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Global Assessments of the Interactions between the Mining Industry and Water Resources

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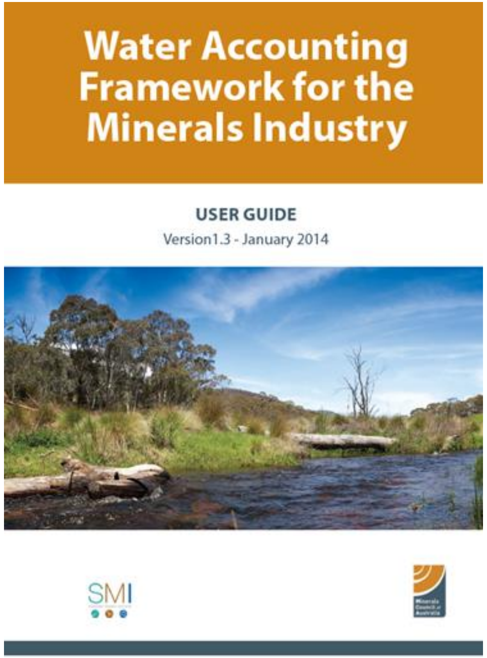
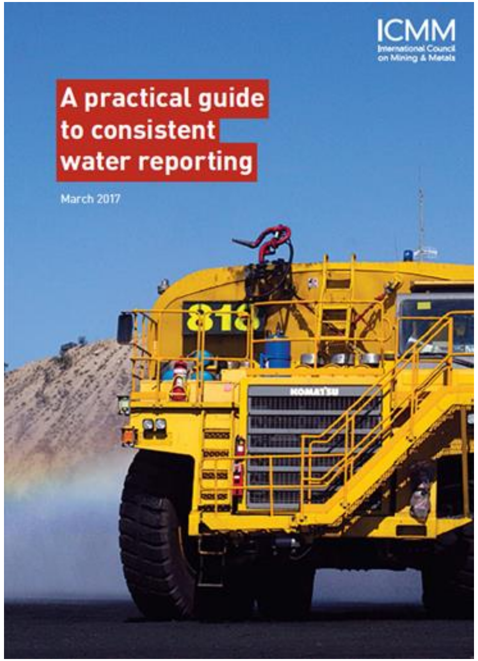
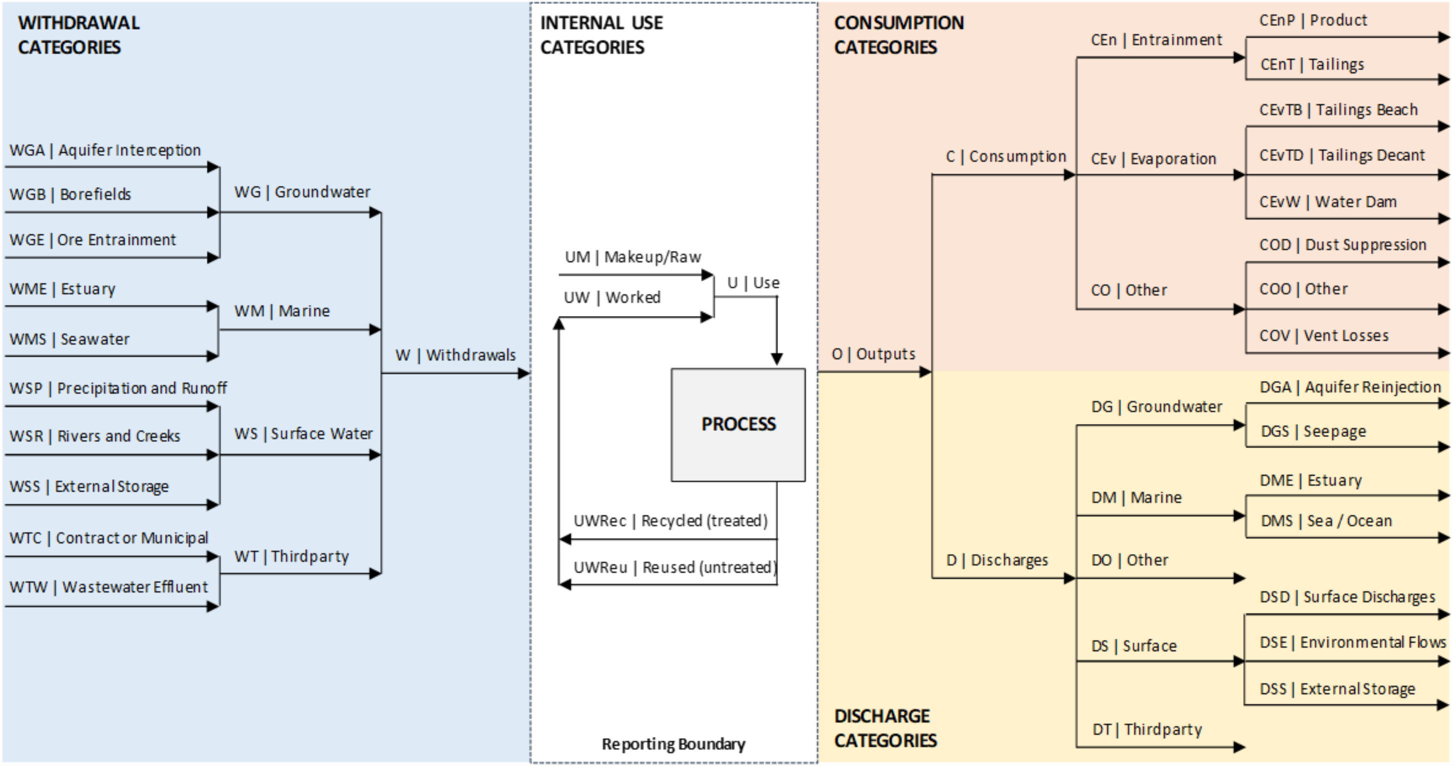
GROUP OF EIGHT AUSTRALIA

