Effects of Drainage and Stagnation on Microbial Communities in Biofilm and Bulk Drinking Water

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INTERMITTENT WATER SUPPLY (IWS)

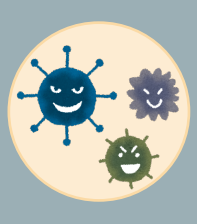
Is when water is not available 24/7. It is common worldwide, but is most prevalent in developing countries

Causes of IWS

Water Scarcity

Inadequate Infrastructure

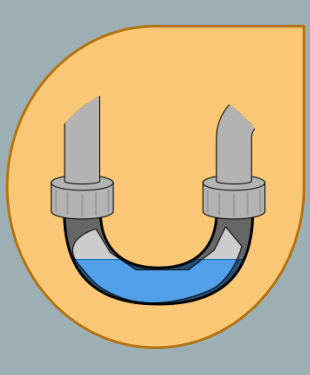
Risks of IWS



Microbial Regrowth
(Possibly pathogens!)

Recontamination and Regrowth During Household Storage

Key Features of IWS are



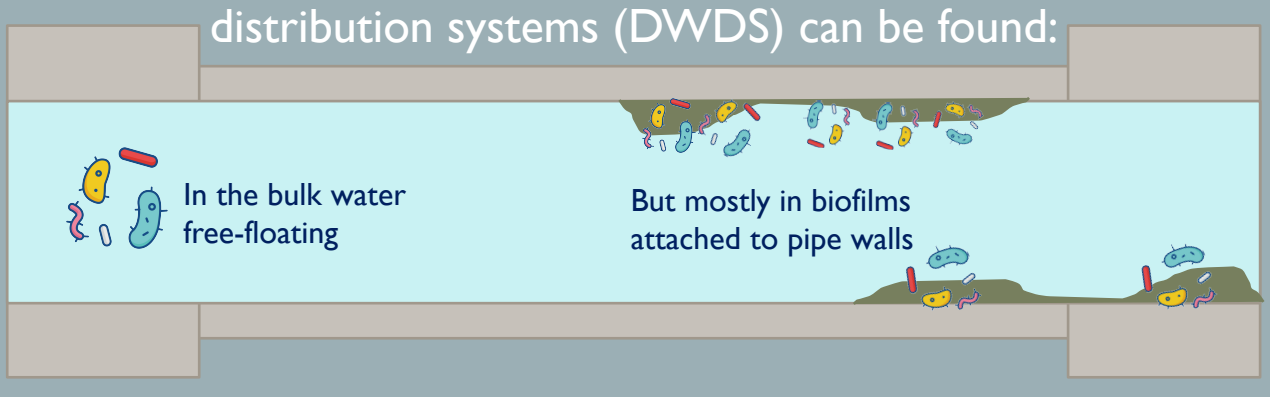
Stagnation

Where water ceases to flow and remains in the pipe.
e.g., Premise plumbing- One may not turn on a specific faucet in a building

Drainage

Where water ceases to flow and none remains in the pipe.
e.g. ,water scarcity- There is simply not enough water to distribute

Microbial communities in our drinking water distribution systems (DWDS) can be found:

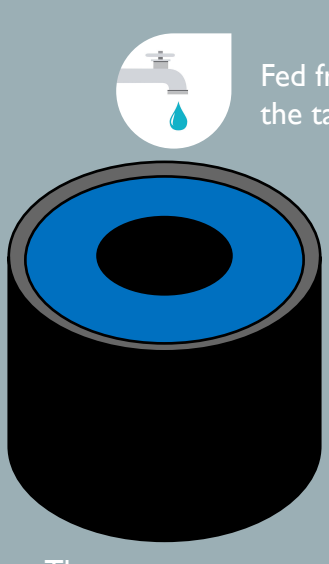


They're everywhere! This is normal, but too many can be problematic. Water treatment plants add disinfectants (like chlorine) to keep them under control

How do drainage and stagnation affect the microbial communities in biofilm and bulk drinking water?

Our experiment aimed to answer this question, but first we needed to simulate pipe flow in the lab

Using small reactors



These reactors were used because sampling real pipes is not accessible

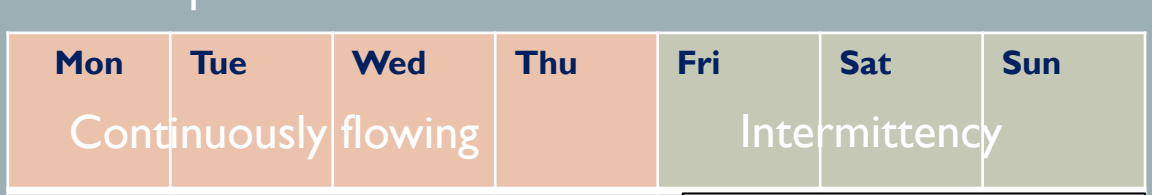
This allowed us to isolate 3 conditions:

Drained

Stagnant

Continuous
(control)

We chose an intermittency period of 3 days, but it can vary greatly from city to city. It can range from a few hours up to a week



