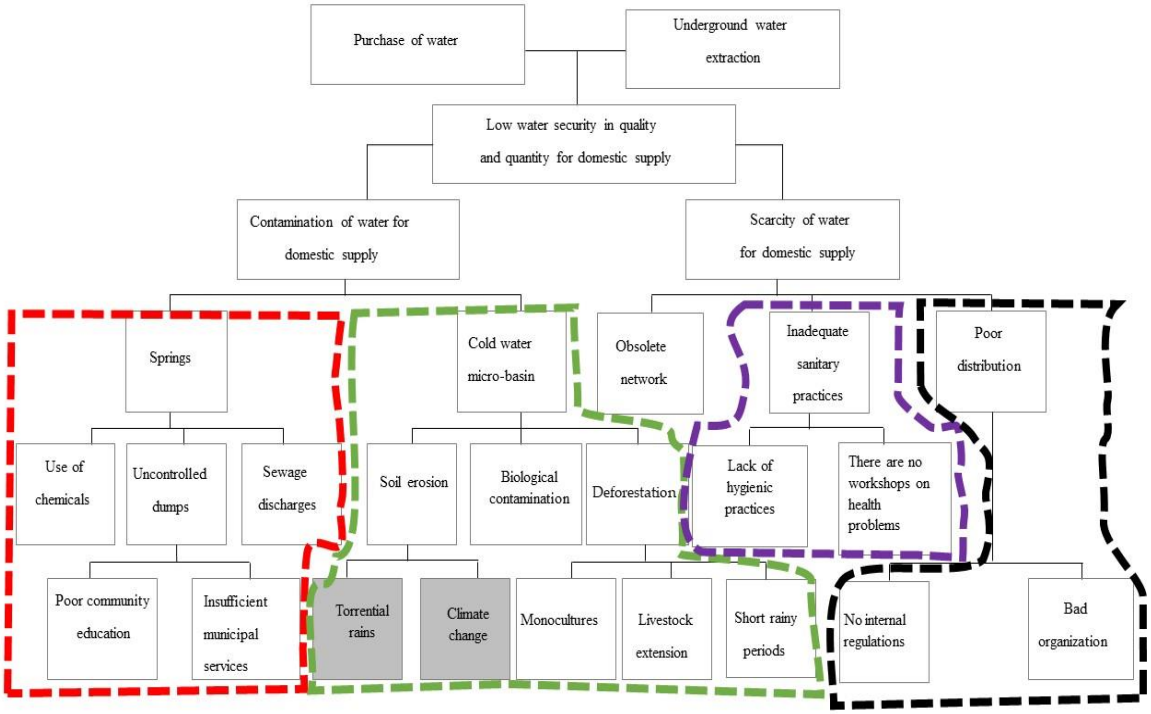
The first step was to raise awareness among the different working groups through two meetings for a first socio-environmental diagnosis. As a second step, two workshops were organized to identify, prioritize and reach a consensus on the problems that impact the residents. In these workshops, opinions on current problems were provided and a set of proposals was gathered that helped in the development of a problem tree (core, causes and consequences), which resulted in logical framework matrices (MML) for each one. of the alternatives that were taken from the problem tree. The latter (the alternatives) became specific projects and, in turn, in ascending order, into two programs, which were integrated into the general MML, which helped increase water security, since it was affected in quantity and quality, the main problem in the community. This nesting of MML in ascending order is known as cascading arrays. This management plan proposal was designed based on the characteristics of the community, its problems and felt needs, taking into account its social, economic and cultural reality.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Results and discussion

As a result of the community participation process, low water supply was identified as the main problem due to two factors: first, the low availability of water for domestic supply in the dry season; the second, the increasing contamination of available water due mainly to the chemicals used in peasant agriculture and the poor management of waste for local surface streams (Sarmiento *et al.*, 2019). In addition, four other themes were identified (figure 1):

Figure 1. Objective tree and analysis of alternatives for water resource in Las Animas, Gro.



