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

https://doi.org/10.23913/ride.v15i29.2133

Scientific articles

Saneamiento de agua gris doméstica, falta de conocimiento en El Cortijo, municipio de Ayutla de los Libres, Guerrero; México

Domestic gray water sanitation, lack of knowledge in El Cortijo, municipality of Ayutla de los Libres, Guerrero; Mexico

Saneamento de águas cinzentas domésticas, falta de conhecimento em El Cortijo, município de Ayutla de los Libres, Guerrero; México

Oscar Figueroa Wences*
Universidad Autónoma de Guerrero, México
13472@uagro.mx
https://orcid.org/0000-0002-0212-0044

Humberto Antonio González González
Universidad Autónoma de Guerrero, México
14380@uagro.mx
https://orcid.org/0000-0001-6718-9942

*Autor de correspondencia

Resumen

El trabajo se realizó porque en la comunidad El Cortijo, municipio de Ayutla de los Libres, región Costa Chica del estado de Guerrero, México, hay un aumento de descargas de agua gris doméstica vertidas al río, que provienen de viviendas cercanas a este cuerpo de agua. El objetivo fue investigar el conocimiento sobre el saneamiento de agua gris doméstica en la comunidad El Cortijo. La metodología empleada fue la cualitativa y el instrumento para recabar la información fue la entrevista, además, se realizó un taller dirigido a ciudadanos. Con los resultados se encontró que la mayoría de los ciudadanos entrevistados no saben que existen métodos sencillos, económicos y amigables con el medio ambiente, para sanear el agua gris de sus viviendas. Se descubrió que la mayoría de las casas ubicadas cerca del río vierten el agua gris al mismo. Se encontró que todos los ciudadanos entrevistados están

preocupados por la contaminación del río debido al vertimiento del agua gris, y manifestaron que desean aprender a sanear el agua gris que se genera en sus viviendas. También existen casas que vierten agua negra al río. Se concluye que el poco conocimiento sobre el saneamiento del agua gris doméstica se debe a la falta de difusión de tecnologías apropiadas para este fin. Por otro lado, en la comunidad está arraigada la idea de que los proyectos deben ser provistos por el gobierno; hace falta mayor intervención de la autoridad comunitaria en el cuidado del río.

Palabras clave: Agua residual, comunidad, educación ambiental, purificación.

Abstract

The work was carried out because in El Cortijo community, municipality of Ayutla de los Libres; Costa Chica region of the state of Guerrero; Mexico, there is an increase in domestic gray water discharges through the river, that come from homes near this body of water. The objective was to investigate the knowledge about domestic gray water sanitation in El Cortijo community. The methodology used was the qualitative and the instrument to collect the information was the semi-structured interview, in addition, a workshop was held for citizens. With the results it was found that the majority of the citizens interviewed do not know that there are simple, economical and environmentally friendly methods to clean up the gray water in their homes. It was found that most of the houses located near the river discharge their gray water into the river. It was found that all the citizens interviewed are concerned about the contamination of the river due to the dumping of gray water, and they stated that they want to learn how to clean up the gray water that is generated in their homes. There are also houses that discharge black water into the river. It is concluded that the little knowledge about domestic gray water sanitation is due to the lack of diffusion of appropriate technologies for this purpose; On the other hand, the community believes that projects should be provided by the government; it means that greater intervention of the community authority is needed in the care of the river.

Keywords: Residual water, community, environmental education, purification.

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

Resumo

O trabalho foi realizado porque na comunidade El Cortijo, município de Ayutla de los Libres, região de Costa Chica, estado de Guerrero, México, há um aumento nas descargas de águas cinzentas domésticas lançadas no rio, provenientes de residências próximas este corpo de água. O objetivo foi investigar o conhecimento sobre o saneamento de águas residuais domésticas na comunidade El Cortijo. A metodologia utilizada foi qualitativa e o instrumento de recolha de informação foi a entrevista. Além disso, foi realizada uma oficina dirigida aos cidadãos.

