SUSTAINABILITY OF WASTEWATER TREATMENT PLANTS: VALIDATING THE APPROACH AND SOLUTION OPTIONS – SLUDGETEC CLOSING WORKSHOP

PROCEEDINGS

Tepeji del Rio Ocampo, Mexico, 12–16 November 2018

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Sustainability of Wastewater Treatment Plants: Validating the Approach and Solution Options – SludgeTec Closing Workshop

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Executive Summary

Poor management of wastewater systems is a common reality in small to medium-sized cities of low to medium-income countries. Poor water quality management negatively impacts both environmental and human health. Against this background, the international community calls for a sustainable management of wastewater treatment systems. The identification of such sustainable systems is, however, not straightforward, given lacking methodologies for sustainability assessment in this field.

The United Nations University for Integrated Management of Material Fluxes and of Resources (UNU-FLORES) promotes the resolution of pressing challenges to the sustainable use and integrated management of environmental resources and furthering the concept of the Water-Soil-Waste Nexus (WSW Nexus). UNU-FLORES has been advocating for sustainable wastewater management since the inception of its research and capacity development agenda and has worked with many other organisations and Member States to improve the current understanding and to produce new knowledge on the topic.

Within this context, UNU-FLORES was pleased to join forces with the Fideocomiso de Infraestructura Ambiental de los Valles de Hidalgo (FIAVHI, Environmental Infrastructure Trust of the Valleys of Hidalgo) and the Universidad de San Carlos de Guatemala (USAC, San Carlos University of Guatemala) to coorganise the "SludgeTec Closing Workshop: Sustainability of Wastewater Systems" from 12–16 November 2018 in Tepeji, Mexico.

This meeting brought together experts from UNU-FLORES, the Technische Universität Dresden (TU Dresden), and the Ministry of Education of Cuba (BIOECO) to identify, alongside with local stakeholders, sustainable solution options in the field of wastewater management. This approach intends to foster participation of all interested and affected stakeholders of the wastewater problem. This issue was addressed through the perspective of a Nexus Approach. The international team considered the current wastewater treatment systems, and options for improving its sustainability status thus highlighting the barriers and pathways for the implementation of sustainable wastewater management options.

The workshop in Mexico aimed at presenting the results of the SludgeTec research work and at identifying sustainable solutions for two case studies: Panajachel, Guatemala and Tepeji, Mexico. The key result was a Letter of Intent for Action developed, written, and signed by all workshop participants that requested the Mayor of Tepeji to take action on the local situation.

Figure 1.1: Workshop participants

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1. Introduction

1.1 Workshop Overview

The closing workshop of the SludgeTec project held in Tepeji, Mexico aimed at presenting the results from the project, discussing the recommendations or orientations for actions derived from it, and discovering collectively specific actions that can now be taken by the stakeholders to improve sustainability. Through a co-design approach, international experts and local stakeholders looked at the most suitable solution options for improving wastewater management together.

The workshop was structured into segments of activities. Participants first were presented with an overview of the current situations of the case studies and the results of the different methodologies applied in the SludgeTec project to the two cases, and discussed experiences from project partners in Mexico and Guatemala. After which, participants jointly worked at (i) envisioning solution options to improve wastewater management sustainability, (ii) selecting sustainable solution options, and (iii) overcoming previously identified barriers for solution implementation.

A field trip organised by FIAVHI allowed participants to discuss issues related to treatment methods and the sustainability of water management with a special focus on water reuse (see Appendix 3).

1.2 The SludgeTec Project

Poor management of wastewater is a major problem in Latin American and Caribbean (LAC) countries. Treated wastewater reaching the environment is often of poor quality, which has negative impacts on the lakes' existing and potential beneficial uses like tourism (poor bathing quality), consumption (poor drinking water supply), and food production (unsafe use of wastewater for irrigation). Sustainable solutions to this problem are needed but are difficult to achieve given the lack of a methodology for sustainability assessments.

The SludgeTec Project in a Nutshell

The SludgeTec project is intended for local stakeholders to co-design, along with international and local experts, sustainable solutions for improved wastewater (and sludge) management. The project is designed in a transdisciplinary manner, which implies the involvement of local stakeholders of the pilot sites: Panajachel, Guatemala and Tepeji, Mexico.

The SludgeTec project developed and applied a methodological model to undertake the first three steps of the five-step Nexus Approach,[1] which follows a basic project management cycle of Plan-Do-Check-Act. The project aimed at assessing the status of wastewater treatment systems at the pilot sites (Steps (1) nexus problem, and (2) aim of the work) and defined ways to overcome respective bottlenecks (Step (3) nexus options). When identifying the nexus options, the project used three sets of methodologies in a transdisciplinary manner, namely: (1) sustainability assessment, (2) stakeholder analysis, and (3) wickedness analysis; which were tested in the two case studies (see Figure 1.2).

[1] For a more comprehensive description of the "Nexus Approach" refer to: Avellán, Tamara, Reza Ardakanian, Sylvain R. Perret, Ragab Ragab, Willem Vlotman, Hayati Zainal, Sangjun Im, and Hafied A. Gany. 2018. "Considering Resources Beyond Water: Irrigation and Drainage Management in the Context of the Water–Energy–Food Nexus." *Irrigation and Drainage* 67 (1): 12–21. https://doi.org/10.1002/ird.2154.

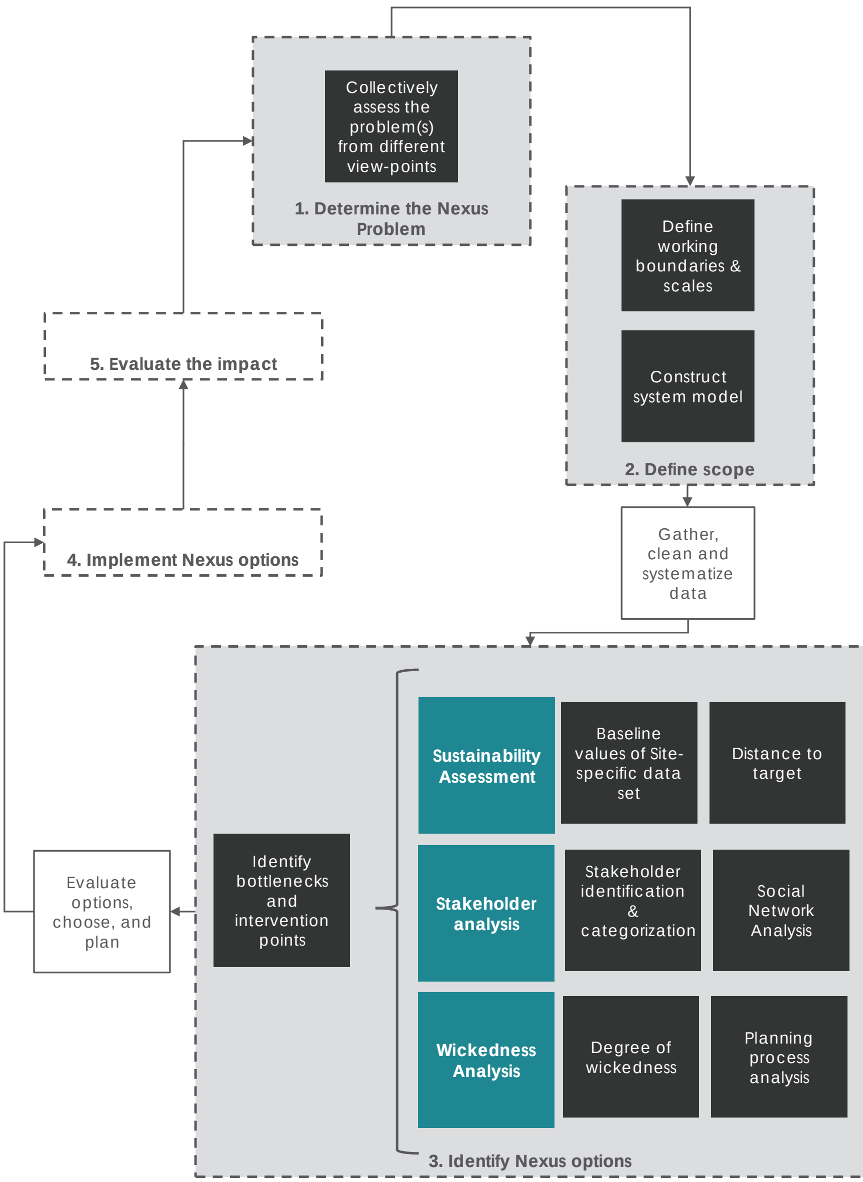

Figure 1.2: Steps 1-3 (shaded in grey) of the Nexus Approach as defined in Avellán et al. (2018) were undertaken in a transdisciplinary manner in the SludgeTec project (reproduced from Avellán et al. (2019)).

1.3 Wastewater as a Resource

Serena Caucci (UNU-FLORES) presented on the relation between wastewater management and health aspects in the use of wastewater. She highlighted the necessity of an appropriate co-design of wastewater management that would consider the inputs of health and technical experts as well as agricultural practitioners. In her talk, Caucci highlighted how wastewater could be a solution in a time of water scarcity, especially in the agricultural sector. Agriculture accounts for more than 70% of the global human water abstraction and such consumption is planned to increase with time (WWAP 2017). The use of wastewater in agriculture goes beyond the single benefit of an alternative source of water provisioning. Wastewater is a provider of nutrients necessary for plant growth and a replacement of mineral fertiliser. Unfortunately, if not properly managed, wastewater can also be harmful for both humans and the environment.

Figure 1.3: Ms Caucci presents on the benefits and risks of wastewater use and its relation to the Nexus Approach.

Technologies and treatment that make wastewater a safe medium for agricultural purposes are already on the market and are available to communities in high-income countries. Such technologies are advanced and comply with standard microbiologic and physical-chemical requirements. Nevertheless, the concentrations and the nature of the contaminants in wastewater define the treatment that needs to be applied before disposal in water bodies. In middle- and low-income countries, high-tech solutions are not always needed, and thus, even countries with a lower income pro capita can afford to achieve treated wastewater for safe reuse. To be effective, traditional wastewater treatment plants have to be modified/adapted to the changing in-situ wastewater inflow characteristics.

