



Ash 2012

Stockholm, 25-27 January 2012



Trends in the environmental properties of Danish MSWI bottom ash during the period 1998 to 2010

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Outline



- **Waste incineration and MSWI bottom ash generation and utilisation in Denmark**
- **Danish regulation on MSWI BA utilisation**
- **Overview of data on MSWI BA leaching**
- **Presentation of selected leaching data on Danish MSWI BA**
- **Conclusions**

29 MSW incinerators in Denmark (2007)



Denmark 2009

Waste incinerated: 3.30 mio t

BA produced: 0.64 mio t

Almost all utilised

Danish Statutory Order No. 1662 of 21 Dec. 2010 on utilisation of residual waste materials and soil for construction works and utilisation of sorted, unpolluted C&D waste



Leaching limit values:

Batch leaching test EN 12457-1
(L/S = 2 l/kg)

TOC < 3 % (w/w)

Minimum distance to drinking water wells: 30 m

Placement above maximum groundwater level

Category 1 not applicable to MSWI bottom ash

| Substance | Category 1+2 | Category 3 | Temp. 1+2 | Inert LF |
|-----------|--------------|------------|-----------|----------|
| | mg/kg | mg/kg | mg/kg | mg/kg |
| Chloride | 300 | 6000 | 3000 | 550 |
| Sulphate | 500 | 8000 | 4000 | 560 |
| Na | 200 | 3000 | 2000 | |
| As | 0.016 | 0.1 | | 0.10 |
| Ba | 0.6 | 8 | | 7.0 |
| Cd | 0.004 | 0.08 | | 0.030 |
| Cr | 0.02 | 1 | | 0.20 |
| Cu | 0.09 | 4 | | 0.9000 |
| Hg | 0.0002 | 0.002 | | 0.0030 |
| Ni | 0.02 | 0.14 | | 0.20 |
| Pb | 0.02 | 0.2 | | 0.20 |
| Se | 0.02 | 0.06 | | 0.060 |
| Zn | 0.2 | 3 | | 2.0 |

Category 2: Roads, paths, squares, noise reduction barriers, 0.3 to 4 m layer, minimum 1 m of soil + cover required

Category 3: Roads and paths, max. 1 m layer, cover, max. 10 % of precipitation

> **Category 3:** Permission may be granted based on the Environmental Protection Act

DHI database on Danish MSWI BA



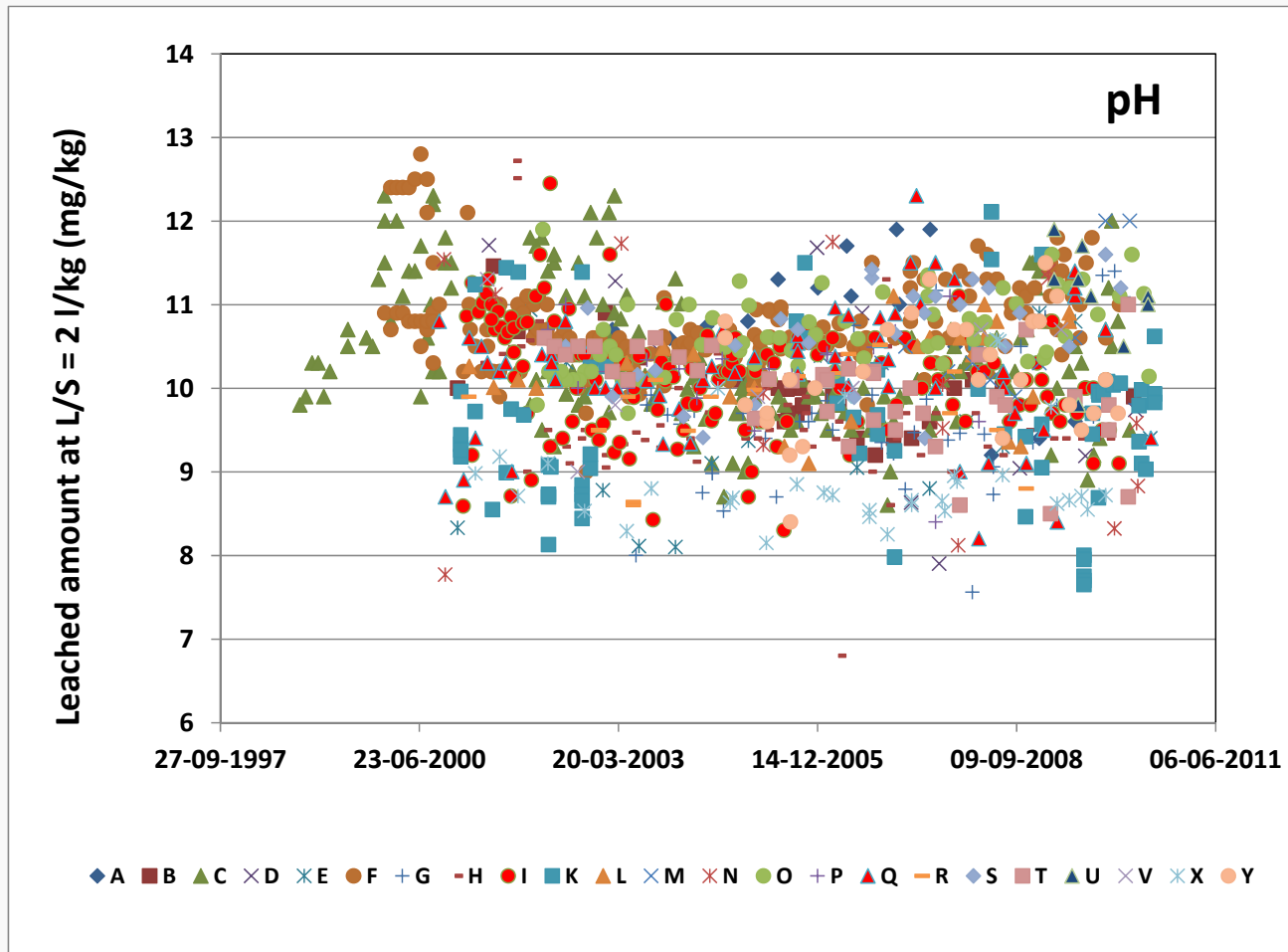
Approximately 1300 datasets on leaching (EN 12457-1, batch test performed at $L/S = 2$ l/kg) of bottom ash from 25 Danish MSW incinerators from the period 1998 to 2010

Several hundreds of the datasets also include analyses of the content of trace elements

Data has been provided by DAFONET

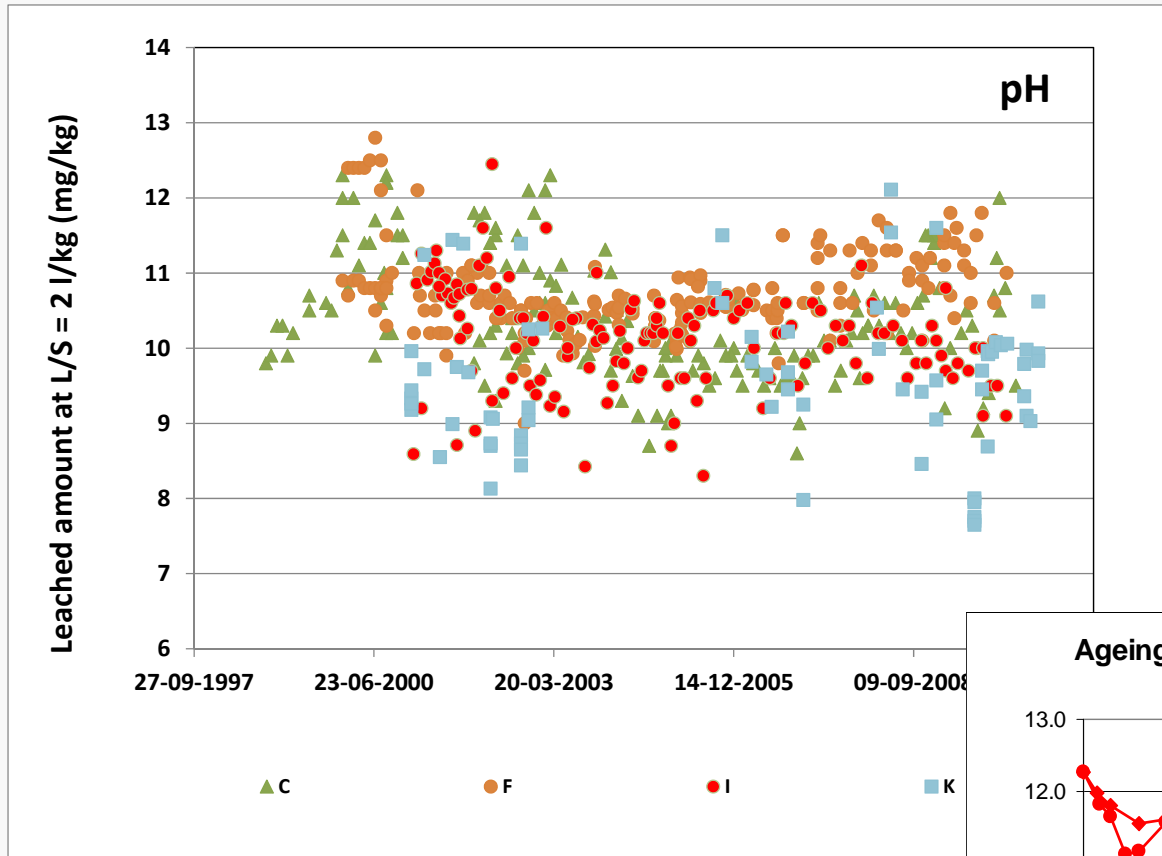
The data are generally presented as median values and are often log-normal distributed

