HEAVY METALS IN DRINKING WATER: PROPOSAL FOR THEIR REMOVAL

Schweizerische Eidgenossenschaft
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Embajada de Suiza en el Perú

Agencia Suiza para el Desarrollo y la Cooperación COSUDE

BluAct Technologies

SABAVIDA

Heavy metals in drinking water: a proposal for their removal. Summary of the “Pilot project for the elimination of heavy metals from drinking water”. SDC, BluAct Technologies, SABAvida. Lima, Peru.

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HEAVY METALS IN DRINKING WATER: A PROPOSAL FOR THEIR REMOVAL

Summary of the “Pilot project for the elimination of heavy metals from drinking water”

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Executive Summary

The present document summarizes the validation study of a technology (granular filter material) for removing heavy metals from water for human consumption in Peru. The study was conducted in 2019 and 2020 in four departments of Peru (Lambayeque, Cerro de Pasco, Moquegua, Tacna), where a part of the population consumes water containing arsenic and lead with levels that exceed the maximum permissible limits (0.01mg/lt). The technology used was developed by BluAct Technologies, a spin-off company of the Swiss Federal Institute of Technology Zurich (ETH Zurich). It is based on activated lactose and carbon protein fibres that do not require energy, are low-cost, adaptable to various formats, scalable, and have no secondary effects. The study was sponsored by the Swiss Agency for Development and Cooperation (SDC) and was carried out by SABAvida in accordance with the Technical Design Standard: Technological Options for Water Treatment Systems in Rural Areas (RM 192-2018-VIVIENDA).

With the objective of analysing their performance in diverse local contexts, the filter material was first tested in filters for household use in rural and peri-urban settlements that are connected to various water supply systems. This initial stage gauged their efficiency and informed design adjustments to achieve an optimal model. Additionally, granular filter material was installed at three water treatment plants of different configuration and coverage to test adaptability and retention capacity, with particular emphasis on arsenic removal.

In a second stage, filter materials were adapted based on calculations and projections for their inclusion into water supply systems. Hereby, the pilot study took advantage of the recently installed Yacango Drinking Water Treatment Plant (Moquegua) and coordinated its work with regional and municipal authorities.

In this process, the Municipal Technical Units of the local governments played an important role in the coordination of the work by involving families, representatives of social organizations, officials and technicians, e.g. from the Regional Directorate of Housing, Construction and Sanitation (DRVCS) of the local governments, the Agency for Social Development of the municipalities, and health care facilities, among others. Additionally, the different stakeholders were trained on the proper handling of filter material within the framework of the pilot project.

The general results of the test application of these filter materials confirmed their efficiency in the reduction of concentrations of arsenic and lead, their adaptability to the various water treatment systems in rural areas, as well as the feasibility for upscaling (costs, access to inputs, logistics, operation, management), and their high cost-efficiency.

1 Problems of water quality in Peru

The world's freshwater resources are increasingly contaminated with heavy metals and other pollutants (UN, 2020)[1]. Heavy metal contamination of drinking water represents a potentially serious threat to human health (Fernández-Luqueño et al., 2013)[2]. The efficient treatment of water is a necessary precondition to guaranteeing the safe supply of drinking water. This applies also to Peru. Therefore, the Peruvian water sector indicates that the incorporation of technologies for the removal of heavy metals to ensure the physicochemical quality of water for diverse populations in Peru remains to be solved (MVCS, 2021)[3].

Environmental pollution from heavy metals in general and water pollution in particular represents one of the most significant socio-environmental and public health problems in Peru. The sources of heavy metals are diverse, including regional geological characteristics, the discharge of wastewater and industrial waste, agrochemical waste, mining tailings and environmental liabilities. The magnitude and scale of heavy metal contamination of water negatively affects the health of the population, production and the environment[4]. The National Sanitation Plan 2022-2026[3] recognizes the problem of heavy metal pollution of drinking water. Solving this problem requires developing and validating technologies for the removal of heavy metals.

In 2020, the Ministry of Health determined that over 10 million people (30% of the country's population) are at risk of exposure to heavy metals and other toxic substances, and that **over 6 million (20%) are at risk of exposure to arsenic and other metalloids**[5].

Table 1. Settlements affected by the presence of heavy metals in drinking water supply 2014-2015

Department	Settlements		%	Parameters
	Total	Affected		
Tumbes	309	84	27.2	Aluminium, Arsenic, Cadmium, Iron, Manganese, Sodium, Lead
Piura	3 591	1 293	36.0	Aluminium
Lambayeque	1 748	70	4.0	Aluminium
La Libertad	4 637	696	15.0	Arsenic, Sodium
San Martín	6 511	1 042	16.0	Arsenic
Lima	6 118	245	4.0	Aluminium, Arsenic, Cadmium, Iron, Sodium, Nickel
Cusco	10 217	4 905	48.0	Arsenic, Aluminium, Iron
Huancavelica	7 052	1 975	28.0	Arsenic, Aluminium, Iron
Ica	2 183	197	9.0	Aluminium, Arsenic, Iron
Ayacucho	7 693	539	7.0	Arsenic, Aluminium, Borium, Cromium, Iron, Sodium, Nickel
Moquegua	1 377	179	13.0	Arsenic
Tacna	874	184	21.1	Aluminium, Arsenic, Iron
Total	52 310	11 409	21.8	

Source: DIGESA[6].