The decision on whether to replace the conventional or other non-conventional water sources with reclaimed wastewater for agricultural irrigation primarily depends on the purpose of reuse and it has to be based on awareness of involved stakeholders. Reuse should aim at the minimisation of risk to acceptable levels for both public health and the environment. Moreover, when thinking of sustainable solutions, the application of such innovation has also to be weighed against foreseen economic benefits. In developing countries, poorly treated wastewater in agriculture could present a clear threat to public health due to microbial virus-based infections that could

indirectly affect public health via wrong irrigation practices and/or consumption of microbially contaminated crops. In these cases, the World Health Organization (WHO) has indicated that the risk of disease caused by pathogens or toxic compounds can be minimised via a reduction in farmers' and consumers' exposure to untreated wastewater.

Although advanced wastewater treatment has already been tested in the Mediterranean countries, reclaimed wastewater is still discharged into freshwater bodies or the sea and not used for agricultural irrigation. The missing continuity and consistency in wastewater use risk assessment makes the topic of reuse a difficult one for policymakers and practitioners. The water quality is of extreme importance in agricultural or landscape irrigation and the parameters defining water quality are unfortunately not often measured nor systematic monitoring strategies planned within the wastewater treatment of municipalities. The uncertainty of the effluent quality strongly influences the acceptance of water reuse among local communities. The application of wastewater reuse in agriculture requires then not only technological know-how but also a deep understanding of the social and cultural barriers. Monitoring strategies are fundamental tools for increasing trust in water reuse safety measures.

2. Current Situation of the Case Studies

2.1 Case Studies

The SludgeTec project worked in two pilot sites: *Los Cebollales*, Lake Atitlan, Panajachel, Guatemala and *Tlaxinacalpan*, Hidalgo State, Tepeji, Mexico. An overview of the current conditions of the cases is presented in Figure 2.1.

Figure 2.1: Overview of the current conditions of Lake Atitlan, Panajachel, Guatemala and Hidalgo State, Tepeji, Mexico (reproduced from Avellán et al. (2019)).

2.2 The State of Water Sanitation in Tepeji and the Requena Dam

Carlos A. Paillés and **Emma Muñoz Alvarado (FIAVHI)** shared their experiences in addressing wastewater management-related problems in the state of Hidalgo, Mexico. They highlighted topics such as the integrated management of natural resources, water requirements in terms of quantity and quality, alternatives to using treated wastewater, and the integrated and timely management of water quality.

Figure 2.2: Mr Carlos Paillés presenting on the wastewater treatment situation in Tepeji and the Lake Requena Dam catchment.

They further shared their experiences in addressing wastewater management-related problems in the states of Hidalgo and Oaxaca in Mexico. The talk focused on the efforts and results of FAIVHI in facilitating the implementation of practices according to the Safe Use of Wastewater in Agriculture (SUWA) and activities for the younger generation in schools to inculcate the culture of water reuse.

Mr Paillés mentioned how the 100-year long journey in water reuse in the Mezquital Valley and stakeholder efforts have resulted in implementation strategies for a more sustainable use of wastewater, such as the recent launch of the Manual of Drinking Water, Sewerage and Sanitation (MAPAS) by CONAGUA and the increasing institutional input for wastewater management in Mexico.

Best practices of water reuse for agricultural, environmental, and municipal purposes were shared, with a special focus on the implementation of decentralised wastewater treatment plants (WWTPs) in Hidalgo, Tepeji and la Sierra Juarez de Oaxaca. Here, water quality and risk management are vital to ensure proper performance of decentralised WWTPs, which is why FIAVHI has been working with other international experts to ensure water quality (see Section 2.2.1). In this context, self-sufficiency and sustainability aspects were highlighted, as well as the concept of zero discharge as the 'engine' for the achievement of the United Nations Sustainable Development Goals (SDGs).

Tepeji del Rio is the first municipality in Mexico that is aiming to treat 100% of the wastewater they produce, with 14 small-scale decentralised WWTPs in operation. Between 95% to 100% of the produced treated wastewater is reused. Mr Paillés stated that self-sufficiency and sustainability are fundamental, as well as the concept of zero discharge in driving sustainable development. He further stressed that the process to reach a collective conscience towards valuing water should start with awareness raising through education, involving children and young people. They can be powerful spokespersons for adults.

The Requena Dam belongs to the hydrological region 26 of the Alto Panuco, which originates from the State of Mexico. Its volume of entry is controlled by the Taxhimay Dam and its main channel, until it reaches its reservoir, is known as the Tepeji River.

The water from the dam is used for various purposes, such as:

- **Fisheries**: In the districts 003 Tula and 100 Alfajayucan, a fishery group "United fishermen of the Presa Requena 20 arcos" consisting of 62 partners is dedicated to the seeding and extraction of carp and tilapia.
- **Tourism and recreation**: Several residential and tourist projects such as "Presa Escondida" with capacity for 1,500 houses, pool, tennis courts, restaurants, and boats and "Amanali country and Nautica club" with capacity for 2,700 houses, a golf course, sports club, and nautical club exist around the dam.

Due to an uncontrolled discharge from WWTPs and raw sewage discharges into the Requena Dam, the water quality of the reservoir is severely impaired and is now posing serious risks to both the environment and the local community.

2.2.1 Improving Wastewater Management: Cooperation between Cuba and Mexico

Alina Morell Bayard (Ministerio de Ciencia de CUBA, BIOECO) explained the importance of water quality in the environment. The quality of water is characterised by its physical-chemical and biological composition. In order for regulatory bodies to allow its use without causing harm, the water sample has to be:

- Free of substances and microorganisms that are dangerous for consumers
- Free of substances that give off unpleasant sensations for consumption (colour, turbidity, smell, taste)

The collaboration between Cuba and Mexico started when Carlos A. Paillés (FIAVHI) approached BIOECO for an evaluation of the performance of their decentralised WWTPs in Mexico. The parameters monitored in one of FIAVHI's WWTP involved the following physical, chemical, and microbiological parameters of the treated wastewater:

- Odour
- Colour
- Temperature
- Biological Oxygen Demand
- Chemical Oxygen Demand
- Total Nitrogen
- pH
- Nitrate
- Nitrites
- Potassium
- Faecal Coliforms
- Total coliforms

The results showed good performance of FIAVHI WWTPs. The average efficiency across the four tested systems of biodigesters for Chemical Oxygen Demand (DQO in Spanish) was 78.6% and the retention efficiency of suspended solids was 78.2%.

2.2.2 Advancing the Safe Use of Wastewater in Agriculture in Mexico

Seeing wastewater as a resource, **Ana Lilia Velasco Cruz (FIAVHI)** highlighted the work done by the United Nations University (UNU-FLORES), the Food and Agriculture Organization of the United Nations (FAO), and other institutions in encouraging the concept of SUWA. She explained the situation regarding SUWA in Mexico.

In Mexico, out of 2,892 installed WWTPs, only 2,337 are in operation (CONAGUA, 2015). Six of them are in the municipal capitals of Ixtlán de Juárez and Capulálpam de Méndez, Oaxaca, Mexico. The total treated wastewater (TWW) volume is at 798 m^3/day.

Mrs Velasco went on to present research on SUWA in Mexico. In particular, she focused on the evaluation of the use of treated wastewater for forage irrigation – of *Zea mays* (corn) and *Chenopodium quinoa willd* (quinoa) – in Ixtlán of Juárez, Oaxaca. Results have shown the following impressive achievements:

- The morphological growth was significantly higher in the crops irrigated with TWW compared to those irrigated with freshwater (FW).
- The accumulation of biomass was greater by up to 60% in corn and 70% in quinoa of the crops irrigated with TWW in relation to crops irrigated with FW. The stem was the organ of greater weight in both crops.
- The presence of nitrogen (N) in the TWW positively influenced the growth and production of quinoa and corn fodder.
- The quinoa (2.69%) presented a higher percentage of N compared to the corn (2.03%). Corn cultivation (0.25%) showed a higher percentage of phosphorus (P) than quinoa culture (0.20%).
- Dry matter yields of 12 tons ha^{-1} of quinoa and almost 11 tons ha^{-1} of corn were obtained without using synthetic fertilisers.
- The proteins contained in quinoa irrigated with TWW were significantly higher than in quinoa irrigated with freshwater.

The practice of SUWA has spared farmers the use of synthetic fertilisers thus representing economic savings and further environmental protection of the area.

Figure 2.3: Ana Lilia Velasco Cruz is presenting on findings of her research on treated wastewater for the irrigation of corn and quinoa.

2.3 The State of Water Sanitation in Panajachel and Lake Atitlan

In the workshop **Enrique Cosenza (Rotary Club Panajachel)** introduced his personal perspective on how Lake Atitlan has changed in water quality over the past 20 years.

Figure 2.4: Mr Cosenza shares his experience of working on wastewater issues in the Lake Atitlan basin.

It coincides largely with the findings of the working paper *Wastewater Management in the Basin of Lake Atitlan: A Background Study* (Ferráns et al. 2018). We present an excerpt of this below:

"In the Atitlan basin, only 55% of the community of the lake is connected to a sewage system and that the remaining 45% use latrines, septic tanks, or soak latrines, which are mostly not being collected and disposed of safely. In total 45,500 m^3 of wastewater is generated every day in the basin, and only approximately 20% receives treatment, which is much less than the roughly 65% of wastewater that is being treated in general in Guatemala (UN-ECLAC 2017). Most of the 11 existing Wastewater Treatment Plants (WWTPs) exhibit very poor performance about the removal of pathogens and nutrients; and none comply with all parameters stipulated in the norm #12-2011. WWTPs face, among others, operation and maintenance problems. The most common bottlenecks are the lack of laboratory facilities, continuous technical training, handling plan for by-products, personnel and supplies, operation and maintenance manuals, and willingness to pay for users. To address these issues particpatory processes are suggested.

