



Centre for Affordable
Water and Sanitation Technology

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CAWST, the Centre for Affordable Water and Sanitation Technology, is a nonprofit organization that provides training and consulting to organizations working directly with populations in developing countries who lack access to clean water and basic sanitation.

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This presentation is used with
Lesson Plan 17: Chemical
Parameters in the Drinking Water
Quality Testing Trainer Manual.

Available at

www.cawst.org/resources



Fluoride in Drinking Water



Learning Expectations

1. Identify the health impacts of harmful levels of fluoride in drinking water.
2. Identify the social impacts of harmful levels of fluoride in drinking water.
3. Discuss fluoride mitigation options.

Where Does Fluoride Come From?

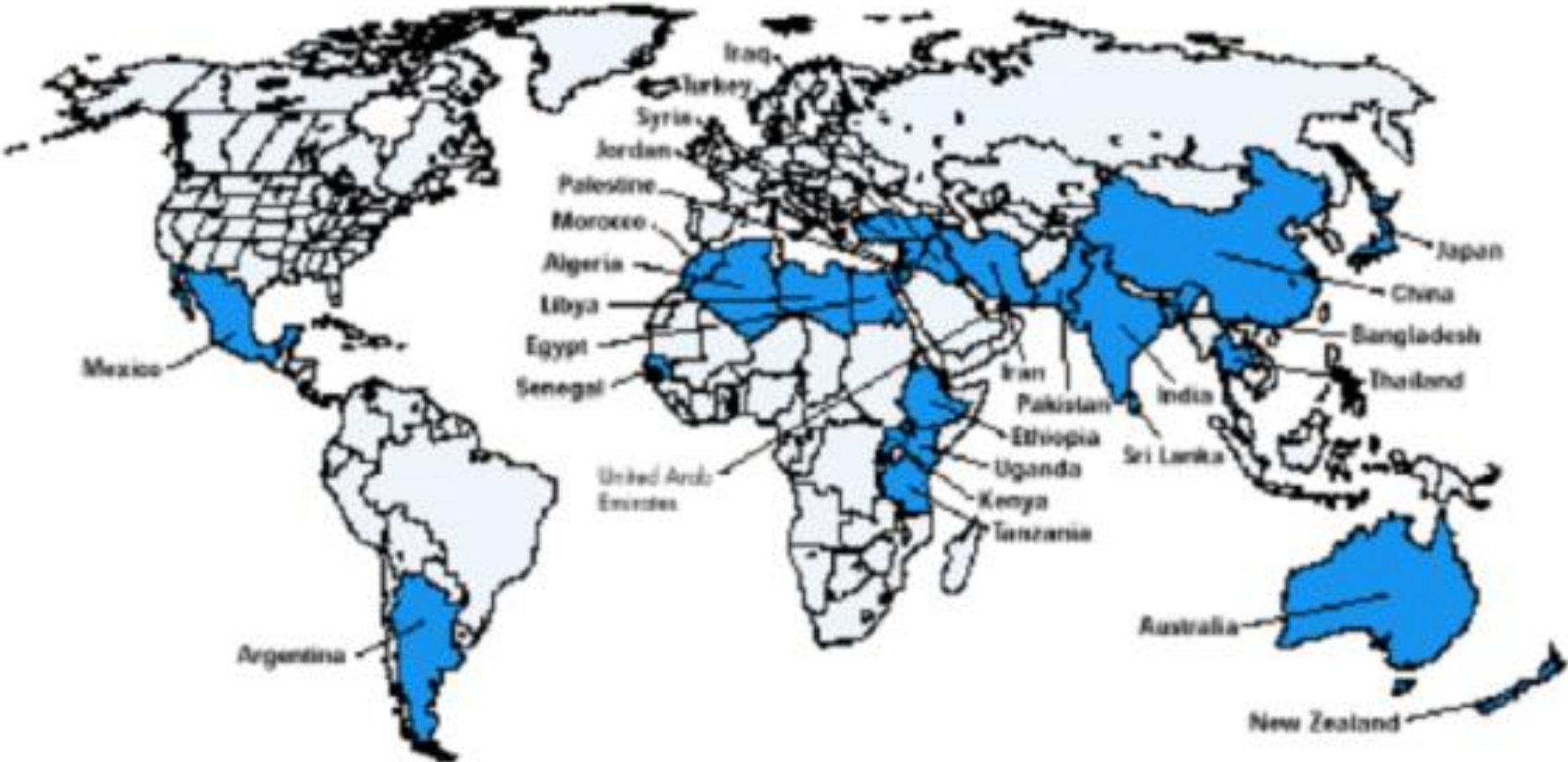
- Natural in groundwater and some surface water
- Human activities

What Does Fluoride Look Like in Water?

