Catchment-based water management in the mining industry: Challenges and solutions

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Water: A “hot topic” in the business community

Table 1: The Ten Global Risks in Terms of Likelihood and Impact

Top 10 global risks in terms of **Likelihood**	Top 10 global risks in terms of **Impact**
1 Interstate conflict	1 Water crises
2 Extreme weather events	2 Spread of infectious diseases
3 Failure of national governance	3 Weapons of mass destruction
4 State collapse or crisis	4 Interstate conflict
5 Unemployment or underemployment	5 Failure of climate-change adaptation
6 Natural catastrophes	6 Energy price shock
7 Failure of climate-change adaptation	7 Critical information infrastructure breakdown
8 Water crises	8 Fiscal crises
9 Data fraud or theft	9 Unemployment or underemployment
10 Cyber attacks	10 Biodiversity loss and ecosystem collapse

Categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Source: Global Risks Perception Survey 2014, World Economic Forum.

http://reports.weforum.org/global-risks-2015/executive-summary/

Water-related risks in the mining industry

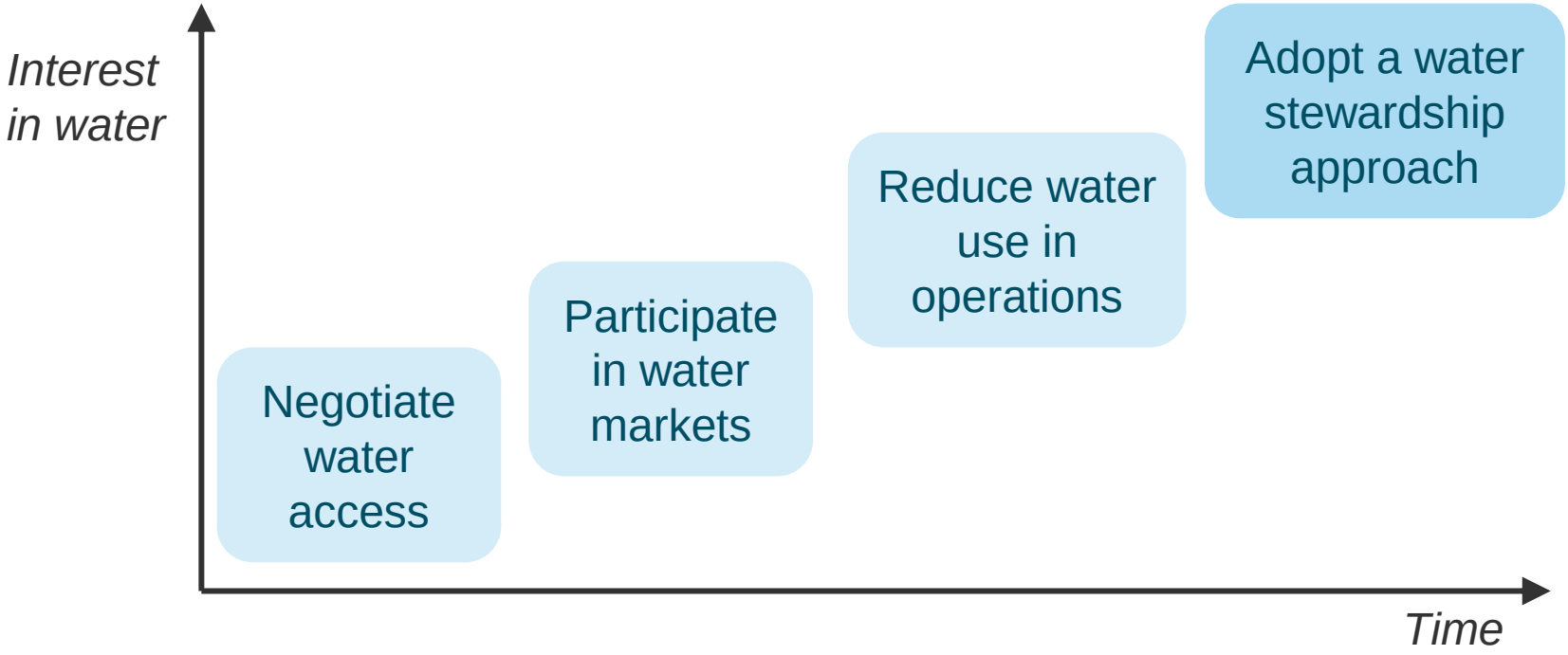
Competition for water access in water-scarce areas

Discharge of contaminated water into river systems

Groundwater impacts from oil/gas extraction

Images from Google Images; web links available on request

Growing attention to water within the mining industry



Kunz, N. C.; Moran, C. J., Sharing the benefits from water as a new approach to regional water targets for mining companies. *J. Clean Prod.* **2014,** *84*, 469-474.

