A Contribution to Sustainable Development in Vietnamese Hard Coal Mining by Mine Dust Mitigation and Waste Rock Dump Stabilization

L. Rattmann
P.N. Martens, T. Katz, I. Özdemir, A. Förster, M. Fuchsschwanz

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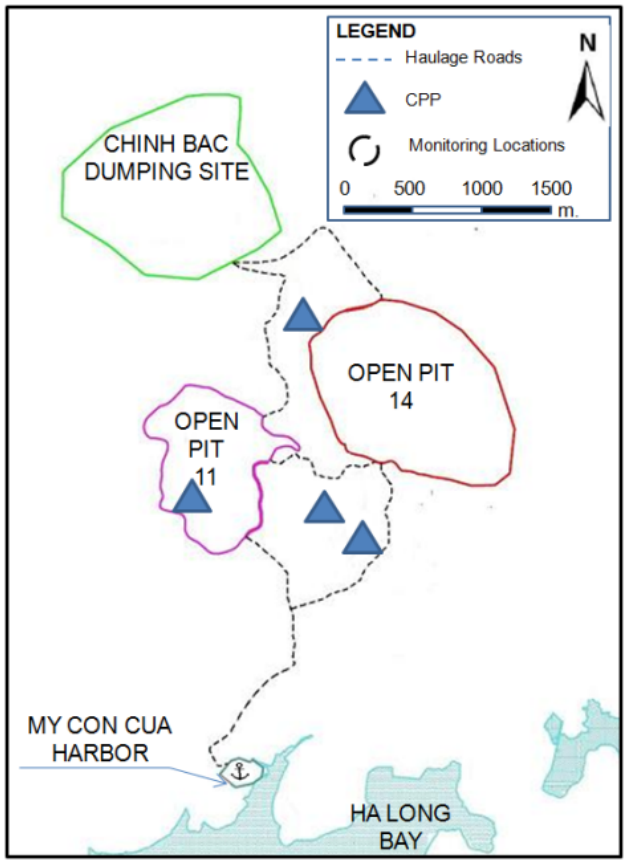
- Waste Rock Dump Stabilization and Rehabilitation
- Waste Water Treatment in Mining
- Dust Mitigation and Monitoring
- Plant based Technologies
- Environmental Management, Capacity Building
- Methods for Planning Land Use after Mining

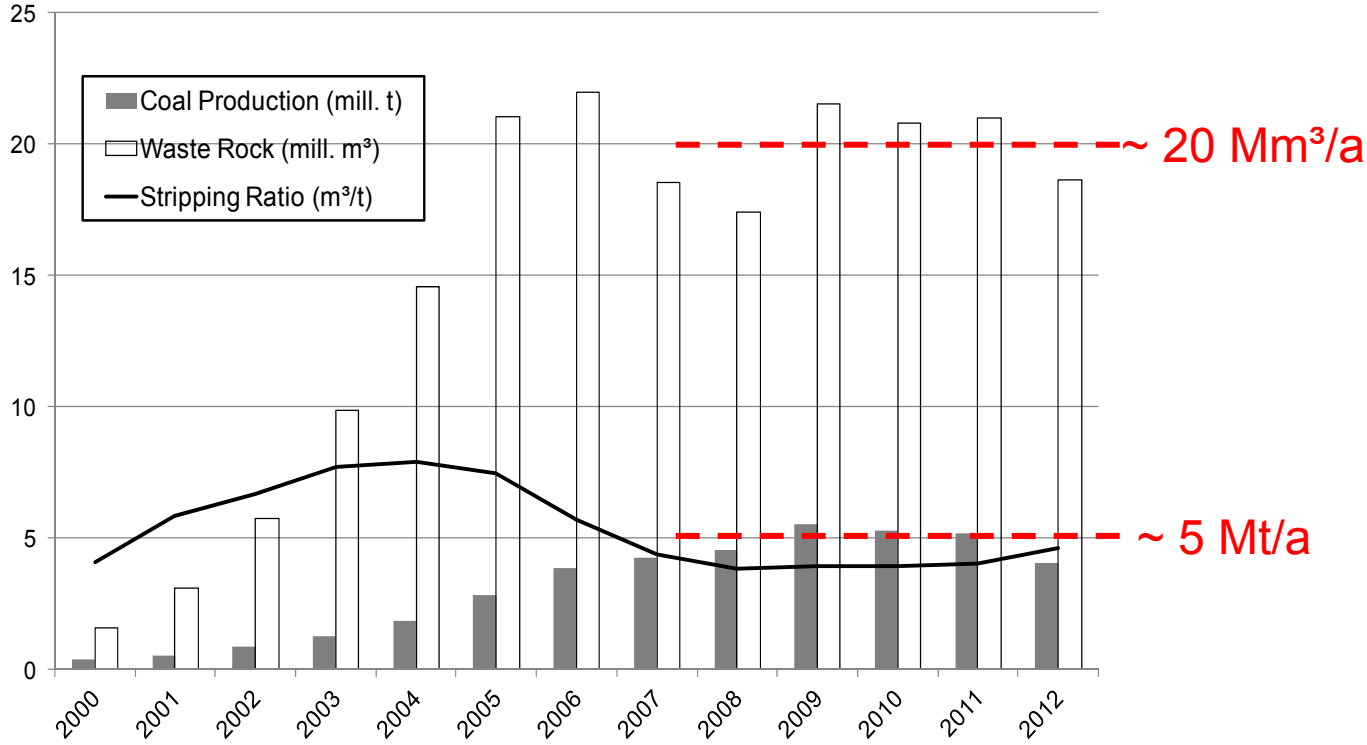
Introduction (I)