In the basin of Lake Atitlan, there are 12 wastewater treatment plants (WWTP). Four WWTPs use activated sludge technology, one employs facultative lagoons and septic tanks, and the other eight facilities use anaerobic reactors and biological percolating filters.

Overall, a 33% of the treated wastewater is reused for crop irrigation while only a 4% reaches directly the lake and 16% is infiltrated in soil. The remaining 47% of the treated wastewater is discharged into the lake's tributary rivers. The large portion of untreated wastewater is discharged into rivers reaching the lake, or onto open grounds.

Further, in each municipality, the percentage of treated wastewater varies according to the availability and capacity of existing WWTPs. Figure 2.5 describes the portion of treated wastewater per municipality around the basin of Lake Atitlan."

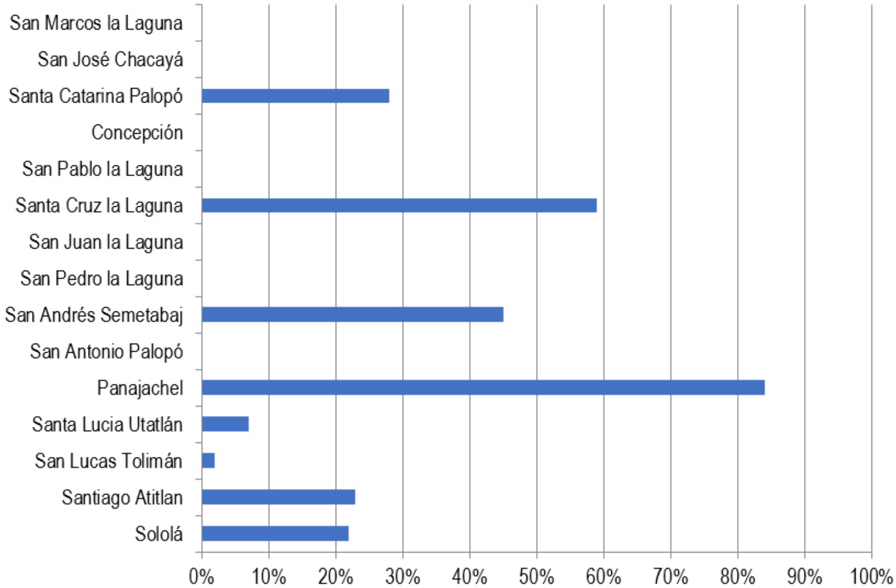

Figure 2.5: Percentage of treated wastewater at each municipality around Lake Atitlan (reproduced from Ferráns et al. (2018)).

3. Results of the SludgeTec Research

3.1 Presenting the Findings

The findings of the SludgeTec research were presented to the stakeholders through a draft version of the case study report: *Towards Sustainable Wastewater Treatment Systems: Implementing a Nexus Approach in Two Cases in Latin America* (Avellán et al. 2019). The stakeholders obtained printed copies of the report and its appendices, and the team also presented the findings in a presentation.

Figure 3.1: The SludgeTec UNU-FLORES team presents the findings of the research of the project.

The main findings were summarized as follows (verbatim from executive summary of the draft version handed to the participants):

"In both cases stakeholders identified the wastewater treatment situation in general as a major cause for larger environmental impacts, in particular on the nearby lakes. Stakeholders further determined that enhancing the local wastewater treatment and environmental awareness in the population could lead to an improved environmental situation and safe-guard or improve the sources of income from the lakes through fishing and tourism. Systems thinking was used to further determine the scope of the problem and used a multi-scalar approach to assess the multiple boundaries of the interconnected systems.

Both cases exhibit unsustainable wastewater treatment system, a fragmented stakeholder landscape and high degree of wickedness. The sustainability for the waste water treatment plant (WWTP) los Cebollales in Panajachel, Guatemala indicates a medium-low level of sustainability. All dimensions show a medium performance (yellow), except the economic dimension, where the assessment is low (red). The sustainability level for the WWTP in Tlaxinacalpan in Tepeji, Mexico shows a moderate to good performance in the available dimensions. However, no economic indicators could be evaluated in this case as data for the identified variables with thresholds was missing.

For the WWTP los Cebollales of Panajachel 31 stakeholders were identified, which can affect or can be affected by it. By applying snowball sampling in the field, the final stakeholder list consists of 62 stakeholders. For Tepeji 12 stakeholders were identified; the final list consists of 17 stakeholders. Both in Guatemala and Mexico, the information availability is poor. Existing information in form of documents and data, focuses on just a few key stakeholders, and in most cases, those who have a lot of information seldom share the information with other stakeholders. The knowledge of the status-quo of the wastewater treatment system is highly fragmented and the stakeholders with the most information are not necessarily the ones who make the decisions. Stakeholders who might have an impact on decision-making often lack information, as most of the information is inaccessible to them.

From the output of the workshops, the problem 'Safe use of wastewater in the Mezquital Valley' and 'Wastewater management in Guatemala' seem to be highly wicked. This is based on rather high degrees of goal conflicts, system complexities, and informational uncertainties. Moreover, our analyses reveal that the planning processes in both pilot sites address the wickedness of the problem only to a very limited extent.

To come from the currently unsustainable to more sustainable wastewater treatment plants and systems, the key and primary stakeholders identified under (1) information sharing, (2) decision making and (3) sustainable solution should gather to a) assess their goal conflicts and seek ways to mediate or overcome these, and b) reduce the level of information uncertainty by sharing available information amongst themselves but also with the secondary and tertiary stakeholders. Subsequently these same stakeholders should consider enhancing their level of good planning for the wicked problem of wastewater treatment by starting to invest in the areas identified as poorly performing of the sustainability assessment.

We suggest considering the following:

a. Recommendations on enhancing environmental performance of treatment plants;
b. Recommendations for improved data collection, storage and sharing;
c. Recommendations on strengthening social networks;
d. Recommendations on management and governance strategies."

3.2 Envisioning Solution Options

Based on the solutions implemented in the past (see Section 2) and on further “good ideas” from the participants, a series of solution options were noted. The results of the interactive workshop sessions were then linked to the results in the Case Study Report in order to derive specific suggestions for practice to advance sustainable wastewater management.

Figure 3.2: Workshop participants thinking about potential solution options.

A “talk to your neighbour” activity was conducted. Participants discussed with their colleagues which potential future option or existing ones could be implemented in the case study areas (sitting either side) and noted down their findings. At the end of the exercise, the participants had a chance to express their opinions to the group.

Repeatedly, participants highlighted the role that the government plays or should play, or the perceived negligence of companies and authorities. Of the solution options, the majority of the highlighted ones were ideas for the future.

3.3 Implementing Potential Solutions – How To?

Participants formed working groups to organise and refine the different recommendations that were given by the research team as well as those that were proposed by participants themselves in previous activities. The main objective was to think about ways to effectively operationalise these recommendations for their specific contexts by answering three questions: What should be done? How? and Why? Through this process, concrete, site-relevant, and possible activities were identified and clustered into general subjects of action areas.

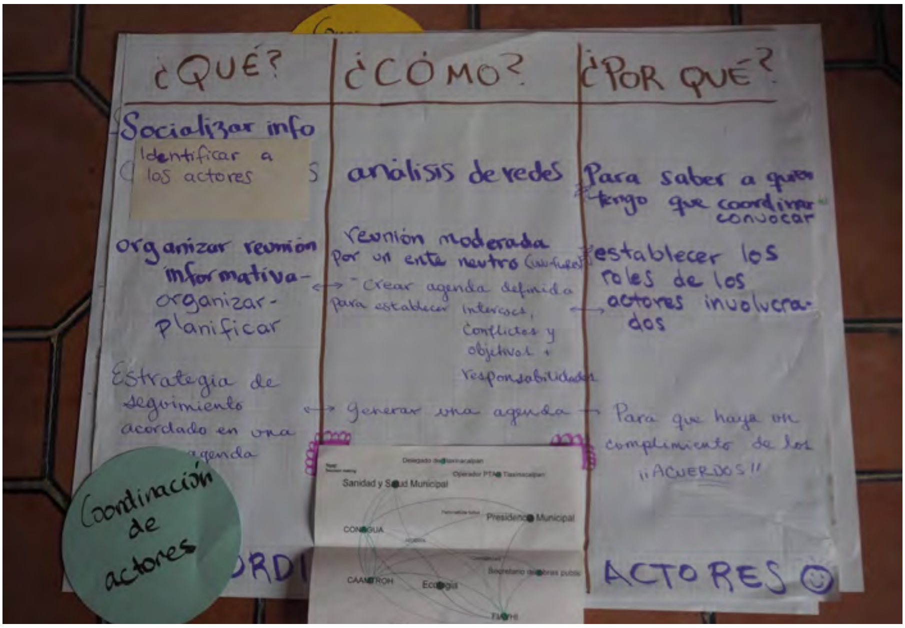

Figure 3.3: Defining the "what", "how", and "why" for each of the actions identified.

