



GeoGen2013 - Towards sustainable safe drinking water supply in developing countries: The challenges of geogenic contaminants and mitigation measures

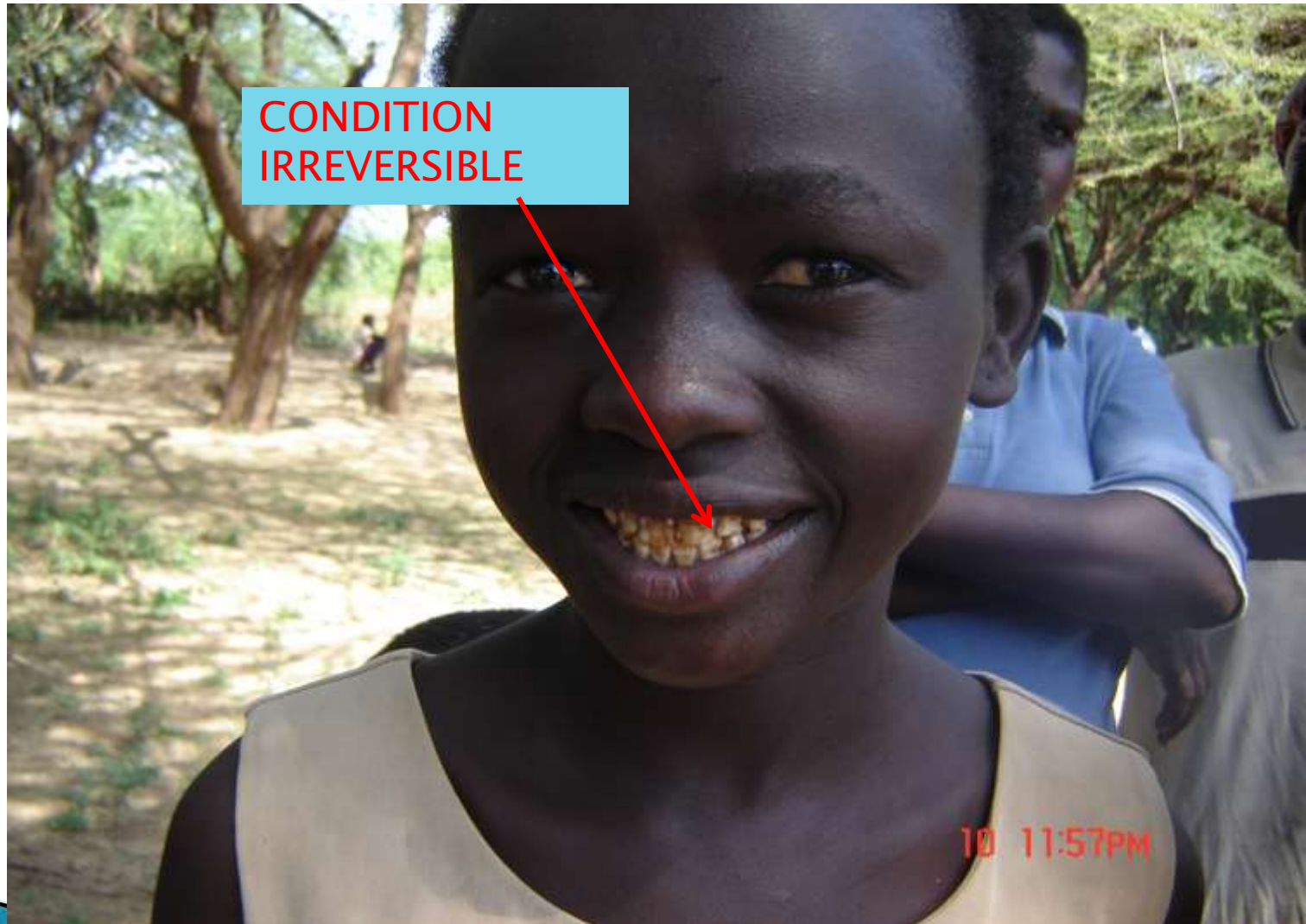
Increasing the utilization of Defluoridation technology

A case study of Nakuru technology (pellets)