- Vietnam, Quang Ninh Province, Ha Long
  - ➔ Ha Long Bay: UNESCO World Heritage Site
- Conflicts of Interest between Tourism and Mining

Introduction (II)

Nui Beo Coal Company (NBCC)





Structure

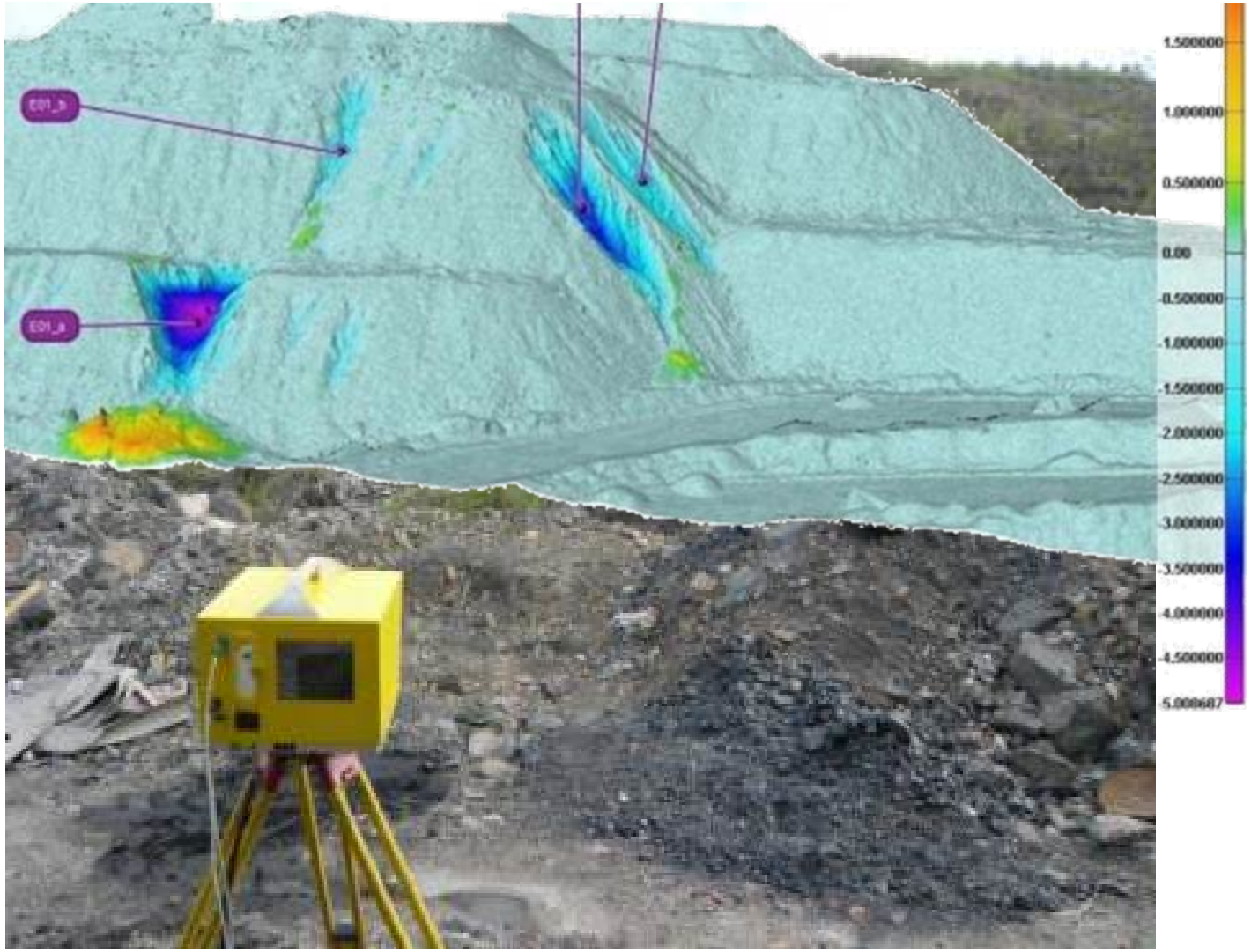
- RAME Subproject 2a:
  Waste Rock Dump (WRD) Stabilization and Rehabilitation
  - ➔ Focus on Mechanical WRD Stability
    - ➔ Slope Stability
    - ➔ Erosion
    - ➔ Subsidence