Water accounting and reporting standards have been developed



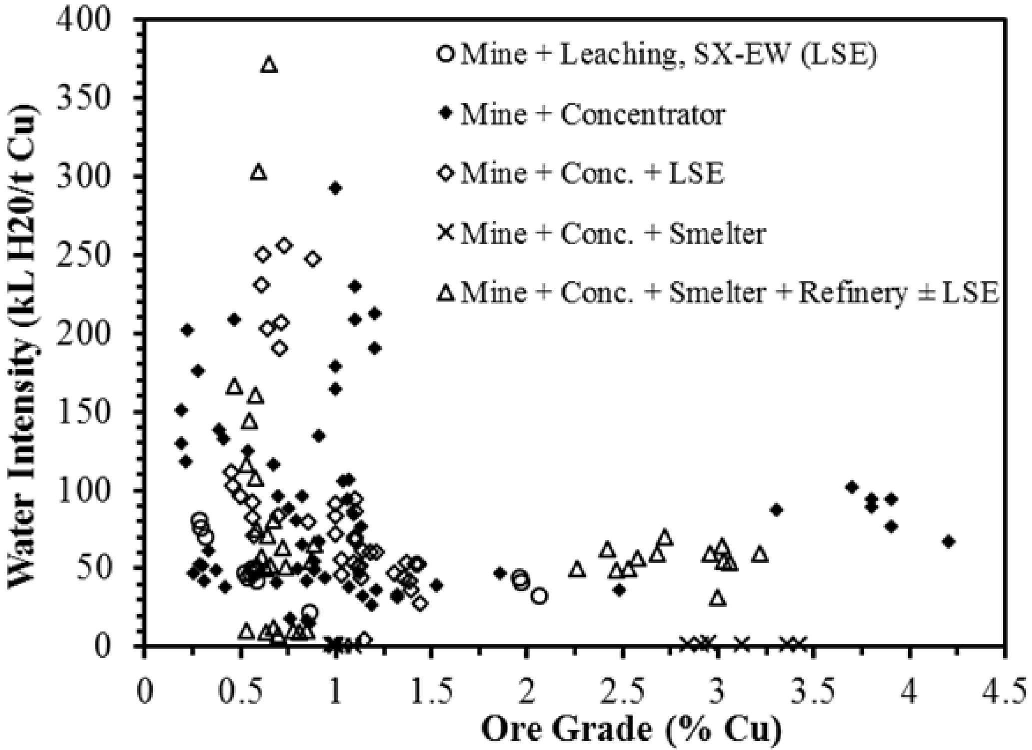


Mining operations can interact with water resources in a variety of ways



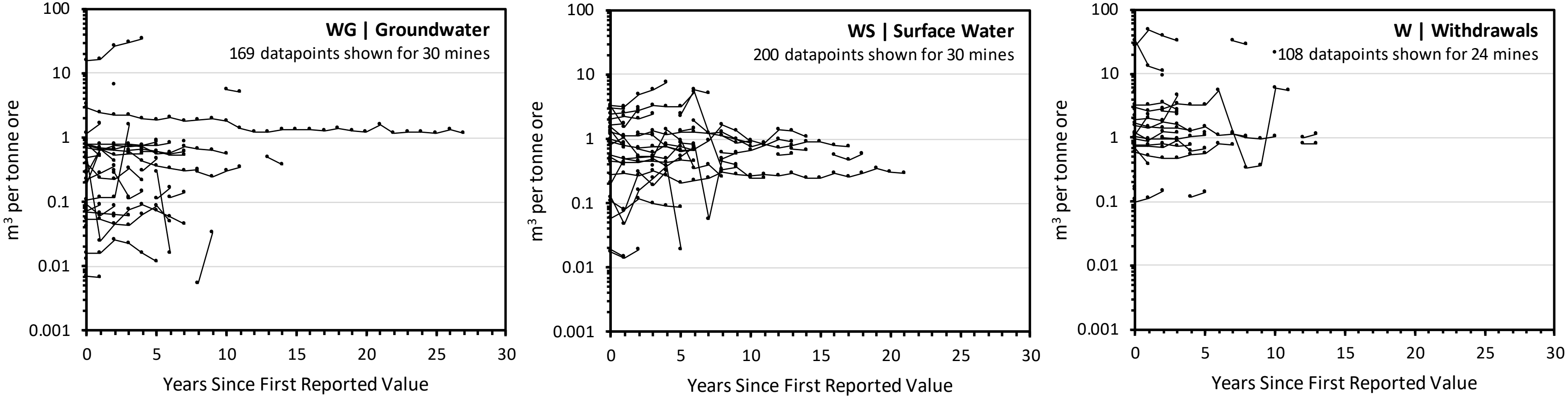
Northey et al. Under review.

There is large variability in water use across mine sites

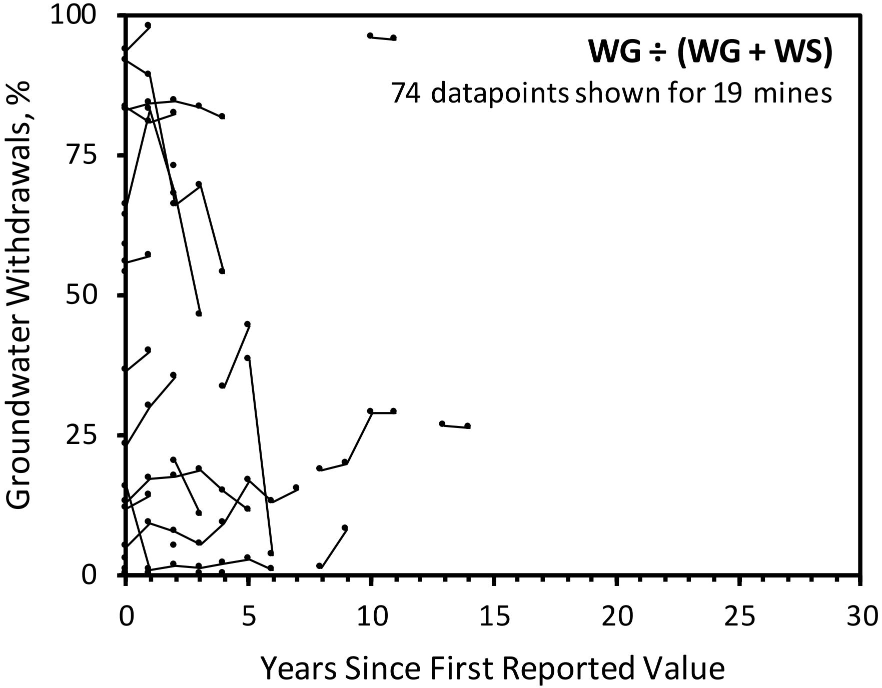


Northey et al. (2013). Journal of Cleaner Production, 40, 118-128.