1. UNESCO, UN-Water, 2020. The United Nations World Water Development Report 2020: Water and Climate Change. Paris, UNESCO.
2. Fernández-Luqueño, F., López-Valdez, F., Gamero-Melo, P., Luna-Suárez, S., Aguilera-González, E.N., Martínez, A.I., García-Guillermo, M.d.S., Hernández-Martínez, G., Herrera-Mendoza, R., Álvarez-Garza, M.A., Pérez-Velázquez, I. R., 2013. Heavy metal pollution in drinking water - a global risk for human health: A review. Afr. J. Environ. Sci. Technol. 7: 567-584.
3. Ministerio de Vivienda, Construcción y Saneamiento, 2021. Plan Nacional de Saneamiento 2022-2026.
4. Defensoría del Pueblo, 2021. En defensa de las personas expuestas a metales pasados, metaloides y otras sustancias químicas: Los impactos de la contaminación ambiental. Informes de Adjuntía series. Informe de Adjuntía N° 19-2021-DP/ AMASPPI.
5. Viceministerio de Salud Pública. Informe Especial N° 060-2020-JAMC-DENOT-DGIESP/MINSA.
6. SDC, 2022. Informe Técnico Sustentatorio para la Elaboración de los Expedientes Técnicos y Sustento Técnico Legal de los Filtros de Tipo Doméstico y Comunal para la Remoción de Arsénico y otros Metales Pesados del Agua Potable para Consumo Humano. Página 15 y 16.

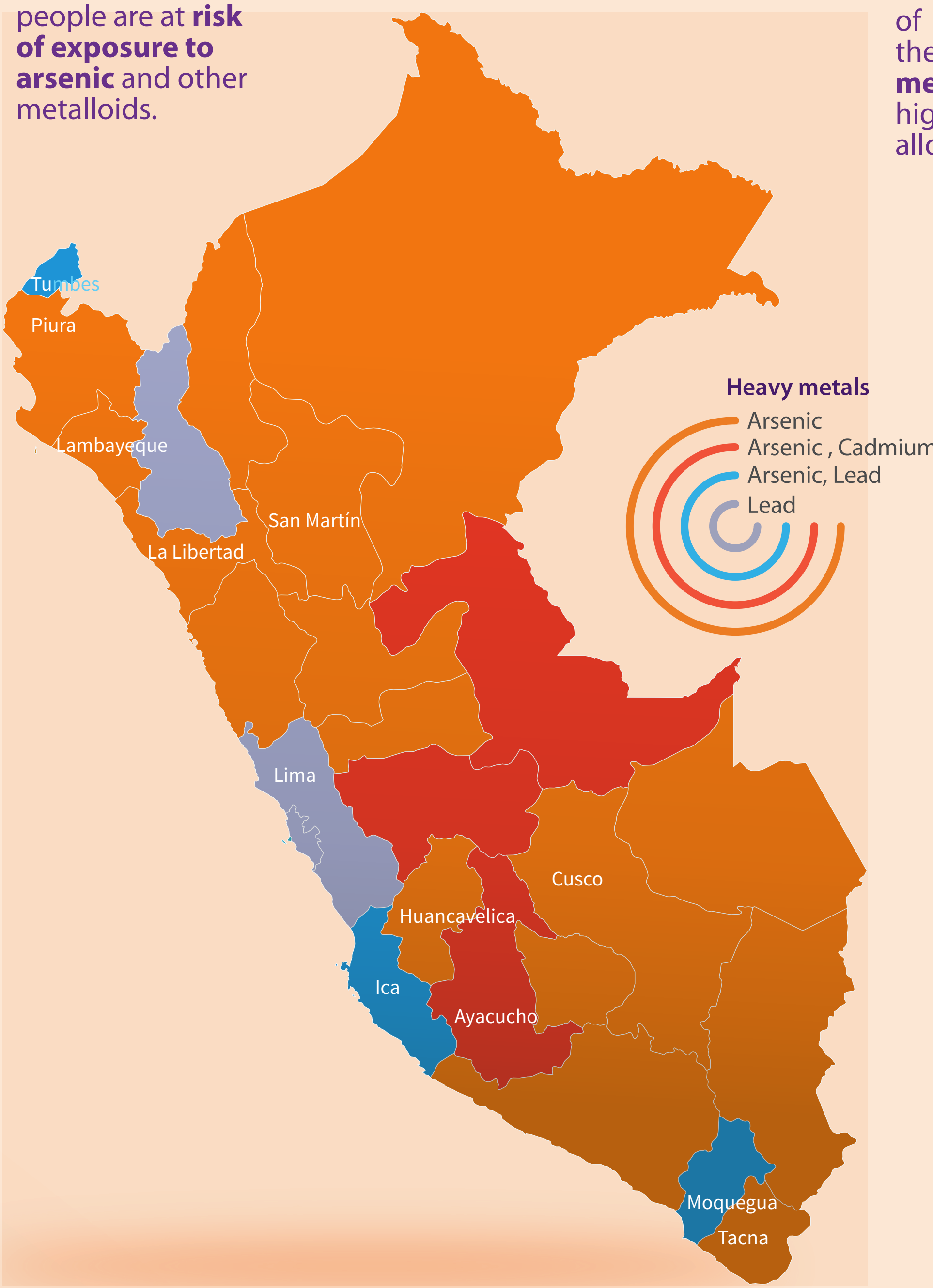
Illustration 1. Regions with water supply that exceeds the maximum permissible limits for heavy metals

+6 millions (20%)

people are at **risk of exposure to arsenic** and other metalloids.

22%

of the settlements of **12** regions exhibited the **presence of heavy metals** with values higher than those allowed by the standard.



Solving

the problem of water contamination requires developing and validating technological proposals.

Source: Ministry of Health, quoted by the Informe Técnico Sustentatorio (SDC and MVCS, 2022).

2 Pilot project: validation of filter technology for the removal of heavy metals from drinking water

In the face of the above-mentioned challenges for the provision of safe drinking water, the Swiss Agency for Development and Cooperation (SDC) identified an innovative, affordable and scalable technology for the removal of heavy metals from drinking water. Developed by BluAct Technologies GmbH, a spin-off company of the Swiss Federal Institute of Technology Zurich (ETH Zurich), this technology is composed of lactose protein fibres and activated carbon and is highly cost-efficient.