pH in MSWI BA from 23 incinerators



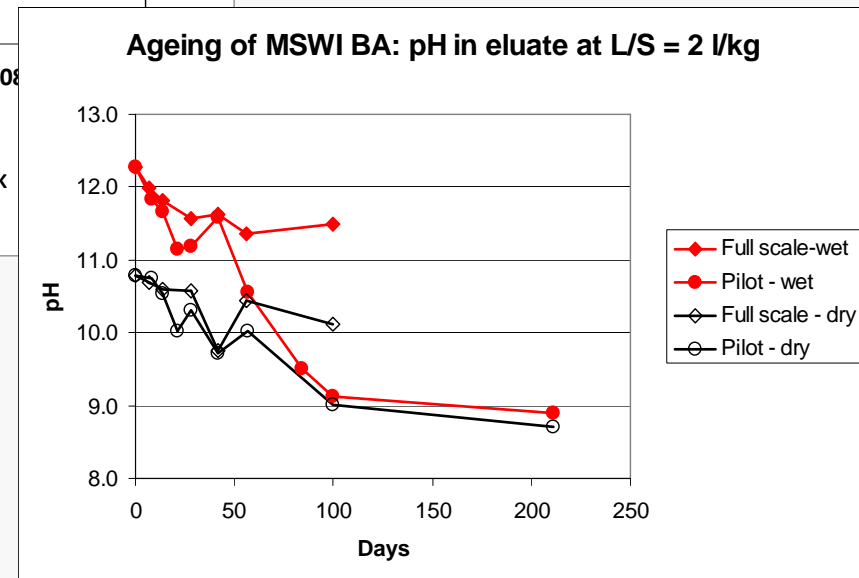
| | |
|--------|------------|
| L/S | 2 l/kg |
| N | 174 |
| Min | 6.8 mg/kg |
| Max | 12.8 mg/kg |
| Median | 10.2 mg/kg |

BA from four of the larger incinerators

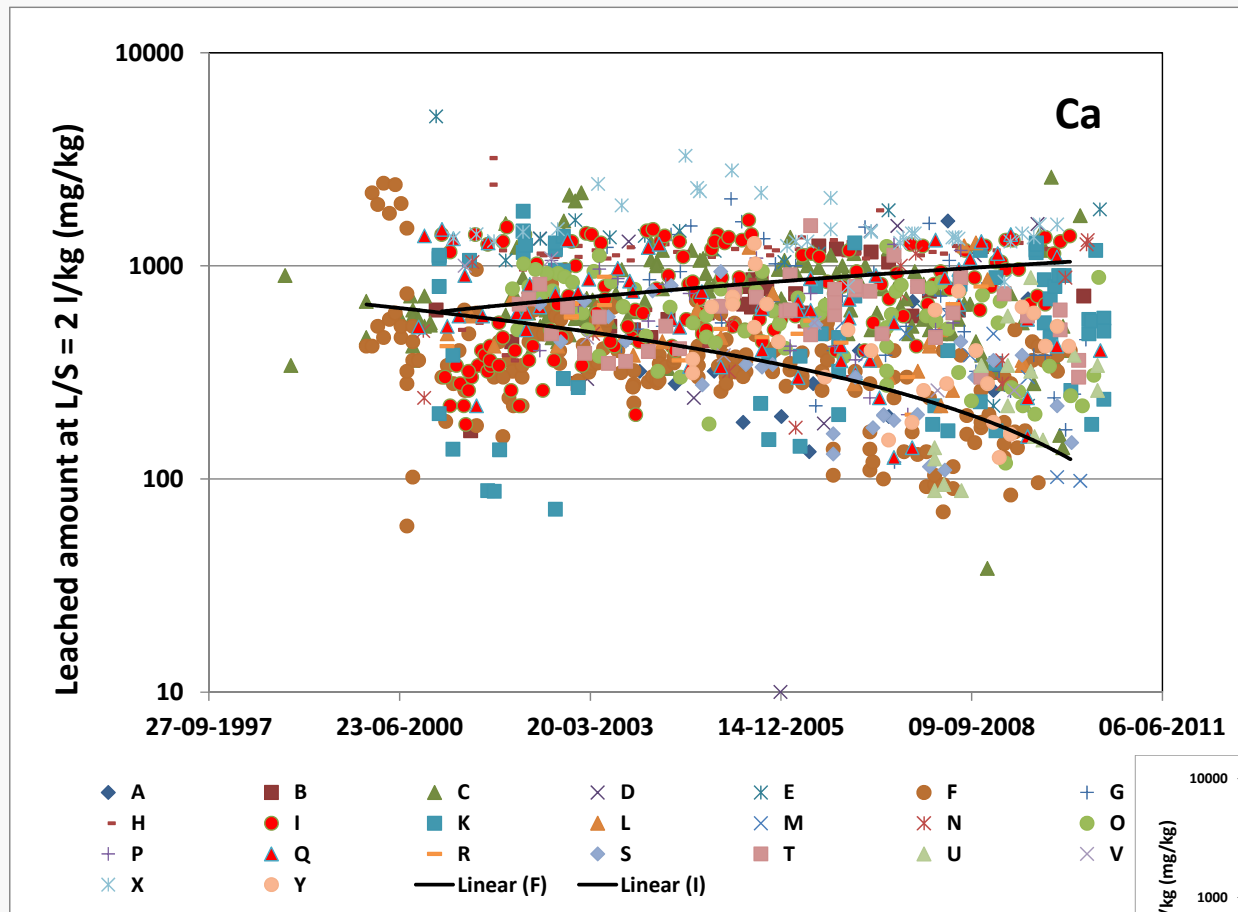


Max 5000 tonnes

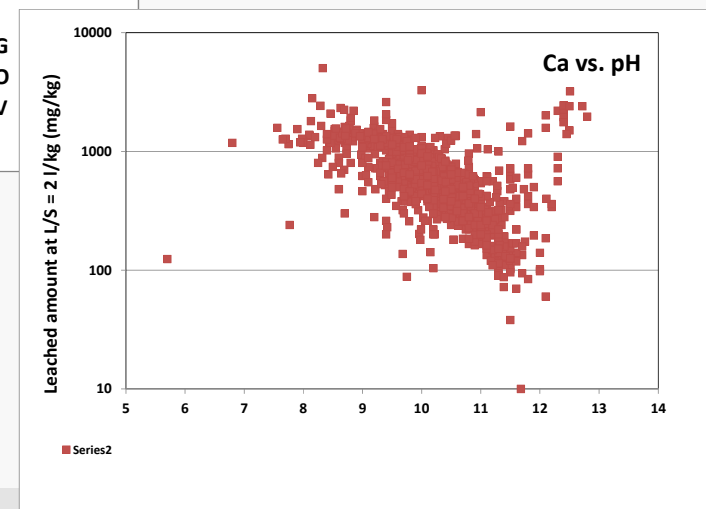
Carbonation is not always effective.....