All components of mine site water balances contribute to this variability

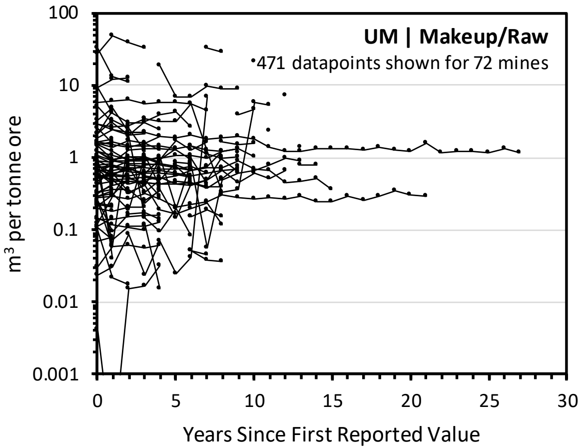


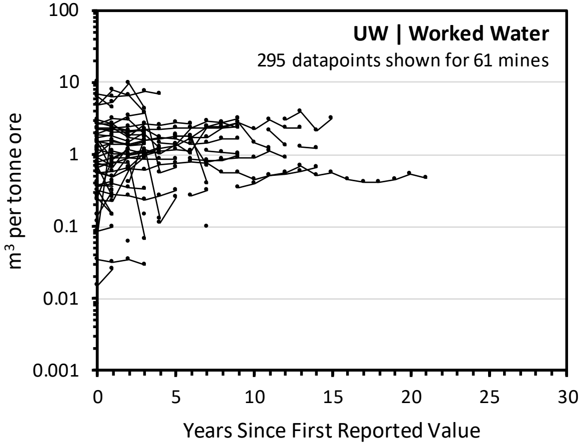
Northey et al. Under review.

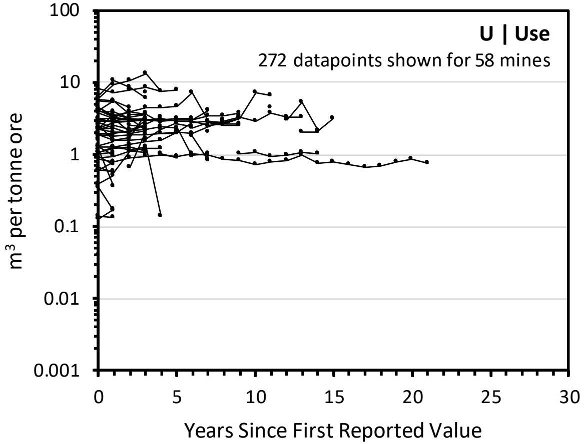


Northey et al. Under review.

Mining operation water balances can vary considerably through time







Northey et al. Under review.

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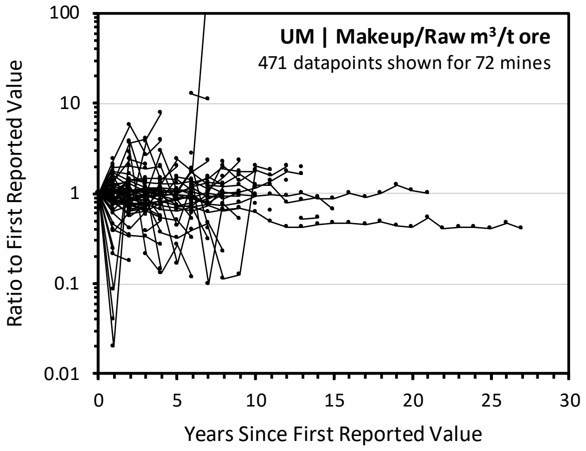