NAKURU DEFLUORIDATION COMPANY LTD. KENYA

**International Conference
Addis Ababa, February 6, 2013**

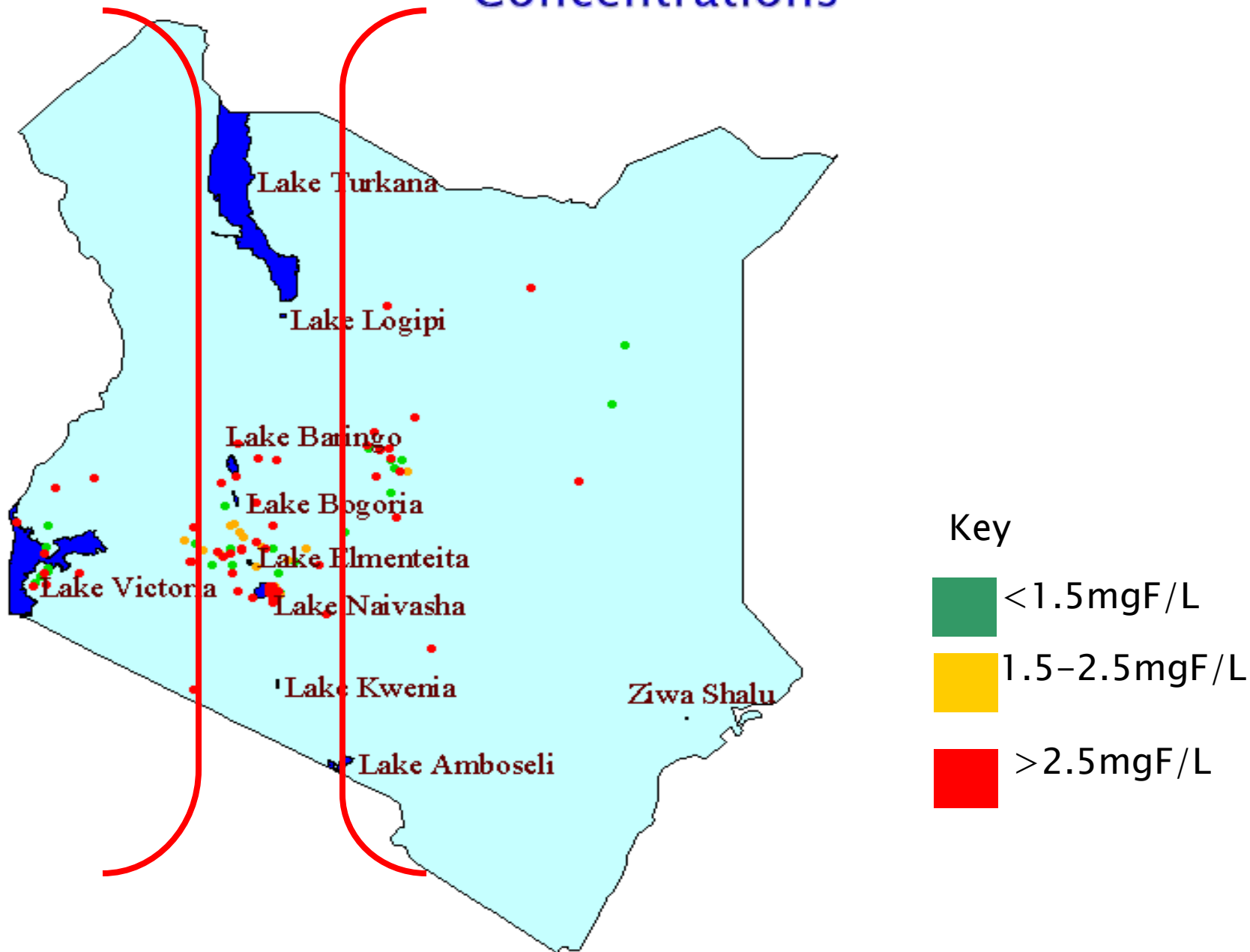
HEALTH EFFECTS OF EXCESS FLUORIDE: DENTAL FLUOROSIS



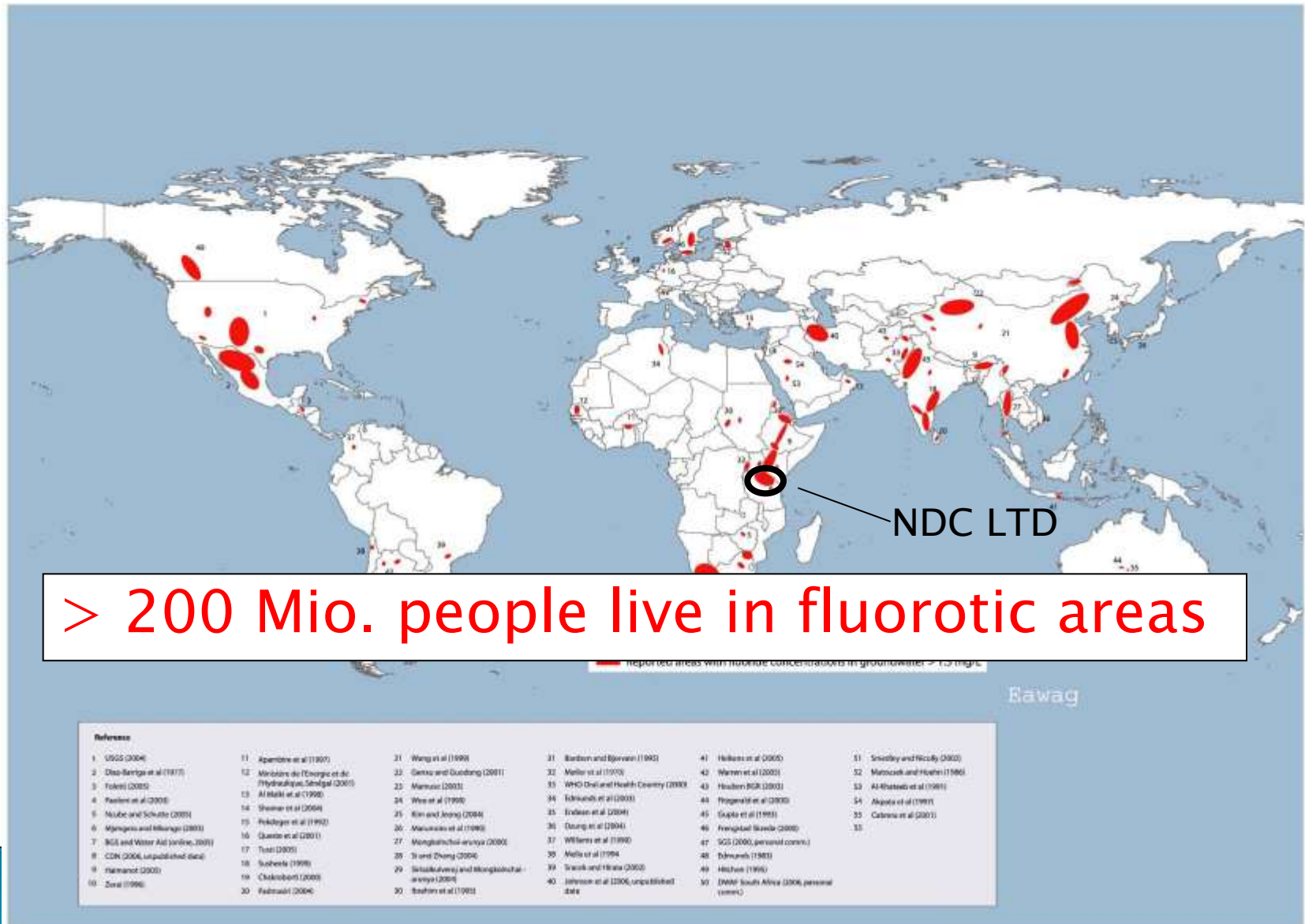
HEALTH EFFECTS OF EXCESS FLUORIDE: SKELETAL FLUOROSIS




Kenya Map Showing Boreholes with Fluoride Concentrations



Fluoride in groundwater



BONECHAR DEFLUORIDATION METHOD THAT NDC USED.

- ▶ It was initially used in the US in 1940's.
 - ▶ Animal bones are charred at 400 – 550°C.
 - ▶ After cooling high quality bone char is obtained.
 - ▶ Crushing, sieving, washing and drying takes place.
 - ▶ Clean dry bone char is then ready for use in the filters.
- 

WHY BONECHAR METHOD THEN?