Source: Own elaboration

Project 1. Clean sources (table 1): Citizens carried out several activities to clean water sources, for which they developed appropriate practices for the use of pesticides in order to avoid contamination and promote more sustainable agriculture. These are new ecologically sustainable options that ensure the environmental services and natural components of a place, mainly its biodiversity, but also ancestral cultural patterns (Peña Díaz, 2019; Plieninger *et al.*, 2015). Therefore, this project helped the purification and protection of sources with sustainable agricultural production.

Likewise, another factor that affects global warming and the loss of biodiversity is water contamination by urban solid waste (Abdel-Shafy & Mansour, 2018; Peña Díaz, 2019; Khandelwal *et al.*, 2019; Leyva-Zuñiga *et al.*, 2021; Valverde Espinoza, 2017). This is more

palpable in rural areas, where social, economic, political and environmental conditions do not exist. For this reason, in the study area, alternatives have been created for environmental management, such as the creation of forest resources and the protection of water sources intended for human consumption, as well as the introduction of ecological dry latrines in areas where there is no drainage. nor sewage (Valverde Espinoza, 2017). However, pollution is being generated by products that are used in agricultural activities.

Table 1. Clean springs project in Las Animas, Guerrero

Narrative summary	Verifiable indicators	Verification means	Basic assumptions
Goal Contribute to improving the quality of spring water for domestic supply in Las Animas Gro.	Improve the water quality of the common use springs of Las Animas by 20%.	Monitoring samples with macroinvertebrates at six springs.	The monitored springs remain stable.
Purpose Decreased pollution of two springs in Las Animas, Gro.	Reduce pollution by 20% in two springs.	Monitoring samples with macroinvertebrates and physicochemical parameters from two springs.	The monitored springs are decreasing their pollution problems.
Components 1. The sustainable farm has been installed for the training of agrochemicals and good management of its waste. 2. Proper management of MSW through the three Rs. 3. The sustainable farm has been installed for the creation of	Contribute 30% to the good quality of water in the common use springs of Las Animas.	Monitoring samples with macroinvertebrates at six springs.	Greater management and use of organic waste.

ecological bathrooms.			
Activities 1.1. Contribute to the establishment of organic agricultural techniques. 1.2. Raise awareness among farmers to take elements of traditional farming that contribute to better management. 2.1. Train to avoid the excessive and uncontrolled use of agrochemicals in agriculture. 3.1 Training for establishing ecological bathrooms.	1.1. In the first year, 20% of the farmers carry out new organic agricultural techniques. 1.2. In the first year, 20% of the farmers carry out traditional farming. 2.1. In the first year, three workshops on agrochemicals in agriculture will be taught. 3.1. In the first year, twenty ecological bathrooms are created.	1.1.Record of citizen attendance at workshops. 1.2.Record of citizen attendance at workshops. 2.1.Record of citizen attendance at workshops. 3.1. Annual report of the municipal commissioner.	1.1.Top production techniques. 1.2.Participation and dialogue of knowledge of agricultural activities among citizens. 2.1. Generation of new knowledge on agrochemical management. 3.1. Assimilation of the application of ecological toilets in the community.

Source: Own elaboration

Project 2. Clean Cold Water Micro basin (table 2): Its objective was to guarantee clean water suitable for domestic use. This activity contributes to the degradation of agricultural lands and causes water problems that result from inadequate practices in various agricultural uses (Zamora *et al.*, 2017). Therefore, the practice of sustainable agriculture is a way of social well-being (Ding *et al.*, 2018), since it is proven that foods absorb physicochemical properties through contaminated water and products derived from them, which can cause health problems. health in consumers (Caloni *et al.*, 2016). Furthermore, the toxic effects of agrochemicals also cause problems for other species (Beckie & Harker, 2017) that help balance ecosystems.

Therefore, the implementation of soil restoration strategies in through reforestation (Rico Hernández *et al.*, 2018) improves soil quality, as well as the growth of vegetation to prevent erosion (Amoah *et al.*, 2018) .