- RAME Subproject 4a:
  Dust Mitigation and Monitoring
  - ➔ Dust Sources
    - ➔ Source Measurements
    - ➔ Emission Factors
  - ➔ Mine Dust Control Approach
    - ➔ Mitigation Methods
    - ➔ Control Factors & Modelling

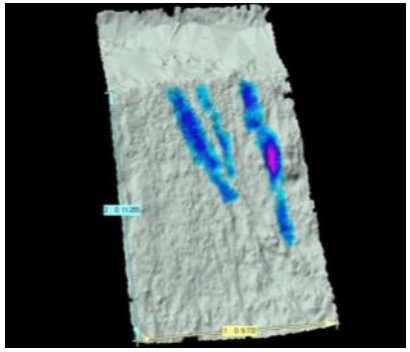
Part I: Dump Stability

- Existing WRD
  - ➔ Heights > 300 m
  - ➔ Single Slope Heights > 150 m
  - ➔ No Vegetation
    - ➔ Stability Problems
- Investigation
  - ➔ Material Parameters
  - ➔ Erosion Modelling
  - ➔ Test Areas
    - ➔ Erosion Assessment
    - ➔ Subsidence Monitoring
- Stabilization Measures

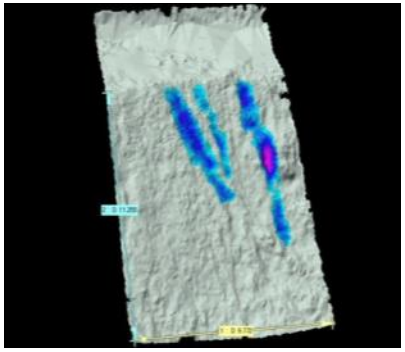
Dump Stability: Erosion Monitoring (I)



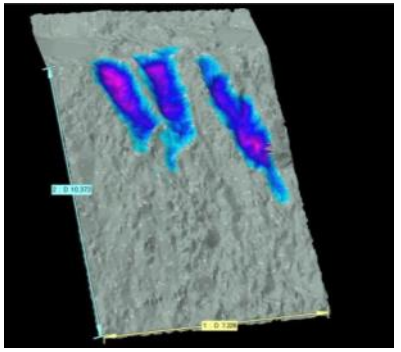
Dump Stability: Erosion Monitoring (II)