In December 2017, an exploratory mission collected water samples from different sources (springs, rivers, lakes, water faucets), measured the presence of lead (Cerro de Pasco) and arsenic (Lambayeque, Moquegua, Tacna), and evaluated the efficiency of the technology to remove both heavy metals in drinking water. The results were promising (removal of 96.8% of arsenic content and 95.7% of lead content). Therefore, SDC and BluAct Technologies decided to initiate a pilot project with the goal of validating the efficiency and effectiveness of the technology.

The project was implemented in **two consecutive stages:**

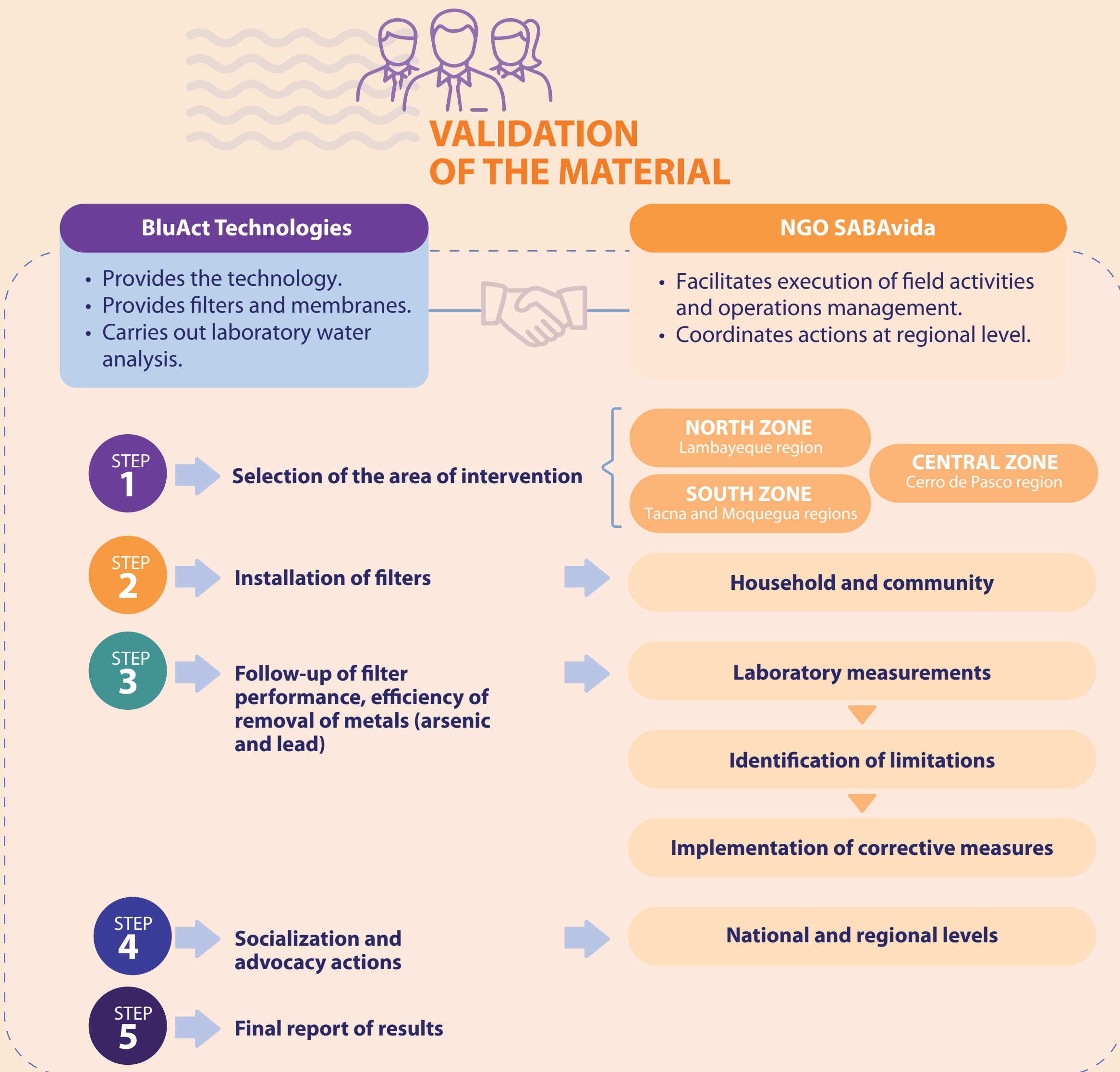
A First stage (April - December 2019)

Implementation of a **pilot study** for the validation of the efficiency and effectiveness of the granular filtering material for the removal of heavy metals in drinking water in eight towns in four departments with presence of heavy metals. The product was evaluated in 28 households and three community supply services.

B Second stage (January - July 2020)

Emphasis was placed on the **validation and operationalisation** of the granular filtering material at the Compact Water Treatment Plant of Yacango (serving 240 families), located in Torata District, Mariscal Nieto Province, in the Department of Moquegua. This is one of the three community water supply services that took part in the first stage.