Table 2. Las Animas Clean Cold Water Micro basin Project, Guerrero

narrative summary	Verifiable indicators	Verification means	Basic assumptions
End Contribute to improving the quality of water in the Agua Fría micro-basin, suitable for domestic supply in Las Animas Gro.	Contribute to 20% of the clean water of the Agua Fría micro-basin.	Monitoring samples with macroinvertebrates and specific ones in the Agua Fría micro basin.	Implementation of internal regulations and clean water for domestic use.
Purpose Reduce pollution in the Agua Fria micro-basin.	Reduce 20% of pollution in the Agua Fria micro-basin.	Monitoring samples with macroinvertebrates and specific ones in the Agua Fría micro-basin.	Better organization and participation of community authorities.
Components 1.1. Management of a sustainable farm: a) Reduce biological contamination due to contaminated sludge. b) Contribute to the restoration of alluvial soils and compost. 2.1. Deforestation mitigation.	Contribute to 30% of the good water quality in the Agua Fría micro basin.	Samples of socio-environmental monitoring.	Regulation and management of agrochemicals and sustainable use of water.

Activities 1.1. Sustainable farm: a) Training for the fertilization of eroded soils with mud and giving workshops for the practice of sustainable polycultures. b) Create cleaning brigades in the river. 3.1. Reforestation campaign.	1.1. Contribute to 20% of the garbage collection in the micro basin. 2.1. Reduce soil erosion in two hundred hectares in the first year and contribute to 40% of the practice of polycultures in three hundred hectares. 3.1. Contribute to 30% of the deforested areas of the Las Animas industrial estate.	1.1.Record of people's attendance at workshops. 2.1.Record of people's attendance at workshops. 3.1.Record of people's attendance at workshops.	1.1.Community participation in workshops and training. 2.1. Community awareness towards water security problems. 3.1. Regulation of forest fires.

Source: Own elaboration

Project 3. Good sanitary practices (table 3): Its purpose was to raise awareness among citizens to carry out good sanitary practices regarding the proper management of water in the town. Rural areas are more susceptible to health problems, as it is believed that poverty leads to poor health and that this leads the poor to increase their level of poverty (Wagstaff, 2002), which, in turn, it is related to the poor health culture that some people in vulnerable locations have.

Therefore, the implementation of environmental education programs (PEA) contribute to mitigating health and environmental problems, since new knowledge is generated, with values and skills among individuals, and where educational institutions are drivers for the reduction of environmental deterioration both in urban and rural places (Casaló & Escario, 2018; Thondhlana & Hlatshwayo, 2018).

In the case of rural areas, problems are exacerbated by insufficient water distribution infrastructure, since failure to provide timely maintenance causes water leaks, coupled with wasteful human behavior (Castillo, 2015). In the case of the study area, in 2020 a new drinking water network was implemented, taken from two points of the local ejido, which helped increase the resource, but also contributed to the expansion to neighborhoods where

they did not benefit. with the resource since its foundation. In this sense, it should be noted that the storage tank has a capacity of 10,000 liters, which is filled twice a day in the rainy season, and only once a day in the dry season. People's satisfaction with the new network is evident, which made the water for all project crucial for good operation, management and distribution of the resource in the localities.

Table 3. Good health practices project

Narrative summary	Verifiable indicators	Verification means	Basic assumptions
Goal Contribute to the rational use of water in the town of Las Animas Gro.	30% of people manage the water resource well.	Record of people's attendance at the workshops on good water habits.	Administration and rational management of water resources.
Purpose Apply good sanitary practices (hygiene).	30% of people are aware of the problems caused by poor sanitary practices.	Record of people's attendance at good health practices workshops.	Application of acquired knowledge towards management of health practices.
Components 1. Use of the new water network. 2. Contribute to good health practices. 3. Training on health problems.	20% of people practice good water use practices.	Samples of socio-environmental monitoring.	They carry out activities to improve environmental problems.
Activities: 1.1. Management of a new network. 2.1. Environmental Education for the good culture of good uses of water	1.1. New drinking water network. 2.1. Contribute to 30% of the knowledge of good water use habits and contribute to 40%	1.1.Photographic evidence for the operation of the new network. 2.1. Record of people's attendance at workshops.	1.1.More efficient infrastructure of the new water network. 2.1 Environmental education activities are carried out.

and health problems.	of good education on health problems.		