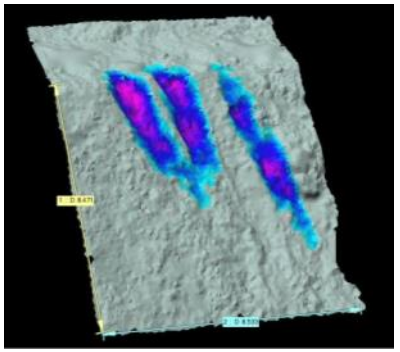
October 2010: 1.17 m³



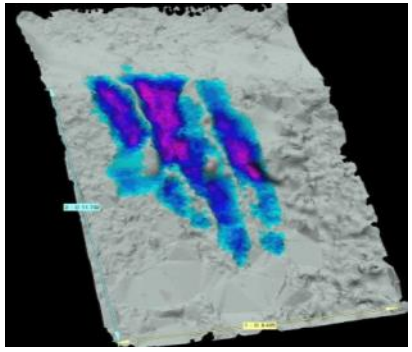
May 2011: 1.26 m³ ⇨



November 2011: 2.80 m³



April 2012: 2.82 m³ ⇨



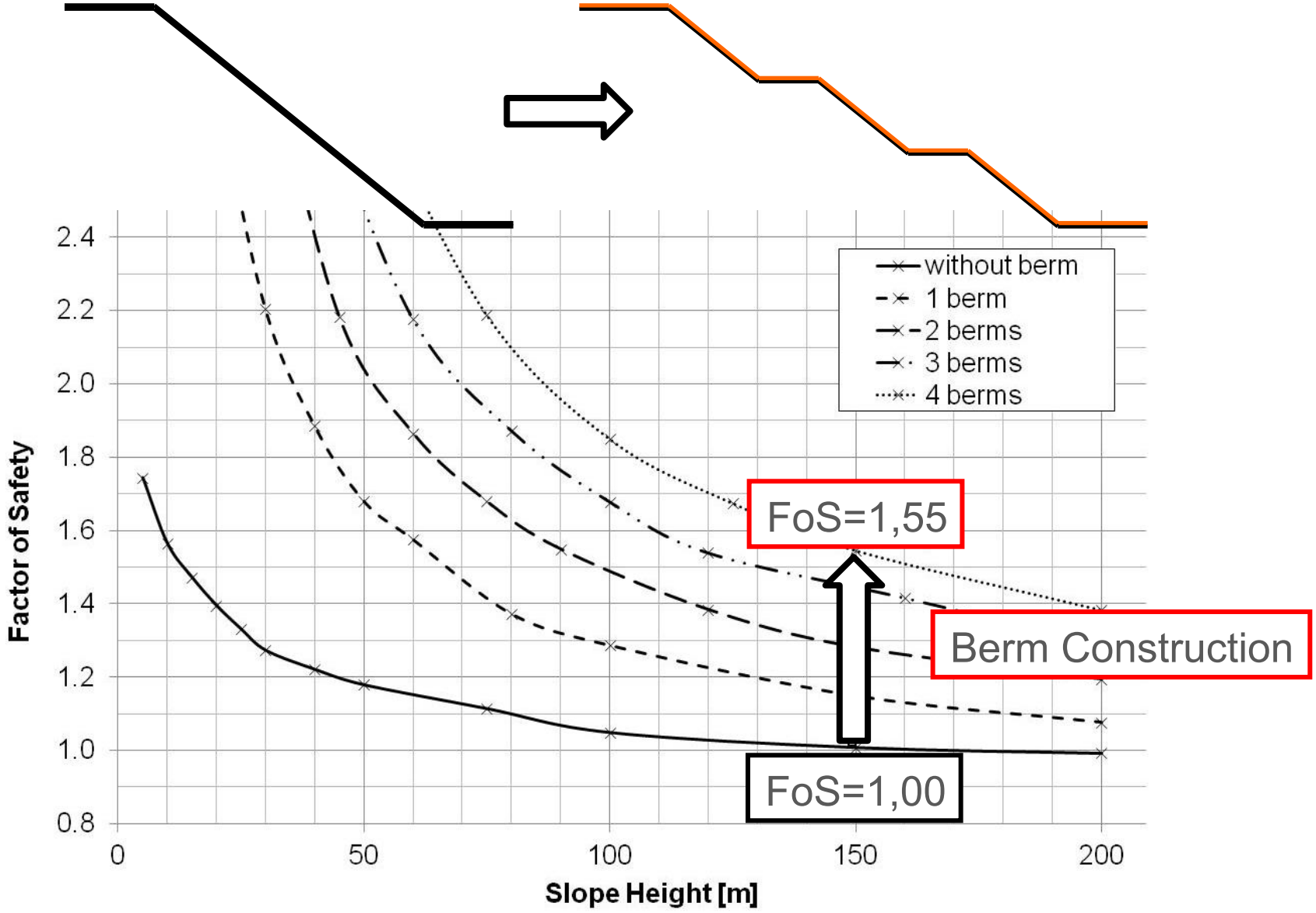
November 2012: 4.63 m³

Stabilization Measures

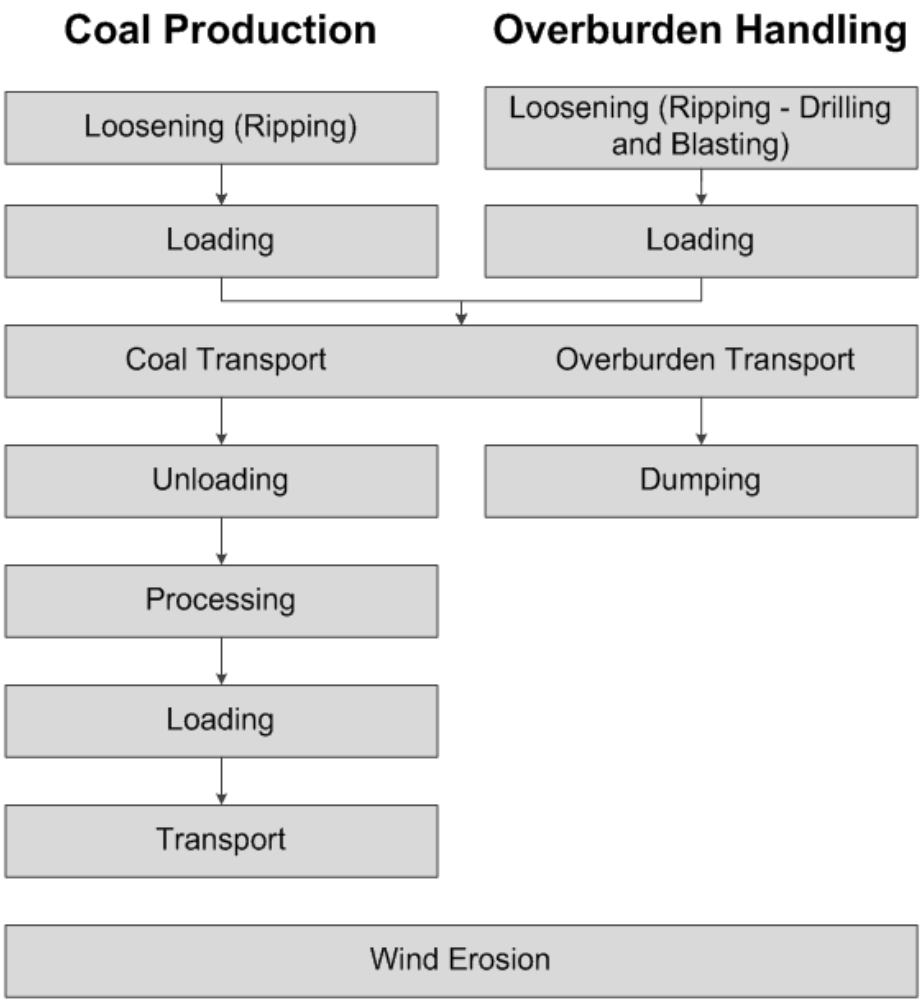
	Aspect Weight	Cost 25%	Slope Stability 10%	Erosion 15%	Land-scaping 5%	Area required 10%	Effects on Production 15%	Applic-ability 20%	Total
1	Height Reduction	--	++	++	+	--	0	--	-0,55
2	Slope Angle Reduction	-	++	+	+	-	0	+	0,25
3	Berm Construction	0	++	+	++	-	-	++	0,6
4	Vegetation	-	0	++	++	0	0	+	0,35
5	Surface Water Control	-	+	++	0	0	+	+	0,5
6	Seepage Water Control	--	+	0	0	0	0	-	-0,6
7	Soil Nails	--	++	+	-	+	0	--	-0,5
8	Support Structures	--	+	0	-	+	0	--	-0,75