Os resultados revelaram que a maioria dos cidadãos entrevistados não sabe que existem métodos simples, económicos e ecológicos para limpar as águas cinzentas das suas casas. Verificou-se que a maioria das casas localizadas próximas ao rio descarregam nele água cinzenta. Verificou-se que todos os cidadãos entrevistados estão preocupados com a poluição do rio devido ao lançamento de águas cinzentas, e afirmaram que pretendem aprender como limpar a água cinzenta que é gerada nas suas casas. Há também casas que despejam água negra no rio. Conclui-se que o pouco conhecimento sobre o saneamento de águas cinzas domésticas se deve à falta de divulgação de tecnologias adequadas para esse fim. Por outro lado, a ideia de que os projectos devem ser fornecidos pelo governo está enraizada na comunidade; É necessária uma maior intervenção da autoridade comunitária no cuidado do rio.

Palavras-chave: Águas residuais, comunidade, educação ambiental, purificação.

Reception Date: May 2024 **Acceptance Date:** October 2024

Introduction

At a global level, the pollution of various bodies of water located in rural populations has become a growing problem. Few countries are really concerned about cleaning up wastewater and raising awareness among the population about a culture of water care; on the contrary: “It is a crisis of water resource management, essentially caused by the use of inadequate methods” (United Nations, 2003). The situation is also alarming: “Because a large part of the planet's water resources are subject to high levels of pollution (Echeverría and Anaya, 2018, p. 2).

Similarly: “In Latin America, the vast majority of countries suffer from the problem of heavy metal contamination in water. In […] Mexico, Argentina, Chile, El Salvador, Nicaragua, Peru and Bolivia, nearly four million people consume water contaminated by arsenic” (Bundschuh *et al* ., 2012, as cited in Reyes *et al.*, 2016, p. 71).

Water pollution in Mexico has been a topic of discussion in recent years, and international programs have even expressed concern about the results of poor water quality; therefore, it is necessary to seek alternatives to mitigate this situation.

Given the prevailing model of water management in Mexico, which results in more water pollution with a larger population and also incorporates water into the mercantilist and utilitarian dynamics of the economy, it is necessary to apply low-cost eco-technologies for the treatment of grey and black water at local and domestic levels.

In this regard, in a study to clean community wastewater in Pastorías, Actopan, Veracruz, by means of wetlands, Marín *et al.* They express that the use of these alternatives: “Reveals the usefulness of plants in treatment wetlands and how they should be planted to improve the removal of pollutants” (Marín *et al.*, 2024, pp. 39-40).

Another similar work is the study: “Greywater treatment for popular social interest housing, carried out in the municipality of Mineral de la Reforma, Hidalgo”, in which it was concluded that: considering the water stress experienced in central Mexico, the development and implementation of strategies and policies to mitigate water scarcity is urgent. Among them, one of the most immediately applicable is the reuse of greywater. The exploratory tests carried out with the proposed filter train allow us to consider the feasibility of developing its hydraulic design and its scaling in popular social interest housing already built or in future subdivisions (Bautista *et al.*, 2023, p. 155).

In the case of the state of Guerrero, have been little promoted, and the result is that: "The inadequate management of solid waste […] and the lack of sites for its final disposal in accordance with national regulations cause pollution problems in soils and bodies of water" (State Development Plan 2016-2021, p. 61).

Given this problem, it was important to conduct the study at a local level, since it had not been carried out in the community. According to Díaz *et al.* (2012, p. 80) “The study of the treatment of domestic wastewater under the principles of the theoretical approach of Sustainable Local Development, allows us to understand the characteristics of the case study with a better approach to reality.”

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

The work is also important for the methodological approach used, as it allowed obtaining the opinion and vision of citizens regarding the problem under study.