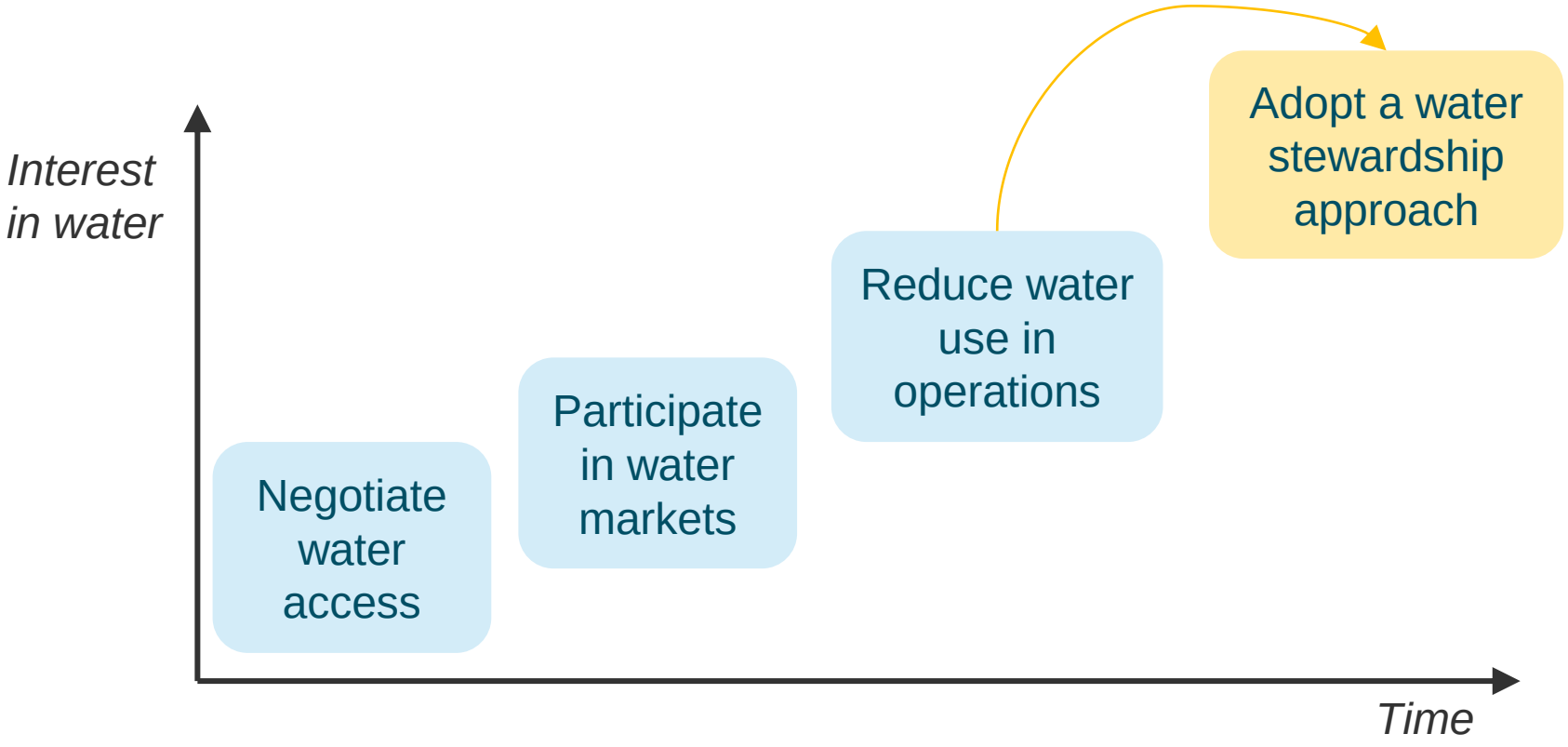
What is a water stewardship approach?

ICMM Member companies should…

"Understand the social, cultural, economic and environmental value of water at the catchment scale to identify material water stewardship risks and provide context for corporate and operational water management".

(ICMM, 2014)

What challenges may be faced when implementing a water stewardship approach?

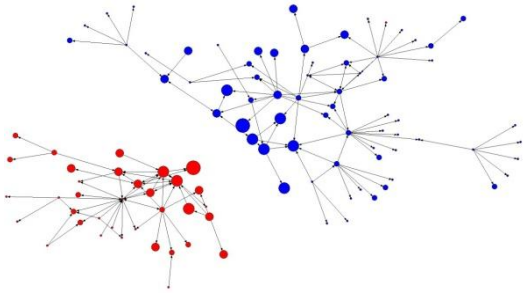


Many sites already have trouble managing water within the mine lease boundary

Mine lease boundary

Mine water systems are complex!
Systems level water balances reveal long term strategic risks relating to flooding and scarcity at many mines (e.g. Kunz 2013; Cote et al. 2010)