Source: Own elaboration

Project 4. Water for all in the town of Las Animas (table 4): Its purpose is to improve distribution and community organization to reduce water scarcity in the town. Much of the regions of the state of Guerrero base their laws on uses and customs, so that people have the power to create their own internal regulations that define their rights and duties (Dehouve, 2018; Gaussens, 2019; Suastegui-Cruz and Hernández-Moreno, 2023). However, the regulations must be updated for any problem that requires control of its correct operation, such as the distribution of water resources in the locality. It must also be taken into account that the municipalities are obliged to work for the benefit of the localities, in this case the implementation of the new network, a task of "political will" that allowed the availability of water to be significantly increased (Mendoza-Espinosa *et al.*, 2019).

The regulation will allow better organization of the population and strengthen community development as a central component of the practice and knowledge of collective work (Clarke, 2018; Das *et al.*, 2016), which will serve to make better decisions for access and enjoy natural resources. This, however, leads to a change in social structures (Despard, 2016; McKinley *et al.*, 2017; Shapiro *et al.*, 2015).

Table 4. Water project for all in the town of Las Animas Guerrero

Narrative summary	Verifiable indicators	Verification means	Basic assumptions
Goal Improvement of the distribution and community organization of the individuals of Las Animas.	Contribute to 30% of good water distribution.	Operation manual for water distribution.	There is a more equitable administration of water.
Purpose Reduce water scarcity in the town of Las Animas.	Contribute to 30% of a good organization in Las Ánimas.	Annual activity report by the municipal commissioner of community projects.	Decision making and community reports according to internal regulations.
Components 1. Operation manual: a) Water distribution. b) Good organization.	Contribute to 30% of the improvement actions for the distribution of the town.	Sum of knowledge, practices and good management of the water resource.	The new regulations are implemented in the short term and rights and obligations are assumed.
Activities 1.1. Operation manual for water distribution for the Las Animas neighborhoods. a) Training for the creation of internal regulations. b) Train for community participation.	1.1. Contribute to 20% of the water distribution of the six neighborhoods in the town of Las Ánimas. a) Contribute 30% to good management of the water resource. b) Contribute to 30% of the community	1.1. Samples of social monitoring by the committees. a) Samples of social monitoring by the committees. b) Record of people's attendance at workshops.	1.1. The new network system is designed with gravity methods for water supply. a) Solutions are given to social problems through water distribution. b) Better organization

	organization for the management of programs for the town.		and joint work of local authorities.

Source: Own elaboration

The importance of designing community plans for the protection and conservation of natural resources is a simple and organized way to execute strategies that arise from the communities. The plan allows working with better results in favor of community organization and improves participation in activities such as the collective cleaning of rivers and public areas (Bussotti *et al.*, 2015; McKinley *et al.*, 2017) .

Another biodiversity management mechanism is the wildlife conservation management units (UMA), a system that was established in 1997 with the objective of helping to reconcile and mutually reinforce biodiversity conservation with productive and development needs. socioeconomic of the rural sector.

The UMA standard establishes that all units need a management plan; In this case, it was made up of four projects (aggregated into two programs) (table 5) for which objectives were established that contributed to good water quality in the town of Las Animas (Jofre-Meléndez *et al.*, 2015; López -Velasco *et al.*, 2015; Vigo Barrios, 2019).