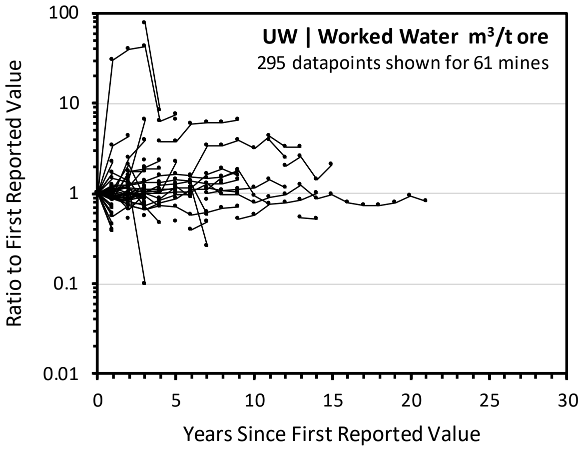

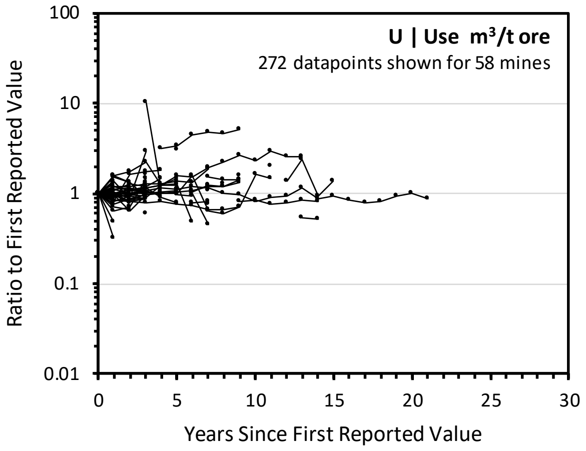

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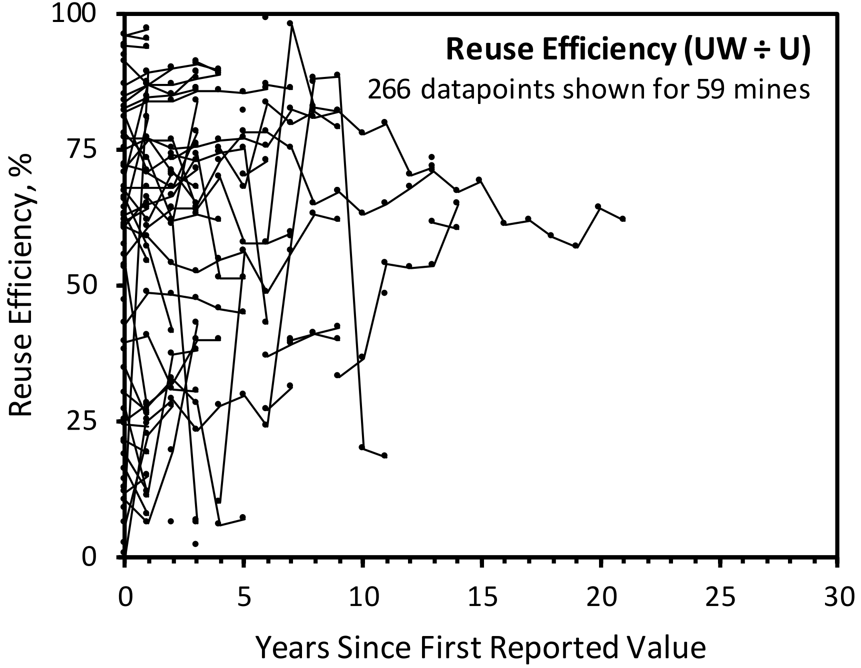
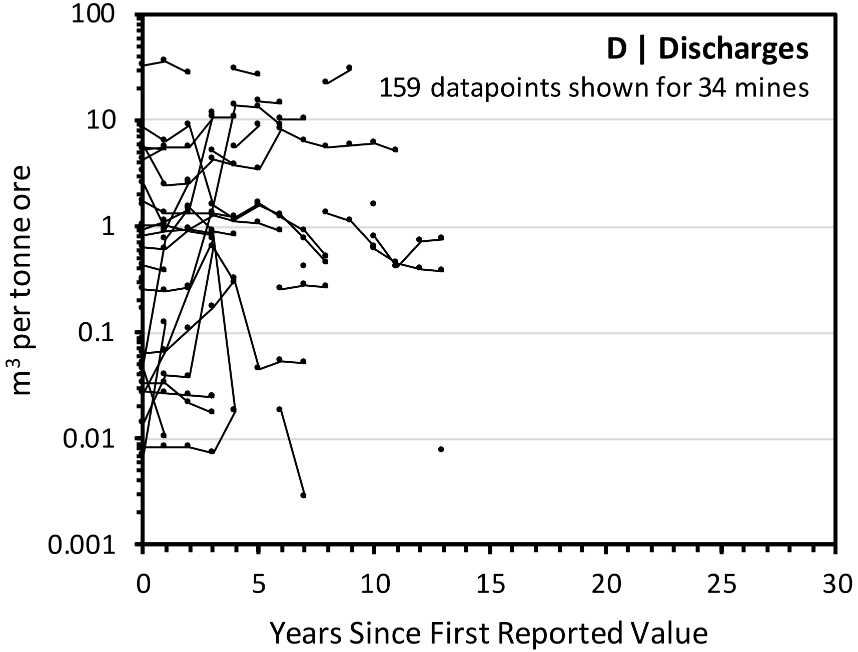
Water Reuse Efficiency



Northey et al. Under review.

Water Discharges



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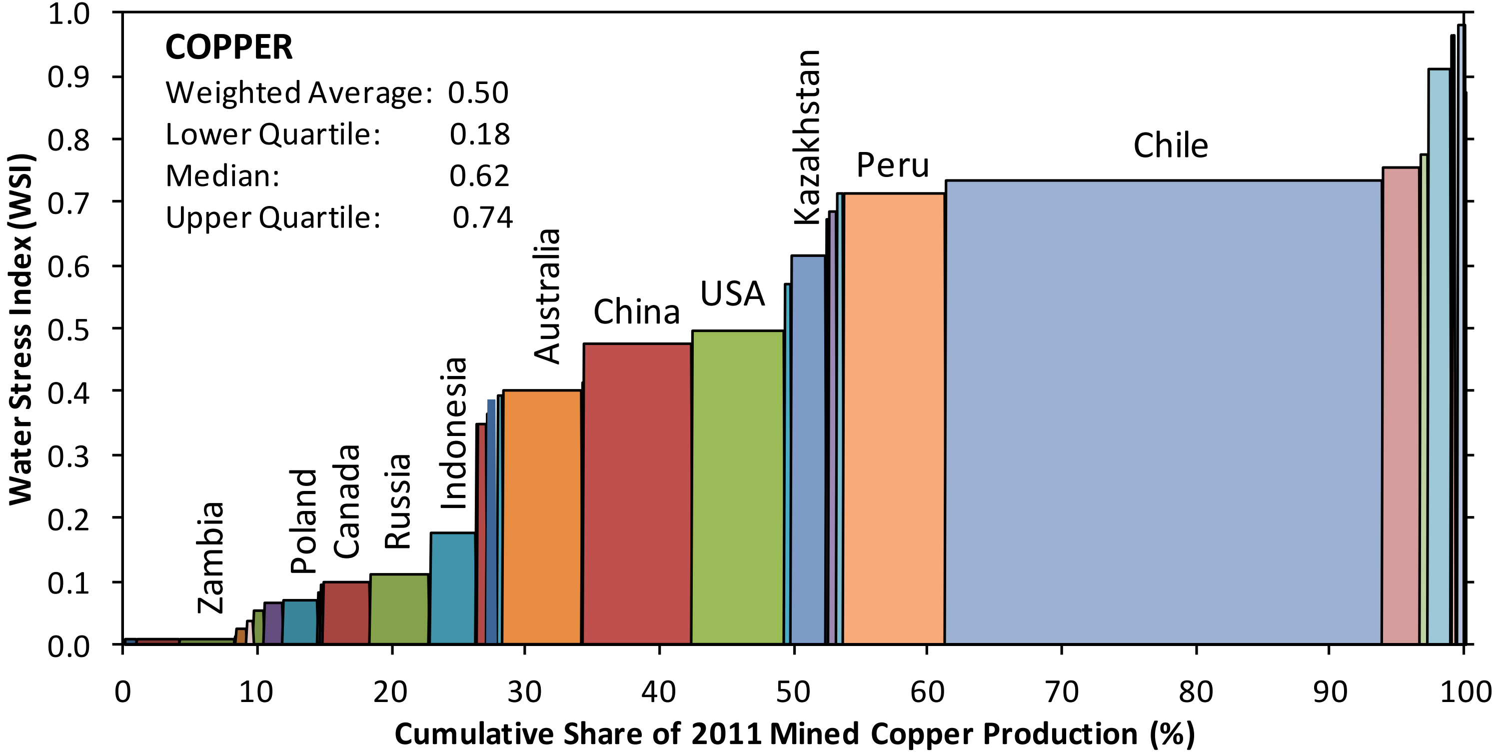
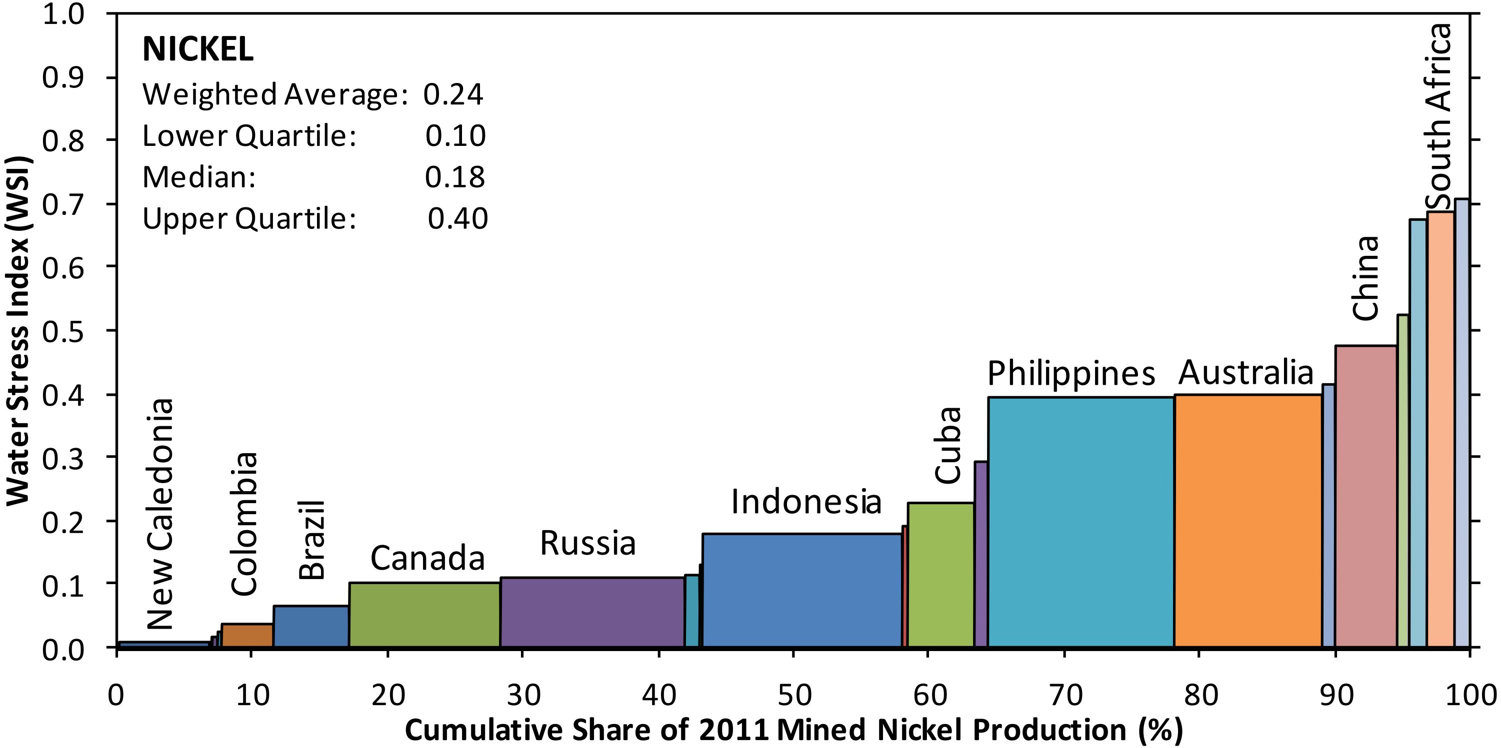
The copper industry is acutely exposed to water stress



