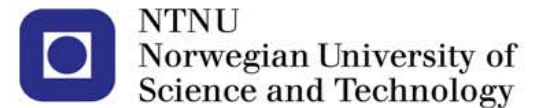


Mineral dust emissions generated in Norwegian surface mineral production – sources, requirements and monitoring programmes

Presented at the
3rd International Conference on Sustainable Development Indicators in the mineral industry, June 2007, Milos island, Greece

By
Mr. Hans Tore Mikkelsen
and
Prof. Tom Myran



Outline of the presentation

This presentation deals mainly with

- dust emissions from mineral production to the ambient air (ext. environment)
- monitoring of dustfall at the neighbourhood of 6 mineral production plants
 - Chosen from monitoring programmes implemented at approx. 30 plants
- An empiric model for estimating suspended dust from dustfall

Summary

- Mineral production plants* emit dust to the ambient air
- Monitoring of dustfall indicates that the dust emission rates at the six mineral production plants are lower than the “limit value”
- Paradoxically, health risk evaluation from dust exposures are made different for
 - Work environment air quality: **Concentration, time of exposure, individual sensitivity** and **composition**
 - Ambient air quality: As work environment but minus **composition**
 - *Quarries, gravel extraction, crushing plants, concentrators etc.

Summary

- The sources of dust are always present
- New or changing processes may cause new sources and new dust emissions
- Spreading of dust depends strongly on meteorological effects
- Mineral dust may cause **health**, **amenity** and **environmental** impacts
- The mineral industry meet increased focus and tougher requirements to both ambient and work environment air quality?
- Conflicts are registered

What is dust or particulate matter(PM)?

Particles matter(PM)/dust in air

- Mineralogical part
- Organic (Insect & plant fragments, pollen, combustion products, soot and oil)
- Other (sea salt spray, textile fibers and droplets)

Total suspended PM in air (max. size 300-400 μm)

- $> 75 \mu\text{m}$ (**dustfall**)
- $< 75 \mu\text{m}$ (**suspended dust**)
- PM_{10} (**inhalable fraction**)

Particle travelling distances - examples (Péwé, 1981):

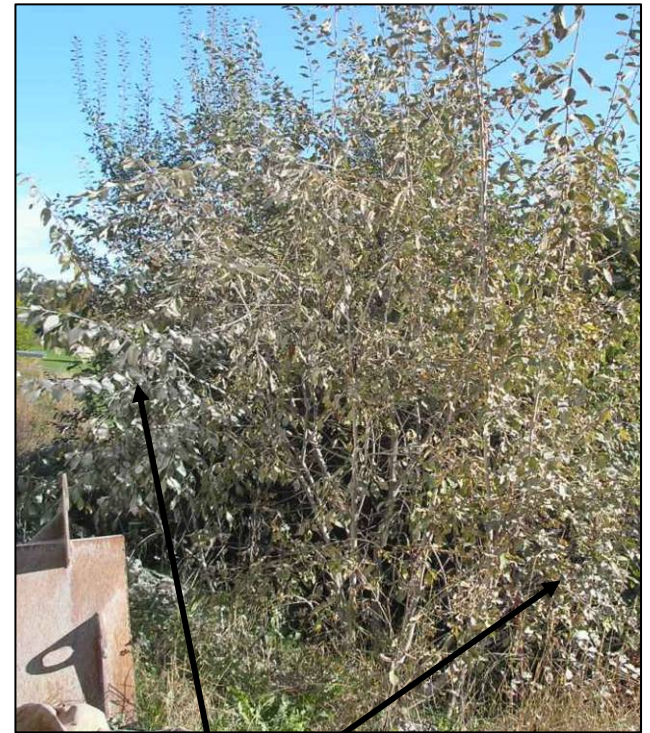
- 5-50 μm \rightarrow 100 km
- 1-10 μm \rightarrow n·1000 km
- $< 2 \mu\text{m}$ \rightarrow enters troposphere, very long distances

Particles with sizes $< 10 \mu\text{m}$ (PM_{10}), are hardly visible in air!