From the solution envisioning as well as from the case study report, a series of interventions were noted on post-it notes. Post-it notes of different colours were used to differentiate the category types identified as follows:

Table 1: Categories of Implementation

Data availability and access (orange):	Socialisation of information (blue):
1. Invest in public access data platforms 2. Invest in effluent quality monitoring periodically 3. Know the total cost of different uses 4. Accounting for drinking water, residual and irrigation expenses 5. Document data collection methods 6. Generation of own data between institutions 7. Request data from responsible companies 8. Interviews with decision makers 9. Provide information to decision makers 10. Create sustainability thresholds 11. Establish knowledge about social networks of each actor 12. Produce information in local language 13. Collaborate with academia to collect and generate missing data 14. Improve measurement techniques for social variables 15. Sort, digitise, and systematise existing data	16. Dissemination of Tepeji's sanitation status in the media 17. Participation in fairs with brochures and informative material on wastewater 18. Model demonstration of the WWTPs 19. Create pages on social networks about WWTPs and sanitation in Tepeji 20. Create website to inform about WWTPs and sanitation in Tepeji 21. Organise a workshop open to the public to inform about the sanitation of Tepeji 22. Establish dissemination channels dedicated to environmental information in Tepeji 23. Provide information on the plans of the new WWTPs in Tepeji 24. Informative session on the situation of the Requena dam and its impact on the health of the local population 25. Signboards about the operation of the WWTPs in simple language 26. Dissemination of data on the quality and quantity of water (aquifers)
Water culture/environmental awareness (light green):	**Consensus building/coordination of actors (yellow):**
27. Awareness fairs 28. Work with school principals 29. Educational activities/games for adults and children 30. Guided tours of the WWTPs 31. Workshops on environmental education 32. Foster the benefits of organic agriculture 33. Workshop/infographic on the benefits of composting 34. Educate about the use of dry toilets 35. Workshops in schools on the hydrological cycle	36. Identify actors through social network analysis 37. Moderate meeting between FIAVHI, CAAMTROH, and others to establish roles and responsibilities among all 38. Establish a follow-up strategy for compliance with the work agreements of the implementers 39. Discussion space between different actors 40. Regular community meetings 41. Conflict management strategies 42. Seek and establish strong relationships with tertiary actors 43. Community meeting to discuss plans for the new WWTPs in Tepeji

Social empowerment (pink):

44. Demand evidence of compliance with regulations
45. Demand compliance with industry standards
46. Demanding the sanction of non-compliance with standards
47. Demanding the valuation of products: effluent, biogas, sludge
48. Request information about WWTPs and sanitation in Tepeji
49. Demand regular monitoring of the environmental situation

In the following activity, post-it notes were mixed and workshop participants were asked to work in four groups to discuss where to place each action item judging by it being *implementable* and *desirable* for the case of Tepeji as per the following matrix (Figure 3.4):

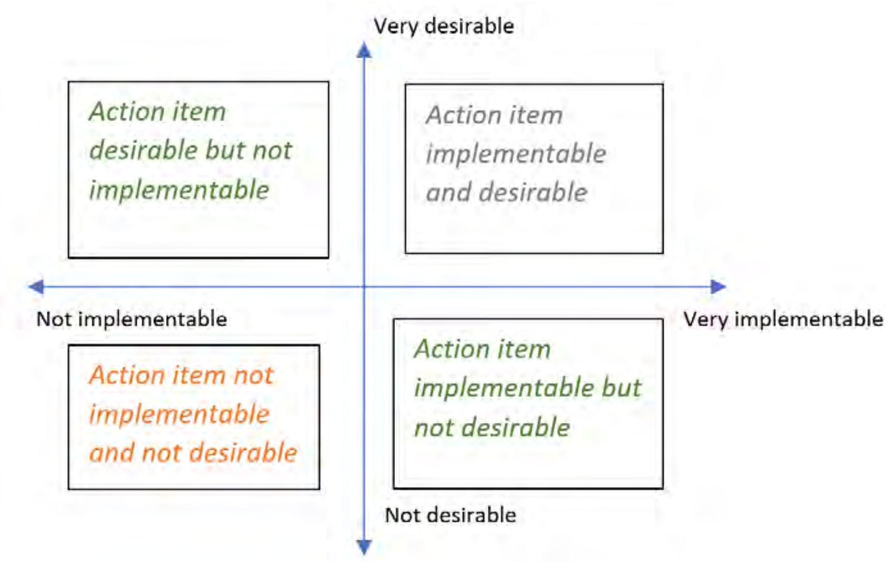

Figure 3.4: Matrix for selecting action items based on their level of being *implementable* and/or *desirable*.

This first exercise yielded the selection of 26 action items in the category of actions that are both *implementable* and *desirable* (top right quadrant) but also 19 action items that are both *desirable* but were not deemed as *implementable* (top left quadrant) (Figure 3.5). Whereas action items of the category 'socialisation of information' (blue stickers), 'environmental awareness' (light green), and 'consensus building' (yellow) made it to the actionable items, issues of 'data availability and access' (orange) and 'social empowerment' (pink) were considered as highly *desirable* but less *implementable*. In particular, the 'socialisation of information' (blue) was considered as very *desirable* and *implementable*. It is also important to note that almost all identified action items (45 out of 49) were considered *desirable*.

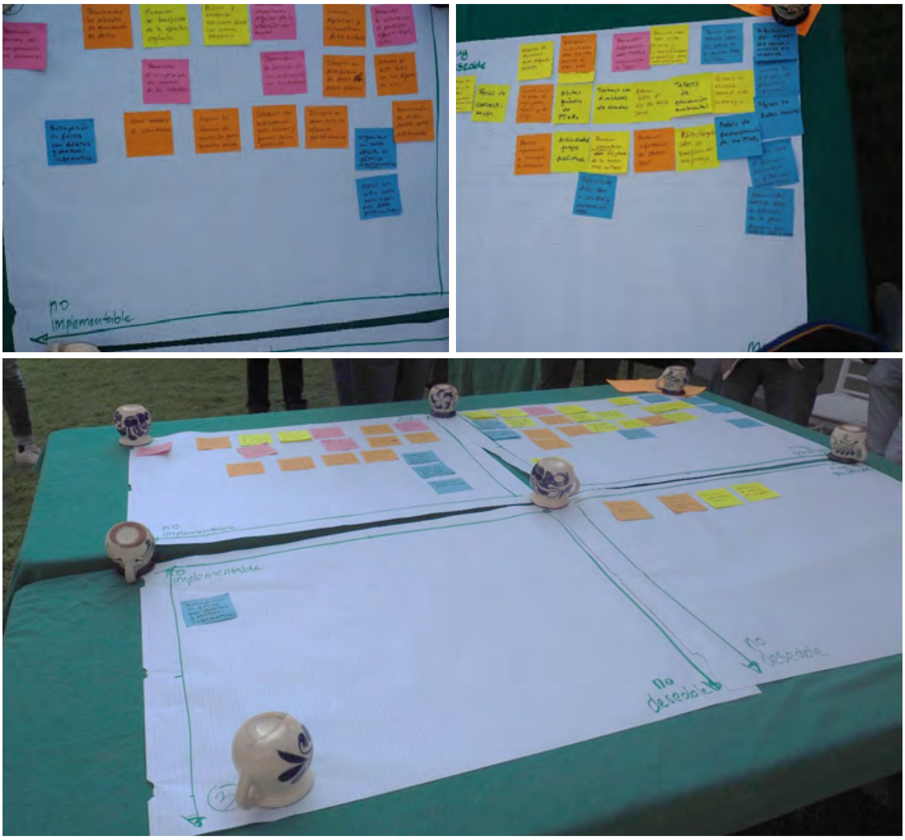

Figure 3.5: Selection of action items that are deemed both *desirable* and *implementable* (top right) and *desirable* but less *implementable* (top left) for the case of Tepeji (Note: Only a few items were deemed not *desirable* (bottom)).

In a next step, workshop participants were asked to take on the role of one of the 17 stakeholders identified in the stakeholder mapping of the SludgeTec project for Tepeji. They were not allowed to represent their own organisation or type of organisation (i.e., community representatives could not take on the role of another type of community representative). They were then asked to reassess the categorised action items by negotiating with each other.

This lively exercise resulted in the reallocation of almost all action items to the category of *"desirable and implementable"*. Participants realised that by negotiating, some of the previously perceived bottlenecks for implementation (lack of resources / time / partners) could be overcome by trade-offs (Figure 3.6). This resulted in three large clusters of actions:

1. Environmental education and awareness raising through a variety of means, e.g., a campaign around World Water Day, tours and information on wastewater and wastewater treatment plants on- and offline, press articles on the situation, etc.
2. Interaction between different stakeholders bi- and multilaterally but also awareness raising in public town hall meetings.
3. Increasing availability and access of information by creating a municipal observatory.

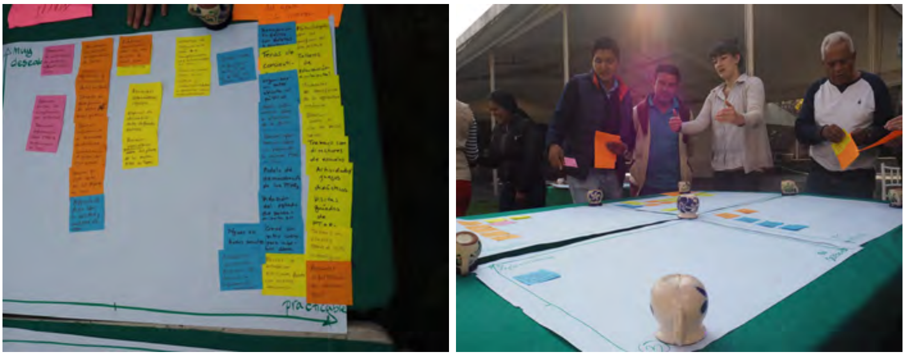

Figure 3.6: Clusters of action items (left) based on synergies between stakeholders (right).

3.4 Barriers and How to Overcome Them

As previous research and experiences show, implementation can be hampered, delayed, or even blocked by various factors, or so-called barriers. Therefore, a barrier analysis identifies perceived barriers and relates them to stakeholders. A short presentation served as a reminder to workshop participants on the responsibility related to water by introducing the concept of water stewardship.

Subsequently, the types of innovation were introduced and illustrated through examples: process innovation (e.g., construction of wastewater treatment plants), organisational innovation (e.g., capacity building scenario according to which extent we want to reach the specified goals, having enough people with capacity, competitiveness for these proposals to grow for another 12 years such that self-sustainability is achieved in 2028), product innovation (e.g., a memorandum of understanding, self-sufficient operation, sufficient capacity, business model – which crops to cultivate depending on the constitution of wastewater), and marketing/communication innovation (e.g., information campaign).

Afterwards, barriers were defined and the barrier profile as a result of a barrier analysis was explained. In general, barriers are identified within the specific context by asking the experts involved. Then, these barriers are evaluated and classified accordingly as no, low, medium, or high barrier. The barrier profile displays the average and spread of this evaluation for each barrier.