Northey et al. (2014). Minerals Engineering, 69, 65-80.

Whereas, the nickel industry is less exposed to water stress



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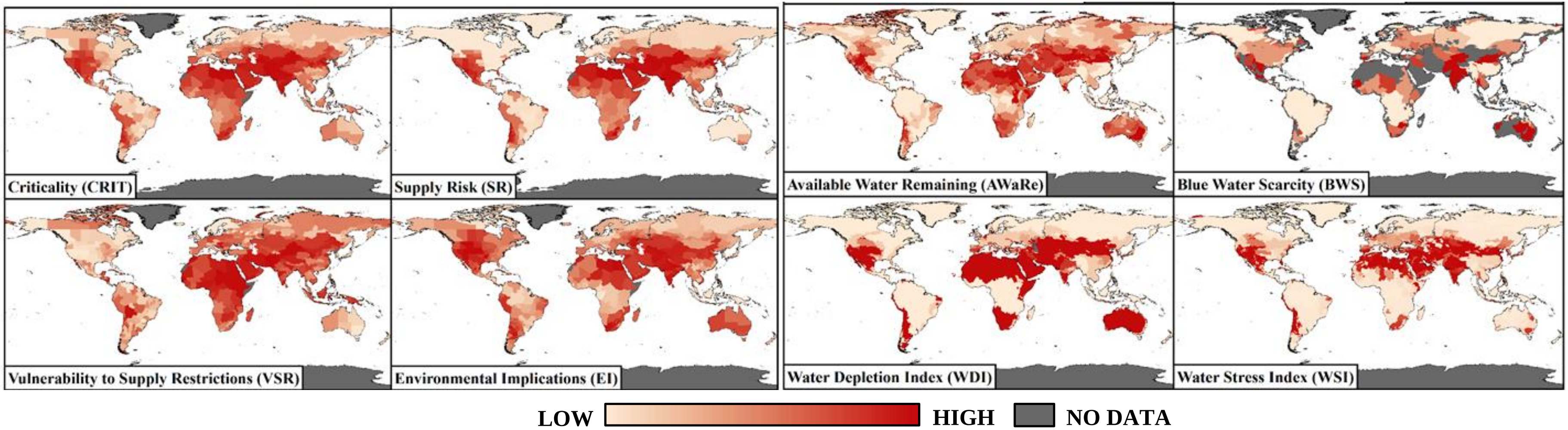
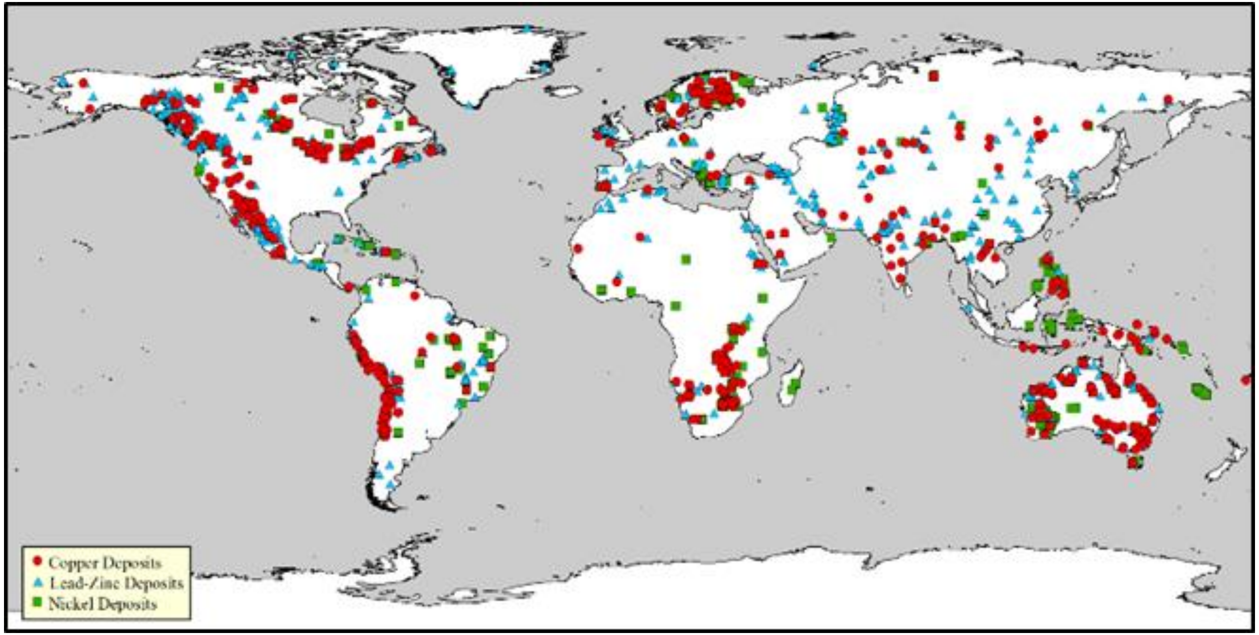
Water stress, scarcity and risk can be measured in various ways