Illustration 2. Methodology for validation of the filter material

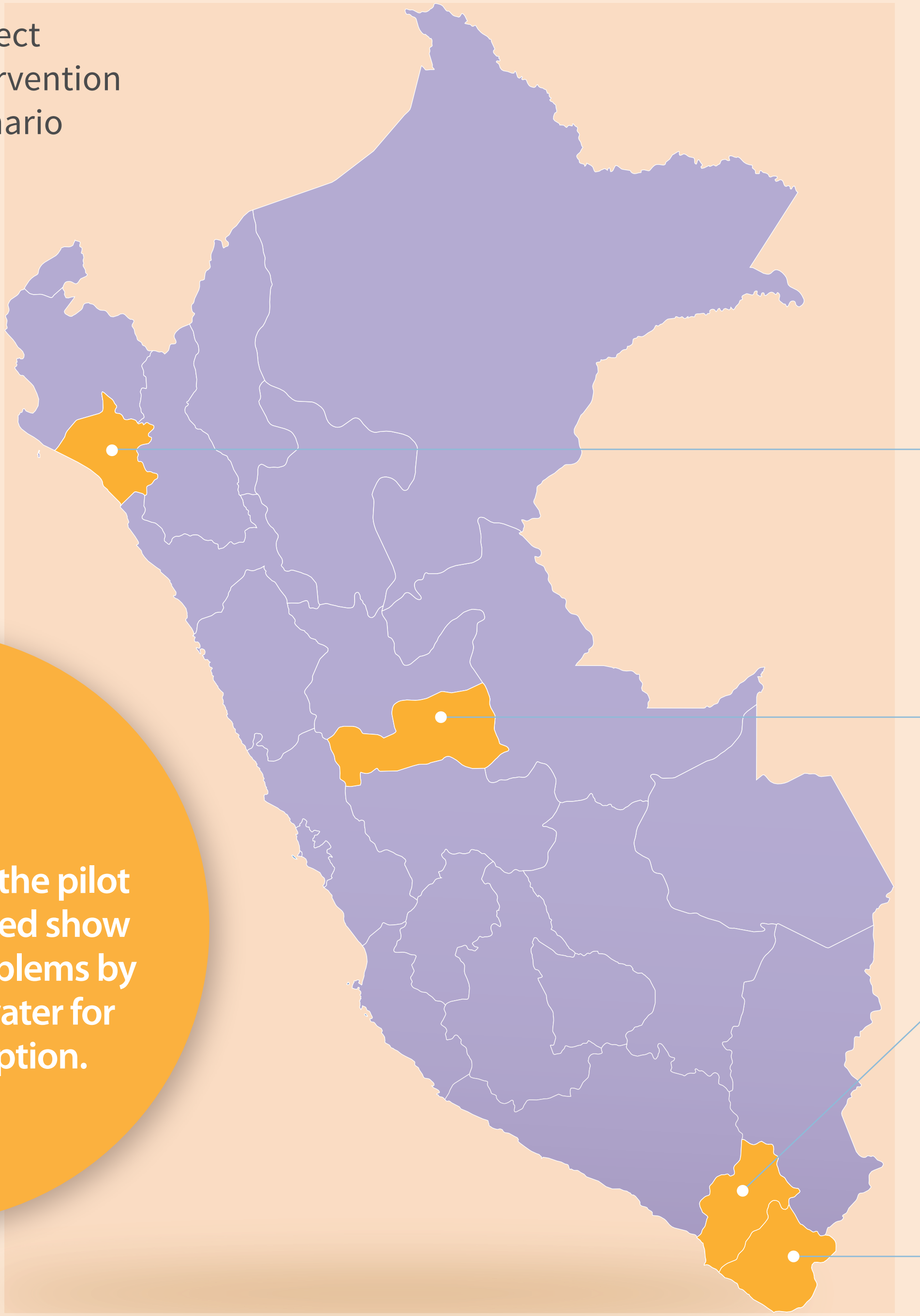


Source: Informe Final – Etapa I (SDC, 2020).

The intervention zones were selected based on the following **criteria**: (i) reported presence of arsenic or lead in the water consumed by the population; preference for the sites visited in 2017; (ii) existence of a household water supply system, preferably in rural zones; (iii) user acceptance for the installation of a household filter prototype in their home; (iv) commitment of the families to help with collecting samples.

In general, all pilot sites showed heavy metal contamination in water for human consumption. At several sites, a state of emergency has been declared due to this situation.

Table 2. Project intervention scenario



All the sites where the pilot study was developed show contamination problems by heavy metals in water for human consumption.

In several places of the study, a state of emergency has been declared due to water contamination.

Lambayeque

Province	District	Settlement	Drinking water supply system	Predominant presence of heavy metals	Household filters	Collective filters
Lamba-yeque	Mórrope	• Sectors Colorada • Laguna-Cruce La Zenaida • El Arca	Pumping from drilled well, without treatment plant	Arsenic	5	-

Pasco

Province	District	Settlement	Drinking water supply system	Predominant presence of heavy metals	Household filters	Collective filters
Cerro de Pasco	Simón Bolivar	• Champa-marca	Pumping from surface source to reservoir, without treatment plant	Lead	4	-

Moquegua

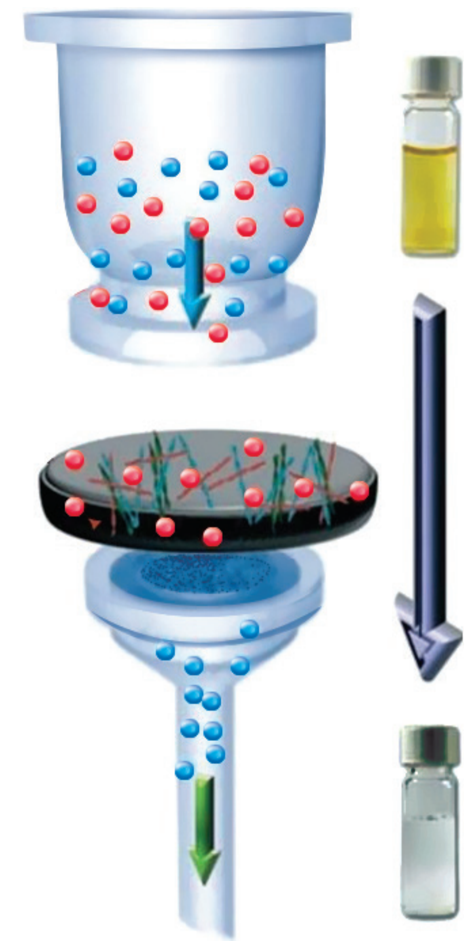
Province	District	Settlement	Drinking water supply system	Predominant presence of heavy metals	Household filters	Collective filters
Mariscal Nieto	Torata	• Sector Jorge Chávez A y B, La Banda • Yacango	Gravity-fed and pumping, without treatment plant	Arsenic, lead	-	Compact water treatment plant

Tacna

Province	District	Settlement	Drinking water supply system	Predominant presence of heavy metals	Household filters	Collective filters
Tacna	Tacna	• Ciudad	Gravity-fed, with water treatment plant	Arsenic	7	Calana water treatment plant
	Inclán	• Poquera • Inclán	Gravity-fed, with water treatment plant	Arsenic	6	Public drinking water tap
Jorge Basadre	Ilabaya	• Ticapampa	Gravity-fed, without water treatment plant	Arsenic	6	-

Source: Informes Finales – Etapas I y II (SDC, 2020).