Consequently, the barrier analysis was conducted within the workshop setting. The participants were split into two groups according to their competencies, experiences, and roles as stakeholders. Relating back to the activities on the previous day of the workshop, two options were prioritised for the barrier analysis:

1. Data collection (obtaining data concerning the state of the environment and performance of the wastewater treatment plant)
2. Capacity building (with regard to creating awareness about the environment)

Figure 3.7 shows the barriers identified by stakeholders to data availability. Interesting are the barriers that are perceived as high (on the left) but also the ones with a wide spread (right) as in the latter case stakeholders seem to perceive those at varying degrees of difficulty.

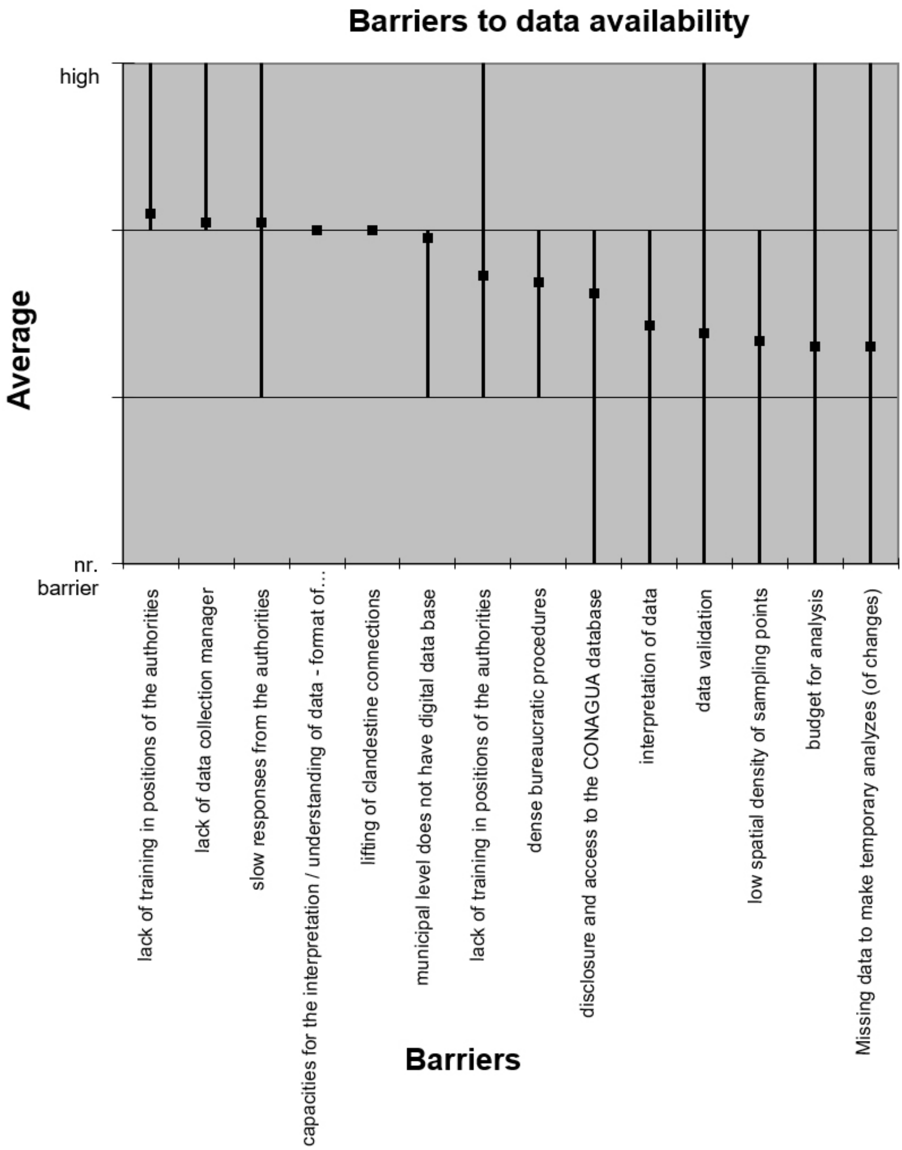

Figure 3.7: Barriers identified by stakeholders to data availability (and access).

To attain better availability of data/information for stakeholders, the following barriers were identified:

- Lack of awareness of reality by officials in charge of the management
- Communication barriers
- No interest shown by the institutions to get informed
- No adequate knowledge/personnel for educational/training purposes
- No interest from locals to get informed/each is driven by self- interest
- Not enough trainings available for the community that shows interest in water culture
- Lack of economic resources
- Missing leadership and/or leader that would enable the improvement of communication among stakeholders
- Reluctance to changes
- No trust in institutions by citizens
- Lack of interest from the institutions' employees to propose trainings both at national and regional level
- Poor communication/advertisement of existing workshops of CONGUA to actors (i.e. CAAMTROH)
- Trainings are not mandatory within the personnel of the water management institutions

Barriers which were either perceived as high or named by the majority were discussed with the participants. These discussions stimulated the development of best practice sharing and aimed at deriving strategies to overcome barriers.

This session had as an objective the education of the participants of a methodology that would entitle follow-up analysis of water management actuality in the future, to identify the perceived barriers and derive strategies to overcome these barriers. An important role is thus played by the discussion section. It is with sharing experience that information can flow and cooperation is stimulated.

4. Developing Collective Demand for Action

Summarising all the results of the different workshop sessions, workshop participants felt that a collective call for action was needed. Hence, together, all workshop participants drafted a letter to the Mayor (Presidente Municipal Constitucional del Municipio) highlighting the findings of the workshop and the need for immediate and urgent action. They called for the following actions (translated to English from the original Spanish letter - see full version in Appendix 6):

1. Organise events to raise awareness and socialise information about the problem of water management and its solutions;
2. Improve the interaction between different actors (in particular the ones related to WWTPs); and
3. Improve the availability of data related to the water problem, through possibly, the construction of a public database.

The letter was handed to the Mayor (Presidente Municipal Constitucional del Municipio) by Carlos A. Paillés and the Director of UNU-FLORES, Prof. Edeltraud Guenther on behalf of all workshop participants at the closing of the event.

Figure 4.1: Moisés Ramirez Tapia, Mayor of Tepeji de Río de Ocampo (Presidente Municipal Constitucional del Municipio), receiving the letter from Carlos A. Paillés and Prof. Edeltraud Guenther, on behalf of all workshop participants, requesting his support for the implementation of actions identified during the workshop.

Closing remarks were given on behalf of the organisers by Carlos A. Paillés, who thanked all participants of the workshop and emphasised how the participation of the international experts and of the members of the communities involved in the process of sanitation and wastewater use has provided a step forward towards an improved wastewater management in the Mezquital Valley and in the area of Lake Atitlan.

Words of thanks were also given by Mr Moises Ramirez Tapia, the Mayor of Tepeji del Rio de Ocampo, who appreciated the long-standing collaboration between the Municipality, FIAVHI, and UNU-FLORES. Ramirez Tapia renewed the motivation of Tepeji and of his community to be part of the process of seeking solutions to the environmental issues in the Mezquital Valley and for LAC as a whole.

Figure 4.2: Tamara Avellan, Serena Caucci, and Angela Hahn providing the Mayor with a copy of the proceedings of the first workshop which took place under his auspices in Tepeji del Rio in 2017.

In order to realise the Nexus Approach, local stakeholders will now have to implement the suggested activities emerging from the workshop discussions and decide if a reassessment of the wastewater situation at a later point using the same methodologies developed is to be carried out. The workshop efforts have proven to be worthwhile with early signals of impact. Following the recognition for the need to implement an awareness raising solution, FIAVHI has, for instance, already implemented part of the recommendations by setting up a Facebook page where information, videos, and lessons learned from the existing wastewater treatment systems as well as environmental awareness are being disseminated (https://www.facebook.com/fiavhi/).

5. References

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Appendix 1: Field Visits

Figure A–1.1: Impressions of the field visits

Appendix 2: General Evaluation of the Workshop

Participants evaluated the workshop through a standard form that was handed out to them at the end of the workshop. Participants were both female (5) and male (12) and represented various stakeholder groups: local community (4), private sector (2), plant operator (2), national decision makers (1), state decision makers (1), and others (6).

In a first step, participants provided numerical evaluations on a five-point scale (1 = minimum/ poor and 5 = maximum/excellent). The following data represent averages rounded to one decimal place, referring to this scale. In general, the majority of participants evaluated the workshop as being excellent. This relates to the overall assessment of the workshop (mean = 4.61), as well as the organisation of the event (mean = 4.76), the balance of presentations and discussion sessions (mean = 4.50), as well as the quality of presentations (mean = 4.78) and interactive sessions (mean = 4.72). Moreover, the majority of the respondents found the workshop very useful. The workshop helped participants to understand the Nexus Approach to the integrated environmental resource management (mean = 4.61), the sustainability of current solutions (mean = 4.82), the stakeholder network (mean = 4.78), and the complexity of the problem (mean = 4.67), as well as in regard to identifying sustainable management options for wastewater and sludge (mean = 4.33) and how to implement the identified solutions (mean = 4.41). In addition, the majority of respondents mentioned that they would be able to use what they had learned in their work (mean = 4.61). The bar chart below (Figure A-2.1) shows the results of the scale questions of the evaluation.

Second, respondents provided some personal opinions in an open category. When asked about the most interesting topics of the workshop, many participants highlighted various points, amongst them included information about wastewater and sludge treatment, solid waste management, and the stakeholders and their interrelations. Other topics highlighted by the participants but not to a lesser extent were SUWA, solution proposals, analysis of barriers, socialisation of information and awareness about environmental issues, and water quality and its monitoring.

Then, respondents were asked for the least interesting topics developed during the workshop. Only 3 out of 18 highlighted a least interesting topic, and all of them mentioned green buildings. Overall, participants showed that they were very satisfied with the presented topics.

When respondents were asked about the key stakeholder for solving the problem, the municipal presidency was the most selected stakeholder; followed by society, authorities, and the local community; and then CONAGUA, experts, and the central government; and finally, farmers, businessmen, and institutions.