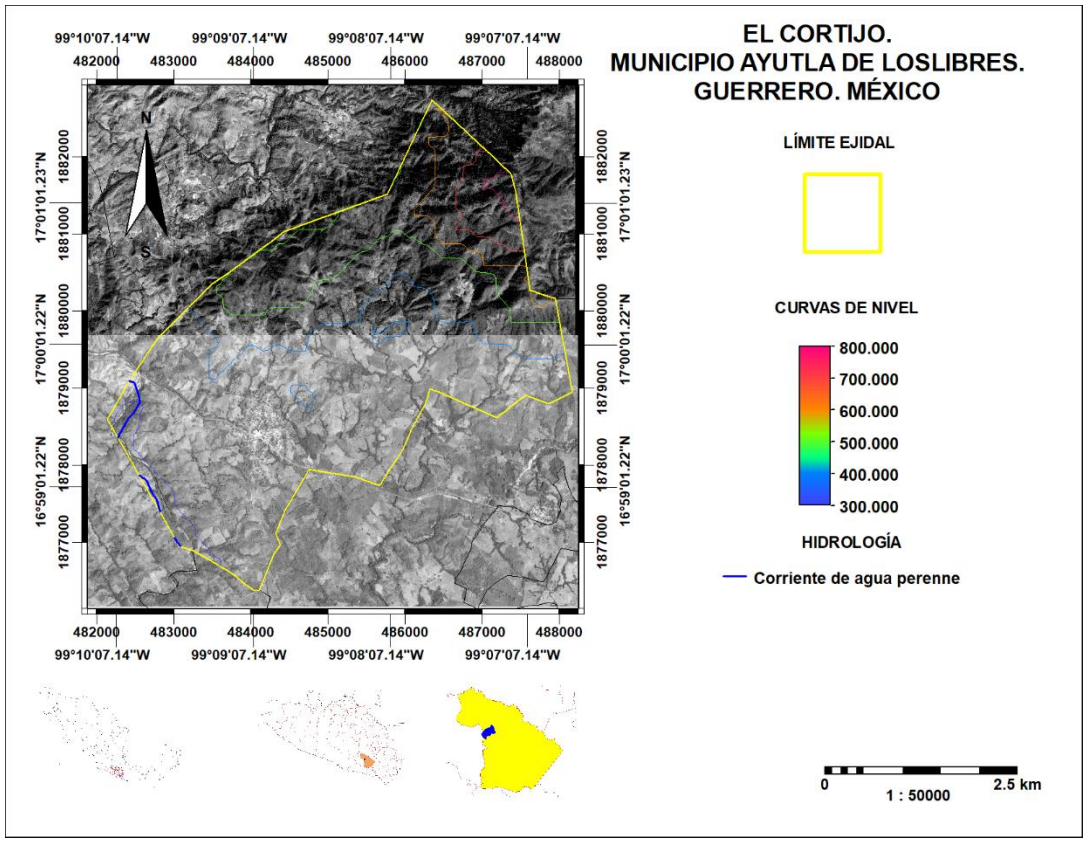
The above makes it necessary to ask the following research question: Is the lack of knowledge about alternatives for the treatment of domestic water what causes wastewater to be dumped into the river in the El Cortijo community, municipality of Ayutla de los Libres, Guerrero; Mexico?

Therefore, the objective of the research was:

1) To investigate what citizens of El Cortijo, municipality of Ayutla de los Libres; Guerrero; Mexico, know about domestic greywater sanitation.

Methodology

Figure 1. Location of the study area.



Source: Prepared by the authors using data from INEGI, 2008.

The methodology used was qualitative.

The qualitative methodology helped to achieve the objectives because: “Qualitative research focuses on understanding and deepening phenomena, exploring them from the

perspective of the participants in a natural environment and in relation to the context" (Hernández *et al.*, 2014, p. 358).

On the other hand, it was found that:

Qualitative methodology constitutes a novel contribution to the field of social sciences, psychology, linguistics, anthropology, history, demography, among others. In this process, quantifiable results are not obtained, as is commonly developed in scientific research. It must be taken into account that this process develops an observation technique, therefore, the results obtained are descriptive. The reasoning method used is inductive. Qualitative methodology serves to scientifically understand human experiences and cultures. Qualitative research tries to understand what people say. It seeks to give a subjective, descriptive response to everything that is related to the human being (De la Roche *et al.*, 2021, p. 19).