3 Filter technology for the removal of heavy metals from drinking water

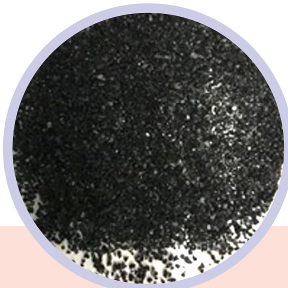


The filtration technology developed by BluAct Technologies GmbH[7] consists of hybrid membranes of amyloid and activated porous carbon. The amyloid is produced from milk proteins. **It is a biodegradable, non-toxic, low-cost material with exceptional capacity to adsorb and extract heavy metal ions and cyanides from drinking water.**

The metallic ions of the toxic pollutants "stick" to the numerous peptide bonds of the protein fibres when water flows through the membranes. Their performance depends on the capacity of the amyloid to selectively absorb the heavy metal pollutants from the solution. **During filtration, the concentration of heavy metal ions is significantly reduced by three to five orders of magnitude.** The process can be repeated several times, maintaining its efficiency even when different ions are filtered simultaneously[8].

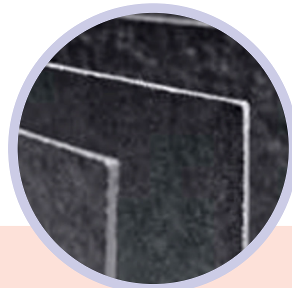
BluAct Technologies developed various product types for the technology to eliminate practically any type of water pollutant. It has been certified by governments (the Spiez Laboratory of the Swiss Government, the Science Research Council of the Government of India), independent agencies (NSF53 and TÜV Rheinland) and by the World Health Organization (WHO). Details of the product types are given as follows:

7. https://www.bluact.com
8. Bolisetty, S., Mezzenga, R. 2016. Membranas híbridas amiloide-carbono para la purificación universal del agua. Nature Nanotech 11, 365–371. https://doi.org/10.1038/nnano.2015.310.



Granular media

Composed of small fibres of protein and porous activated carbon that can be used to eliminate heavy metal ions from water. It is possible to recondition the filter by following the manufacturer's special instructions, an activity that the Potable Water Treatment Plant (PWTP) should oversee.



Hybrid membranes

Are based on a mixture of small protein fibres, activated carbon and cellulose fibres, and can be used in pressure filtration equipment. The mesh size can be adjusted depending on the pollutant (colloidal or microbiological).

Cartridges

Are an "all–in-one" solution for portable water filtration. They instantly filter multiple pollutants in tap water, especially heavy metals, pesticides and microbial contaminants (bacteria).

Adaptability to any existing filter casing is an added advantage, along with the absorption of multiple pollutants and high performance, versatility in the processing of small and large water volumes, use of sustainable manufacturing materials, zero energy requirements for operation, proven scalability, and good regenerative capacity.

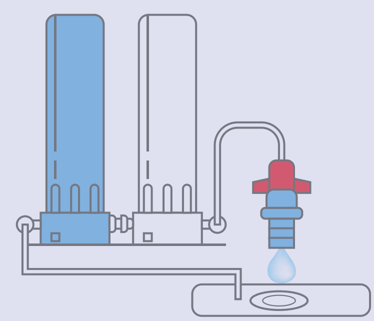
In any case, the product must be used within 36 months of fabrication. **Once used, the product must be handled as industrial waste, following official regulations,** although its storage, handling and transportation are not dangerous to people and the environment.

4 Experience of the pilot project: use in domestic and communal systems

In the pilot study in Peru, the technology was implemented in the form of a *household use filter* to treat drinking water at home, and for *water treatment systems* covering large populations.

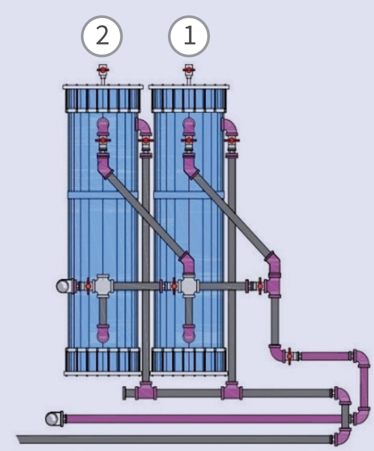
Domestic type

Consisting of a household use cartridge, a plastic container to accommodate the cartridge and accessories. The bypass valve (T connection) is connected to the kitchen water system. Optionally, an activated carbon filter can be added to control possible issues with taste or smell due to characteristics of the supply system.



Communal type

Consisting of a system of two filters in series. The first, filled with hybrid granular material and other layers of filtering material, removes heavy metals from water. The second, containing activated carbon over several layers of sand eliminates odours and tastes. This option does not require electrical power, but it does require sufficient water pressure for the filtration process and is recommended when the concentration of heavy metals exceeds the maximum permissible limits (MPL) established by regulations. It is complementary to microbiological and/or physical-chemical water treatment processes carried out previously. In the case of Yacango (compact system), the filters were installed directly in the pre-filters. In the case of Inclán (water kiosk-type), the filters were added to the final filtration unit.



The water quality was analysed prior to the installation of the filtering material. In all cases, the analyses showed that the drinking water delivered to households contained concentrations of arsenic that were three to 70 times higher than the Peruvian permissible limits (Table 3). Under this scenario, different filter options were tested to evaluate their performance.