With regard to the absent stakeholders in the closing workshop, many respondents highlighted the absence of authorities from all levels (municipal, state, and federal), then representatives of the population, and followed by the Secretary of Environment. Many other institutions were mentioned by the participants, some stakeholders from the other pilot site Panajachel, such as universities (USAC), representatives of the educational and health sector, AMSCLAE, and CONCYT. Also, a higher participation of CAAMTROH would have been preferred.

In terms of future events, participants suggested including more information in the local language, in addition to more technical information, and greater dissemination of the outcomes deriving from the workshop.

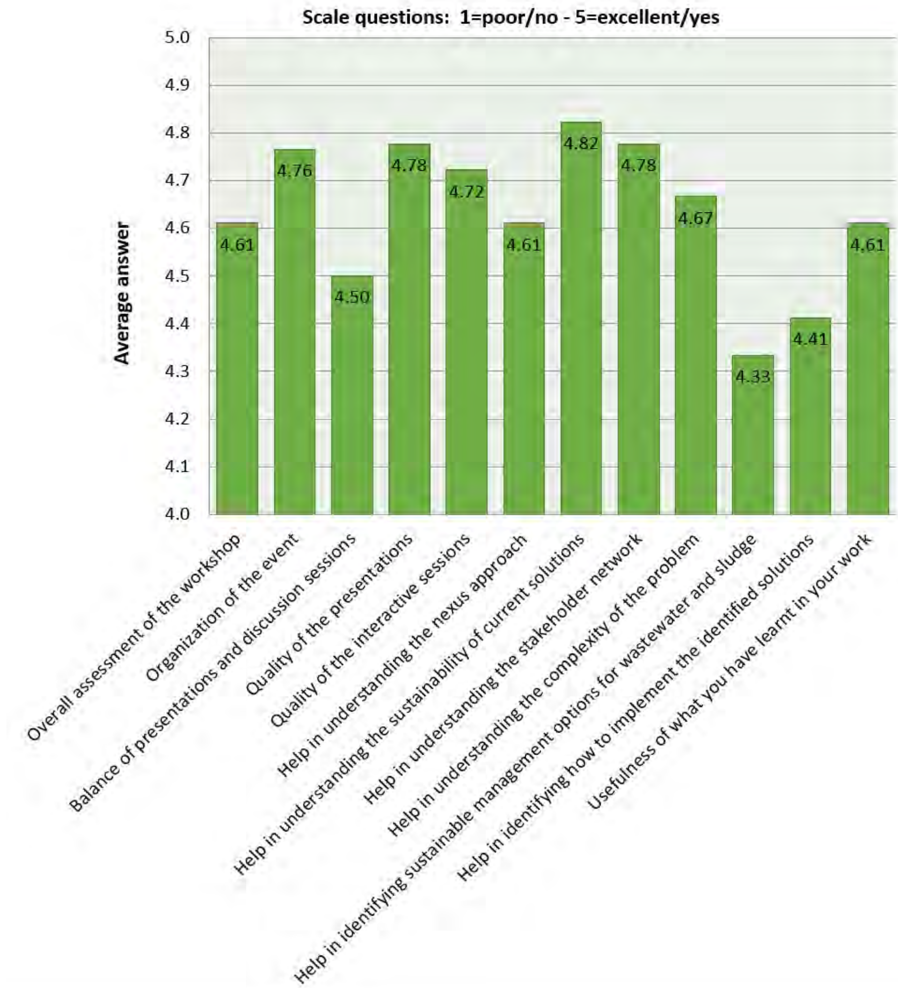


Figure A–2.1: Assessment of the evaluation of the workshop.

Appendix 3: Programme Highlights

PROGRAMA PRINCIPAL

DÍA 1 Lunes, 12 de Noviembre 2018

09:00–17:00	**Visita de campo**

DÍA 2 Martes, 13 de Noviembre 2018

	Hacia una gestión sostenible de las aguas residuales
8:30 – 9:00	**Acreditación**
9:00 – 9:45	**Palabras de apertura**
9:45 – 10:30	**El trabajo de FIAVHI para mejorar la gestión de aguas residuales en la región**
11:00 – 12:30	**El proyecto SludgeTec**
12:30 – 14:00	**Almuerzo**
14:00 – 14:45	**Estado de la presa Requena y la situación del agua en la región de Tepeji**
14:45- 15:30	**Estado del lago de Atitlán**
15:30 – 16:00	**Descanso**
16:00-18:00	**Presentación de los informes de referencia**
18:00 – 18:15	**Repaso día 2** **Descripción día 3**

DÍA 3 Miércoles, 14 de Noviembre 2018

	Opción de solución de visualización y desarrollo
8:30–9:00	**Acreditación**
9:00–9:15	**Resumen día 2** **Descripción día 3**

2 TALLER DE CIERRE DE SLUDGETEC: SOSTENIBILIDAD DE SISTEMAS DE AGUAS RESIDUALES – VALIDACIÓN DE OPCIONES

09:15-10:30	**Opciones actualmente identificadas o implementadas por los actores interesados del lugar**
10:30- 11:00	**Descanso**
11:00-12:30	**Agua residual como un recurso** **Uso seguro del agua residual en la agricultura – SUWA** **Sesión de discusión**
12:30-14:00	**Almuerzo**
14:00-14:45	**Soluciones actuales para la gestión de aguas residuales en México**
14:45-15:30	**Soluciones actuales para la gestión de aguas residuales en Guatemala**
15:30-16:00	**Descanso**
16:00 – 17:30	**Actividades interactivas para la concepción de soluciones**
17:30-18:00	**Puntos críticos para las intervenciones identificadas por SludgeTec**
18:00 – 18:15	**Repaso día 3** **Descripción día 4**

DÍA 4 Jueves, 15 de Noviembre 2018

	Elección de la solución
8:30 – 9:00	***Acreditación***
9:00 – 9:15	**Resumen del día 2 y del día 3**
9:15 – 10:00	**Gestión de residuos sólidos: residuos municipales, residuos orgánicos y lodos**
10:00-10:30	**Agua residual, lodo y producción de Biogas**
10:30- 11:00	**Descanso**
11:00-11:30	**Edificios verdes. Cero descarga. Ecología urbana**
11:30 – 12:30	**Evaluación de opciones**

12:30 – 14:00	**Almuerzo**
14:00 – 16:00	**Actividades participativas para la elección de la solución**
16:30-18:00	**Resultados de los grupos de trabajo**
18:00-18:15	**Repaso día 4** **Descripción día 5**

DÍA 5 Viernes, 16 de Noviembre 2018

	Planificación
8:30 – 9:00	**Acreditación**
9:00 – 9:15	**Resumen del día 4 y descripción del día 5**
9:15 – 10:00	**Planificación de las mejores practices de gestión**
10:00-11:00	**Ejercicio de planificación**
11:00-11.30	**Descanso**
11:30 – 12:45	**Ejercicio de planificación (parte II)**
12:45 – 14:00	**Almuerzo**
14:00 – 15:30	**Plenario de cierre**
15:45 – 16:15	**Descanso**
16:15 – 16:45	**Energías alternativas**
16:45 – 17:45	**Voto de agradecimiento y observaciones finales**

Appendix 4: International Team of Experts

EQUIPO INTERNACIONAL DE EXPERTOS

En orden alfabético

Dra. Tamara Avellán
Universidad de las Naciones Unidas (UNU-FLORES)
Dresde, Alemania

Como investigadora en la Unidad de Manejo de Recursos Hídricos en UNU-FLORES, la Dra. Avellán se enfoca en las posibilidades de reducir pérdidas de recursos a través del estudio de las relaciones entre agua, suelo y residuos. Bióloga de profesión, ha investigado los impactos ecológicos de la calidad de agua en la biota acuática y los efectos del exceso de nutrientes en la morfología vegetal. Trabajó con agricultores en el Uruguay para encontrar soluciones sostenibles al aumento de aguas residuales en la cuenca, lo que llevó a la instalación del primer humedal construido localmente que utiliza especies de plantas endógenas, en 2008.

MSc. Lucía Benavides
Consultora en la Universidad de las Naciones Unidas (UNU-FLORES)
Dresde, Alemania.

Maestra en Gestión de Recursos Naturales por la Universidad de Ciencias Aplicadas de Colonia (TH-Köln). Lucía Benavides trabajó en iniciativas comunitarias para la sostenibilidad, formándose paralelamente como arquitecta y urbanista, Investiga las relaciones entre sistemas humanos y naturales Su trabajo se ha enfocado en ciudades latinoamericanas, donde ha estudiado, por ejemplo, las posibilidades de recuperación de servicios ecosistémicos ligados al agua en la Ciudad de México, y el metabolismo de recursos naturales de las ciudades medianas en la región.

Dra. Serena Caucci
Universidad de las Naciones Unidas (UNU-FLORES)
Dresde, Alemania

Como Investigadora asociada en la UNU-FLORES, la Dra. Serena Caucci trabaja en el campo de desarrollo de capacidades en proyectos con múltiples actores, tales como la Iniciativa Uso Seguro de Aguas Residuales en Agricultura (SUWA), opciones de manejo de lodos y sostenibilidad.
La Dra. Caucci ha trabajado cercanamente con socios transdisciplinarios y ha desarrollado colaboraciones internacionales en el campo de evaluación de riesgos microbiológicos relacionados con procesos de saneamiento y manejo de contaminación ambiental. Antes de unirse a la UNU-FLORES, trabajó en el instituto de Hidrobiología de la Universidad Técnica de Dresde y en el Centro Helmholtz para el Medio Ambiente-(UFZ) en temas de saneamiento de agua y resistencia a antibióticos en ambientes antropogénicos.

Prof. Jorge Cifuentes
Universidad San Carlos of Guatemala (USAC)
Guatemala, Guatemala

El Sr. Cifuentes es profesor e investigador en la USAC. Investiga en las áreas de nanotecnología, biomateriales y tratamiento de aguas residuales en la Escuela de Ingeniería Mecánica y en el Centro de Investigación de Ingeniería de la USAC. Tiene un gran interés en impartir cursos de posgrado, tales como Instrumentación y Control, y Energía renovable y no renovable. El Prof. Cifuentes posee una maestría en Ingeniería Mecánica y Nanocompuestos de la Universidad de Kyung Hee, Corea del Sur y actualmente está desarrollando investigación en cambio climático y sostenibilidad para obtener su grado doctoral.