Dust emission examples



Dust emission from a quarry



Dust deposited on tree leaves (near sand blasting facility)

Sources of particulate matter

Mineral production:

- Blasting
- Loading and rock handling
- Crushing & sieving
- Transport (conveyors, vehicles etc)
- Ground areas
- Stockpiles
- Land fills
- Roads

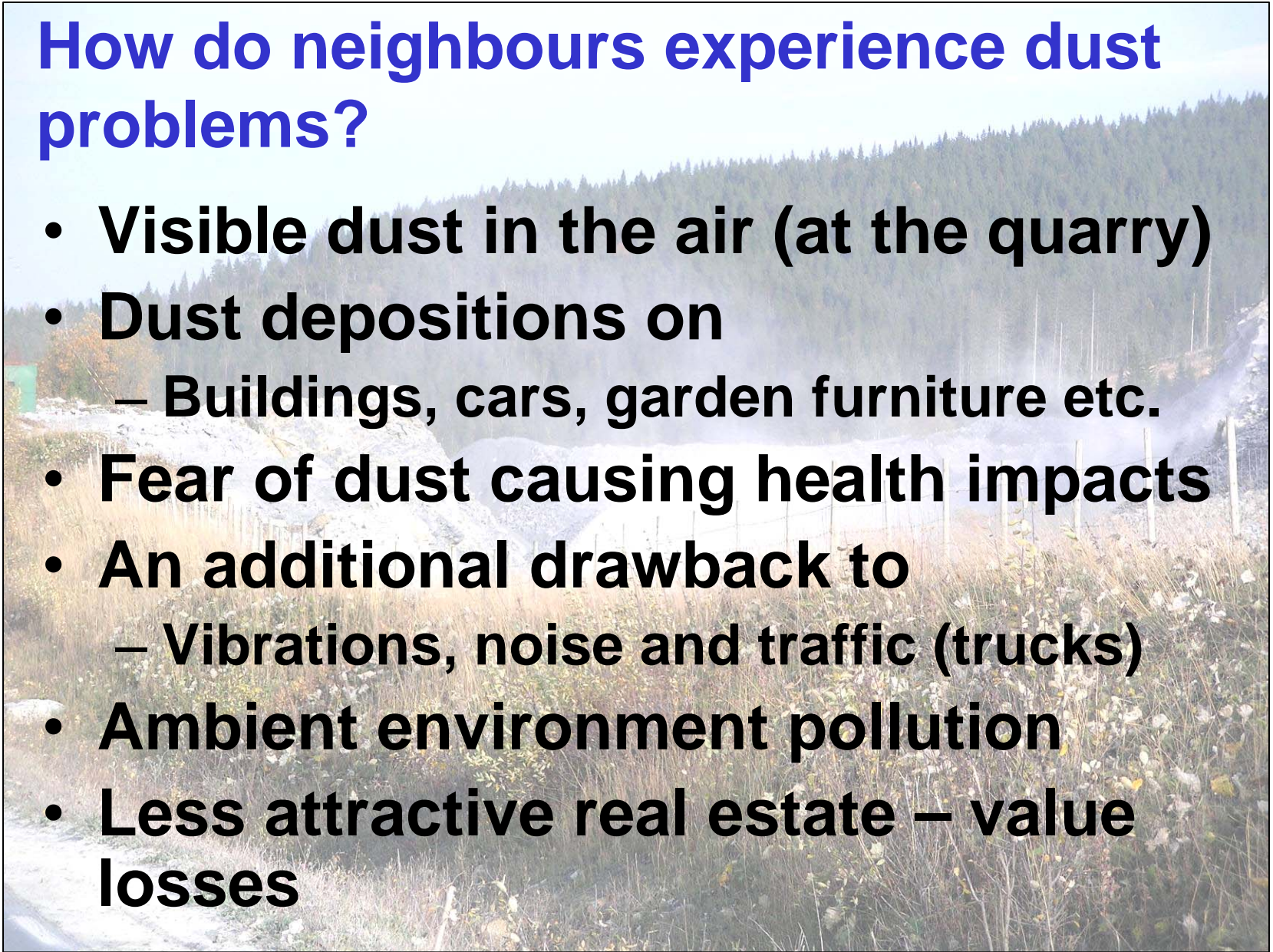
Other:

- Public traffic/sand on icy roads
- Other industry
- Wood burning stoves



How do neighbours experience dust problems?