Table 3. Presence of heavy metals in water supply systems in the Tacna and Moquegua zones

Parameter	Maximum Permissible Limit (MPL)	**Poquera** Tacna	**Ticapampa** Tacna	**Jorge Chávez** Moquegua
Arsenic (mg/lt)	0.01	0.279	0.678	0.031
		2,790% of MPL	6,780% of MPL	310% of MPL
Iron (mg/lt)	0.3	0.009	0.001	0.001
		3% of MPL	0% of MPL	0% of MPL

Source: Informe Final – Etapa I (SDC, 2020).

4.1. Household filters

The technology (hybrid membrane filters) was applied in four prototypes distributed to 28 households. This allowed for testing of different combinations of filter components and modes of installation, thus optimising combinations until reaching a final model.

TYPE I Simple membrane filter

Basic prototype consisting of a pressure filter with two metal plates. Subsequently, a sand filtration unit was incorporated to improve water quality and flow of solid matter at the connections, thus preventing membrane clogging.

TYPE II Double filter

Double filter consisting of a sand pre-filter and a cup filter containing a cartridge with granular filtration material (first arsenic filtration). This system is connected to a membrane filter as described in Type I (second arsenic filtration).

TYPE III Ceramic filter

Consisting of a single cup type filter which contains a ceramic cartridge filled with granular filtering material.

TYPE IV Hybrid filter

Consisting of a cup filter with a hybrid cartridge, which contains granular material and compact membrane material. To improve the water inflow, a pre-filter with a sand cartridge was added.

4.2. Collective systems

Public drinking water tap in Poquera (Inclán, Tacna):

A public tap was adapted by installing a filter with hybrid granular material (activated carbon, milk protein, cellulose) in a 200-liter tank, conditioned with a gravel layer. Subsequently, this prototype was optimised by adding a pre-filtration unit to improve the conditioning of the inflowing water.

Water treatment plant system in the Calana water utility company (Tacna, Tacna):

The system was prepared by adding a layer of 35 centimetres of hybrid granular material (approximately 80 kg of activated carbon and milk protein) in a 600-liter tank; with a gravel layer (15 cm) underneath and in the outflow zone (15 cm).

Compact treatment plant in the Jorge Chávez Sector - Sector B (Torata, Moquegua):

This consists of a flocculator, a decanter, and sand and activated carbon filters. The granular material was installed in the final part of treatment, replacing the existing carbon with new granular material.

Compact treatment plant in Yacango (Torata, Moquegua):

The granular material was incorporated in multimedia filters, avoiding pre-treatment by means of a direct water intake bypass from collection into the filtration units. Given the high turbidity values of the outflowing water (the regulations recommend less than five Nephelometric Turbidity Units), it is necessary to improve the treatment with a refining unit at the end of the process.

The local governments, through their Municipal Technical Units (ATM), played a very important role in coordinating the activities and especially in the identification of families and water supply systems for the pilot study. Representatives of social organizations, officials and technicians of the Regional Directorate of Housing, Construction and Sanitation (DRVCS) of the regional governments, the Agency for Social Development of the municipalities, and healthcare entities, among others, also took part.

5 Results of the pilot study

The objective of the study was to demonstrate the efficiency and effectiveness of the technology (filter material) in the removal of heavy metals present in water for human consumption. This involves demonstrating the percentage by which the technology reduces arsenic and lead contamination in water and its capability to reduce their concentration to levels below the MPL established by national regulations (MPL for arsenic and lead = 10 ppb or 0.01 mg/lt).

5.1. Household prototypes

The analyses show that the filter material in the household filters removed heavy metals from water with an efficiency of 78.1% for arsenic and 71.4% for lead[9]. These resulting concentration levels are mainly influenced by the following factors: initial concentration of heavy metals, water turbidity, water flow, time for filter conditioning, frequency of cleaning and/or change of cartridge, and care in handling.

The analyses show that the filter material in the household filters **removed heavy metals from water with an efficiency of 78.1% for arsenic and 71.4% for lead.**

Table 4. Efficiency achieved in household filters

Source of drinking water in settlements where household filters were installed	Initial concentration at the treatment plant (PWTP)	# of household with installed filters	# of tests applied in households	Average efficiency (%)
Efficiency for arsenic		**24**	**426**	**78.1**
Poquera Plant	279.0 ppb	6	94	85.3
Ticapampa Plant	678.0 ppb	6	135	80.3
Mórrope	without PWTP	5	84	76.9
Efficiency for lead		**4**	**35**	**71.4**
Cerro de Pasco - Simón Bolívar	without PWTP	4	35	71.4
Total		**28**	**461**	**77.5**

Source: Informe Técnico Sustentatorio (SDC and MVCS, 2022).

Initial concentration of 20.0 ppb was estimated as the cut-off to ensure that the concentration values for arsenic in water will be below the MPL after filtration. Figures above this reference require pre-treatment of the raw water.

Water analyses in Cerro de Pasco households showed initial values below the MPL. Also under these conditions, the filter demonstrated high efficiency for further lead removal in both installed prototypes (78,7% and 64,4% respectively).

9. The validation allowed adjusting the filters in the process. The final prototype achieves an efficiency higher than 95% (oral communication: SABAvida).

5.2. Prototypes installed in collective systems

According to the laboratory analyses, the general pattern shows significant reduction of arsenic concentration by the collective filters, in most cases below the MPL, **and a 61.95% to 98.9% average efficiency**[10]. These are very encouraging results to think of centralized treatment as the best option for the application of this technology.

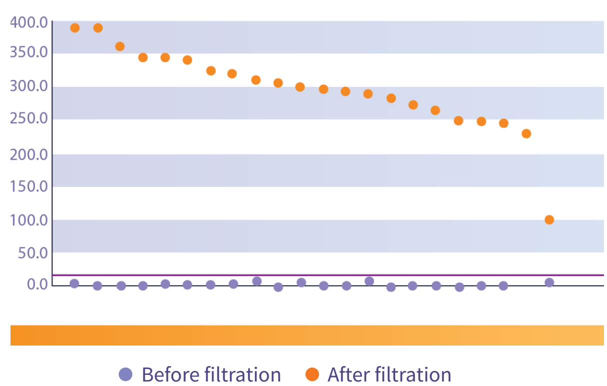
The experience has demonstrated the convenience of counting on systems that include previous conditioning structures for better treatment of raw water, as well as control of intermittent water flow and filtration speed (between 3 to 5 m^3/h) and adequate operation and maintenance of the filtration units where the filtration material is placed.