Table 5. Water security plan for the town of Las Animas, municipality of Tecoanapa, Guerrero

Narrative summary	Verifiable indicators	Verification means	Basic assumptions
Goal Contribute to water security for domestic supply in Las Animas Gro.	Contribute to 60% of good water distribution	Registration by the municipal commissioner of the people who benefit from the water resource	Better administration of water resources by municipal authorities and citizens.
Purposes 1.1. Improve the quality of water for domestic supply. 2.1. Improve the distribution of water resources for domestic supply.	30% of people know the problems caused by poor sanitary practices	Registration by the municipal commissioner of deep wells in the town	Regulation of deep wells by authorities and citizens.
Component one Decreased pollution of two springs in Las Animas, Gro. Component two Reduce pollution in the Agua Fria micro-basin.	Contribute to 60% of the good water quality of the springs in Las Animas, Gro. Contribute to 60% of the good water quality in the Agua Fría micro-basin.	Health center records of people who have had gastrointestinal and skin problems. Health center records of people who have had gastrointestinal and skin problems.	Public health problems are reduced and health measures are implemented
Component three Apply good sanitary practices (hygiene). Component four Improve distribution to reduce water scarcity in the town of Las Animas.	Contribute to 60% of good sanitary practices (hygiene). Contribute to 60% of good distribution to reduce water scarcity	Health center registration of dengue, Zika and chikungunya problems due to bad practices. Tours by the authorities to	There is greater efficiency of health problems.

	in the town of Las Animas.	distribute the resource and reduce water scarcity.	Greater surveillance of the water distribution network.

Fountain: own elaboration

Conclusions

The development of projects and strategies designed to address water supply and quality problems in the community allowed good management of natural resources and the conservation of biodiversity, as well as raising awareness among citizens to reduce pollution, promote sustainable agricultural practices, improve environmental education and strengthen community organization.

Furthermore, the log frame matrix provided a relatively quick and participatory way to choose options considering multiple impacts, sectors, dimensions of resilience, and stakeholder perspectives. The measures identified in the projects revolved around increasing human and social capital (organization, training and community participation), so it is expected that this model will be replicated in places with similar characteristics in order to improve the quality of services, food, health and local development.

Future lines of research

Community projects and programs that have active citizen participation must be evaluated, since this makes the development of activities for the benefit of an entire population more feasible. In this sense, social, economic and environmental development has to be seen from the bottom up so that people can be empowered by their problems and contribute to their mitigation, a crucial issue for social sciences.

On the other hand, it is worth highlighting that similar research has been carried out on diagnostic evaluation with the logical framework matrix in Latin American countries, although these have been very scarce in Mexico, which would set the tone for understanding locally what the forms are of community organization and participation. Therefore, it is suggested to guide lines of research that help environmental, social and economic conservation.

References

Abdel-Shafy, H. I. and Mansour, M. S. M. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian Journal of Petroleum*, *27*(4), 1275-1290. https://doi.org/10.1016/j.ejpe.2018.07.003

Amoah, I. D., Adegoke, A. A. and Stenström, T. A. (2018). Soil-transmitted helminth infections associated with wastewater and sludge reuse: A review of current evidence. *Tropical Medicine & International Health*, *23*(7), 692-703. https://doi.org/10.1111/tmi.13076

Beckie, H. J. and Harker, K. N. (2017). Our top 10 herbicide-resistant weed management practices: Our top 10 practices. *Pest Management Science*, *73*(6), 1045-1052. https://doi.org/10.1002/ps.4543

Bussotti, F., Pollastrini, M., Holland, V. and Brüggemann, W. (2015). Functional traits and adaptive capacity of European forests to climate change. *Environmental and Experimental Botany*, *111*, 91-113. https://doi.org/10.1016/j.envexpbot.2014.11.006

Caloni, F., Cortinovis, C., Rivolta, M. and Davanzo, F. (2016). Suspected poisoning of domestic animals by pesticides. *Science of The Total Environment*, *539*, 331-336. https://doi.org/10.1016/j.scitotenv.2015.09.005

Casaló, L. V. and Escario, J.-J. (2018). Heterogeneity in the association between environmental attitudes and pro-environmental behavior: A multilevel regression approach. *Journal of Cleaner Production*, *175*, 155-163. https://doi.org/10.1016/j.jclepro.2017.11.237

Castillo, M. V. L. (2015). Análisis económico del consumo medido de agua potable en la ciudad de Puno. *Revista Investigaciones Altoandinas*, *17*(1), 117-124.

Clarke, S. (2018). *Social Work as Community Development: A management model for social change*. Routledge.