- **Visible dust in the air (at the quarry)**
- **Dust depositions on**
 - Buildings, cars, garden furniture etc.
- **Fear of dust causing health impacts**
- **An additional drawback to**
 - Vibrations, noise and traffic (trucks)
- **Ambient environment pollution**
- **Less attractive real estate – value losses**



Particulate matter (PM)- legislation

Requirements to concentration of particulate matter

Particulate matter (PM)	Average	Limit value	Max. excesses/ nonconformances	Evaluation limit (U/L/max.)
Air quality (AQ):				
Suspended dust PM ₁₀	24 hour 365 days	50 µg/m ³ 40 µg/m ³	< 35 times/year	U: 30 µg/m ³ -7x L: 30 µg/m ³ -7x
Dust deposition	30 days ±2days	5 g/m ² /30days	0 times / one year monitoring	d < 500 meters
Working environment – administrative norms (AdN):				
Mineral dust (inert dust)	8 hour / 40 hour week	Tot: 10 mg/m ³ Res: 5 mg/m ³	EU-proposal for respirable silica: 0,05 mg/m ³	Exp < 1/4 AdN → OK!
Quartz	8 hour / 40 hour week	Tot: 0,3 mg/m ³ Resp: 0,1 mg/m ³		AdN > Exp > 1/4 AdN → monitoring & contr. action evaluation
Asbestos	8 hour / 40 hour week	0, 1 fibre/m ³		Exp > AdN → Cause? Immediate control actions!

Monitoring dustfall

- Monitoring according to:
 - NS 4852 Air quality. Measurement of Atmospheric dustfall. Horizontal deposit gauge method, Standards Norway.
- Result
 - Total dustfall
 - Mineralogical dustfall
 - Organic dustfall

Dustfall [grams/m²/30days]