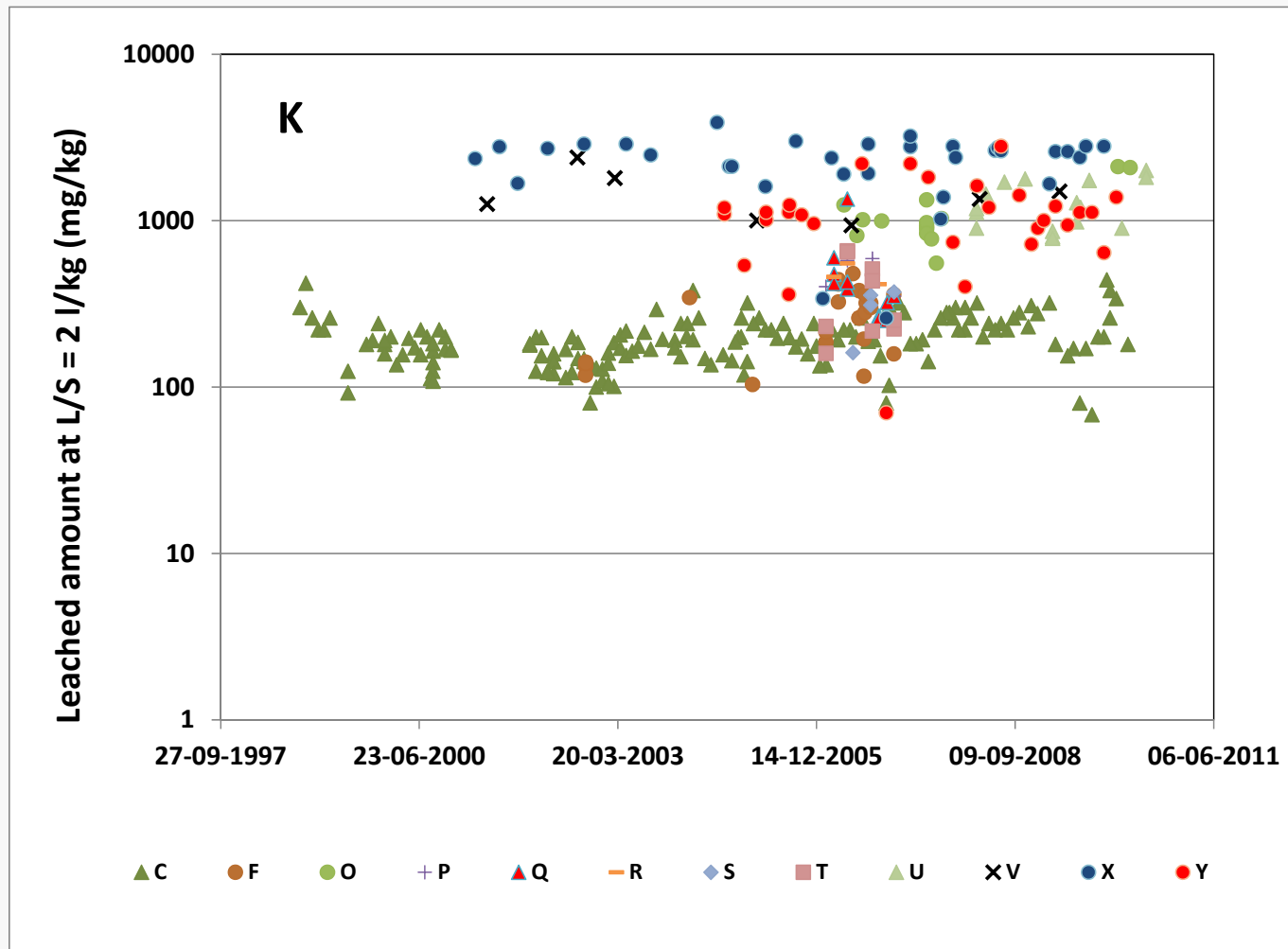
Leaching of Ca from Danish MSWI BA



| | |
|--------|------------|
| L/S | 2 l/kg |
| N | 1129 |
| Min | 103 mg/kg |
| Max | 5020 mg/kg |
| Median | 566 mg/kg |