Northey et al. (2017). Global Environmental Change, 44, 109-124.

Mineral resources are located across all hydrological zones



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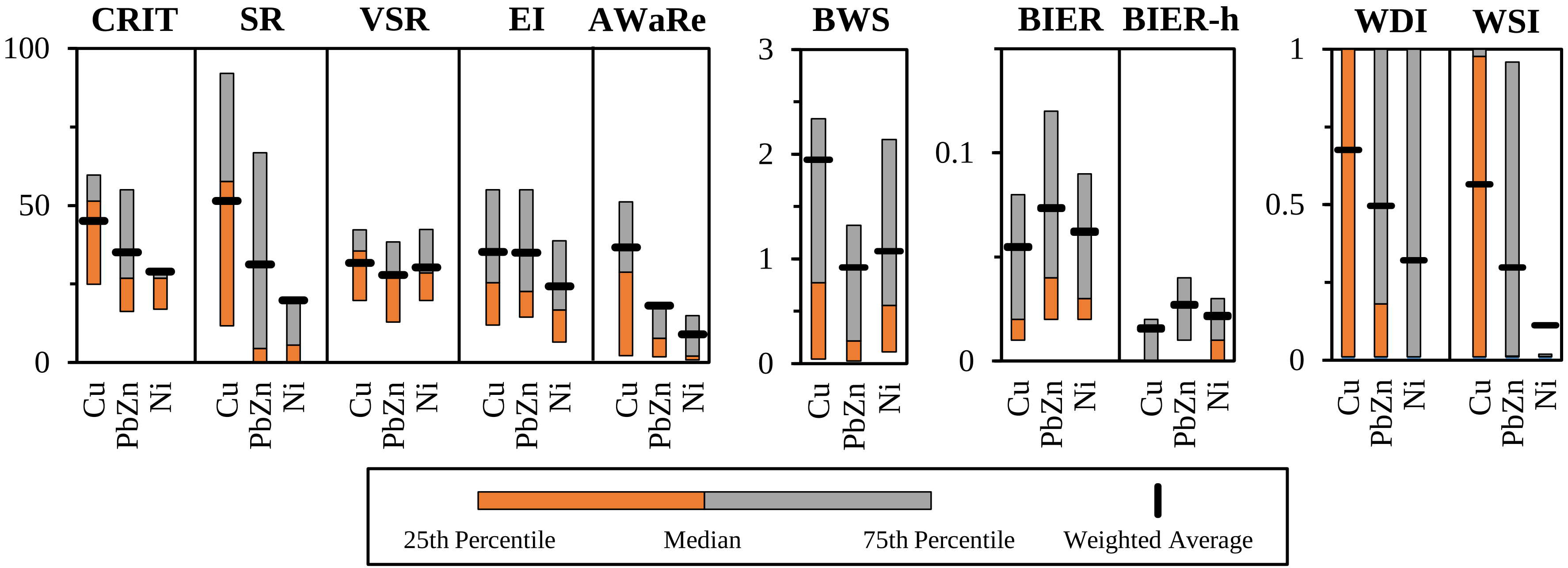
Benchmarking the risks facing commodity groups is possible



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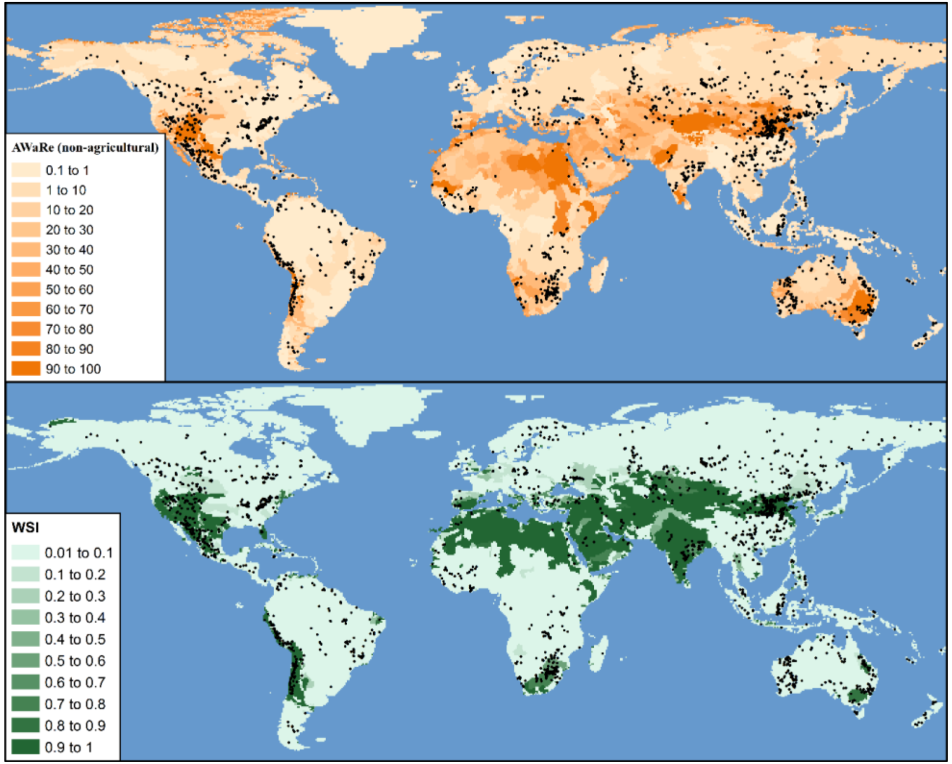
Detailed datasets improve understanding of these issues