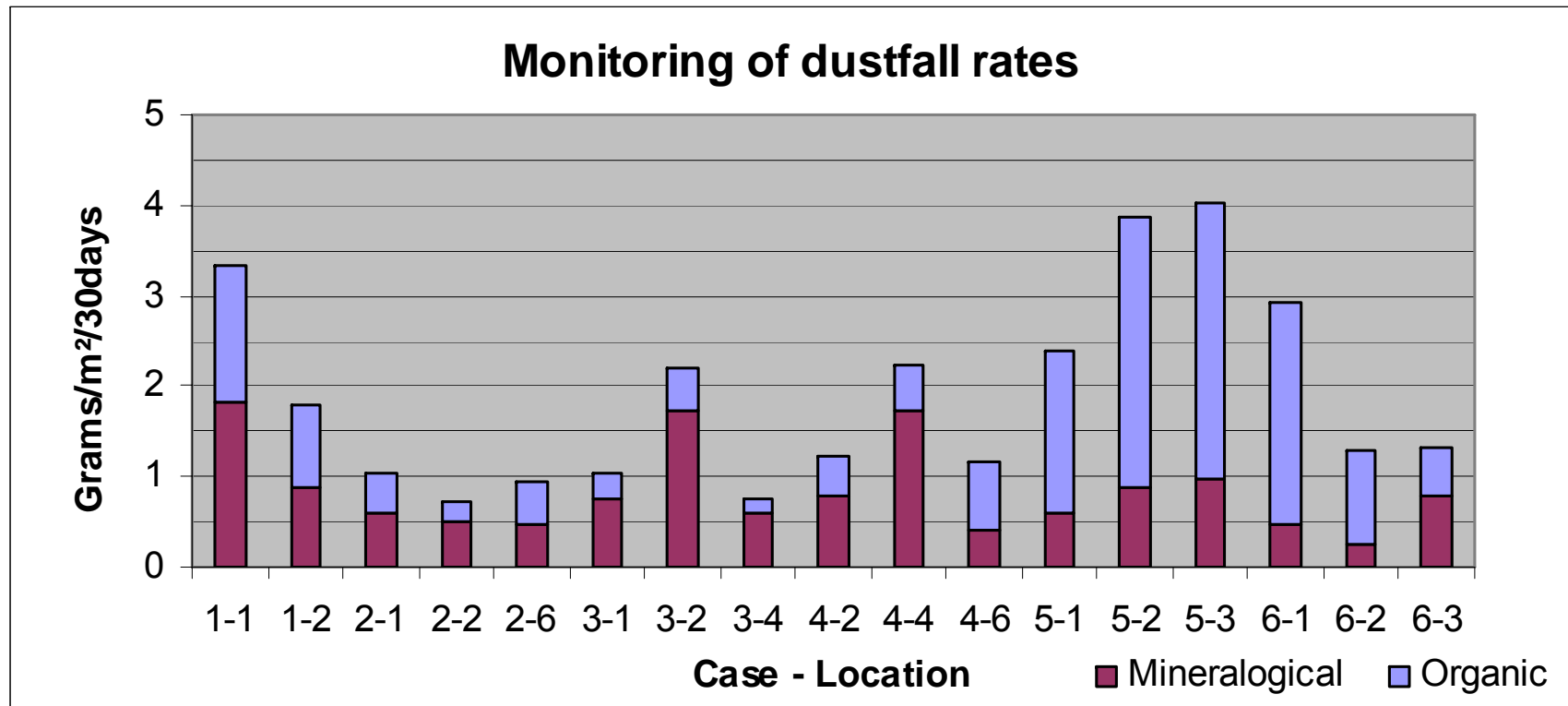
Monitoring dustfall

Six cases/companies, 17 sample locations

Case	Sample locations	Source descriptions
1	1-1; 1-2	Stockpile at pier
2	2-1; 2-2; 2-6	Tailings disposal, main road
3	3-1; 3-2; 3-4	Industrial area, factory point sources
4	4-2; 4-4; 4-6	Industrial area, factory point sources
5	5-1; 5-2; 5-3	Aggregates plant, open pit, industrial area
6	6-1; 6-2; 6-3	Aggregates plant, open pit, industrial area