It was finally found that:

> A qualitative methodology [sic] helps to rebuilding the subjectivity of the partners and, at the same time, to control it, by being based on an intersubjective dialogue as a self-regulation factor. Ultimately, what is intended is to find solutions to specific problems that make up a common project (Ramírez, 2023, p. 37).

To resear knowledge about domestic greywater sanitation, a semi-structured interview was used as a tool.

"The interview, […] constitutes the natural, spontaneous and profound flow of the experiences and memories of a person through the presence and stimulation of another person who investigates, who manages, through this description, to capture […] its diverse meanings" (Carballo, 2001, p. 14).

It was also found that the In-Depth Interview, a technique of immediate, face-to-face interaction, it aims to know in depth a particular topic; a script with the main topics to be addressed can be used as a directed interview; however, the interviewee must be allowed to freely express their interests, beliefs and feelings regarding the topic. Therapeutic confidentiality is maintained. After the interview, the data is transcribed and analyzed and interpreted (Conejero, 2020, p. 244).

For the study, interviews were conducted with adults, both men and women. The information collected was interpreted through content analysis.

On the other hand, the location map of the study area was prepared with digital data from the National Institute of Statistics and Geography INEGI, 2008 and with the ILWIS 3.31 software.

Also, a workshop was designed and delivered:

"Workshops are a technique that allows the active participation of participants in identifying and solving problems, and in decision-making" (García, 2023, p. 208).

Workshop Description: Design and construction of a grease trap for the treatment of domestic grey water

To carry out part of the project, a face-to-face interaction workshop was held with families from the community.

It was carried out once the interview stage was completed.

It took place on the community basketball court.

It helped raise awareness among people and community authorities about the problem of river pollution.

To carry out the workshop, a group of citizens and community authorities were invited to participate. The objective of the workshop was to: The same was to show the participants the construction of a grease trap for the treatment of domestic grey water, using low-cost materials.

The workshop was attended by 150 people, including the ejidal commissioner. Later We went to the home of a person, to demonstrate the installation of the grease trap on site.

The following materials were used to build the grease trap:

- A 50-litre plastic drum.
- Two 90° PVC elbows.
- Three 10-centimeter nipples.
- Three leather bands.
- A marker.
- A small knife.
- Silicone or glue.
- A cotton filter, activated carbon, fine gravel, sand and coarse gravel.

Results

Knowledge about the discharge of grey and black water into the community river

Most of the interviewees stated that: “yes” there are houses that pour grey and black water into the river, only one interviewee stated that he did not know.

Table 1. Citizen knowledge of the fate of grey and black water.

Sex	Level of education	Occupation	Are there homes in the community that dump grey and black water into the river?
Female	Secondary	Housewife	"Yeah"
Female	Baccalaureate	Employee	"Yeah"
Male	Secondary	Carrier	"Yeah"
Female	Primary	Housewife	"Yeah"
Male	Degree	Student	"Yeah"
Female	Degree	Housewife	"Yeah"
Male	Secondary	Plumber	"Yeah"
Male	Baccalaureate	Taxi driver	"Yeah"
Female	Preparatory	Student	"No"
Female	Primary	Housewife	"Yeah"
Male	Secondary	Carrier	"Yeah"
Male	Primary	Construction worker	“Yes, most of the people”
Female	Primary	Housewife	"Yeah"

Female	Secondary	Housewife	"Yeah"
Female	Secondary	Housewife	"Yeah"
Female	Preparatory	Housewife	"Yeah"
Female	Primary	Housewife	"Yeah"
Female	Primary	Housewife	"Yeah"
Female	Degree	Student	"Yeah"
Female	None	Housewife	"Yeah"

Source: Prepared by the authors using field data.

Knowledge of methods for treating domestic grey water

As a result of the study, it was identified that the majority of the participants in the interviews do not know that there are simple methods to treat the grey water generated in their homes.