		All Resources															
						Contained Value (%)		Weighted Averages, Metal Basis									
Country	Deposit Type	No.	Mt Ore	% Cu	Mt Cu	Cu	Others Metals >5%	CRIT	SR	VSR	EI	AWaRe	BWS	BIER	BIER-h	WDI	WSI
Afghanistan	Sediment-hosted Cu	1	240.0	2.30	5.52	100		87	100	76	84	19	2.71	0.16	0.08	0.58	0.40
Algeria	Volcanogenic Massive Sulfide	2	18.1	0.65	0.12	35	Pb, Zn, Au	57	89	39	18	9	-	0.01	0.00	0.32	0.41
Argentina	Epithermal	1	201.1	0.04	0.08	13	Pb	57	94	26	12	100	-	0.01	0.00	1.00	1.00
Argentina	Porphyry	8	7616.5	0.38	28.68	47	Au, Mo	54	70	23	56	24	0.56	0.06	0.01	0.74	0.71
Australia	Epithermal	3	29.6	0.27	0.08	40	Au	15	0	12	23	19	0.56	0.04	0.00	1.00	0.10
Australia	Iron Oxide Copper-Gold	25	10853.1	0.85	92.00	49	U3O8, Au	23	0	15	36	27	3.34	0.01	0.00	1.00	0.02
Australia	Magmatic Sulfide	12	211.2	0.44	0.92	23	Ni, Co	19	0	21	26	10	5.87	0.04	0.01	0.30	0.69
Australia	Other	15	781.2	0.24	1.88	38	Au	25	3	16	39	51	2.35	0.05	0.00	1.00	0.03
Australia	Porphyry	20	6841.3	0.22	15.17	38	Au	24	6	10	38	80	2.54	0.05	0.00	0.89	0.16
Australia	Sediment-hosted Cu	4	133.3	1.25	1.66	100		20	0	16	31	17	0.22	0.02	0.00	1.00	0.01
Australia	Sediment-hosted Pb-Zn	11	578.4	1.34	7.77	99		15	0	12	23	13	0.22	0.04	0.01	1.00	0.01
Australia	Skarn	9	143.0	0.56	0.80	79	Au	18	0	16	28	7	2.38	0.03	0.01	0.49	0.01
Australia	Volcanogenic Massive Sulfide	50	721.4	0.92	6.61	72	Au	23	2	18	34	29	3.20	0.03	0.00	0.92	0.06
Bolivia	Epithermal	1	6.3	2.30	0.15	95	Zn	36	22	56	14	2	-	0.16	0.02	0.01	0.01
Bolivia	Sediment-hosted Pb-Zn	1	485.0	0.02	0.10	29	Pb, Zn, Ag	36	22	56	14	1	0.00	0.11	0.04	0.01	0.01
Botswana	Magmatic Sulfide	4	477.2	0.23	1.11	21	Ni, PGM	35	16	50	32	21	2.14	0.09	0.01	1.00	0.54
Botswana	Sediment-hosted Cu	5	810.5	0.68	5.47	99		35	16	49	31	35	0.04	0.15	0.01	0.98	0.01
Brazil	Epithermal	1	3.8	0.90	0.03	100		9	2	14	5	0	0.00	0.20	0.08	0.01	0.01
Brazil	Iron Oxide Copper-Gold	6	1806.2	0.77	13.90	70	Au	9	2	14	5	0	0.01	0.13	0.06	0.01	0.01
Brazil	Magmatic Sulfide	3	299.5	0.16	0.47	7	Ni	18	3	17	26	5	0.38	0.03	0.01	0.02	0.03
Brazil	Porphyry	1	712.8	0.23	1.61	35	Au	11	1	15	11	1	0.01	0.16	0.05	0.01	0.01
Brazil	Volcanogenic Massive Sulfide	1	33.5	0.25	0.09	10	Zn, Pb, Au	22	1	36	9	0	0.00	0.21	0.10	0.01	0.01

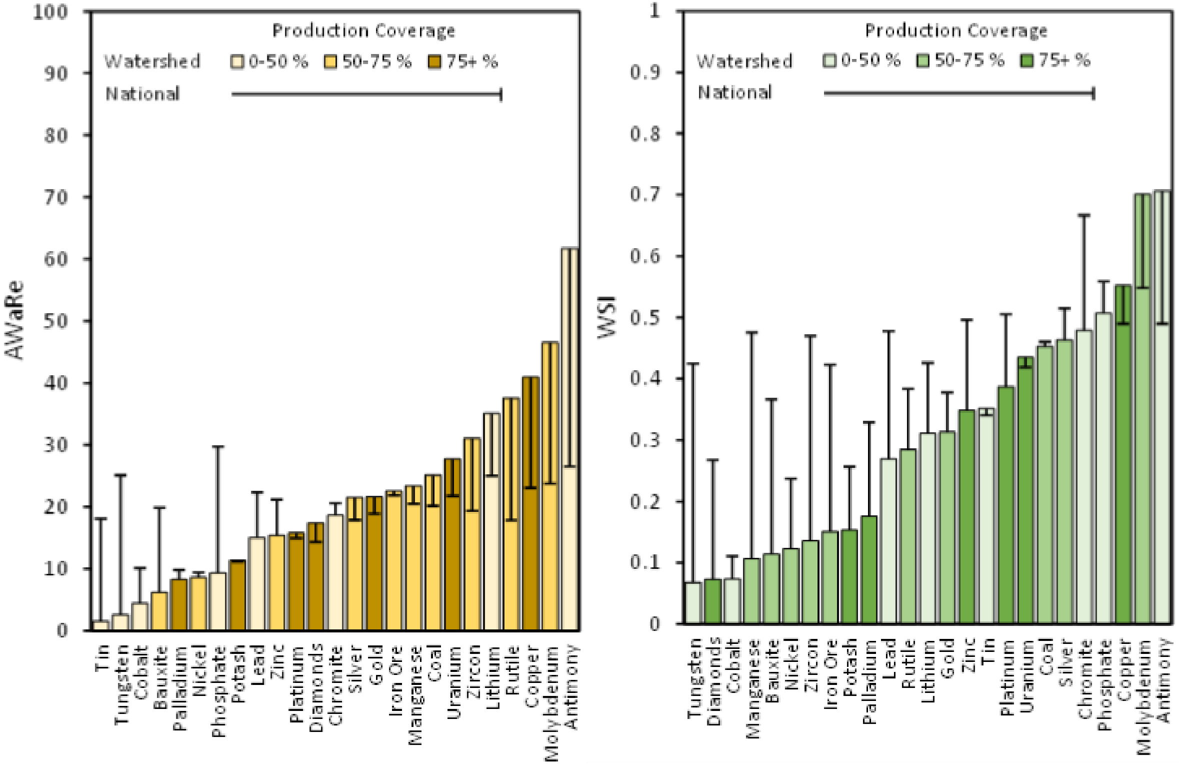
Northey et al. (2017). Global Environmental Change, 44, 109-124.