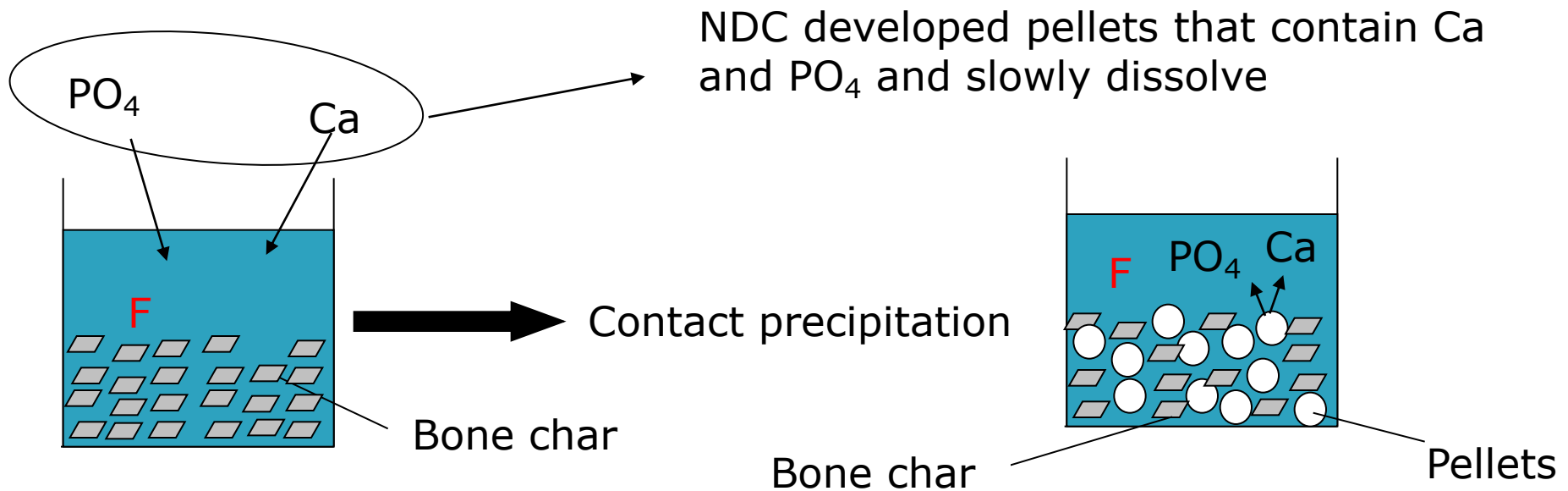
- ▶ The method is safe.
- ▶ All the fluoride can be removed.
- ▶ The filters are easy to use.
- ▶ Its produced locally and is durable.
- ▶ All materials can be replaced locally.

THIS BECAME
EXPENSIVE TO
MAINTAIN FOR
MANY
BENEFICIARIES

BRIEF HISTORY

- ▶ CDN WQ has been producing bone char since 1998 to use in household and community filters
- ▶ There was a problem of insufficient filter life. CDN WQ embarked on intensive lab research on pellets in collaboration with Eawag.
- ▶ This lead to the adaptation of **contact precipitation** to prolong filter life.
- ▶ The technology was promising and full scale implementation started in 2006–Kenya
- ▶ Joint research, documentation and dissemination is still ongoing.

CONTACT PRECIPITATION



- 1991
 - First scientific publication on CP and its ability to remove fluoride (Christoffersen et al., 1991)
- 1996
 - Pilot plant in Tanzania. Due to high maintenance effort plant was abandoned (Dahi, 1996)
- 2004 – 2006
 - CDN WQ develops pellets
- 2006 – 2013
 - NDC Field Scale Implementation, Monitoring and Joint research with Eawag is still ongoing.

PRODUCTION OF FILTER MATERIALS



Crushing
Sieving
Washing



Curing
Washing
Sprinkling



LABORATORY EXPERIMENTS



- PVC columns with 260 ml filter material; Contact Precipitation (CP), Pellets:Bonechar ratio of 3:1;
- Pellet size:2–6.3mm; Bone Char(BC) size:1–4mm
- Flowrate 10Bv/day
- Distilled Water spiked with 6mgF/l used at Eawag and Natural ground water with 6.2 mgF/l used in Kenya