Connell, D. and Grafton, Rq. (2008). Planning for water security in the Murray-Darling Basin. *Public Policy*, *3*(1), 67-86.

Cook, C. and Bakker, K. (2012). Water security: Debating an emerging paradigm. *Global Environmental Change*, *22*(1), 94-102. https://doi.org/10.1016/j.gloenvcha.2011.10.011

Das, C., O'Neill, M. and Pinkerton, J. (2016). Re-engaging with community work as a method of practice in social work: A view from Northern Ireland. *Journal of Social Work*, *16*(2), 196-215. https://doi.org/10.1177/1468017315569644

Dehouve, D. (2018). Estado plural, indios plurales. *Revista Trace*, *46*, 11. https://doi.org/10.22134/trace.46.2004.492

Despard, M. R. (2016). Challenges in Implementing Evidence-Based Practices and Programs in Nonprofit Human Service Organizations. *Journal of Evidence-Informed Social Work*, *13*(6), 505-522. https://doi.org/10.1080/23761407.2015.1086719

Ding, D., Liu, P. and Ravenscroft, N. (2018). The new urban agricultural geography of Shanghai. *Geoforum*, *90*, 74-83. https://doi.org/10.1016/j.geoforum.2018.02.010

García, E. (1973). *Modificaciones al sistema de clasificación climática de Köppen. Instituto de Geografia.* UNAM. Serie Libros n.º 6.

Gaussens, P. (2019). Por usos y costumbres: los sistemas comunitarios de gobierno en la Costa Chica de Guerrero. *Estudios Sociológicos*, *37*(111), 659-687.

Jofre-Meléndez, R., Cervantes-Pérez, J. and Barradas, V. L. (2015). Calidad del agua de la niebla captada artificialmente en la microcuenca del río Pixquiac, Veracruz, México: Resultados preliminares. *TIP. Revista Especializada en Ciencias Químico-Biológicas*, *18*(2), 122-130.

Kang, K., Park, S., Kim, Y. S., Lee, S. and Back, K. (2009). Biosynthesis and biotechnological production of serotonin derivatives. *Applied Microbiology and Biotechnology*, *83*(1), 27-34. https://doi.org/10.1007/s00253-009-1956-1

Khandelwal, H., Dhar, H., Thalla, A. K. and Kumar, S. (2019). Application of life cycle assessment in municipal solid waste management: A worldwide critical review. *Journal of Cleaner Production*, *209*, 630-654. https://doi.org/10.1016/j.jclepro.2018.10.233

Leyva-Zuñiga, A. P., Rosas-Acevedo, J. L., Aguilar Cucurachi, M. S., Gálan-Castro, E. A., Juárez-López, A. L., Arellanos-Wences, H. J. and Suastegui-Cruz, S. (2021). Problemática socioambiental por residuos sólidos urbanos en Las Ánimas, municipio de Tecoanapa, Guerrero, México. *Academia Journals*, *13*(1), 139-143. https://static1.squarespace.com/static/55564587e4b0d1d3fb1eda6b/t/6061331c89261203271fade1/1616982823485/Tomo+03+-+Memorias+Academia+Journals+Fresnillo+2021.pdf

López-Velasco, R., Rodríguez-Herrera, A., González-González, H., Olivier-Salomé, B. and Montalvo-Marques, C. (2015). Percepción de calidad de vida, contaminación y riesgo en localidades rurales del Municipio de Tecoanapa, Guerrero. *Estudios en Biodiversidad*, *14*. https://digitalcommons.unl.edu/biodiversidad/14/

McKinley, D. C., Miller-Rushing, A. J., Ballard, H. L., Bonney, R., Brown, H., Cook-Patton, S. C., Evans, D. M., French, R. A., Parrish, J. K., Phillips, T. B., Ryan, S. F., Shanley, L. A., Shirk, J. L., Stepenuck, K. F., Weltzin, J. F., Wiggins, A., Boyle, O. D., Briggs, R. D., Chapin, S. F., … Soukup, M. A. (2017). Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation*, *208*, 15-28. https://doi.org/10.1016/j.biocon.2016.05.015