Table 2. Knowledge about methods for treating grey water in homes.

Sex	Level of education	Occupation	Did you know that there are simple methods to treat the grey water generated in your home?
Female	Secondary	Housewife	"No"
Female	Baccalaureate	Employee	"No"
Male	Secondary	Carrier	"No"
Female	Primary	Housewife	"Yeah"
Male	Degree	Student	"No"
Female	Degree	Housewife	"Yeah"
Male	Secondary	Plumber	"No"
Male	Baccalaureate	Taxi driver	"No"
Female	Preparatory	Student	"No"
Female	Primary	Housewife	"No"
Male	Secondary	Carrier	"Yeah"
Male	Primary	Construction worker	"No"
Female	Primary	Housewife	"Yeah"
Female	Secondary	Housewife	"No"
Female	Secondary	Housewife	"No"
Female	Preparatory	Housewife	"No"
Female	Primary	Housewife	"No"
Female	Primary	Housewife	“I think so”
Female	Degree	Student	"No"
Female	None	Housewife	"No"

Source: Prepared by the authors using field data.

Knowledge about grease traps

Of the 20 respondents, 15 said they had no idea what a grease trap is or what it is used for, which indicates that the majority of the population is unaware of domestic water treatment methods.

Table 3. Knowledge of grease traps in domestic water.

Sex	Level of education	Occupation	Do you know what a domestic grease trap is?
Female	Secondary	Housewife	"No"
Female	Baccalaureate	Employee	"No"
Male	Secondary	Carrier	"No"
Female	Primary	Housewife	"No"
Male	Degree	Student	"No"
Female	Degree	Housewife	"Yeah"
Male	Secondary	Plumber	"Yeah"
Male	Baccalaureate	Taxi driver	"No"
Female	Preparatory	Student	"No"
Female	Primary	Housewife	"No"
Male	Secondary	Carrier	"Yeah"
Male	Primary	Construction worker	"No"
Female	Primary	Housewife	"Yeah"
Female	Secondary	Housewife	"No"
Female	Secondary	Housewife	"No"
Female	Preparatory	Housewife	"No"
Female	Primary	Housewife	"No"

Female	Primary	Housewife	"Yeah"
Female	Degree	Student	"No"
Female	None	Housewife	"No"

Source: Prepared by the authors using field data.

If you have little knowledge about how to treat the water in your home, why do you think this is?

Most of the interviewees said that the lack of information on methods for cleaning water in homes is due to the low importance that community and municipal authorities have given to this issue.

Of the interviewees who have little knowledge about grease traps for treating domestic grey water, this is because they have heard about it in talks and at school.

Table 4. Causes of lack of knowledge on how to treat grey water in the home.

Sex	Level of education	Occupation	If you have little knowledge about how to treat the water in your home, why do you think this is?
Female	Secondary	Housewife	"I don't know"
Female	Baccalaureate	Employee	“The school”
Male	Secondary	Carrier	“The communities”
Female	Primary	Housewife	“In talks”
Male	Degree	Student	“There is no training”
Female	Degree	Housewife	“It’s easier to throw it away”
Male	Secondary	Plumber	“There are no water care programs”
Male	Baccalaureate	Taxi driver	“It is not given importance”
Female	Preparatory	Student	“We waste water”
Female	Primary	Housewife	"I don't know"
Male	Secondary	Carrier	“There are no projects”
Male	Primary	Construction worker	“There is no direction”
Female	Primary	Housewife	“They don’t replicate knowledge”
Female	Secondary	Housewife	“The authorities do not give information”
Female	Secondary	Housewife	“Lack of information”
Female	Preparatory	Housewife	“I bet those who know don’t give us guidance”
Female	Primary	Housewife	"I don't know"

Female	Primary	Housewife	"The authorities do not give information"
Female	Degree	Student	"I have not informed myself, nor investigated"
Female	None	Housewife	"There is no information"

Source: Prepared by the authors using field data.