- Odorless, tasteless, colorless
- There is only one way to tell if present – TESTING!



Where in the World is Fluoride Found?



What Are the Health Effects?

- Low doses help make teeth strong and prevents decay (0.5–1.0 mg/L)
- Higher doses can cause staining and pitting (1.5–4.0 mg/L)
- Very high doses harms the skeleton (>10 mg/L)



Dental fluorosis



Skeletal fluorosis

Fluoride Guidelines

WHO Guideline <1.5 mg/L

Dose	Symptoms
< 0.5 mg/L	Susceptible to dental caries
0.5 - 1.0 mg/L	Lower dental caries
1.5 - 4 mg/L	Dental fluorosis
> 4 mg/L	Dental and skeletal fluorosis
>10 mg/L	Crippling fluorosis

How Can We Treat Fluorosis?

- There is no treatment to cure fluorosis
- Made worse by poor nutrition
 - Calcium and vitamin D deficiencies
- Eating tamarind can help to delay fluorosis
 - Enhances urinary excretion of fluoride



(Credit: www.maji.go.tz)

Social Impact

- Social acceptance
 - People rejected by others
 - May have to isolate themselves
- Socio-economic
 - Not able to work because of physical deformation and pain
 - Income loss for families



(Credit: www.drinking-water.org)

How Do We Treat Drinking Water for Fluoride?

- Very few practical or common household technologies
- More research needed to find simple and affordable technologies
- Find a different source of drinking water
- Dilute groundwater with a different source (e.g., rainwater)

Integrated Fluoride Mitigation

Multidimensional approach:

- Water
- Food
- Environnement

Alternative Fluoride-Free Sources

- Low fluoride groundwater
- Improved dug wells
- Rainwater harvesting
- Surface water

+ Nutrition

Defluoridation Technologies

- Adsorption/Ion Exchange
- Precipitation/Sedimentation
- Membrane filtration
- Distillation

+ Nutrition

How is Fluoride Removed?

1. Adsorption / Ion-Exchange

- Fluoride ions are collected on the surface of the adsorbent
- Fluoride is removed from solution onto another surface in exchange for a less problematic chemical

2. Precipitation / Sedimentation

- Chemical reaction forms precipitate
- Precipitate can be settled or filtered out of the water

3. Membrane filtration

- Filters that have a very small pore size to trap the fluoride

4. Distillation

Activated Alumina

What is It?

- Activated alumina placed in a container

How Does it Work?

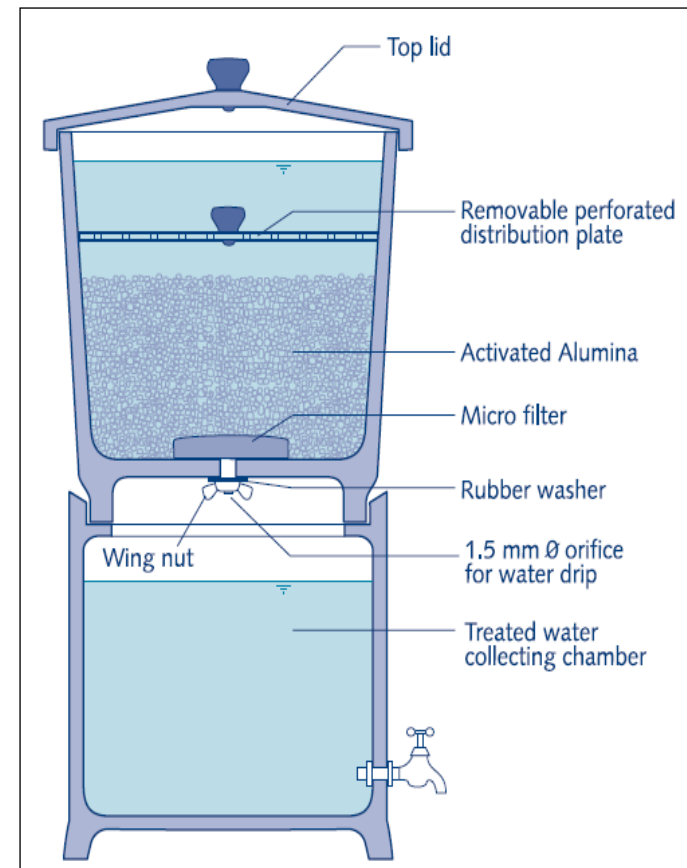
- Fluoride adsorbs to the alumina

What is the Effectiveness?