Ongoing Dump Stabilization at Cẩm Phả

Dump Stability - Slopes



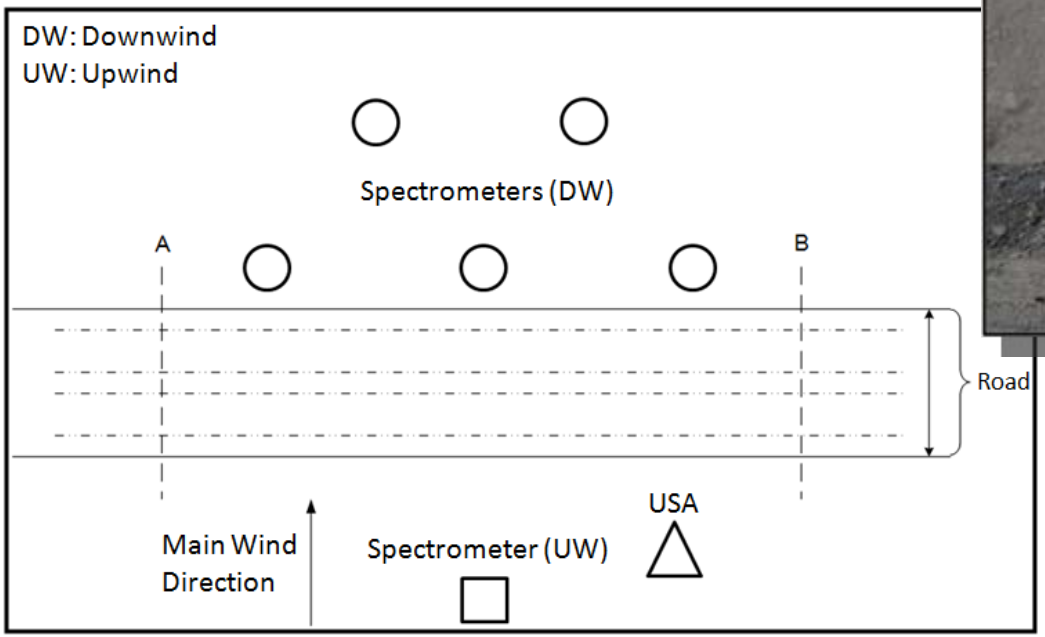
Dust Emission Sources at NBCC Mining Area