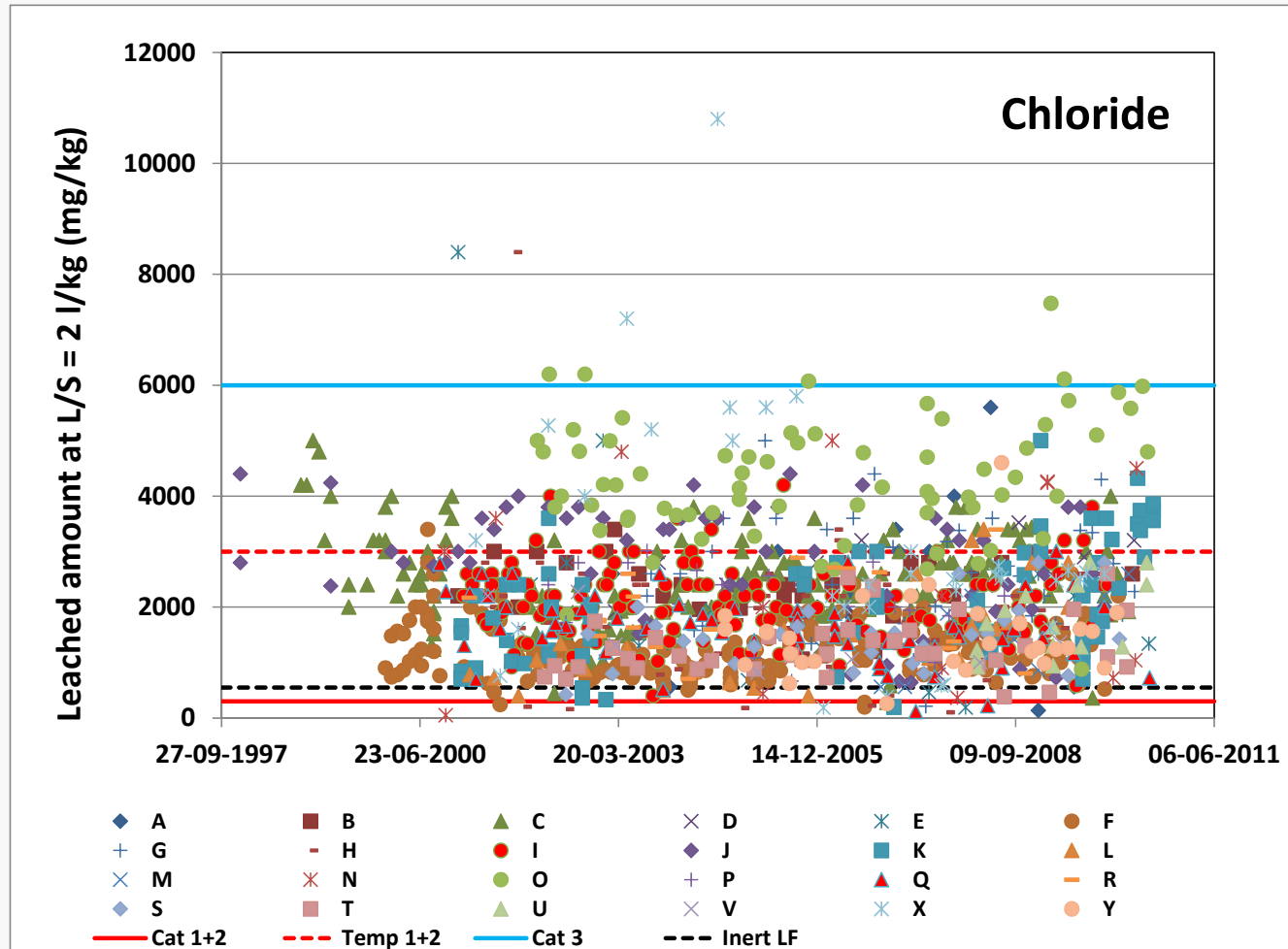


Leaching of K from Danish MSWI BA



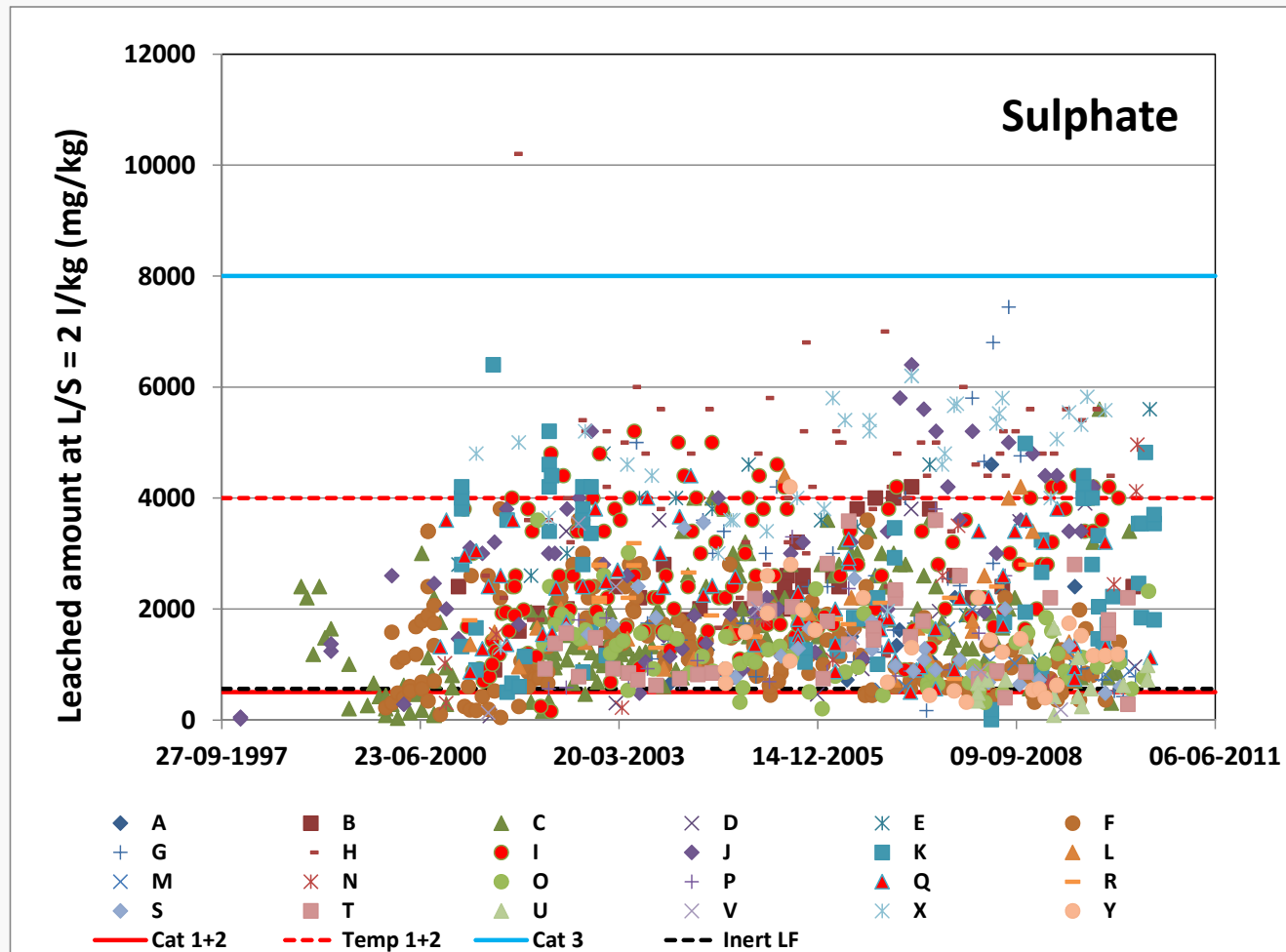
| | |
|--------|------------|
| L/S | 2 l/kg |
| N | 233 |
| Min | 97 mg/kg |
| Max | 2111 mg/kg |
| Median | 201 mg/kg |

Leaching of Cl⁻ from Danish MSWI BA



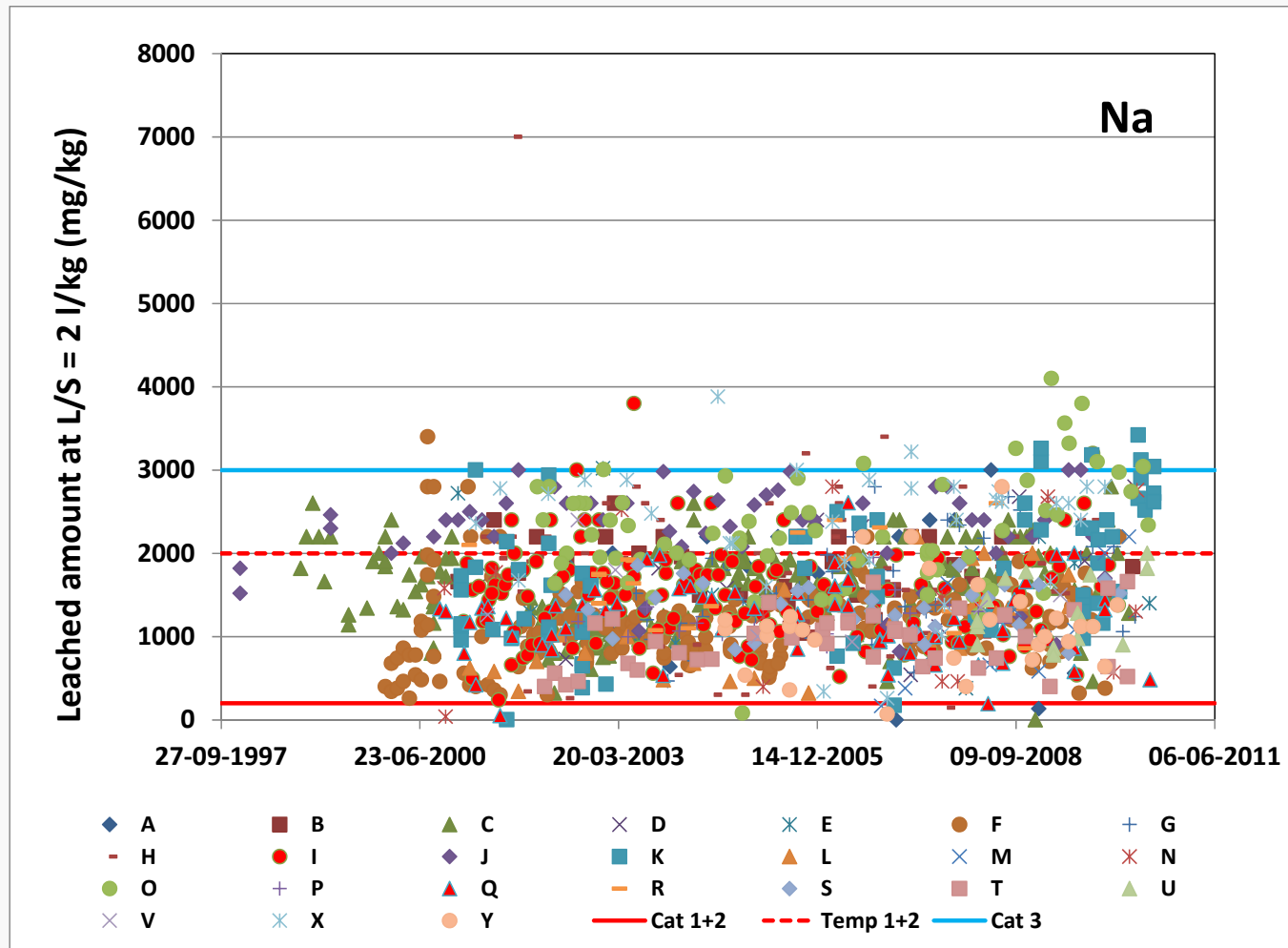
| | |
|----------|-------------|
| L/S | 2 l/kg |
| N | 1209 |
| Min | 383 mg/kg |
| Max | 10800 mg/kg |
| Median | 1930 mg/kg |
| Cat 1+2 | 300 mg/kg |
| Cat 3 | 6000 mg/kg |
| Temp 1+2 | 3000 mg/kg |
| Inert LF | 550 mg/kg |

