Highlights from the CINARA–University of Glasgow community event

In 2022, 2.2 billion people still lacked access to safely managed drinking water, and four-fifths of those without access to even basic services lived in rural or remote areas. Providing accessible, safe, and sustainable drinking water in these regions is a global challenge: from the rural and peri-urban areas of Colombia to the remote islands of Scotland.

The Instituto CINARA, at the Universidad del Valle in Cali, Colombia, has pioneered the design, development, and construction of sustainable Multi-Stage Filtration plants (MSF) for drinking water production. These systems are ideally suited to small, remote communities and are characterised by low energy and chemical consumption.

While these plants have been thoroughly studied and optimised from a hydraulic perspective, their biological activities have largely been overlooked. Last summer, the Instituto CINARA and the University of Glasgow joined forces to shed light on the complex biological phenomena taking place in these systems, not just to uncover this "black box," but to use this knowledge to strengthen treatment and make it more robust against future pollution threats.

Three MSF plants—**Vallejuelo, La Sirena, and Arroyohondo**—were sampled by two Universidad del Valle students, **Laura Isabella Vergara** and **Verónica Agudelo Guzmán**. During their eight-month research internships in Glasgow, under the supervision of **Dr. Marta Vignola**, they analysed the samples using advanced techniques such as **flow cytometry**, **qPCR**, and **DNA sequencing**. This work marks the **first scientific investigation** of microbial life inside Colombia's multi-stage filtration plants.

On **23 May**, community leaders, water plant operators, and researchers gathered at the **CINARA Institute** to hear about the results of the study and learn about the microbial communities inhabiting these systems and how we can use them to our advantage. The event was co-organised by **Prof. Miguel Peña Varón** and **Prof. Luis Darío Sánchez Torres** of CINARA, and **Dr. Marta Vignola** of the University of Glasgow.

The event began with a brief presentation by Dr. Vignola, who introduced the project and emphasised the importance of understanding these biological processes to enhance overall treatment outcomes. Her remarks set the stage for the main presentations by **Laura** and **Verónica**, who shared their findings with a room full of people who manage and operate these systems every day.

- **Microbial Dynamics & Pathogen Presence**
  Verónica showed how microbial cells and pathogens move through each treatment step, pinpointing where the process is most (and least) effective.
- **The Role of Microorganisms in Sand Filters**
  Laura revealed that these filters are more than physical barriers: they're biological powerhouses. The sand layers host complex microbial communities capable of actively breaking down contaminants such as pesticides.
- **Key takeaway**
  Slow-sand filters aren't passive; they're living reactors that, under the right conditions, can shield drinking water from both pathogens and chemicals.

One of the event's most powerful moments came during the panel discussion. Plant operators, community members, and academics shared their experiences and frustrations. The top concerns raised by the participants were:

- **Watershed pressure.** Deforestation and farming near intakes raise raw water turbidity and introduce faecal bacteria such as *E. coli*.
- **Resource limitations.** Rural plants often lack staff, testing kits, and spare parts needed for continuous, high-quality treatment

However, participants backed **slow-sand filtration** as a low-cost technology that already fits rural areas, but called for:

1. **Stronger peer networks** among plant operators to swap successful practices.
2. **Joint funding bids** via territorial associations to upgrade infrastructure.
3. **Hands-on training** so local operators become "community facilitators of water quality".

What's Next? Charting a Community-Led Research Roadmap

The workshop didn't end with just talk. Together, participants co-designed a research roadmap grounded in local needs:

1. **Handling Rainy-Season Turbidity:**
   Test better flocculation methods and roughing media to pretreat the water during high turbidity events.
2. **Microbe-Contaminant Interactions:**
   Expand research on the biological degradation of contaminants to improve filter efficiency.
3. **Social Scalability:**
   Translate research findings into practical guidelines and provide constant training for operators.

A Shared Future for Safe Water

This wasn't just a scientific meeting, it was a moment of connection between disciplines, contexts, and geographies. As Dr. Marta Vignola said during her virtual remarks:

"Slow-sand filters are already doing a great job. Our job as researchers is to decode their biology to improve the treatment. In collaboration with the operators and the communities, we can co-design better systems so that every community can rely on them, even when conditions turn rough."

A scientific manuscript summarising last summer's sampling campaign, especially the interactions between eukaryotic and prokaryotic communities in slow sand filters, is currently in preparation. Stay tuned for project updates.

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