Mendoza-Espinosa, L. G., Burgess, J. E., Daesslé, L. and Villada-Canela, M. (2019). Reclaimed water for the irrigation of vineyards: Mexico and South Africa as case studies. *Sustainable Cities and Society*, *51*, 101769. https://doi.org/10.1016/j.scs.2019.101769

Meng, Q., Chen, X., Lobell, D. B., Cui, Z., Zhang, Y., Yang, H. and Zhang, F. (2016). Growing sensitivity of maize to water scarcity under climate change. *Scientific Reports*, *6*(1), 19605. https://doi.org/10.1038/srep19605

Misselhorn, A. and Hendriks, S. L. (2017). A systematic review of sub-national food insecurity research in South Africa: Missed opportunities for policy insights. *PLOS ONE*, *12*(8), e0182399. https://doi.org/10.1371/journal.pone.0182399

Peña, H. (2016). *Desafíos de la seguridad hídrica en América Latina y el Caribe*. Cepal.

Peña Díaz, S. (2019). Condiciones hídricas en la Cuenca del Valle de México. *Tecnología y Ciencias del Agua*, *10*(2), 98-127.

Plieninger, T., Bieling, C., Fagerholm, N., Byg, A., Hartel, T., Hurley, P., López-Santiago, C. A., Nagabhatla, N., Oteros-Rozas, E., Raymond, C. M., van der Horst, D. and Huntsinger, L. (2015). The role of cultural ecosystem services in landscape management and planning. *Current Opinion in Environmental Sustainability*, *14*, 28-33. https://doi.org/10.1016/j.cosust.2015.02.006

Ray, D. K., Gerber, J. S., MacDonald, G. K. and West, P. C. (2015). Climate variation explains a third of global crop yield variability. *Nature Communications*, *6*(1), 5989. https://doi.org/10.1038/ncomms6989

Rico Hernández, J. R., Gómez-Lucas, I., Navarro-Pedreño, J., Jordán, M. M., Bech, J., Nieto Asencio, V. M. and Portel Iñiguez, N. (2018). Environmental consequences from the use of sewage sludge in soil restoration related to microbiological pollution. *Journal of Soils and Sediments*, *18*(6), 2172-2178. https://doi.org/10.1007/s11368-017-1721-5

Romo Aguilar, M. L. and Maldonado, J. D. (2022). Justicia social: Accesibilidad a espacios públicos en contextos de marginación urbana en Ciudad Juárez, Chihuahua, México.

Perspectiva Geográfica, *27*(1), 11-31. http://www.scielo.org.co/scielo.php?pid=S0123-37692022000100011&script=sci_arttext

Roque-Malo, S. and Kumar, P. (2017). Patterns of change in high frequency precipitation variability over North America. *Scientific Reports*, *7*(1), 10853. https://doi.org/10.1038/s41598-017-10827-8

Rosas Acevedo, J. L., Sánchez Infante, A., Rosas Acevedo, A. Y., Sampedro Rosas, M. L. and Juárez López, A. L. (2016). Acuatic Insects at Southeast of Wetlands in the Tres Palos Lagoon, Acapulco, Guerrero, Mexico. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *25*(1), 89-99.

Rosas-Acevedo, A. Y., Sánchez-Infante, A. and Rosas-Acevedo, J. L. (2015). Calidad del agua en la subcuenca fluvial La Garita, Acapulco, Guerrero por monitoreo con insectos. *Estudios en Biodiversidad*, *10*, 121-129.

Sarmiento, E. G., Pérez, J. R. and Ortiz-Ospino, L. (2019). Análisis de las tecnologías en sistemas de abastecimiento de agua potable. *Investigación y desarrollo en TIC*, *10*(2), 32-44.