Table 5. Average efficiency per type of collective water supply system

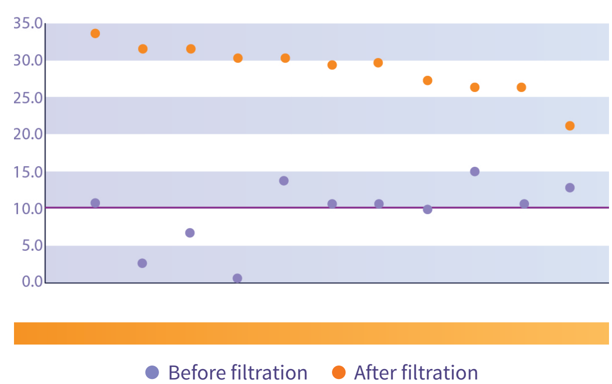
Pilots in supply systems	Range of arsenic concentration (ppb) before filtration	Range of arsenic concentration (ppb) after filtration	# of tests	Average efficiency
Poquera public drinking water tap	390.0 – 102.0	8.8 – 0.1	22	98.9
Jorge Chávez Plant	33.0 – 21.0	15.0 – 1.0	11	64.5

Source: Informe Final – Etapa II (SDC, 2020).

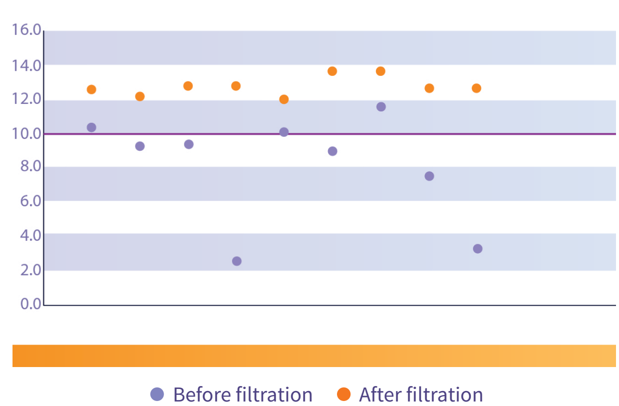
Arsenic concentration (ppb) at the Poquera Treatment Plant before and after the filter



Arsenic concentration (ppb) at the Jorge Chávez Treatment Plant before and after the filter



Arsenic concentration (ppb) at the Yacango Treatment Plant before and after the filter



10. The validation made it possible to adjust the quality of the granular material. The final version of the granular material offers a higher regeneration capacity (oral communication: SABAvida).

5.3. Economic aspects

Table 6 shows the prices of filters and filtering material (imported) upon arrival in Callao/Lima. Import and transportation costs from Lima to the households or treatment plants need to be added to calculate the final price on site. The frequency of filter replacement (household option) and of the filtering material (communal option) depends on factors such as the concentration of heavy metals, water quality (turbidity), water flow and population served. There are no energy costs to be included in the calculations, as the technology does not require energy.

Table 6. Costs of filters and filtering material upon arrival in Callao/Lima

Type of filter	Use	Price
Cartridge	Household	US$ 30.00 (without IGV)
Plastic container to accommodate the cartridge and accessories	Household	US$ 50.00 (without IGV)
Granular material	Community	US$ 20.00 per kilogram (without IGV)

Source: Informe Sustentatorio (SDC and SABAvida, 2022).

The study also designed a communal water supply system by water hauling (water kiosk) for 150 persons, with a cost estimate to produce filtered water of US$ 0.42 per m^3 for this type of system. **In the case of the Yacango PWTP, the cost of water treated with the technology was estimated at US$ 0.27 per m^3, and with conventional treatment for the removal of heavy metals at US$ 0.80 per m^3.**

5.4. Social aspects

The families that participated in the study reported that the water filtered with this technology was of better quality and more trustworthy. Therefore, **they were willing to pay US$ 2.9 per month on average for the service of water provision,** representing an additional 46.6% of the usual cost (at the time of the survey they paid US$1.97 per month), even if the technology is in communal facilities rather than in their homes.

In the Yacango Treatment Plant, the projected cost of producing water treated with the technology is 1.02 Soles (USD$0.27) per m^3, while with conventional technology it is 3.05 Soles (USD$0.80) per m^3.

Families that were consulted about the project would be willing to pay 11 Soles (USD$2.90) per month on average for the service.

6 Factors influencing the development of the technological solution

The **most relevant aspects** that influence the development of the technology are:

Institutional

The effectiveness of the technology facilitates the promotion of its use in national sectorial programs (such as the National Rural Sanitation Program), private initiatives developed under the "*obras por impuestos*" ("works for taxes") mechanism or private investments under corporate social responsibility schemes. The technology can be adapted to existing drinking water treatment systems and included in the design of new systems.

Local governments, through the ATMs, should provide assistance and follow-up on the implementation of this technology to communal operators known in Peru as the Administrative Boards for Sanitation Services (JASS), and, if required, directly undertake the operation of water services through the creation of Municipal Management Units (UGM).

Technical

The validation of the technology generated important information on its efficiency and effectiveness in the removal of heavy metals. On the other hand, it highlighted how external factors can affect the effectiveness of the filter material, requiring a minimum level of water quality prior to its filtration.

The process must include responsible handling of the used filter membranes, which must be treated as industrial waste.

Social

The user's recognition of having a better-quality water supply allows for the valuation of the water, generates adequate conditions for the good use and maintenance of the system, and leads to a higher readiness to pay a family quota or fee for the application of the technology. The lower operation cost of water treatment per m^3 compared to other technologies currently used is key to this.