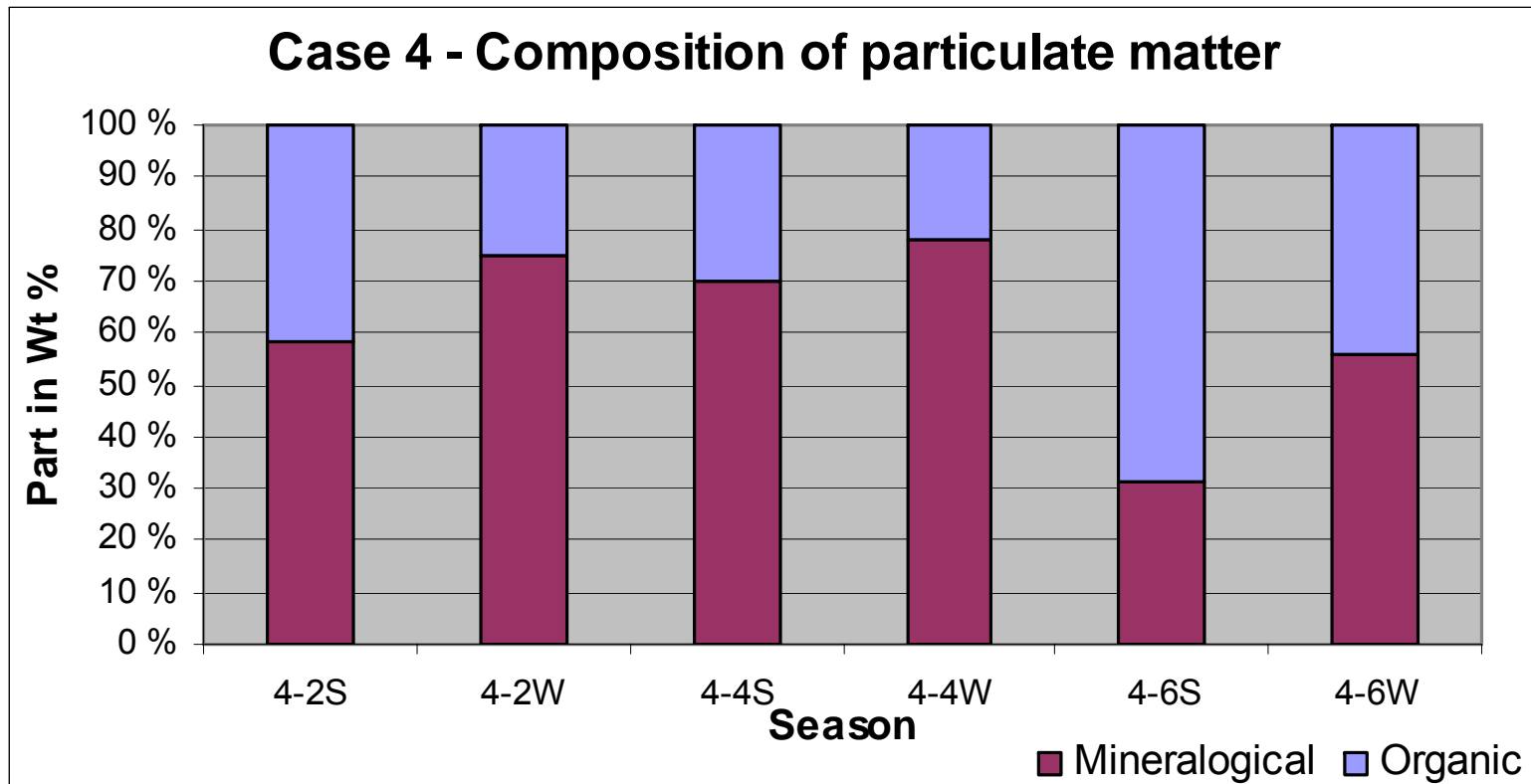
Dustfall monitoring results



Plotted from data presented in table 2 in the SDIMI2007 conference proceedings!

Case 4 Seasonal variations

Period May 1998 – March 2004



S = Summer season (1. April – 30. Sept.)

W= Winter season (1. Oct. – 31. March)

Empiric model for estimating suspended dust from dustfall

Parallel monitoring of traffic situations in Trondheim, Norway (Hedalen, 1997):

- Suspended dust concentration (PM10) and dustfall
- Covariation between PM10 and dustfall
- Development of empiric model

Equations:

$$\text{PM10,AVERAGE}(x) = 2.5 \cdot x + 7.8 \quad (1)$$

$$\text{PM10,MINIMUM}(x) = 0.7 \cdot x + 7.8 \quad (2)$$

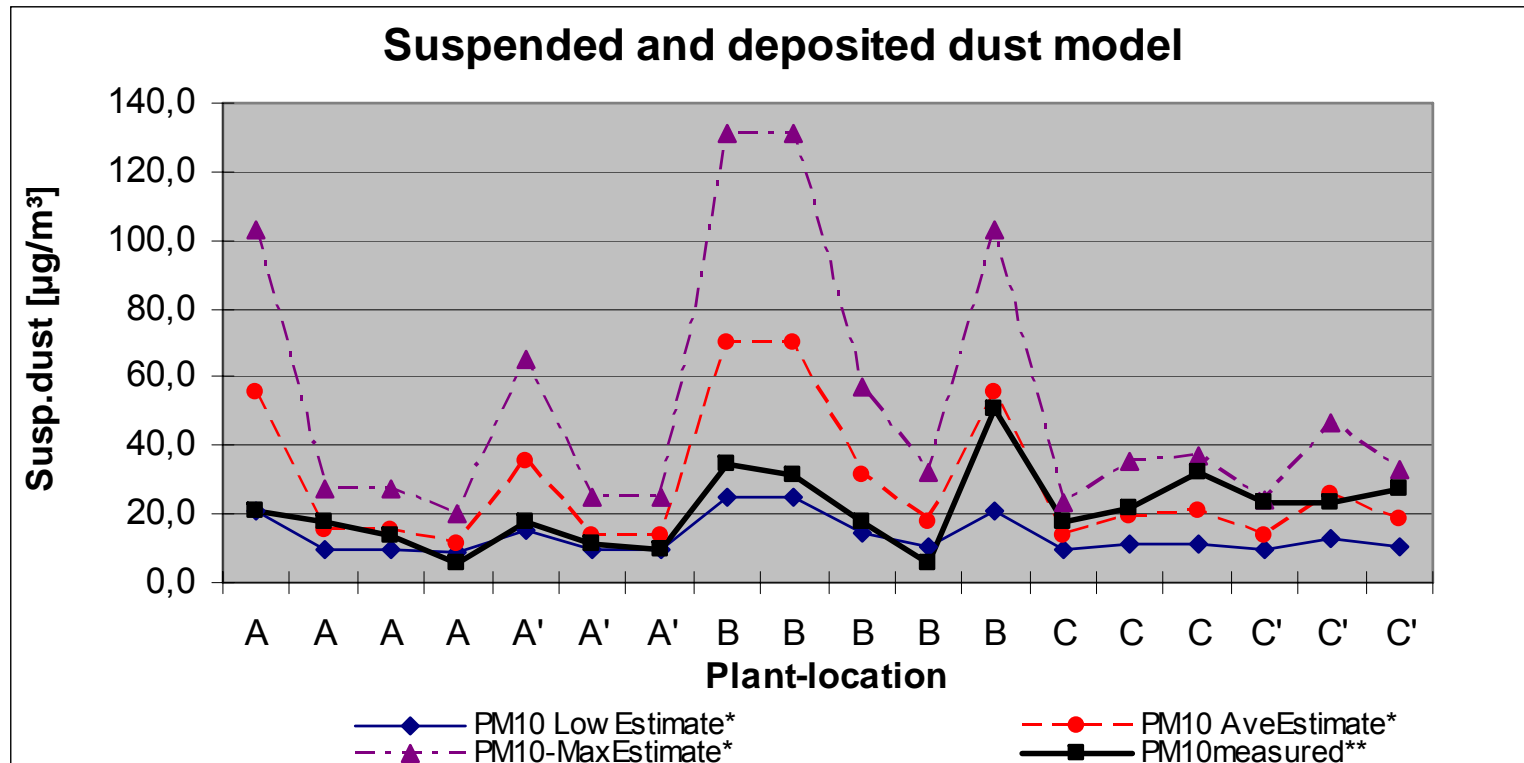
$$\text{PM10,MAXIMUM}(x) = 4.7 \cdot x + 13.1 \quad (3)$$

x: Total rate of dustfall [g/m²/30 days]

PM10: Suspended dust concentration [µg/m³]

Parallel monitoring

Estimated & measured dust in suspension



Source: Furseth, L.M. (2005)