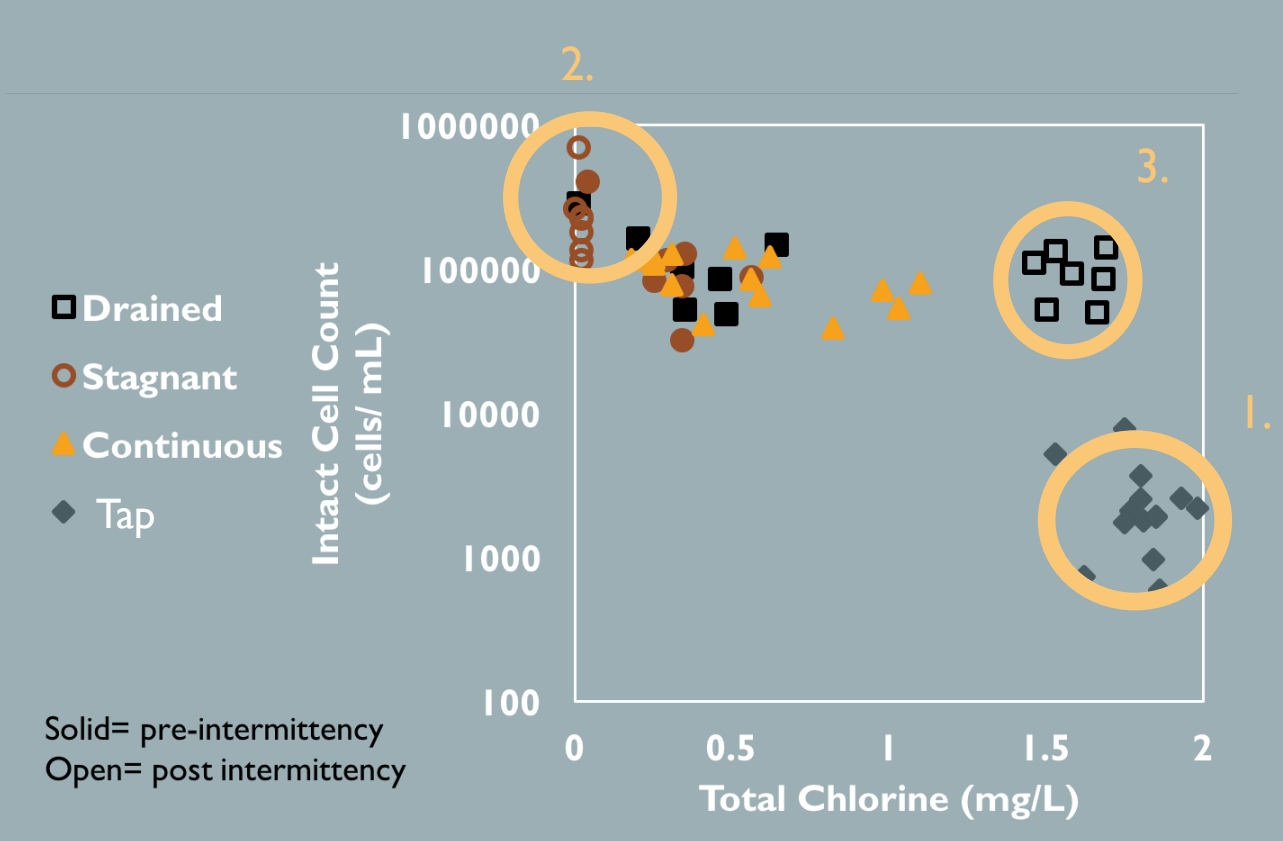
Sample after intermittency ends

Sample before intermittency begins

During this intermittency, one reactor gets drained and stays empty for the weekend, and another sits with stagnant water

Total chlorine disinfectants were measured

Intact cell counts were enumerated
(an intact cell strongly suggests viability)



1. This is tap water, which we used to feed our reactors and compare our results from the reactors to

2. The stagnant reactor had a much greater number of intact cells than the tap after stagnation, and little chlorine residuals. Chlorine in the existing tap water was likely consumed and allowed for microbial growth

3. The drained reactor had higher chlorine residuals because to sample it after drainage, we refilled with tap and operated for a few minutes before sampling. The 100X difference appears to be microbes knocked off from biofilm

References:
[1] Wingender, J. & Flemming, H. C. Contamination potential of drinking water distribution network biofilms. *Water Sci. Technol.* **49,** 277–86 (2004). **[2]** Wingender, J. & Flemming, H. C. Biofilms in drinking water and their role as a reservoir for pathogens. International Journal of Hygiene and Environmental Health. **214,** 417-423 (2011). **[3]** Kumpel, E. & Nelson, K. L. Intermittent water supply: prevalence, practice, and microbial water quality. *Environ. Sci. Technol.* **50,** 542–553 (2016). **[4]** Galaitsi, S. E. *et al.* Intermittent domestic water supply: A critical review and analysis of causal-consequential pathways. *Water* **8,** 274 (2016).
[5] Klingel, P. Technical causes and impacts of intermittent water distribution. *Water Sci. Technol. Water Supply* **12,** 504–512 (2012). **[6]** Erickson, J. J., Smith, C. D., Goodridge, A. & Nelson, K. L. Water quality effects of intermittent water supply in Arraiján, Panama. *Water Res.* **114,** 338–350 (2017).