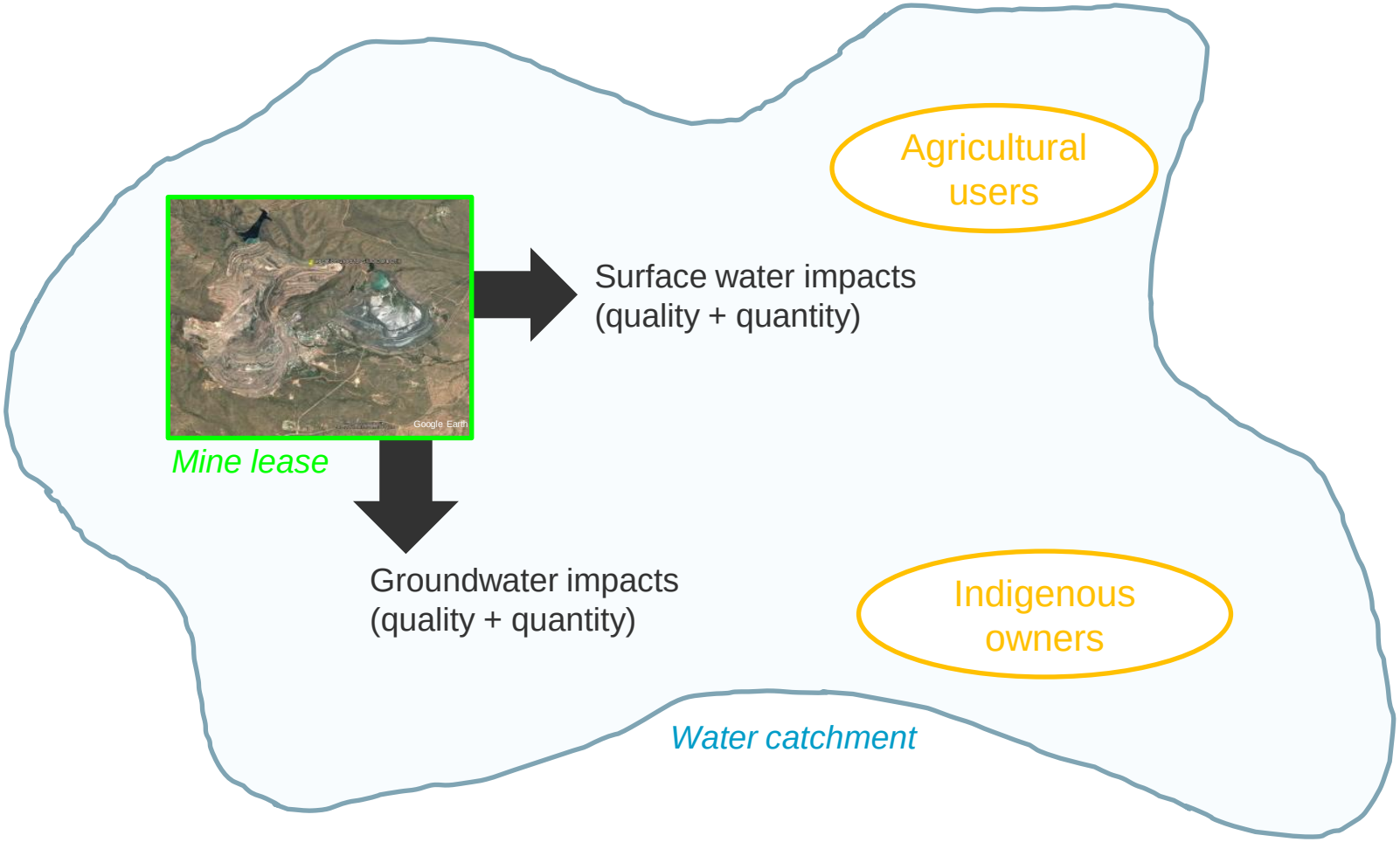
Social systems are complex too!
A network analysis revealed a "siloed" mentality about water (Kunz 2013)



Mining and Mobile Maintenance
Production Processing

Relevance for water stewardship…

- *Sites already struggle to manage water effectively within the mine lease*
- *So what challenges will be faced at the catchment scale?*



Water stewardship strategy will be harder!

	Water management within the mine lease	Water stewardship at the catchment-scale
Stakeholders who need to be involved	Employees within the company	Employees Governments Surrounding community Indigenous groups
Water balance	Responsibility can be bounded at the mining lease	How wide should the boundary be? Entire water catchment? Is a full watershed approach necessary for all mining sites?

A water catchment approach has similarities with Integrated Water Resources Management…

Integrated Water Resources Management (IWRM):

"A process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

(Global Water Partnership Technical Advisory Committee, 2000)

A "catchment-based approach" for the mining industry:

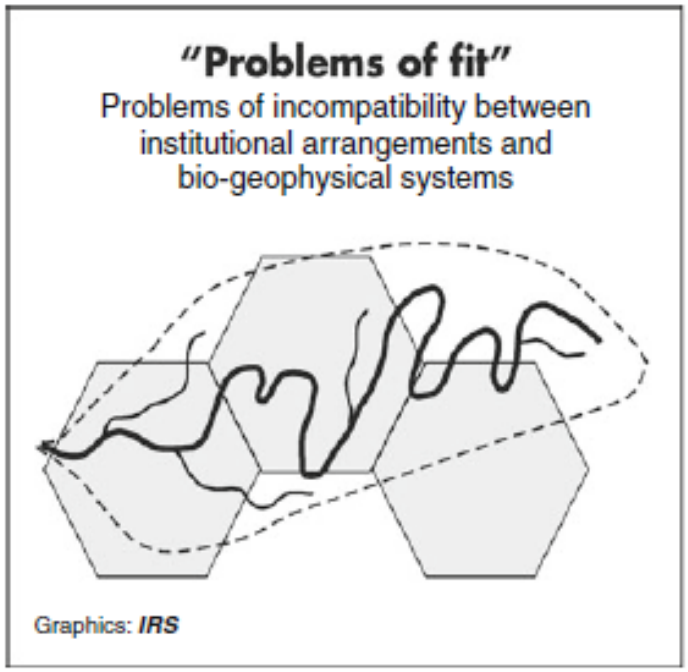
"Understand the social, cultural, economic and environmental value of water at the catchment scale to identify material water stewardship risks and provide context for corporate and operational water management"