MSc. Néstor De la Paz
Consultor en la Universidad de las Naciones Unidas (UNU-FLORES)
Dresde, Alemania

Como consultor en UNU-FLORES, el Sr. de la Paz desarrolla tareas aplicando enfoques transdisciplinarios con una perspectiva en Geomática y un fuerte enfoque en la Sostenibilidad y la Gestión Integrada del Agua Urbana. Durante sus recientes estudios de postgrado en CentroGeo (Ciudad de México), el Sr. De la Paz ha participado en investigación aplicada para abordar las necesidades sociales en el diseño, desarrollo e implementación de soluciones en Geomática respaldadas por tecnología de Sistemas de Información Geoespacial y análisis espacial en temas de Gestión de Agua Residual.

Prof. Dr.-Ing. habil. Christina Dornack
Universidad Técnica de Dresde (TUD)
Dresde, Alemania

La profesora Dornack es la directora del Instituto de Manejo de Residuos y Economía Circular de la Universidad Técnica de Dresden. El principal enfoque de sus investigaciones es el manejo de lodos y de desechos biológicos e industriales. La Prof. Dornack también dicta cursos en economía circular, manejo de bioenergía, y fuentes alternativas de energía. Antes de unirse a la TUD, ocupó varias posiciones dentro del sector industrial, incluyendo la empresa Energy Saxony e.V. y obtuvo amplia experiencia en temas de energía, procesos de pulpa y papel, y reciclaje y manejo de recursos materiales.

Prof. Dr. Edeltraud Guenther
Universidad de las Naciones Unidas (UNU-FLORES) y Universidad Técnica de Dresde (TUD)
Dresde, Alemania

La profesora Guenther estudió administración de empresas en la Universidad de Augsburgo. Después de haber estudiado lenguas en Ginebra, se convirtió en profesora de contabilidad financiera. Dedicó su tesis doctoral a la contabilidad ambiental y sus campos de investigación se enfocan en: la medición del desempeño ambiental, la gestión basada en valores de los recursos ambientales, el análisis de barreras y la desaceleración del consumo, así como los procesos de producción. La Dra. Guenther ha sido profesora de administración de empresas en la cátedra de Gestión Ambiental y Contabilidad de la TUD desde 1996. Es directora y fundadora del PRISMA - Centro de Medición y Evaluación de la Sostenibilidad, y actualmente es directora del Instituto FLORES de la Universidad de las Naciones Unidas (UNU-FLORES)

MA. Angela Hahn
Universidad de las Naciones Unidas (UNU-FLORES)
Dresde, Alemania

Angela Hahn es Gerente del Proyecto SludgeTec. Tiene una Licenciatura en Trabajo Social y una Maestría en Gestión de Conflictos Interculturales de la Universidad Alice Salomon en Berlín, Alemania. Trabajó en la Universidad Alice Salomon como Asistente de Investigación y en la coordinación de proyectos internacionales. El enfoque de sus estudios es el desarrollo comunitario, la resiliencia, la vulnerabilidad social, la resolución de conflictos, el mantenimiento de la paz y los aspectos culturales del desarrollo. Durante sus estudios tuvo varias oportunidades de realizar proyectos de investigación participativa en campo, abonando a profundizar en el especial interés que tiene en el trabajo comunitario en América Latina.

Dra. Anne-Karen Hueske Dipl.-Kffr.
Universidad Técnica de Dresde (TUD) Dresde, Alemania

La Dra. Anne-Karen Hueske es la directora científica del PRISMA - Centro de Medición y Evaluación de la Sostenibilidad de la TUD. Su investigación se enfoca en las barreras del cambio organizacional e innovación, y en la medición y evaluación de la sostenibilidad. La Dra. Hueske posee un Diploma en Administración de Empresas de la TUD y una Maestría en Gestión Internacional de la Universidad de Estrasburgo de la Escuela de Manejo.. Dedicó su tesis doctoral al análisis de barreras.

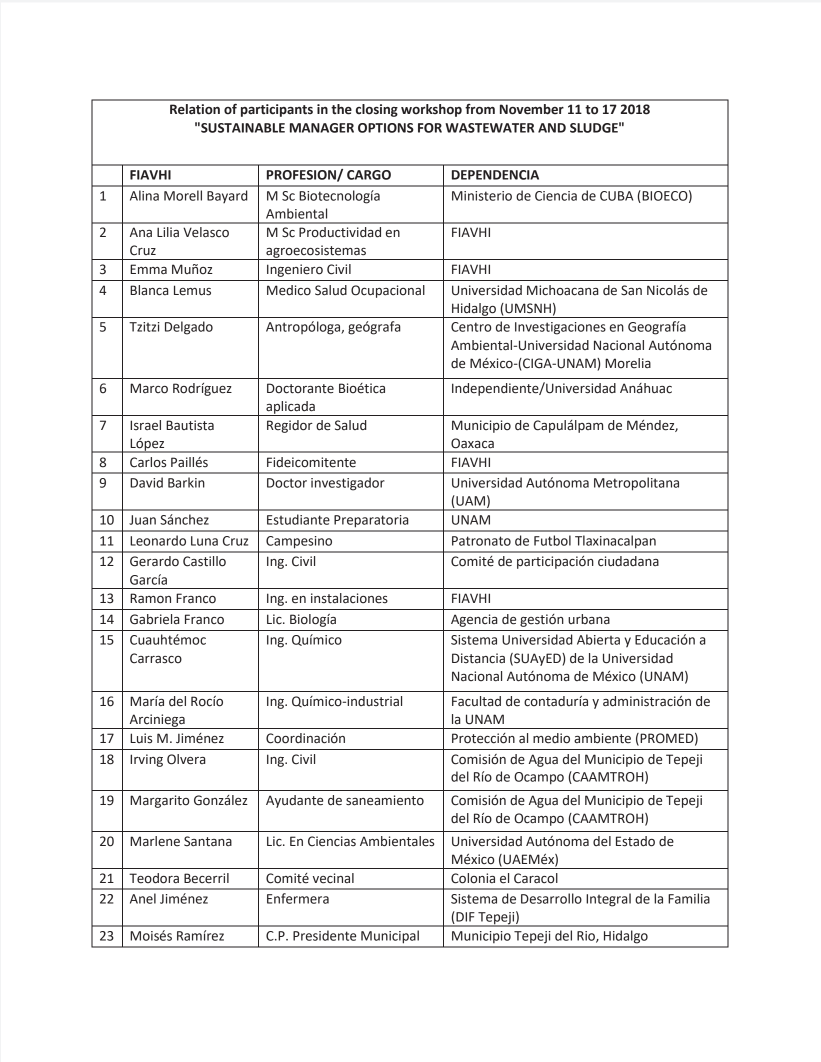
Dipl. Ing. Andrea Müller
Universidad de las Naciones Unidas (UNU-FLORES) y Universidad Técnica de Dresde (TUD) Dresde, Alemania

Andrea Müller es Ing. Bioquímico de la Pontificia Universidad Católica de Valparaíso, Chile. Con un fuerte enfoque en bioprocesos, realizó pasantías en PTAR en Chile y en el Centro de Bio-procesamiento de Desechos Sólidos de la Universidad de Queensland, Australia. Actualmente es estudiante del programa de doctorado UNU-FLORES y TUD formando parte de la Unidad de Manejo de Recursos Hídricos (UNU-FLORES) y de la Unidad de Desarrollo Ambiental y Manejo de Riesgos (TUD). Andrea enfoca su estudio en el desarrollo de un marco de referencia para apoyar la toma de decisiones respecto a la reutilización de aguas en zonas con riesgo de escasez hídrica.

Sr. Carlos A. Paillés
Fideicomiso Infraestructura Ambiental de los Valles de Hidalgo (FIAVAHI) Hidalgo, Mexico

El Sr. Paillés es el Principal fideicomisario de FIAVHI. Actualmente también es Presidente del Comité de Certificación de Capacidades en Riegos Tecnificados con Agua Residual Tratada. El Sr. Paillés tiene años de amplia experiencia en manejo de recursos naturales y manejo de aguas. Desde 1999 ha dirigido varias iniciativas para promover el uso seguro de aguas residuales en agricultura. Esto incluye el diseño e implementación de 29 Plantas de Tratamiento de Aguas Residuales (PTARs) en el estado de Oaxaca, México. Desde 2008 ha implementado 15 proyectos pilotos de PTARs en el valle del Mezquital y la municipalidad Tepeji, específicamente para reuso de aguas residuales en agricultura.