* Estimates of suspended dust concentrations are based on dustfall

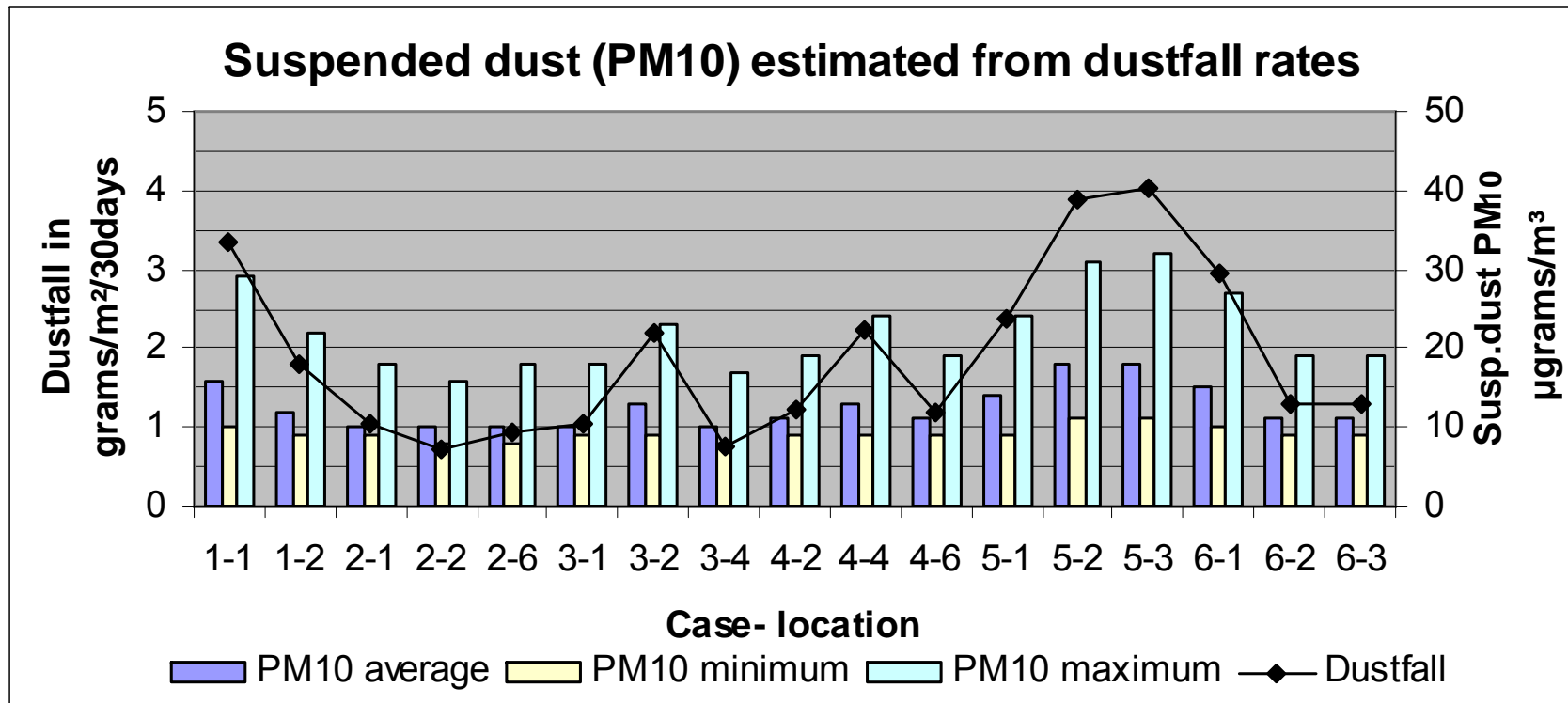


** Measured PM10: Sequential Air Sampler, type EK



Monitoring results

The six cases – susp.dust estimates



Plotted from data presented in table 3 in the SDIMI2007 conference proceedings!

To minimise ambient environment dust problems

You need to focus on:

- HSE management
 - Setting goals
 - Daily follow-up at the plant
- Control actions - evaluate and implement
- Inform, educate and train your employees
- Inform your neighbours
- Take your neighbours seriously – dialogue is extremely important to avoid conflicts!

Control actions

- Water sprays, chemicals, foam
- Equipment covers, e.g. conveyor covers combined with dust filters
- Mine area rehabilitation
- Monitoring – incident – activity planning
- Organisational actions
- Maintenance improvements (equipment and vehicles).

Conclusions

- Monitoring of dustfall show rates being lower than 5 grams/m²/30days (acceptable level)
 - At the six cases/companies (17 sample locations)
 - Also low levels compared with city traffic situations
- Seasonal variations can be seen
- Organic contents up to 80%
- Increasing contributions from other dust sources at distances over 500 meter
- Increasing focus on dust emissions to amb.air
 - neighbours, society, mass media, pollution control authorities, environmentalists and other