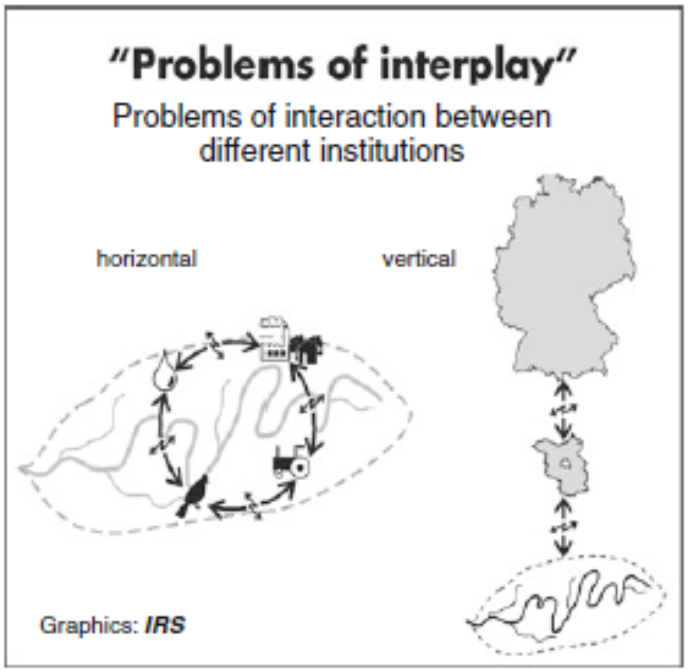
(ICMM, 2015)

This raises a research challenge…

- How can the mining industry avoid the same pitfalls that governments faced in implementing IWRM?

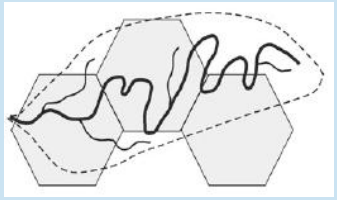
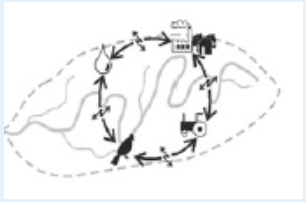
IWRM should overcome three coordination challenges:





Horlemann, L., Dombrowsky, I., 2012. Institutionalising IWRM in developing and transition countries: the case of Mongolia. Environmental Earth Sciences 65, 1547-1559.
Fig. 1 *Problems of fit and interplay. Source: After Moss (2003b, p. 34, 37).*

IWRM implementation: A case study from Mongolia

Coordination challenge	How it was faced	How it was overcome
Problems of fit 	Most of the 29 river basins in Mongolia transverse provincial borders	Provisions were made within the water law to establish river basin corporations (RBCs)
Horizontal interplay 	Responsibilities for water are spread across 6 government ministries	A National Water Committee (NWC) was founded to coordinate activities between ministries
Vertical interplay 	There is a fuzzy picture of responsibilities at the national level which is passed down to the local level	RBCs could potentially coordinate different sectoral interests *and* administrative levels at the basin scale

(Horlemann and Dombrowsky, 2012)

These three coordination challenges may also be faced by mining companies!

Coordination challenge	How it is faced
Problems of fit	Company boundaries do not align with watershed boundaries. The impacts of industrial activity arise due to the "cumulative impacts" of multiple sites (Franks et al. 2013).
Horizontal interplay	Industrial water users cannot on their own achieve desirable water outcomes at the catchment scale. They do not have the legitimacy to play this role in society, necessitating collaborations with governments, civil society etc.
Vertical interplay	Many companies encounter challenges in *implementing* corporate water and sustainability strategies at an operational scale.

Questions of interest for my future research

Coordination challenge	How it is faced	Research question
Problems of fit	Company boundaries do not align with watershed boundaries, necessitating consideration of "cumulative impacts".	How might companies better collaborate to jointly develop catchment-scale water strategies?
Horizontal interplay	Industrial water users must collaborate with governments, civil society in order to achieve catchment-scale goals.	Which organisational forms would maximise the legitimacy of private sector efforts towards catchment-based water management?
Vertical interplay	Many companies encounter challenges in *implementing* corporate water and sustainability strategies at an operational scale.	Which organisational level (from ICMM to a mine site operator) should be responsible for which aspect of a catchment water strategy?

Thanks for listening!

Acknowledgements:

- Eawag colleagues
- Representatives from ICMM, WBCSD, WWF and selected mining companies for sharing perspectives on water stewardship
- Prof Chris Moran and Dr Tim Kastelle (University of Queensland)

Questions? Contact me!