Leaching of SO₄ from Danish MSWI BA



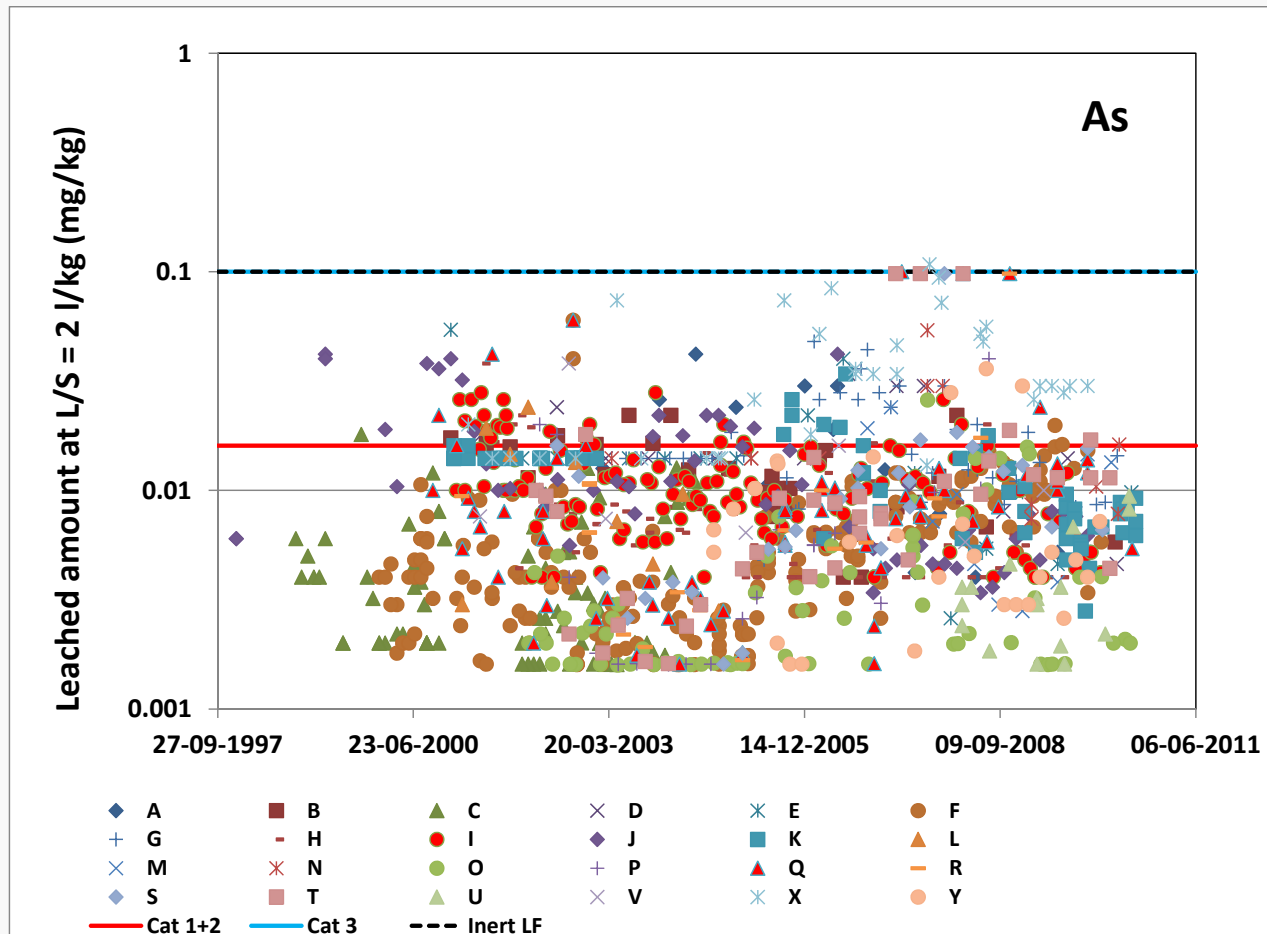
| | |
|----------|-------------|
| L/S | 2 l/kg |
| N | 1129 |
| Min | 200 mg/kg |
| Max | 10200 mg/kg |
| Median | 1700 mg/kg |
| Cat 1+2 | 500 mg/kg |
| Cat 3 | 8000 mg/kg |
| Temp 1+2 | 4000 mg/kg |
| Inert LF | 560 mg/kg |

Leaching of Na from Danish MSWI BA



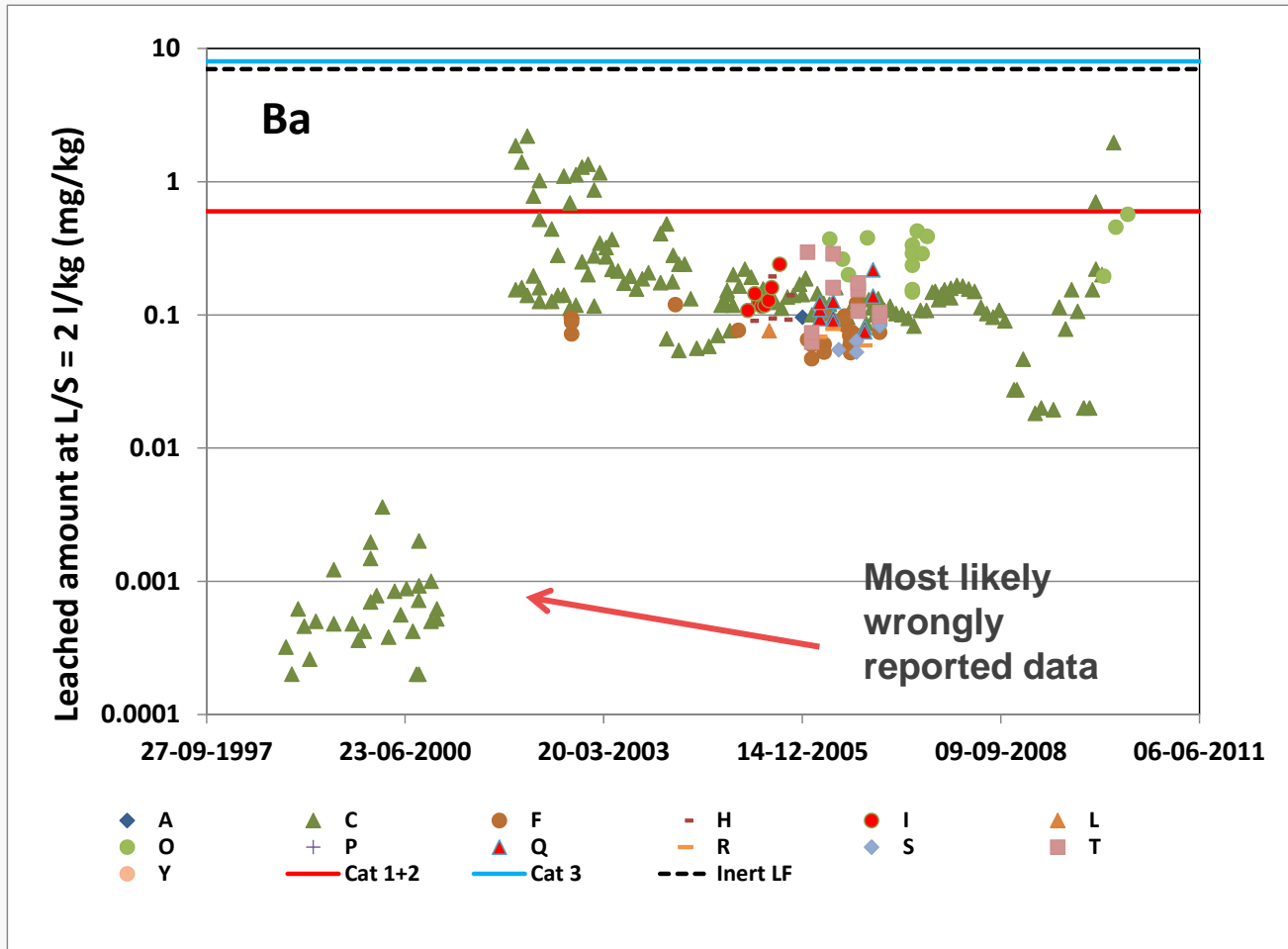
| L/S | 2 l/kg |
|----------|------------|
| N | 1207 |
| Min | 342 mg/kg |
| Max | 7000 mg/kg |
| Median | 1460 mg/kg |
| Cat 1+2 | 200 mg/kg |
| Cat 3 | 3000 mg/kg |
| Temp 1+2 | 2000 mg/kg |