- 90% fluoride removal in batch
- Up to 98% fluoride removal in column

Cost:

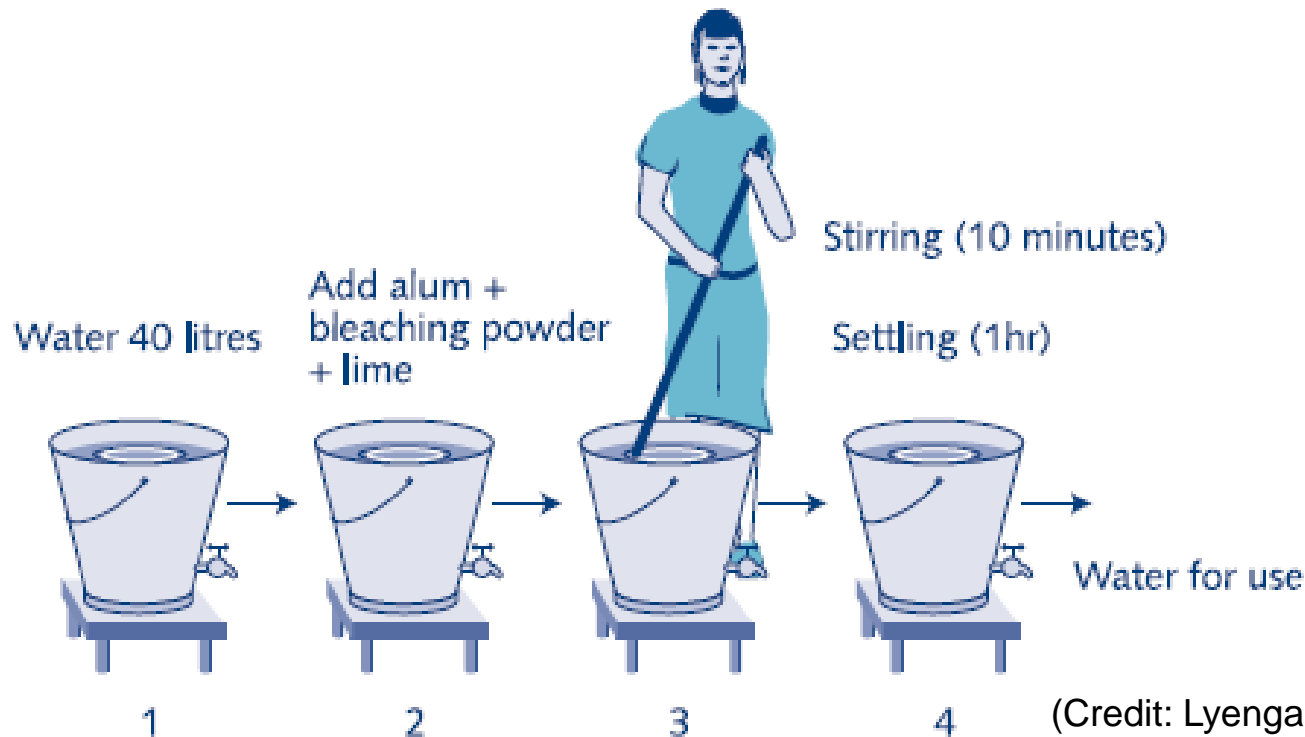
- US\$35-50 capital cost
- US\$1.3-2/kg media replacement cost/year



(Credit: Lyengar, 2002) 15

Nalgonda Technique

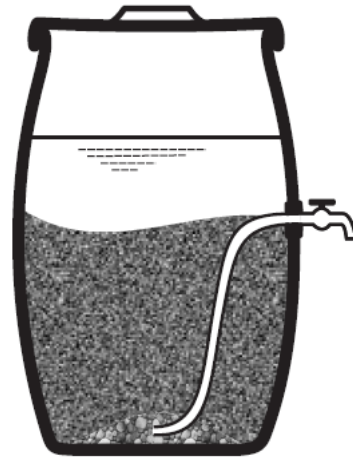
- **What is It?** Alum and lime added to water
- **How Does it Work?** Fluoride is precipitated, also reacts with alum to make a fluoride complex which settles to the bottom
- **What is the Effectiveness?** Up to 70% fluoride removal
- **Cost:** No capital cost, US\$12/year for chemicals