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- http://ch.linkedin.com/in/nadjakunz

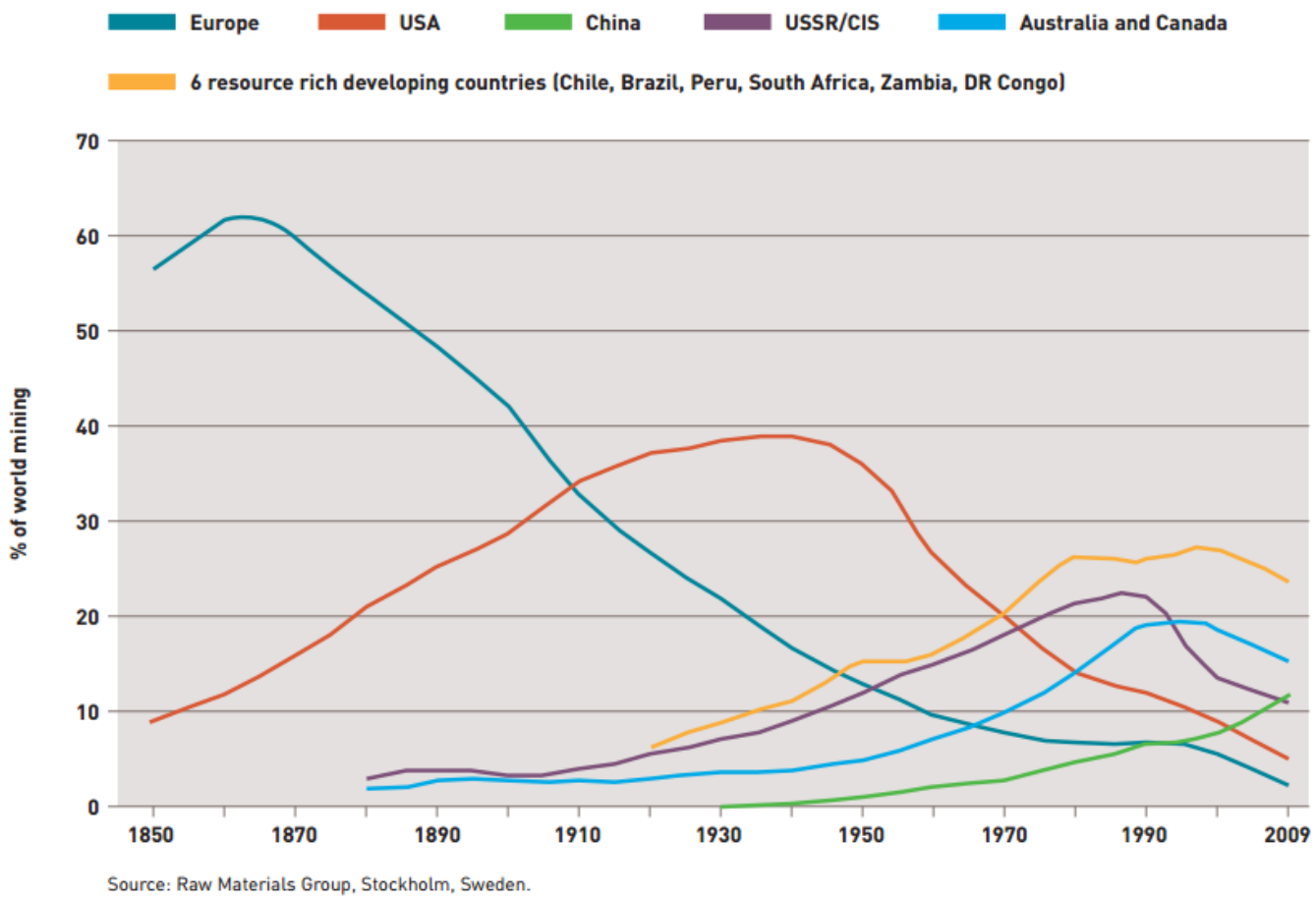
To answer Bern's question…

- *What are the challenges and opportunities relating to mining, water and communities?*

Challenges: Mining moving to developing countries

Figure 3: Location of world mining by region, 1850 to the present

World mining is measured as the total value at the mine stage of all metals produced in all countries.



Source: Raw Materials Group, Stockholm, Sweden.

(ICMM, 2014) http://www.icmm.com/document/4441

Opportunities: Mining as water stewardship leaders?

"If the public sector is doing its job in overseeing the sustainable management of water and effectively managing shared risk, there is little or no justification for business engagement in water policy"

(Hepworth and Orr, 2013)