Leaching of As from Danish MSWI BA

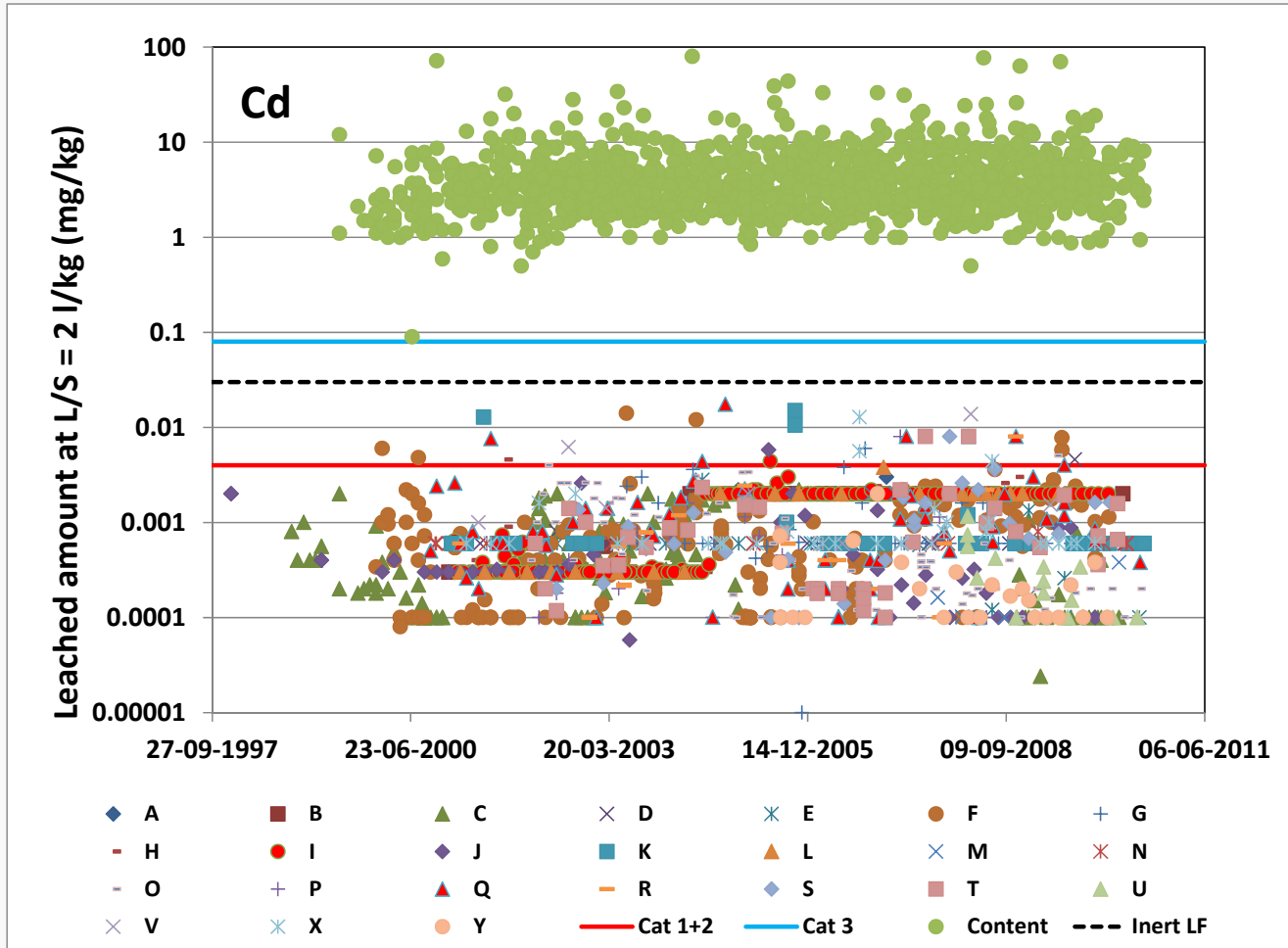


| | |
|----------|--------------|
| L/S | 2 l/kg |
| N | 1119 |
| Min | 0.0016 mg/kg |
| Max | 0.11 mg/kg |
| Median | 0.0076 mg/kg |
| Cat 1+2 | 0.016 |
| Cat 3 | 0.10 |
| Inert LF | 0.10 mg/kg |