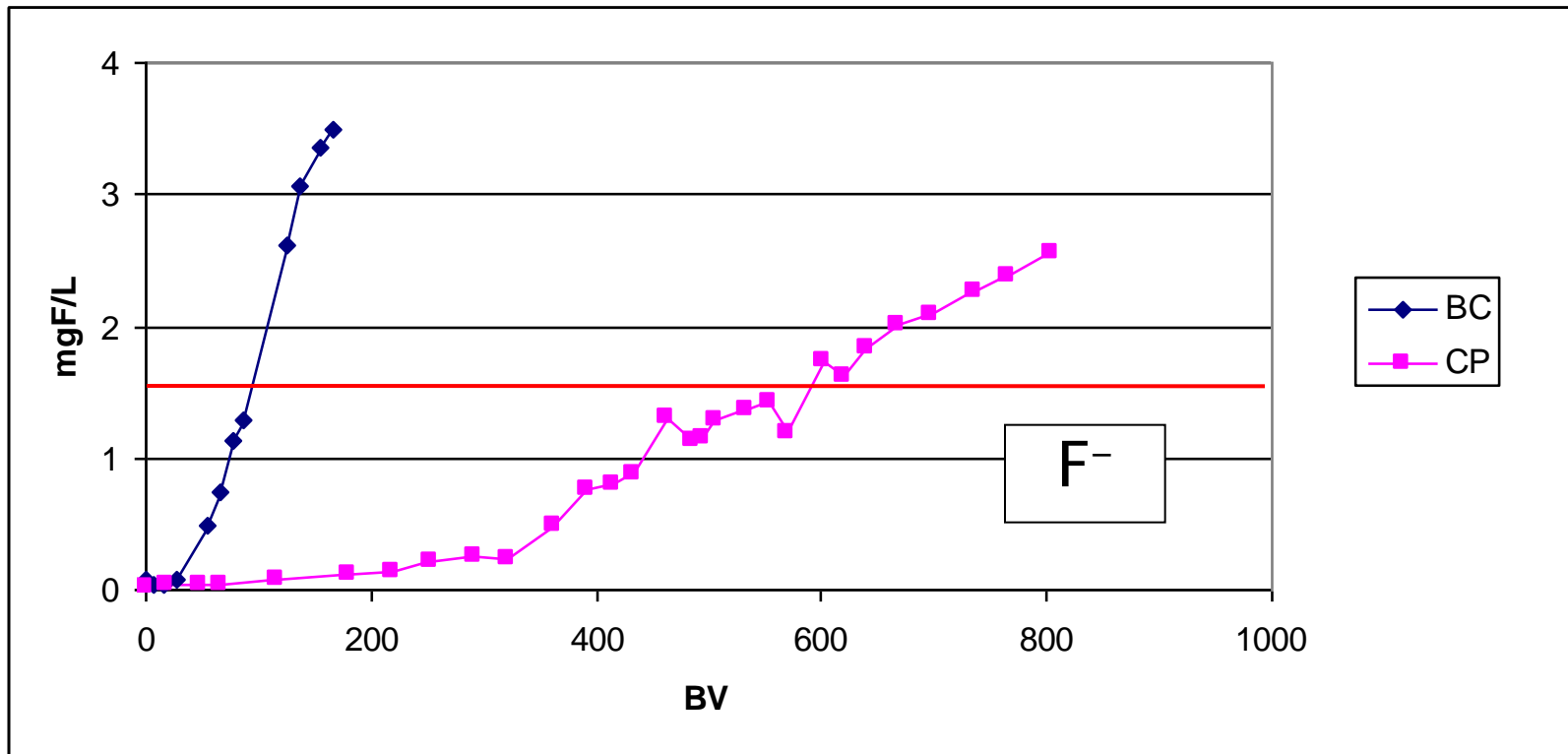
Experimental set-up

- column experiments
- peristaltic pumps maintain a constant flow
- NaF is added to deionised water
- treated water is collected and analysed:
 - fluoride and pH by electrode
 - Ca, PO₄ and other ions/trace elements by ICP-OES/ICP-MS



Presented by: Esther Wanja

Comparison: contact precipitation versus bone char



CP is 6.5 times better

Pellet:

Second

Ratio:

3:1

Flow rate:

10 BV/day

F inlet concentration:

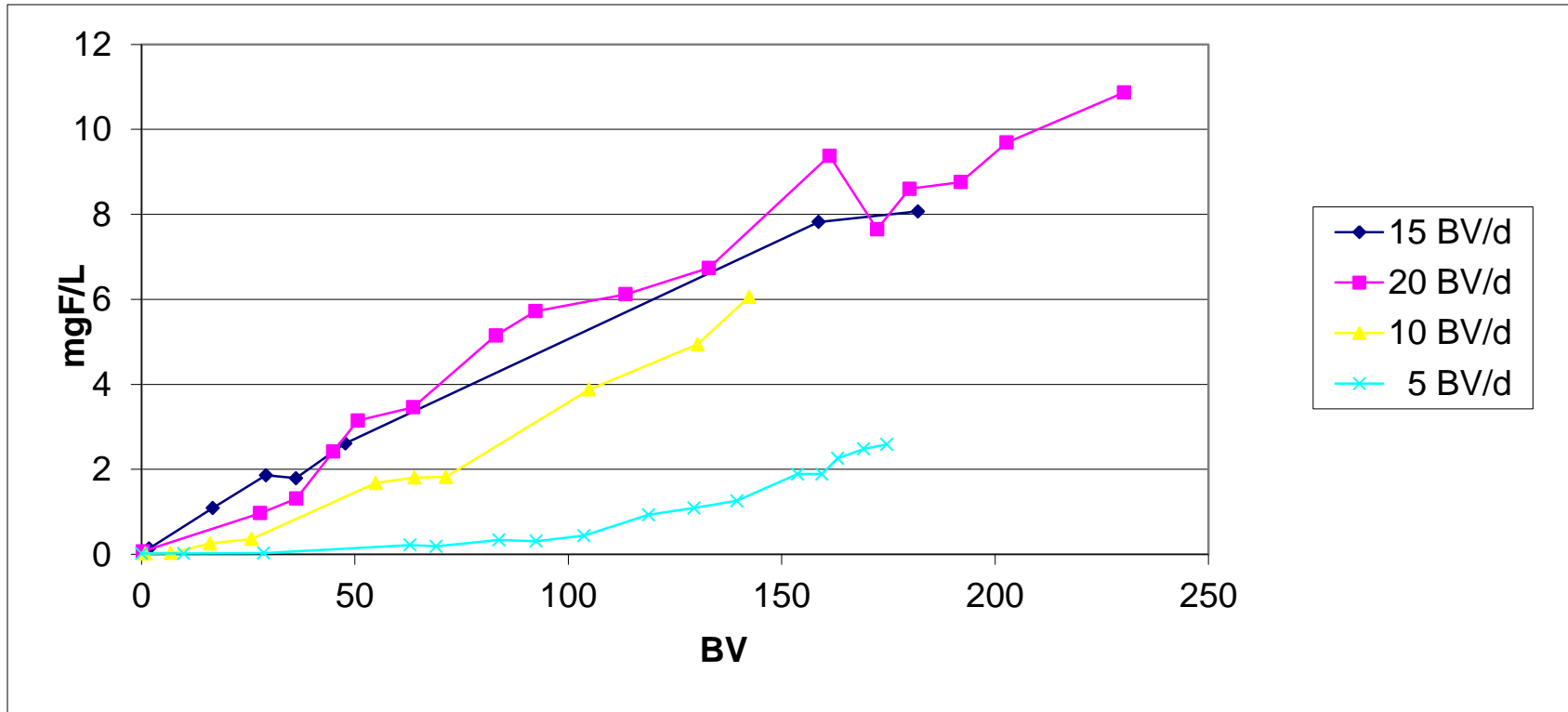
6 mgF/L

COMPARISON: CONTACT PRECIPITATION VERSUS BONE CHAR

Take home message:

- Each comparison strongly depends on the experimental design, mainly fluoride concentration in the inlet and flow rate.
- The lower the flow rate and the lower the fluoride inlet concentration the better is the performance of contact precipitation compared to bone char filtration.