Challenges relating to mining-water-community

Globally, mining-community conflicts are rising

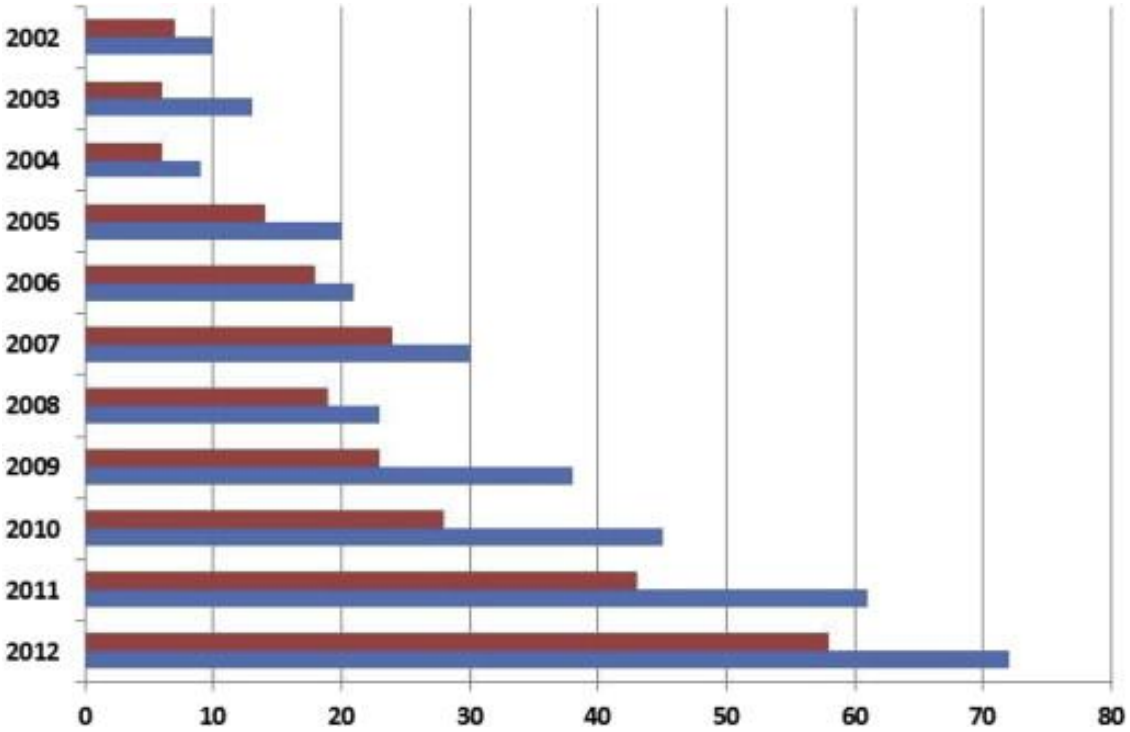


Fig. 3 Increase in mining-community conflicts, 2002–2012.
The documented incidents encompass conflict in cases where escalation of tension has led to active public protest and/or physical violence, sometimes leading to harm and in the extreme, death.
Source: Preliminary ICMM research, 2014

R.Anthony Hodge

Mining company performance and community conflict: moving beyond a seeming paradox
Journal of Cleaner Production, Volume 84, 2014, 27 - 33
http://dx.doi.org/10.1016/j.jclepro.2014.09.007

Environmental issues the most frequent issue in dispute

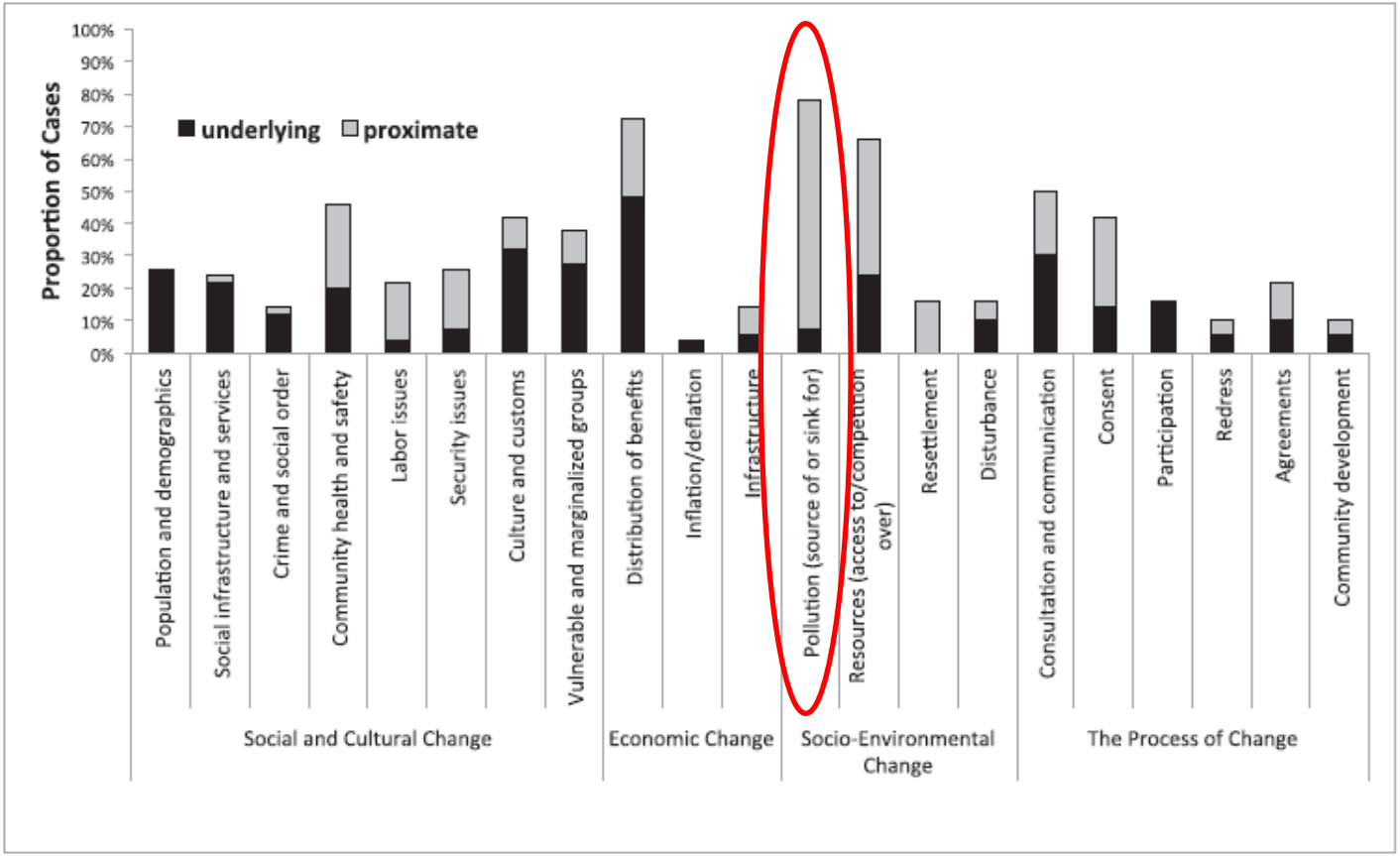


Fig. 1. Cases of mining company–community conflict: Issues in dispute ($n = 50$).