Emission Factor Development

Real-time Emission Measurements

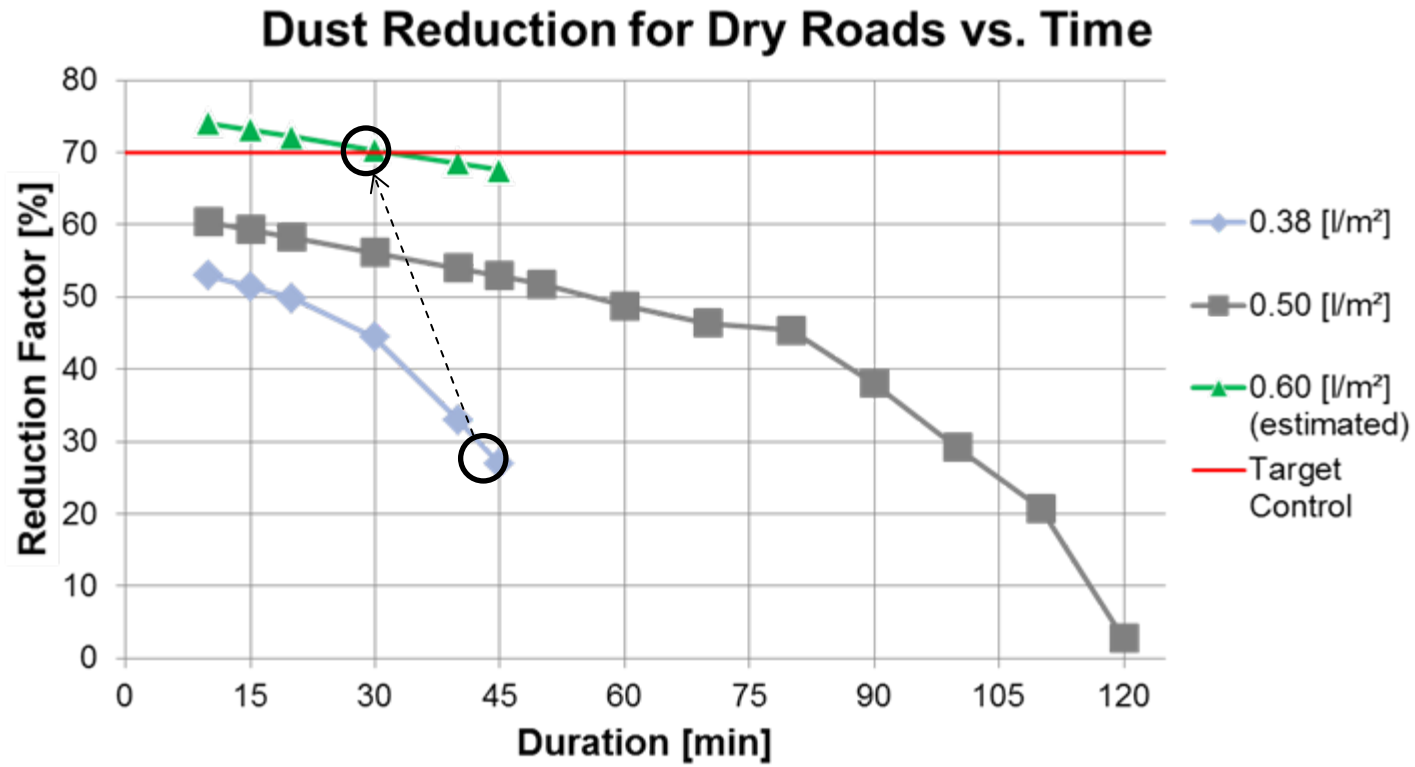
- Emission Concentration and Wind Condition Measurements
- Measurements of Parameters influencing Dust Emission
- Provide Dataset for Emission Factor Development



Dust Emission Factors – Contribution to Dust Generation

Mining Activity		Emission Factor	Contribution to the Dust Generation (%)
Coal Production		various	**11.24**
Overburden Handling	Drilling (case 1)	28.17 (g/m)	**0.32**
	Drilling (case 2)	320.67 (g/m)	
	Drilling (case 3)	1,279.80 (g/m)	
	Blasting	0.53 (g/t)	**0.06**
	Loading (case 1)	3.93 (g/t)	**0.58**
	Loading (case 2)	3.78 (g/t)	
	Loading (case 3)	4.70 (g/t)	
	Haulage (case 1)	880 (g/km*truck)	***53.87***
	Haulage (case 2)	524 (g/km*truck)	
	Haulage (case 3)	1,124 (g/km*truck)	
	Haulage (case 4)	392 (g/km*truck)	
	Dumping	0.225 (g/t)	**0.04**
Wind Erosion		0.198 (g/m^2*hr)	***33.80***