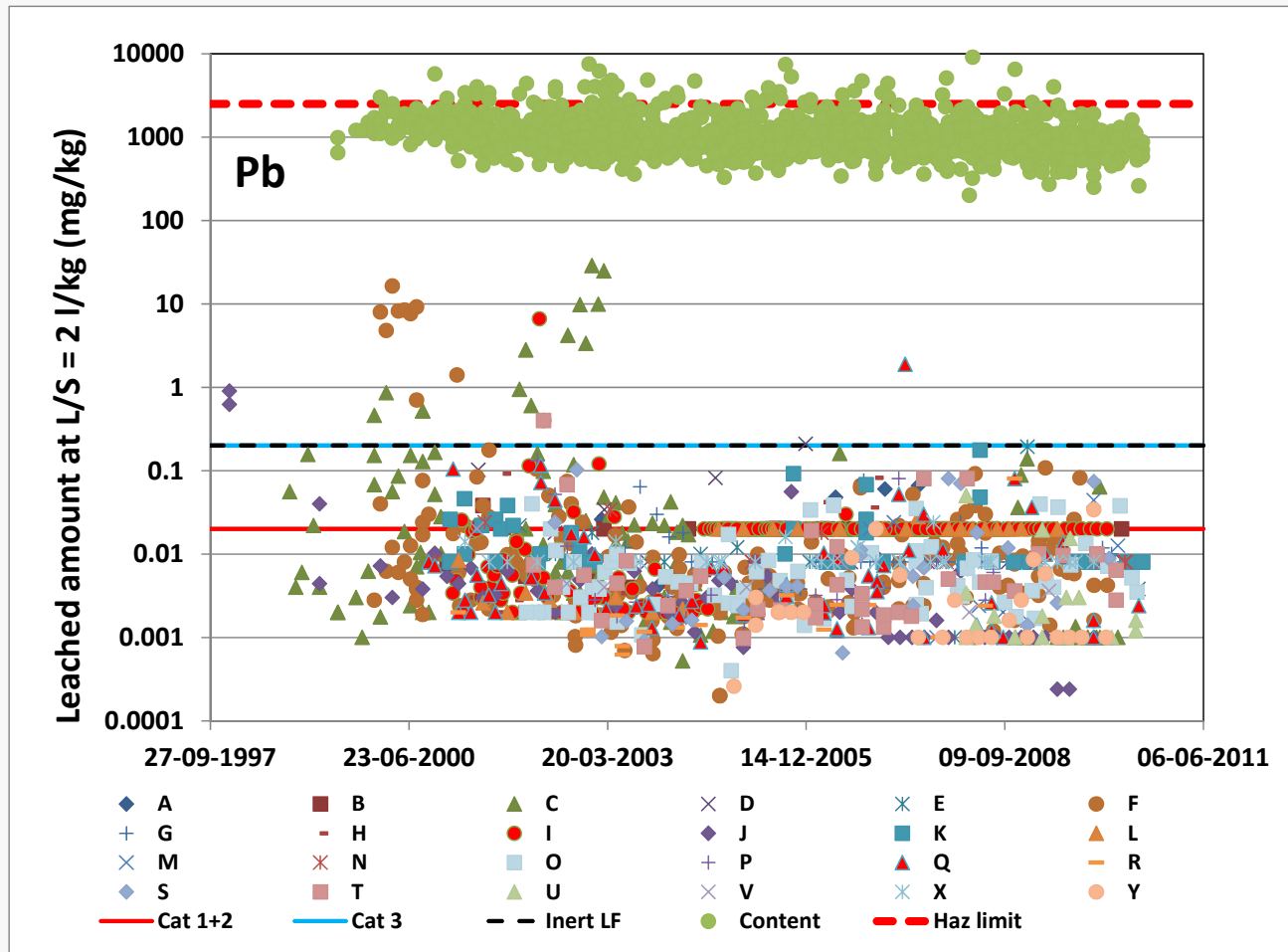
Leaching of Ba from Danish MSWI BA



| | |
|----------|--------------|
| L/S | 2 l/kg |
| N | 253 |
| Min | 0.0002 mg/kg |
| Max | 2.2 mg/kg |
| Median | 0.12 mg/kg |
| Cat 1+2 | 0.6 mg/kg |
| Cat 3 | 8 mg/kg |
| Inert LF | 7 mg/kg |

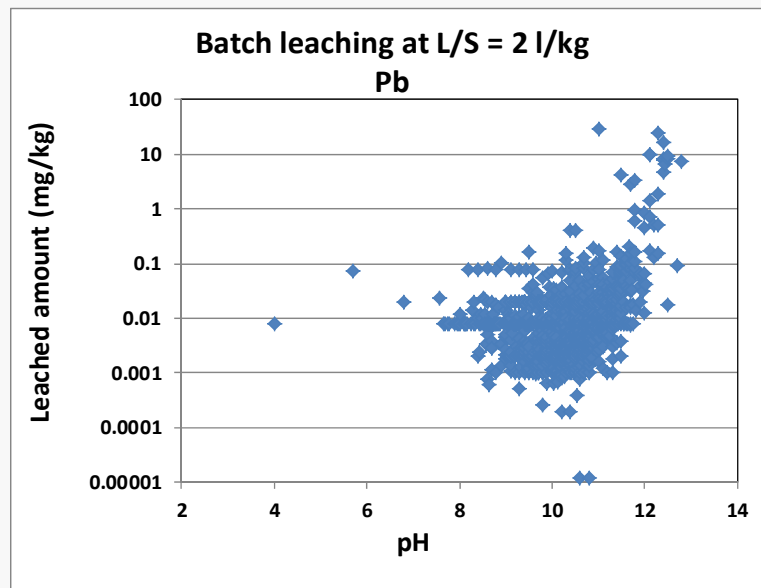
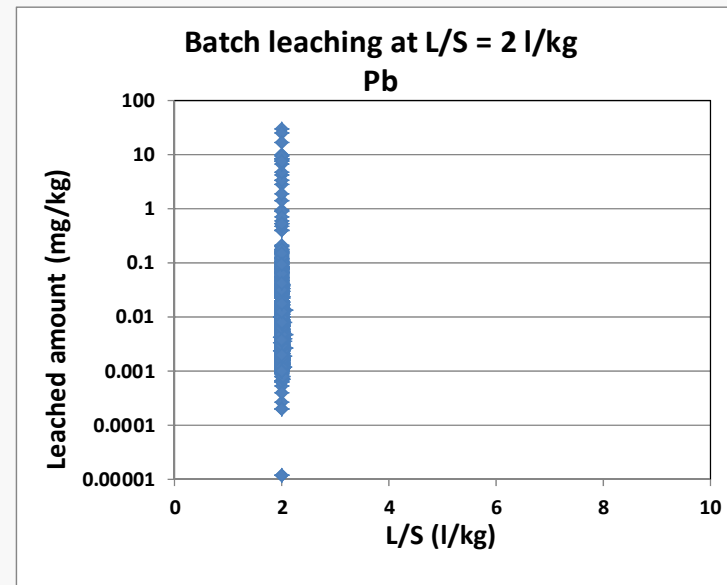
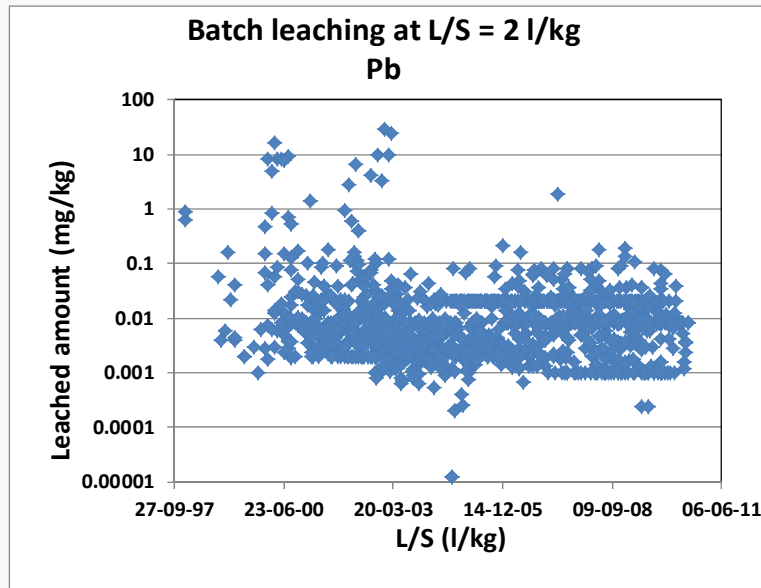


| L/S | 2 l/kg |
|----------|---------------|
| N | 1209 |
| Min | 0.00010 mg/kg |
| Max | 0.018 mg/kg |
| Median | 0.00060 mg/kg |
| Cat 1+2 | 0.016 |
| Cat 3 | 0.10 |
| Inert LF | 0.10 mg/kg |