Sustainability

The tested heavy metal removal technology is feasible to be used within the current regulatory framework of the water and sanitation sector in Peru. Currently, the filter material is produced outside of the country, which can lead to limitations in its timely availability. However, BluAct is interested in transferring the technology to Peru for the in-country production of the filter material, as demand increases. Conditions for this exist, given the dimension of the problem in the country.

7 Conclusions

7.1. On the BluAct filter material technology

01 Design

The technology offers options for use by individual households and in collective systems (water treatment plants). Its versatility and adaptability for application in diverse types of treatment plants stands out.

02 Efficiency

In this pilot study, the household filters have shown a 78.1% efficiency in the reduction of arsenic concentrations. In the case of collective systems, the minimum efficiency was 62% and the maximum 99%. In most cases, the filters reduced contamination below MPL levels.

03 Cost-efficiency

The technology is cost-efficient. In the case of household filters, the cost of US$ 30 to US$ 50 (without IGV, the Peruvian value added tax) can be incorporated into family water services fees in rural areas. In the case of collective systems, the production cost of filtered water in the Yacango (Moquegua) PWTP is US$ 0.27/m^3 compared to US$ 0.80/m^3 for conventional treatment to remove heavy metals.

04 External factors

The technology is used in the final phase of the treatment process, its performance and effectiveness depending on external factors such as water flow, physicochemical parameters and turbidity of the water.

05 Reuse

The technology in its form of a granular medium can be regenerated before replacement, which extends its lifespan and reduces the costs of treatment.

06 Social valuation

Households are willing to pay for the cost of using domestic filters. Families adopting this technology need to be trained to ensure optimal management.

7.2. On the institutional framework and technological development for water services

01 Context

There is a favourable regulatory framework for the use of the technology in drinking water supply systems. BluAct is interested in supporting the technology transfer to produce filter material in Peru, if the conditions for taking the technology to scale are favourable.

02 Availability

The technology is available for use in public, public-private (via the "works for taxes" mechanism) and private (corporate social responsibility) investment projects, to benefit primarily rural and dispersed populations.

03 Local Capacity

Capacity strengthening is key for facilitating the use of the technology by communal water services providers (Administrative Boards for Sanitation Services) and municipalities (Municipal Management Units).

04 Upscaling

The potential for upscaling of the technology is high considering that there are 10,000 PWTP (of the 31,000 in total in the country)[11] in eight departments with high levels of arsenic in untreated water for household use[12].

11. https://datass.vivienda.gob.pe, reviewed February 13th, 2023.

12. Castro de Esparza, M.L., 2016. Minimización de riesgos para la salud por metales pesados en el agua de consumo humano. Expo Agua Perú 2016.

8 Recommendations

01 **Promote the use of this technology in existing national programs and private initiatives,** which can be adapted to existing water treatment systems and included in the design of new systems benefitting the most vulnerable populations.

02 **Build and strengthen capacities in the municipalities for the management of innovative systems** for the treatment of water contaminated with heavy metals and the dissemination of information about their performance. In the case of Peru, the experience of the NGO SABAvida, responsible for carrying out the validation study of the technology, is valuable in this context.

03 The use of this technology must include **measures to reduce the external factors that affect its performance** such as water flow, physico-chemical parameters and turbidity of the water.

04 In the case of Peru, it is important to **characterize and quantify the demand for this technology with greater precision,** in coordination with the Ministry of Housing, Construction and Sanitation (MVCS) and the Ministry of Health (MINSA). The objective is to design short-, medium- and long-term strategies for its upscaling at the national level, initially focused on particularly critical zones.

05 If conditions for the in-country production of the filter material do not exist, **efficient import channels for the material must be established to ensure the availability** of the technology for operation and maintenance of the systems in which the technology is already applied.

ACRONYMS

ATM	Municipal Technical Unit
DIGESA	General Directorate for Environmental Health
DRVCS	Regional Directorate for Housing, Construction and Sanitation
EPS	Water utility company
ETH Zurich	Swiss Federal Institute of Technology Zurich
GmbH	Private limited company (in German: “Gesellschaft mit beschränkter Haftung“)
IGV	General sales tax (equivalent to the valued added tax)
JASS	Administrative Boards for Sanitation Service
MINSA	Ministry of Health
MPL	Maximum permissible limit
MVCS	Ministry of Housing, Construction and Sanitation
NGO	Non-governmental organization
PNS	National Sanitation Plan
PNSR	National Rural Sanitation Programme
ppb	Parts per billion
PWTP	Potable Water Treatment Plant
SDC	Swiss Agency for Development and Cooperation
UGM	Municipal Management Unit
WHO	World Health Organization

SDC Regional Hub Lima

The SDC Regional Hub Lima brings together three programmes: Climate Change and Environment, Water, and Disaster Risk Reduction and Rapid Response. The activities and projects of the Regional Hub have a regional focus and are carried out mainly in the Andean countries.

Climate Change and Environment

Water

Disaster Risk Reduction and Rapid Response

Regional Programme Disaster Risk Reduction and Rapid Response

The Disaster Risk Reduction (DRR) and Rapid Response (RR) Programme of SDC's Regional Hub focuses on **integrated risk management related to natural hazards** in the Andean countries of Peru, Bolivia, and Ecuador.

The vision of the Regional DRR & DRR Programme is a more resilient Andean region where development setbacks and human suffering due to disasters are reduced through more effective disaster risk management. It aims for sustainable and resilient development at local, national and regional levels, using a participatory approach to leave no one behind.

The DRR & RR Programme works along three thematic pillars:

Pillar 1
Strengthening of Disaster Risk Governance

Pillar 2
Strengthening Partners' Preparedness for Response

Pillar 3
Strengthening of Swiss Institutional Capacities in DRR and RR in the Region

The DRR & RR Programme counts on a unique rapid response instrument of SDC called the **Rapid Intervention and Support Group (GIAR)** for the region Latin America and Caribbean. The GIAR is mandated to coordinate Swiss humanitarian interventions in the region in the case of a natural disaster.