Shapiro, V. B., Hawkins, J. D. and Oesterle, S. (2015). Building Local Infrastructure for Community Adoption of Science-Based Prevention: The Role of Coalition Functioning. *Prevention Science*, *16*(8), 1136-1146. https://doi.org/10.1007/s11121-015-0562-y

Suastegui Cruz, S. (2021). Estrategias para la seguridad hídrica ante los cambios de precipitación por efectos del cambio climático. *RIDE Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, *12*(23). https://doi.org/10.23913/ride.v12i23.1039

Suastegui Cruz, S., Rosas Acevedo, J. L., Hernández Castro, E., Rodríguez Herrera, A. L. and Reyes Umana, M. (2017). Caracterización del uso actual del suelo en Las Ánimas, municipio de Tecoanapa, Guerrero. *Revista Iberoamericana de Ciencias*, *4*(6), 132-143.

Suastegui Cruz, S., Rosas Acevedo, J. L., Reyes Umaña, M., Rodríguez Herrera, A. L., Hernández Castro, E., Gallardo López, F. and Leyva Zúñiga, A. P. (2018). Water Scarcity Index Calculation, Atlas Animas, Tecoanapa Municipality, Guerrero, Mexico. *The Journal of Social Sciences Research*, *4*(5), 74-79. http://arpgweb.com/?ic=journal&journal=7&info=aims

Suastegui-Cruz, S. and Hernández-Moreno, T. (2023). *Saberes ambientales campesinos para la conservación y aprovechamiento del agua como bien común de Las Animas, comunidad de Tecoanapa, Guerrero, México*. *7*(25), 35-39. https://federacionglobal.com/FEGLININ/No25/jun2023/Vol-2/access.html

Thondhlana, G. and Hlatshwayo, T. N. (2018). Pro-Environmental Behaviour in Student Residences at Rhodes University, South Africa. *Sustainability*, *10*(8), 2746. https://doi.org/10.3390/su10082746

Turral, H., Burke, J. and Faurès, J.-M. (2011). *Climate change, water and food security*. Food and Agriculture Organization of the United Nations (FAO).

Valverde Espinoza, C. F. (2017). *Baños ecológicos secos para mejorar las condiciones de saneamiento en la comunidad turística de Conoc, Huánuco, 2017* (trabajo de grado). Universidad César Vallejo.

Vigo Barrios, M. I. (2019). *Eficiencia y costo de tres tipos de malla en la captación de agua de neblina en el Abra de Coimolache, Hualgayoc* (trabajo de grado). Universidad Privada del Norte.

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S. E., Sullivan, C. A., Liermann, C. R. and Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, *467*(7315), 555-561. https://doi.org/10.1038/nature09440

Wada, Y. and Bierkens, M. F. (2014). Sustainability of global water use: Past reconstruction and future projections. *Environmental Research Letters*, *9*(10), 104003.

Wagstaff, A. (2002). Pobreza y desigualdades en el sector de la salud. *Revista Panamericana de Salud Pública*, *11*, 316-326.

Zamora, F., Torres, D., Medina, M. y Labarca, R. (2017). Efecto de los sistemas agroforestales sobre La fertilidad de suelos de ladera de la sierra falconiana (Venezuela). *Revista Academia*, *16*(37).

Contribution Role	Author(s)
Conceptualization	Sirilo Suastegui Cruz and Felipe Gallardo López (Equal).
Methodology	Felipe Gallardo López (Principal). Sirilo Suastegui Cruz (Supporter)
Software	Sirilo Suastegui Cruz
Validation	Sirilo Suastegui Cruz
Formal Analysis	Sirilo Suastegui Cruz (Principal). Felipe Gallardo López (Supporter).
Investigation	Sirilo Suastegui Cruz
Resources	Sirilo Suastegui Cruz
Data curation	Sirilo Suastegui Cruz (Principal). Felipe Gallardo López (Supporter).
Writing - Preparation of the original draft	Sirilo Suastegui Cruz
Writing - Review and editing	Sirilo Suastegui Cruz and Felipe Gallardo López (Equals).
Display	Sirilo Suastegui Cruz (Principal). Felipe Gallardo López (Supporting).
Supervision	Sirilo Suastegui Cruz (Principal). Felipe Gallardo López (Supporter).
Project management	Sirilo Suastegui Cruz
Fund acquisition	Sirilo Suastegui Cruz