Franks, D. M.; Davis, R.; Bebbington, A. J.; Ali, S. H.; Kemp, D.; Scurrah, M., Conflict translates environmental and social risk into business costs. *Proceedings of the National Academy of Sciences* **2014,** *111*, (21), 7576-7581.

Opportunities relating to mining-water-community

- Mining industry as a leader for water stewardship?

Further research shows a widespread lack of systemic thinking and a siloed mentality

Mitchell, P., Steen, J., Moran, C., Bradbrook, M., Henderson, C. Macaulay, S., Higgins, L., Kastelle, T., **Kunz, N.** (2014) *Productivity in mining: now comes the hard part – A global survey*, Report by Ernst and Young and the Sustainable Minerals Institute. Available at: http://www.ey.com/GL/en/Industries/Mining---Metals/EY-productivity-in-mining-now-comes-the-hard-part

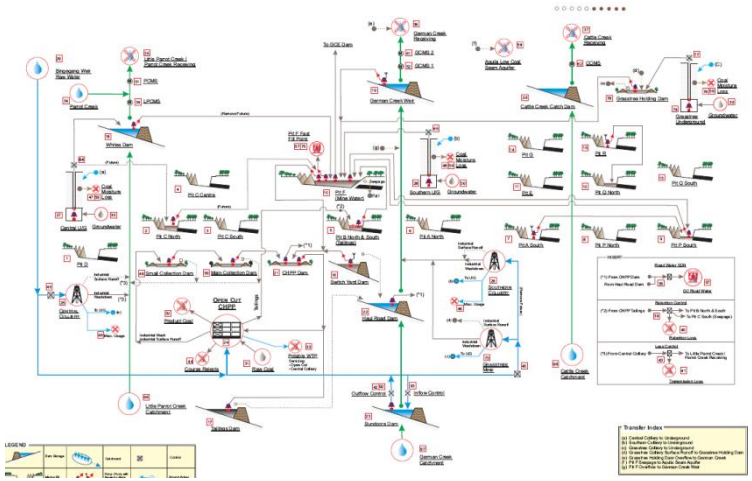
The need for systems thinking in mining

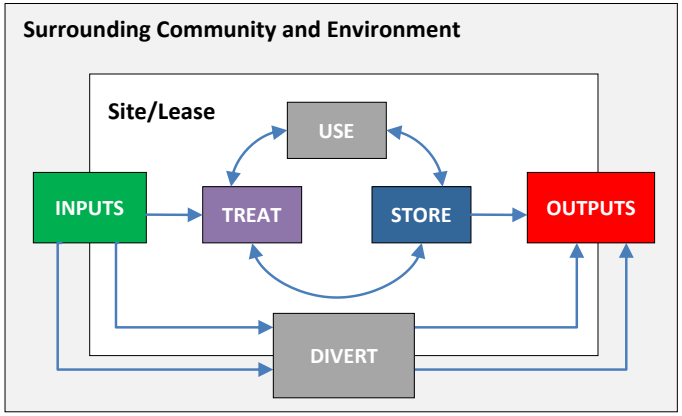
*"Systematic thinkers at a mine site do very well because **they're doing something that a lot of us don't do**. There are a lot of people who jump to conclusions without any analysis. They say, "This is what the problem is." and they spend six months, quite often working and helping on tasks irrelevant to the issue."*

*"How wonderful would it be if the drilling operator knew that by drilling the right hole size and the blaster knew that by blasting it right so it's not oversized, that there will be no downstream impacts. That by not doing it right it can impact the shovel operator and the truck driver. The **challenge is trying to get them to understand how they all fit in**."*

Interview quotes from (Mitchell et al. 2014)

Understanding technical complexity





Bottom-up engineering model

Systems model

Images: Engineering model (site data); Systems model (Moran et al. 2006; Cote et al. 2010)