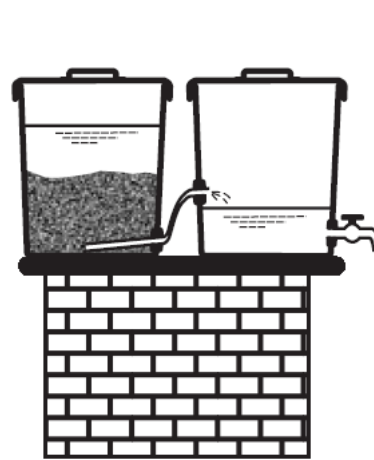
(Credit: Lyengar, 2002)

Bone Charcoal Filter

- **What is It?** Crushed bone char (made from animal bones) is placed in a container
- **How Does it Work?** Fluoride changes places with carbonate in bone char
- **What is the Effectiveness?** 90-99% fluoride removal
- **Cost:** US\$17-23 capital cost, US\$1.8/1000 litres operating



A. Drum



B. Double Bucket



C. Column Filter

(Credit: WHO Fluoride in Drinking-Water, 2006)

Clay

What is It?

- Powdered clay used in a bucket system
- Freshly fired clay/brick chips used in column filters

How Does it Work?

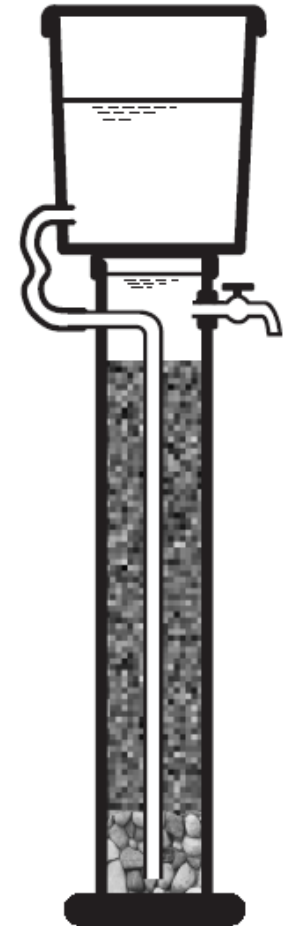
- Fluoride adsorbs to the clay

What is the Effectiveness?

- >93% fluoride removal (depends on quality of clay and type of filter)

Cost:

- Not available



(Credit: WHO Fluoride in Drinking-Water, 2006)

Contact Precipitation

What is It?

- Calcium and phosphate added, then filtered through bone char pre-saturated with fluoride

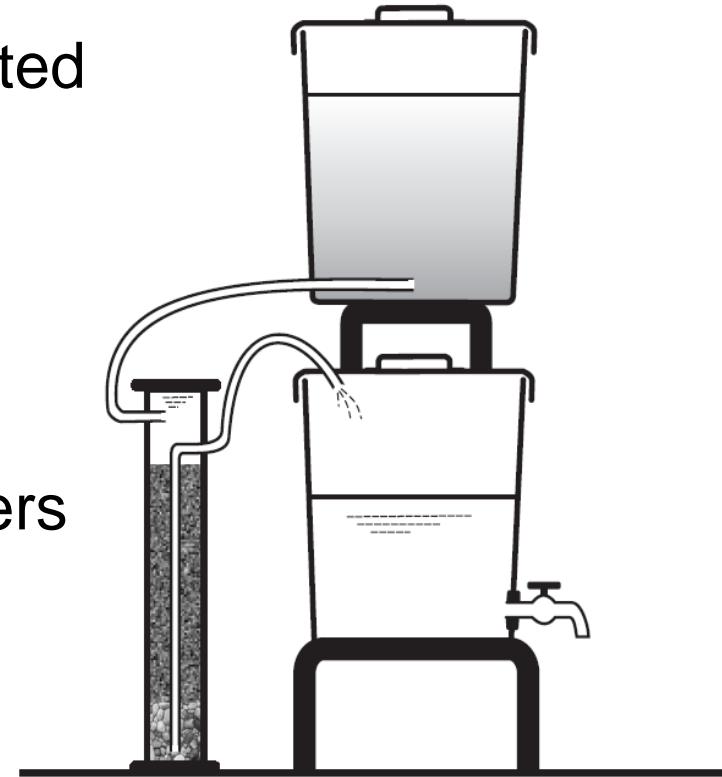
How Does it Work?

- Calcium and phosphate precipitate fluoride (slow reaction)
- Bone char precipitates faster and filters out fluoride

What is the Effectiveness?

- 90-95% fluoride removal

Cost: Not available



(Credit: WHO Fluoride in Drinking-Water, 2006)

Review

1. What are the health impacts of excessive fluoride in drinking water?
2. What are the social impacts of people who have fluorosis?
3. What are some of the mitigation options for fluoride in drinking water?