Would you like to know how to make a grease trap to clean the grey water in your home?

All interview participants answered that they would like to know how to make a grease trap. They commented that this is a topic that must be treated with all seriousness, and that it has to do with community participation.

Table 5. People who would like to know how to make a grease trap.

Sex	Level of education	Occupation	Would you like to know how to make a grease trap to clean the grey water in your home?
Female	Secondary	Housewife	"Yeah"
Female	Baccalaureate	Employee	"Yeah"
Male	Secondary	Carrier	"Yeah"
Female	Primary	Housewife	"Yeah"
Male	Degree	Student	"Yeah"
Female	Degree	Housewife	"Yeah"
Male	Secondary	Plumber	"Yeah"
Male	Baccalaureate	Taxi driver	"Yeah"
Female	Preparatory	Student	"Yeah"
Female	Primary	Housewife	"Yeah"
Male	Secondary	Carrier	"Yeah"
Male	Primary	Construction worker	"Yeah"
Female	Primary	Housewife	"Yeah"
Female	Secondary	Housewife	"Yeah"
Female	Secondary	Housewife	"Yeah"
Female	Preparatory	Housewife	"Yeah"

Female	Primary	Housewife	"Yeah"
Female	Primary	Housewife	"Yeah"
Female	Degree	Student	"Yeah"
Female	None	Housewife	"Yeah"

Source: Prepared by the authors using field data.

The interviewees also pointed out that water is a vital resource that serves as a basis for human survival, and commented that the lack of water can have major consequences for the population, not only in the community, but also throughout the world.

Discussion

The results of this research show that the contamination of the river in the El Cortijo community, municipality of Ayutla de los Libres, Guerrero; Mexico, is related to the lack of knowledge of the citizens about the existence of alternatives such as grease traps or biodigesters, to clean domestic wastewater, this coincides with what was reported by: Díaz *et al* . (2012) who state that these alternatives: "Are not conventionally considered by the governing bodies, but they can be part of the response for the treatment, and in particular for those dispersed areas" (Díaz *et al.*, 2012, p. 79). These alternatives, because they are not considered by governments at different levels, are also not disseminated in the population. Which is related to the results, since there were citizens who stated that local authorities do not give importance to the issue of river care.

On the other hand, it is shown that the factor that most contaminates the river in the community is wastewater, a situation that is related to what was stated by Sarmiento *et al.* (2019) “Among the causes of greatest impact on water quality […] [is] the contamination of the water resource with untreated domestic wastewater, due to the lack of adequate sanitation systems, mainly in rural areas” (Sarmiento *et al.*, 2019, p. 6).

Most of the citizens participating in the study are unaware that there are environmentally friendly technologies to treat grey water from their homes, but they are interested in knowing how they work and implementing them. This is linked to what Martínez and Narváez (2017) stated: “To solve water quality problems, […] [it is] necessary to

formulate comprehensive intervention strategies, which seek to generate social appropriation of the technology to be implemented" (Martínez and Narváez, 2017, p. 24).

Finally, the project was limited by the financial resources needed to implement grease traps in a large number of homes in the community. However, it was relevant because it generated useful information for decision-making regarding the sanitation of domestic wastewater. The methodology used can be used in other areas with similar problems; the work allowed participants to reflect on the problem of contamination of the community's river and the need to clean up water from homes.

Conclusions

River pollution is one of the issues that has little relevance in the community. This is associated with the lack of projects and programs by the municipality to mitigate the problem, which generates little interest from the population to obtain information on how to treat water.

River pollution is carried out with knowledge of the environmental damage, as all the people who participated in the interviews stated that they understand the problem that is generated, but they do it because they think they have no other choice.

The community does not have a plan to reduce pollution of the river and stormwater channels, and the authorities have no proposals to counteract this environmental problem.

The houses that have been built in recent years are designed with drainage pipes that lead to the river and storm drains, which increases river pollution.