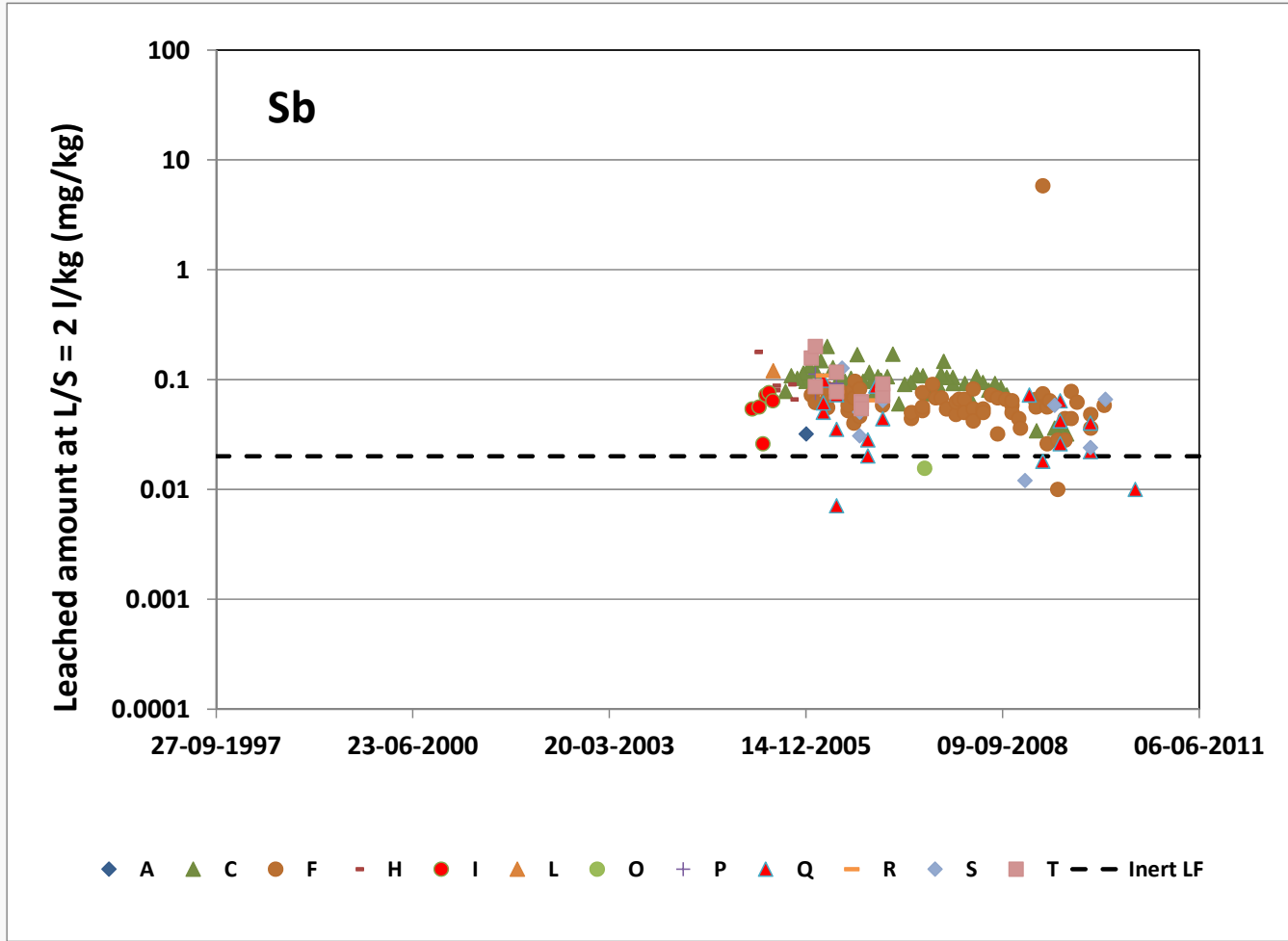


| | |
|----------|--------------|
| L/S | 2 l/kg |
| N | 1209 |
| Min | 0.0010 mg/kg |
| Max | 29 mg/kg |
| Median | 0.0080 mg/kg |
| Cat 1+2 | 0.020 |
| Cat 3 | 0.20 |
| Inert LF | 0.20 mg/kg |

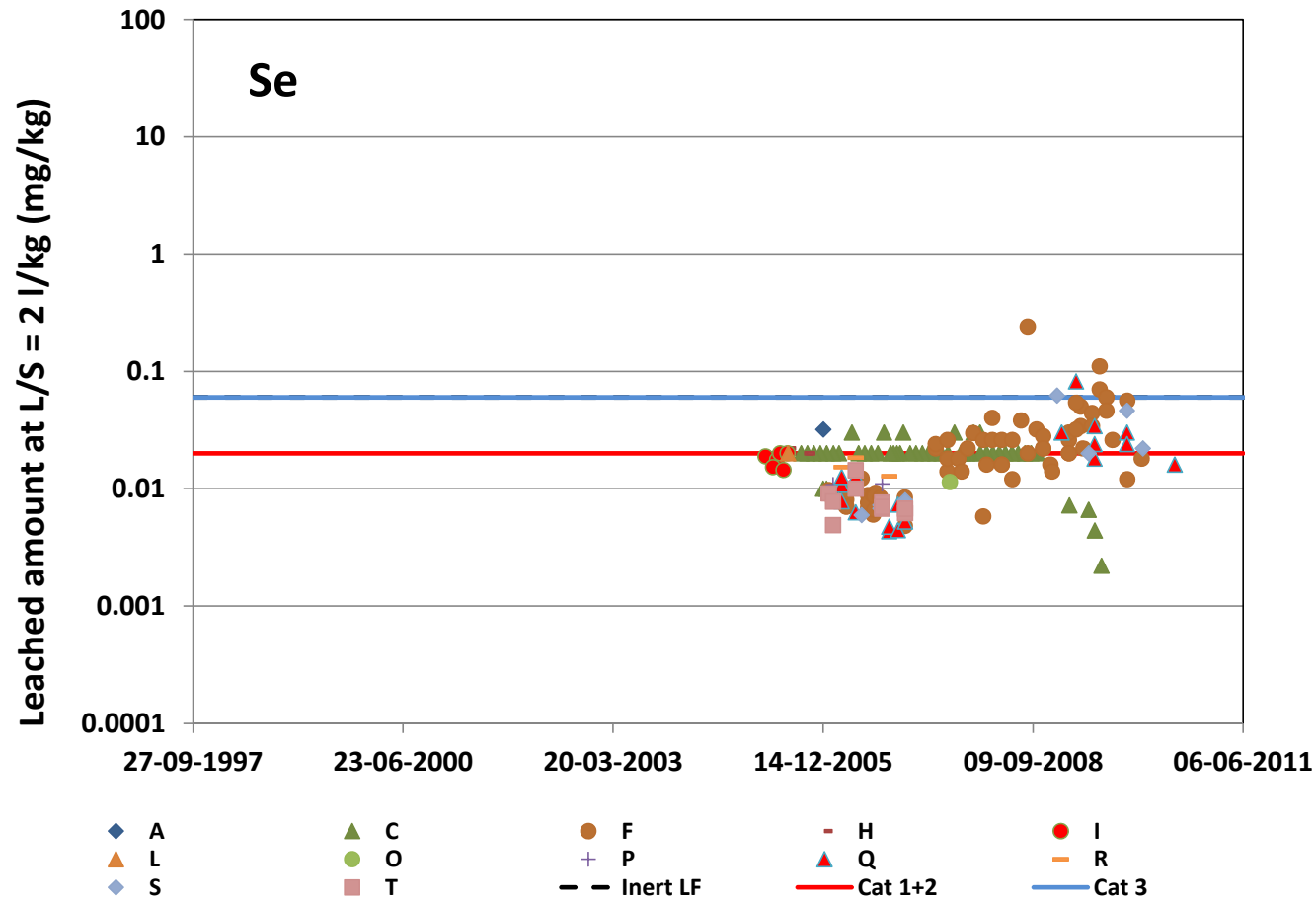
MSWI bottom ash – 1185 DK datasets



Leaching of Pb



| | |
|----------|-------------|
| L/S | 2 l/kg |
| N | 174 |
| Min | 0.014 mg/kg |
| Max | 5.8 mg/kg |
| Median | 0.068 mg/kg |
| Inert LF | 0.02 mg/kg |



| | |
|----------|-------------|
| L/S | 2 l/kg |
| N | 174 |
| Min | 0.005 mg/kg |
| Max | 0.24 mg/kg |
| Median | 0.020 mg/kg |
| Cat 1+2 | 0.02 mg/kg |
| Cat 3 | 0.06 mg/kg |
| Inert LF | 0.06 mg/kg |

Conclusion



| Substance | No of datasets | Median value | Category 1+2 | Category 3 | Temp. 1+2 | Inert LF | Trend? |
|-----------|----------------|--------------|--------------|------------|-----------|----------|-----------|
| | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | |
| Chloride | 1209 | 1930 | 300 | 6000 | 3000 | 550 | |
| Sulphate | 1129 | 1700 | 500 | 8000 | 4000 | 560 | |
| Na | 1207 | 1460 | 200 | 3000 | 2000 | | |
| As | 1119 | 0.0076 | 0.016 | 0.1 | | 0.10 | |
| Ba | 253 | 0.12 | 0.6 | 8 | | 7.0 | Decrease? |
| Cd | 1209 | 0.00060 | 0.004 | 0.08 | | 0.030 | |
| Cr | 1208 | 0.064 | 0.02 | 1 | | 0.20 | Increase? |
| Cu | 1209 | 1.1 | 0.09 | 4 | | 0.90 | |
| Hg | 247 | 0.000077 | 0.0002 | 0.002 | | 0.0030 | |
| Ni | 1209 | 0.010 | 0.02 | 0.14 | | 0.20 | |
| Pb | 1209 | 0.0080 | 0.02 | 0.2 | | 0.20 | |
| Sb | 174 | 0.068 | | | | 0.02 | Decrease |
| Se | 174 | 0.020 | 0.02 | 0.06 | | 0.060 | Increase |
| Zn | 1209 | 0.020 | 0.2 | 3 | | 2.0 | |

Yellow: Limit value exceeded by the median value



Thank you for your attention!