INFLUENCE OF THE FLOW RATE



Ratio: 3:1

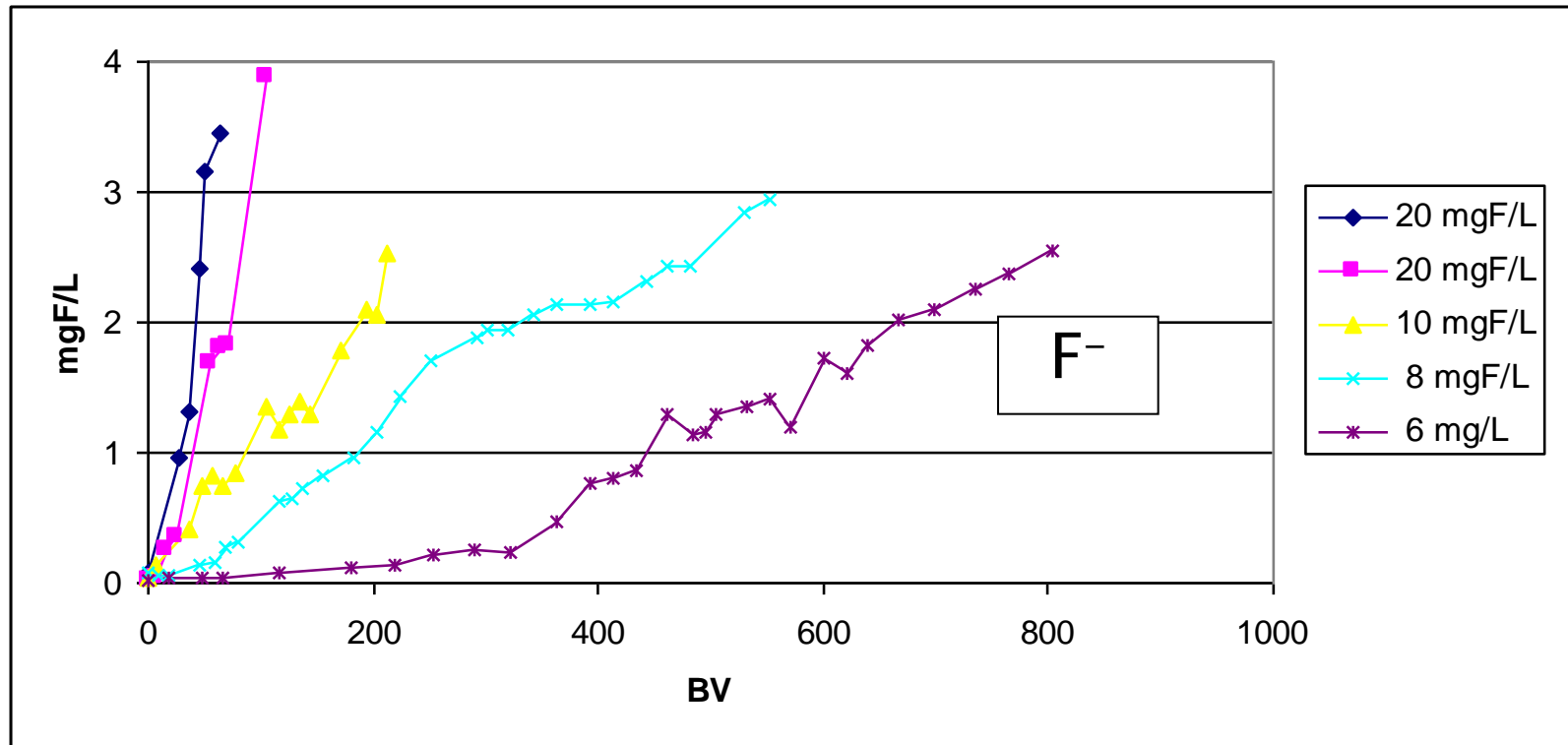
F inlet concentration: 20 mgF/L

INFLUENCE OF THE FLOW RATE

Take-home message:

- Especially for CP, flow rate plays an Important role on the fluoride uptake capacity: The slower the flow rate the bigger the uptake capacity of the filter.
- Generally speaking, flow rates should ideally not exceed 5 BV/d, even at low fluoride inlet concentrations.
- For BC influence of varying flow rates is smaller.

INFLUENCE OF FLUORIDE INLET CONCENTRATION



Ratio:

3:1

Flow rate:

10 BV/d

INFLUENCE OF FLUORIDE INLET CONCENTRATION

Take-home message:

- Especially for CP, fluoride concentration in the inlet plays an important role on the fluoride uptake capacity: The lower the fluoride inlet concentration the bigger the uptake capacity of the filter.
- It can be concluded that the higher the fluoride concentration in the inlet the greater the importance of keeping the flow rates low.

SUMMARY AND CONCLUSIONS

- The technology is promising and filter life is prolonged by 5 times better than bone char technology
- Contact precipitation is complex with adsorption, dissolution and precipitation reactions.
- Optimization is currently ongoing so as to enhance pellets quality, filter performance and filter maintenance.

THANK YOU



ALL TO ACHIEVE A
FLUOROSIS FREE
SOCIETY