Women are mostly responsible for the disposal of grey water from homes, often using this water to water plants or to wash floors. This reflects a marked social division of labor in the community, where women are responsible for solving problems and needs within the home, while men are engaged in agriculture, herding, trade, transportation and construction.

Only on the main street there is a drainage pipe, but many houses are not connected. But what is more advisable than conventional drainage and water treatment plants; in rural communities, the option is to treat wastewater in the houses themselves or to use collective solutions based on nature, such as artificial wetlands.

The remains of dead animals and solid waste are also deposited in the river.

During the dry season, the river water stagnates in small puddles that mix with waste water, which increases the proliferation of disease-transmitting mosquitoes.

Residents of communities located downstream receive contaminated water, which can generate conflicts between communities.

The participants in the study are interested in treating the wastewater in their homes, but they stated that they do not have the financial resources to do so and that they are highly dependent on government support.

Future lines of research

It is necessary that, under a basin approach, comprehensive studies of water resources management be carried out in the community and surrounding communities. These studies must incorporate the social, economic, political-administrative, cultural, technological and biophysical subsystems. This will allow interdisciplinary work, understanding and explaining the interactions between various social and environmental factors that intervene in the generation of problems of supply, contamination, scarcity or availability of water, and thus achieve better management of this natural resource at the community level. In addition, it is essential that studies be developed in which, through the participation of the population in the communities, domestic water treatment systems are designed, implemented and evaluated, through nature-based solutions. Such as, the Unique Systems for the Treatment, Reuse of Water, Nutrients and Energy (SUTRANE) at the home level, and artificial wetlands at the community level.

References

Bautista-Gómez, M. I., Rodríguez-Reyes, D. A., Castañeda-Robles, I. E., del Refugio González-Sandoval, M. y Escalante-Lozano, J. E. (2023). Tratamiento de aguas grises para viviendas de interés social popular. *Pädi Boletín Científico de Ciencias Básicas e Ingenierías del ICBI*, *11*(Especial 3), 151-156. https://repository.uaeh.edu.mx/revistas/index.php/icbi/article/view/11509

Bundschuh en Reyes, Y.C., Vergara, I., Torres, O.E., Díaz-Lagos, M. y González, E.E. (2016). Contaminación por metales pesados: Implicaciones en salud, ambiente y seguridad alimentaria. *Revista Ingeniería Investigación y Desarrollo.* 16(2), 66-77. https://dialnet.unirioja.es/servlet/articulo?codigo=6096110

Carballo, R. F. (2001). La entrevista en la investigación cualitativa. *Pensamiento actual*, *2*(3). https://revistas.ucr.ac.cr/index.php/pensamiento-actual/article/view/8017

Conejero, J. C. (2020). Una aproximación a la investigación cualitativa. *Neumología Pediátrica*, *15*(1), 242-244. https://www.neumologia-pediatrica.cl/index.php/np/article/view/57

Díaz-Cuenca, E., Alvarado-Granados, A. R. y Camacho-Calzada, K. E. (2012). El tratamiento de agua residual doméstica para el desarrollo local sostenible: el caso de la técnica del sistema unitario de tratamiento de aguas, nutrientes y energía (SUTRANE) en San Miguel Almaya, México. *Quivera. Revista de Estudios Territoriales*, *14*(1), 78-97. https://www.redalyc.org/pdf/401/40123894005.pdf

De la Roche, M. M., Estupiñán, A. M. V. y Pulido, M. A. (2021). Características e importancia de la metodología cualitativa en la investigación científica. *Revista Semillas del Saber*, *1*(1), 18-27. https://revistas.unicatolica.edu.co/revista/index.php/semillas/article/view/314

Echeverría-Molina, J., & Anaya-Morales, S. (2018). El derecho humano al agua potable en Colombia: decisiones del Estado y de los particulares. *Vniversitas*. (136), 1-14. Recuperado de: https://doi.org/10.11144/Javeriana.vj136.dhap

García, G. (2023). Investigación cualitativa desde el método de la investigación acción: Qualitative Research from the Action Research Method. *Revista de Artes y Humanidades UNICA*, *24*(51), 196-210. https://revistas.unicaedu.com/index.php/ahu/article/view/72

Hernández-Sampieri, R., Fernández-Collado, C. y Baptista-Lucio, M. (2014). *Metodología de la Investigación*. México: (6a ed. pp. 31-364). McGRAW-HILL.