Understanding social complexity

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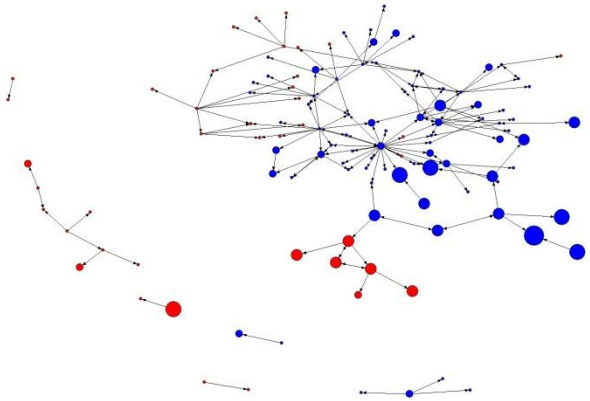
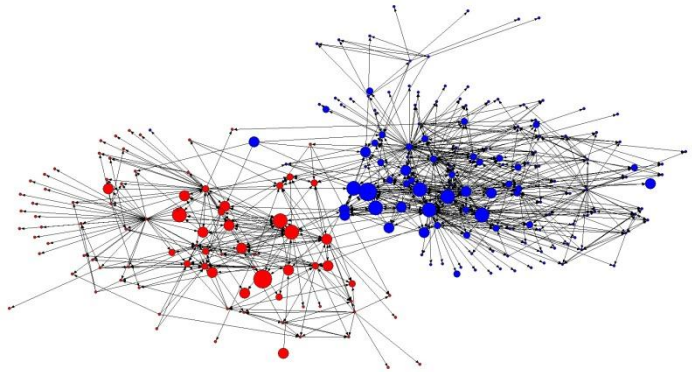
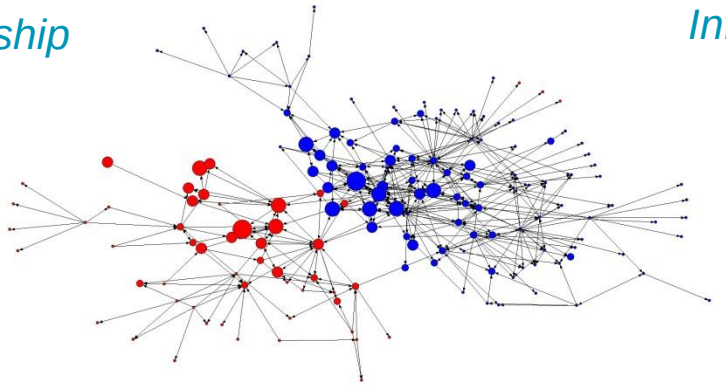


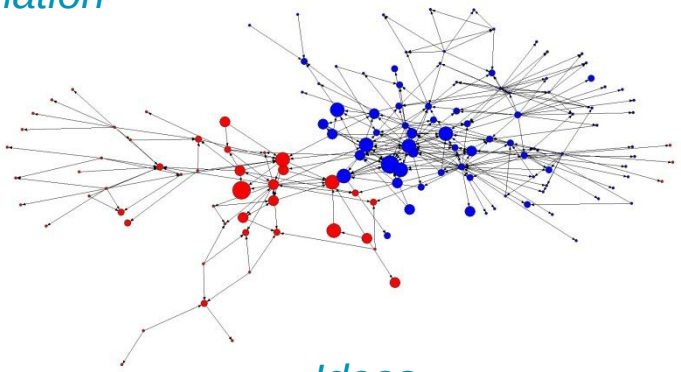
Friendship



Information



Problem-solving



Ideas

Image shows frequent interactions (at least once a week) *(Kunz, 2013)*

Why don’t they talk about water?

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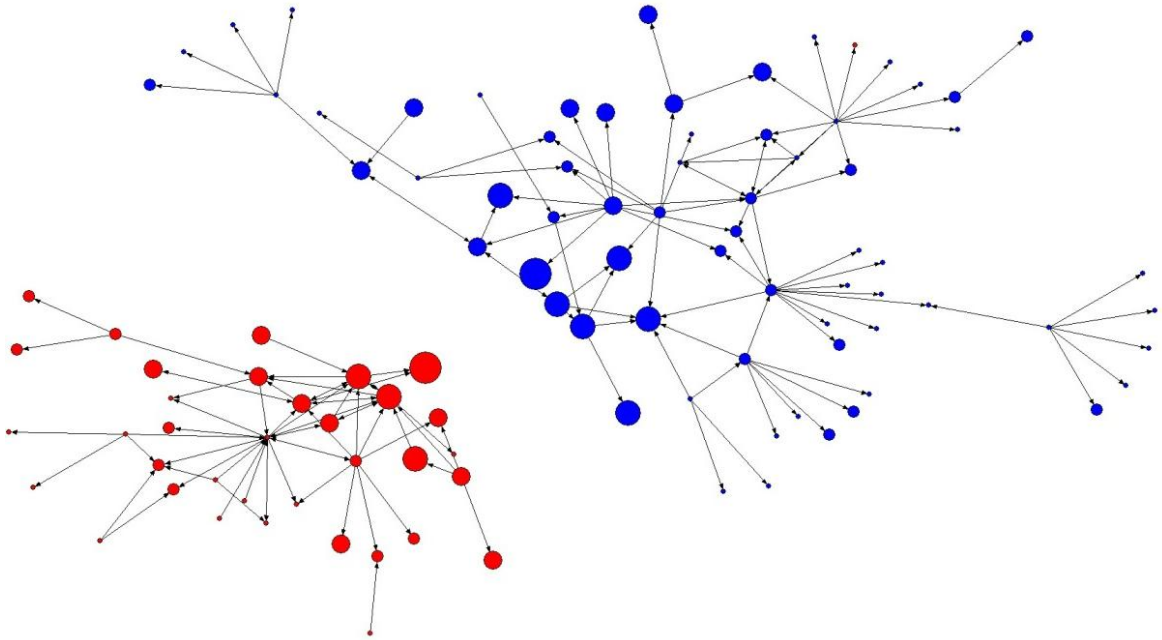
Production Processing



Frequent interactions (at least once a week) *(Kunz, 2013)*