Appendix 5: List of Participants



	Relation of participants in the closing workshop from November 11 to 17 2018 "SUSTAINABLE MANAGER OPTIONS FOR WASTEWATER AND SLUDGE"		
	FIAVHI	**PROFESION/ CARGO**	**DEPENDENCIA**
1	Alina Morell Bayard	M Sc Biotecnología Ambiental	Ministerio de Ciencia de CUBA (BIOECO)
2	Ana Lilia Velasco Cruz	M Sc Productividad en agroecosistemas	FIAVHI
3	Emma Muñoz	Ingeniero Civil	FIAVHI
4	Blanca Lemus	Medico Salud Ocupacional	Universidad Michoacana de San Nicolás de Hidalgo (UMSNH)
5	Tzitzi Delgado	Antropóloga, geógrafa	Centro de Investigaciones en Geografía Ambiental-Universidad Nacional Autónoma de México-(CIGA-UNAM) Morelia
6	Marco Rodríguez	Doctorante Bioética aplicada	Independiente/Universidad Anáhuac
7	Israel Bautista López	Regidor de Salud	Municipio de Capulálpam de Méndez, Oaxaca
8	Carlos Paillés	Fideicomitente	FIAVHI
9	David Barkin	Doctor investigador	Universidad Autónoma Metropolitana (UAM)
10	Juan Sánchez	Estudiante Preparatoria	UNAM
11	Leonardo Luna Cruz	Campesino	Patronato de Futbol Tlaxinacalpan
12	Gerardo Castillo García	Ing. Civil	Comité de participación ciudadana
13	Ramon Franco	Ing. en instalaciones	FIAVHI
14	Gabriela Franco	Lic. Biología	Agencia de gestión urbana
15	Cuauhtémoc Carrasco	Ing. Químico	Sistema Universidad Abierta y Educación a Distancia (SUAyED) de la Universidad Nacional Autónoma de México (UNAM)
16	María del Rocío Arciniega	Ing. Químico-industrial	Facultad de contaduría y administración de la UNAM
17	Luis M. Jiménez	Coordinación	Protección al medio ambiente (PROMED)
18	Irving Olvera	Ing. Civil	Comisión de Agua del Municipio de Tepeji del Río de Ocampo (CAAMTROH)
19	Margarito González	Ayudante de saneamiento	Comisión de Agua del Municipio de Tepeji del Río de Ocampo (CAAMTROH)
20	Marlene Santana	Lic. En Ciencias Ambientales	Universidad Autónoma del Estado de México (UAEMéx)
21	Teodora Becerril	Comité vecinal	Colonia el Caracol
22	Anel Jiménez	Enfermera	Sistema de Desarrollo Integral de la Familia (DIF Tepeji)
23	Moisés Ramírez	C.P. Presidente Municipal	Municipio Tepeji del Rio, Hidalgo

24	Gerardo Pacheco Medina	Relaciones Internacionales	Corporación Internacional Hidalgo (COINHI)
25	Blanca Rosa Moreno	Periodista	Portal Contrapuntos
26	María del Carmen Márquez	Lic. En periodismo	Sur de Hidalgo
27	Ernesto Cadena Acosta	Arq. Director General	Secretaria de Desarrollo Económico (SEDECO/COINHI)
28	Félix Herminio Morales	Ing. Subdirector	Comisión de Agua y Alcantarillado del Municipio de Tula de Allende, Hgo. (CAPyAT)
29	Francis Obsomer	Técnico en Hidroponía	Iniciativa Civil que organiza cursos en hidroponía
30	Otoniel Reyes López	Ingeniero	Comisión Nacional del Agua (CONAGUA)
31	Rosalba Montelongo	Ing. Química	Comisión Nacional del Agua (CONAGUA)
32	Florencio García	Representante	Ejido Progreso Atotonilco de Tula, Hgo.
33	Arlette Ramírez	Ing. Ambiental	FIAVHI
34	Lucio López Granados	Ex-operador de la PTAR y miembro del patronato de Futbol	Tlaxinacalpan
	GUATEMALA		
1	Enrique Consenza		
	UNU-FLORES		
1	Edeltraud Guenther		
2	Tamara Avellan		
3	Serena Caucci		
4	Néstor de la Paz		
5	Angela Hann		
6	Lucia Benavides		
7	Andrea Muller		
8	Christina Dornack		
9	Anne-Karen Hushe		

Appendix 6: Letter to the Mayor

Hacienda Caltengo, Tepeji del Rio de Ocampo,
26 de noviembre del 2018.

C.P. Moisés Ramirez Tapia
Presidente Municipal Constitucional del Municipio de Tepeji de Río de Ocampo
P R E S E N T E

Por medio de la presente damos a conocer a usted los resultados y propuestas de solución a la problemática de aguas residuales en el municipio, que resultaron del taller del cierre de SludgeTec: „Sostenibilidad de sistemas de aguas residuales - validación de opciones"

En este taller, realizado entre el 12 y el 16 de noviembre del presente, por la UNU-FLORES y FIAVHI, en donde participaron miembros de la academia, representantes de las localidades, el patronato de futbol de Tlaxinacalpan, la CAAMTROH, representantes del comité de participación ciudadana del Río Tula, representantes de Cuba y Guatemala, así como de los estados de Oaxaca y Michoacán, se presentaron los resultados de la investigación del proyecto SludgeTec y se realizó un análisis a conciencia de la problemática local.

El proyecto SludgeTec examinó la sostenibilidad de una PTAR de lodos activados en la localidad de Panajachel, Guatemala, y de una planta con biodigestores seguidos por humedales artificiales cuyo efluente se destina al riego (publico urbano y agrícola), en la localidad de Tlaxinacalpan, Tepeji. Tras las investigaciones se constató que la sostenibilidad de la planta de tratamiento de los Cebollales presenta un nivel medio a bajo de sostenibilidad, mientras que la planta de Tlaxinacalpan exhibe un nivel moderado a bueno, dentro de las dimensiones que fue posible analizar. La lista total de actores identificados en Panajachel fue de 62, mientras que en Tepeji fue de17, se constata que el conocimiento del status quo de las plantas de tratamiento esta altamente fragmentado y que los actores con la mayor cantidad de información no son necesariamente los que toman las decisiones. El proyecto también encontró que la problemática de uso de aguas servidas es altamente compleja a causa de altos grados de conflictos de metas, complejidad de sistemas e incertidumbre de información. Los análisis revelan que los procesos de planificación en ambos sitios resuelven la complejidad del problema de forma limitada.

Queremos poner a su consideración lo siguiente:

- Encontramos 3 grandes rubros de soluciones:

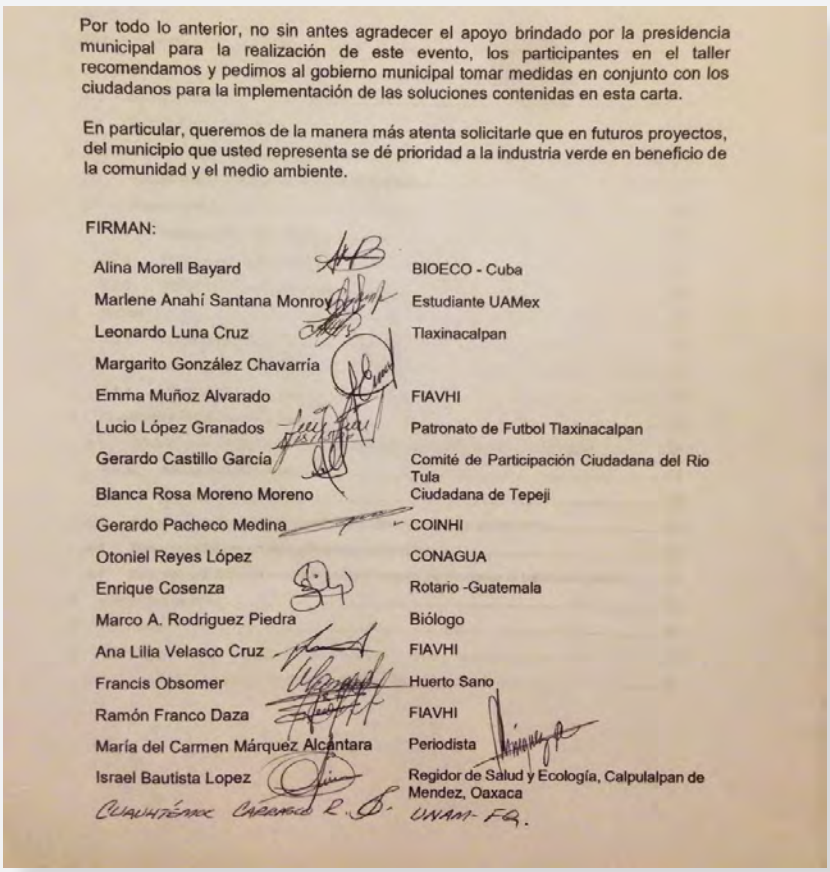
1. Eventos para concientizar y socializar información acerca de la problemática del agua y sus soluciones, en el marco del día mundial del agua y otras fechas relacionadas.

2. Mejorar la interacción entre distintos actores, en especifico (1) la presidencia municipal a través de la secretaria de obras publicas y la CAAMTROH, FIAVHI, CONAGUA. Para estos fines proponemos sostener una reunión con los actores mencionados a la brevedad posible. Actores adicionales que hemos identificado y con los cuales proponemos acercamientos posteriores las comunidades locales, el sector industrial empresarial, la secretaría de ecología municipal y la prensa

3. Mejorar la disponibilidad de datos relacionados a la problemática del agua, a través, posiblemente, de la construcción de una base de datos publica. Esto incluiría la recopilación, sistematización y validación de datos ya existentes entre distintas instituciones, así como la generación de datos faltantes a través de monitoreos.

FIRMAN:

Alina Morell Bayard	BIOECO - Cuba
Marlene Anahí Santana Monroy	Estudiante UAMex
Leonardo Luna Cruz	Tlaxinacalpan
Margarito González Chavarría	
Emma Muñoz Alvarado	FIAVHI
Lucio López Granados	Patronato de Futbol Tlaxinacalpan
Gerardo Castillo García	Comité de Participación Ciudadana del Rio Tula
Blanca Rosa Moreno Moreno	Ciudadana de Tepeji
Gerardo Pacheco Medina	COINHI
Otoniel Reyes López	CONAGUA
Enrique Cosenza	Rotario -Guatemala
Marco A. Rodriguez Piedra	Biólogo
Ana Lilia Velasco Cruz	FIAVHI
Francis Obsomer	Huerto Sano
Ramón Franco Daza	FIAVHI
María del Carmen Márquez Alcántara	Periodista
Israel Bautista Lopez	Regidor de Salud y Ecología, Calpulalpan de Mendez, Oaxaca


Por todo lo anterior, no sin antes agradecer el apoyo brindado por la presidencia municipal para la realización de este evento, los participantes en el taller recomendamos y pedimos al gobierno municipal tomar medidas en conjunto con los ciudadanos para la implementación de las soluciones contenidas en esta carta.

En particular, queremos de la manera más atenta solicitarle que en futuros proyectos, del municipio que usted representa se dé prioridad a la industria verde en beneficio de la comunidad y el medio ambiente.

FIRMAN:

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CUAUHTÉMOC CARRASCO R. S.	UNAM- FQ.

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ADVANCING A NEXUS APPROACH TO THE SUSTAINABLE MANAGEMENT OF ENVIRONMENTAL RESOURCES

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