INEGI. (2008). Bases digitales de curvas de nivel. Instituto Nacional de Estadística y Geografía. México.

Marín-Muñiz J.L, López-Alba E, Sandoval Herazo L.C. y Zamora S. (2024). Remoción de contaminantes de aguas residuales comunitarias mediante humedales de tratamiento: Efecto de la vegetación y posicionamiento de sembrado para condiciones de diseño. *Emerging Trends in Education*, *8*(1), 39-48. https://dialnet.unirioja.es/servlet/articulo?codigo=9589964

Martínez-Jaramillo, E. A. y Narváez Mora, N. O. (2017). Apropiación social de una tecnología no convencional para el tratamiento del agua en la vivienda, vereda el Motilón, Pasto (Nariño). [(Tesis de maestría. Universidad Tecnológica de Pereira. Colombia]. https://repositorio.utp.edu.co/handle/11059/7923

Naciones Unidas. (2003). Agua para todos, agua para la vida. Programa de las Naciones Unidas sobre el desarrollo de los Recursos Hídricos en el Mundo. UNESCO.

Plan Estatal de Desarrollo 2016-2021. Gobierno del Estado de Guerrero.

Ramírez, M. (2023). La importancia de la metodología cualitativa para el Balance Social: Herramienta para el fortalecimiento de la identidad cooperativa autogestiva. *Revista Iberoamericana de Economía Social y Solidaria ECOSS*, (2), 42-42. https://ecoss.ibero.mx/index.php/ecoss/article/view/19

Sarmiento, E. G., Pérez, J. R., & Ortiz-Ospino, L. (2019). Análisis de las tecnologías en sistemas de abastecimiento de agua potable. *Investigación y desarrollo en TIC, 10*(2), 32-44. Recuperado de https://goo.su/ziWQlXu

Photographic annex

Figure 2. Pipe that pours waste water into the river.

Source: Prepared by the authors based on field work.

Figure 3. House pipe that discharges waste water into the river.

Source: Prepared by the authors based on field work.

Figure 4. Appearance of river water at domestic grey water discharge points.

Source: Prepared by the authors based on field work.

Figure 5. Pipe that discharges grey water into the river.

Source: Prepared by the authors based on field work.

Figure 6. Pipe that discharges grey water into the river.

Source: Prepared by the authors based on field work.

Figure 7. Grey water discharge pipe.

Source: Prepared by the authors based on field work.

Figure 8. Grey water discharge pipe

Source : Prepared by the authors based on field work.

Figure 9. Pig farm a few meters from the river.

Source: Prepared by the authors based on field work.

Photographic annex of the workshop

Figure 10. Explanation of the construction of a grease trap for domestic grey water.

Source: Prepared by the authors based on field work.

Figure 11. Workshop instructors and participating citizens.

Source: Prepared by the authors based on field work.

Figure 12. Workshop instructors and participating citizens.

Source: Prepared by the authors based on field work.

Contribution Role	Author(s)
Conceptualization	Oscar Figueroa Wences «main»
Methodology	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Software	Humberto Antonio Gonzalez Gonzalez "main"
Validation	Oscar Figueroa Wences «main»
Formal Analysis	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Investigation	Oscar Figueroa Wences «same», Humberto Antonio Gonzalez Gonzalez «same», Hugo Rayon Elacio «same», Zitlali Nava Santos «same», Alexander Cano Mora «same»
Resources	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Data curation	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Writing - Preparing the original draft	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Writing - Review and editing	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Display	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”
Supervision	Oscar Figueroa Wences "main",
Project Management	Oscar Figueroa Wences "main",
Acquisition of funds	Oscar Figueroa Wences “same”, Humberto Antonio González González “same”