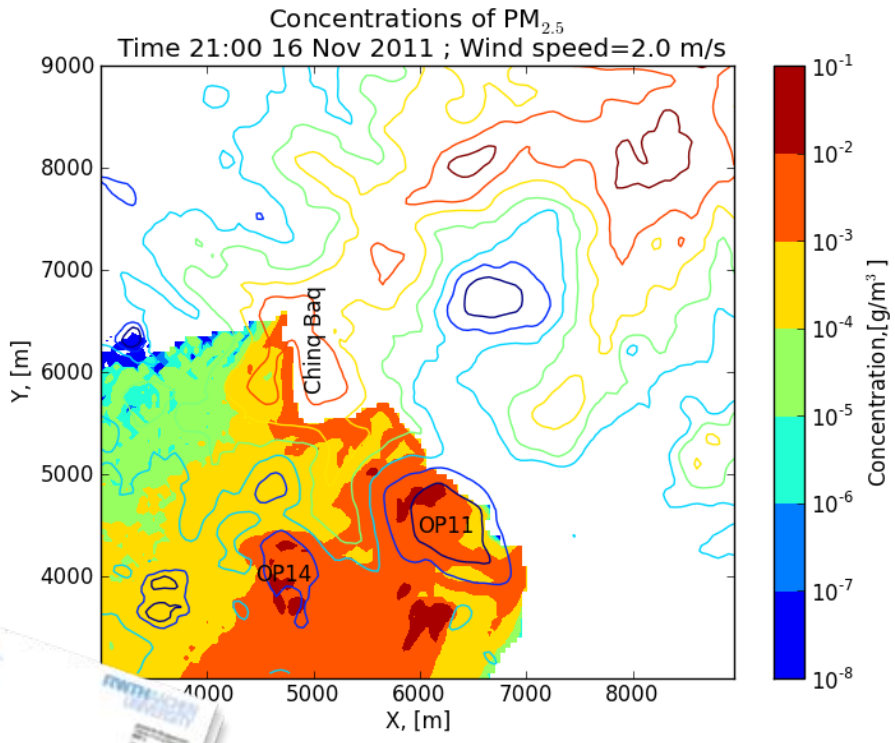
Reduction Factor Development (Example)

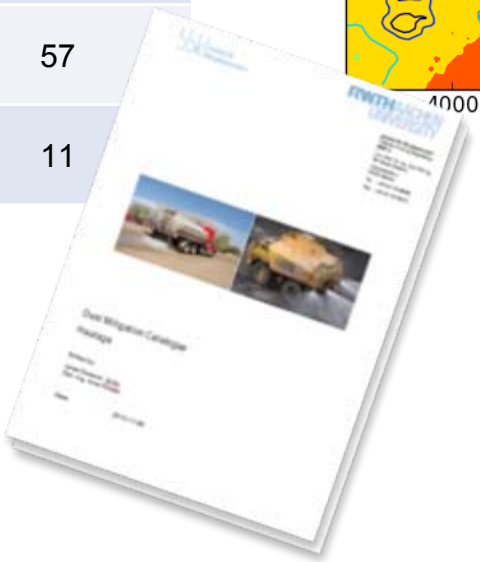


NBCC Watering Rate [l/m²] in 45 min	NBCC Reduction [%]		Optimized Watering Rate [l/m²] in 30 min	Optimized Reduction [%]
0.38	27		0.60	70

Dust Mitigation Methods & Dust Dispersion Modelling

Mining Activity		Suggested Dust Mitigation Method	Dust Reduction Potential [%]
Overburden Handling	Drilling	Wet Drilling	79
	Blasting	-	-
	Loading	Wetting Material	48
		Wetting working Surface	9
	Haulage	Water Spraying	70
	Dumping	Reducing Dumping Height	57
		Wetting Working Surface	11





Conclusions

- Dump Stabilization
  - ➔ Stabilization is important for all further Rehabilitation Measures
  - ➔ Change of Morphology is the cheapest and most effective Measure
  - ➔ Surface Drainage Measures and Vegetation help to increase Erosion
- Dust Mitigation
  - ➔ Site-specific Mine Dust Emission and Reduction Factors required for Identification of Mine Dust Problem and corresponding control Options
  - ➔ Developed Mitigation Methods provide cost-effective Dust Control at NBCC Mine Site

➔ Results are implemented by Vietnamese Project Partners!

Thank you for your Attention!

Dr. Ludger Rattmann
BBK I, Deputy Head

Tel. +49 241 80-95678
E-Mail: rattmann@bbk1.rwth-aachen.de

Institute of Mining Engineering I
Institut für Bergbaukunde I (BBK I)

Prof. Per Nicolai Martens

Wuellnerstr. 2
52062 Aachen
Germany

Tel. +49 241 80-95667
Fax. +49 241 80-92272
E-Mail: bbk1@bbk1.rwth-aachen.de
Web: http://www.bbk1.rwth-aachen.de/en

RAME
Research Association
Mining and Environment
in Vietnam

Web: http://www.rame.vn

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