Industry wide assessments of water scarcity risks are possible



Northey et al. (2018). Journal of Cleaner Production, 184, 788-797.

Exposure to water scarcity risks varies considerably across commodities



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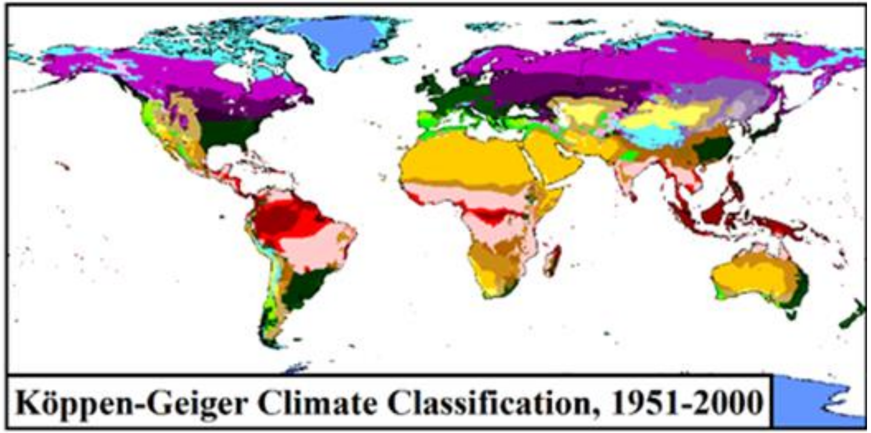
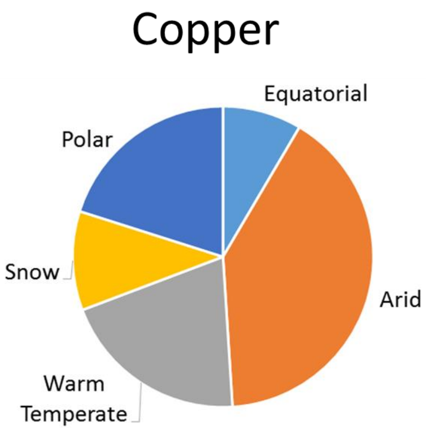
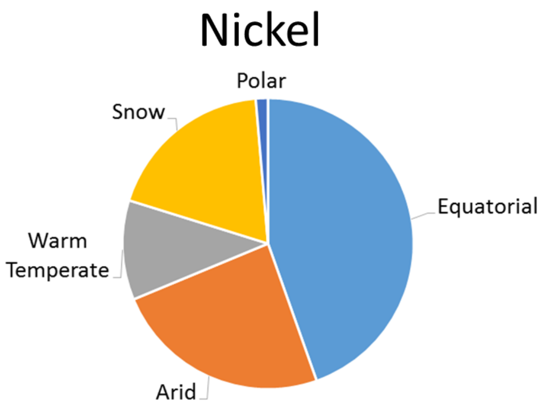
Mineral resources are distributed across all major climate regions







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Climate understanding can also be used to better evaluate industry risks

Köppen-Geiger Climate Classification		Observed (Kottek et al., 2006)											
		1951-2000											
		Copper				Lead-Zinc				Nickel			
		No.	Mt Ore	% Cu	Mt Cu	No.	Mt Ore	%Pb+Zn	Mt Pb+Zn	No.	Mt Ore	% Ni	Mt Ni
	Equatorial	**74**	**31,735**	**0.48**	**151**	**51**	**437**	**4.98**	**22**	**129**	**10,133**	**1.29**	**130**
Af	Fully humid	24	17,297	0.55	95	11	86	5.23	4	47	4,186	1.41	59
Am	Monsoonal	12	9,584	0.38	36	3	49	2.24	1	29	1,639	1.16	19
As	Summer dry	2	9	2.45	0	3	4	2.55	0	4	63	1.96	1
Aw	Winter dry	36	4,845	0.41	20	34	298	5.39	16	49	4,245	1.20	51
	Arid	**255**	**158,801**	**0.45**	**721**	**237**	**13,387**	**2.48**	**331**	**149**	**18,433**	**0.38**	**71**
BSh	Steppe, hot arid	85	16,564	0.42	70	90	4,833	3.73	180	53	13,216	0.24	31
BSk	Steppe, cold arid	49	42,196	0.35	149	60	5,996	0.94	57	22	95	1.50	1
BWh	Desert, hot arid	68	21,940	0.63	137	74	1,887	3.19	60	73	4,690	0.68	32
BWk	Desert, cold arid	53	78,101	0.47	365	13	671	5.09	34	1	432	1.39	6
	Warm Temperate	**169**	**63,455**	**0.57**	**361**	**173**	**4,448**	**2.60**	**116**	**71**	**10,922**	**0.30**	**32**
Cfa	Fully humid, hot summer	22	5,245	0.34	18	20	308	6.61	20	7	577	0.86	5
Cfb	Fully humid, warm summer	37	4,710	1.04	49	70	657	4.28	28	10	382	0.82	3
Cfc	Fully humid, cool summer	1	10	1.17	0	5	39	5.26	2	-	-	-	-
Csa	Summer dry, hot summer	17	4,258	0.36	16	34	2,314	1.76	41	5	411	1.05	4
Csb	Summer dry, warm summer	13	27,377	0.55	151	14	328	1.66	5	7	619	0.77	5
Csc	Summer dry, cool summer	-	-	-	-	-	-	-	-	-	-	-	-
Cwa	Winter dry, hot summer	65	15,813	0.70	111	17	152	7.30	11	32	6,361	0.15	10
Cwb	Winter dry, warm summer	14	6,043	0.28	17	13	650	1.23	8	10	2,573	0.22	6

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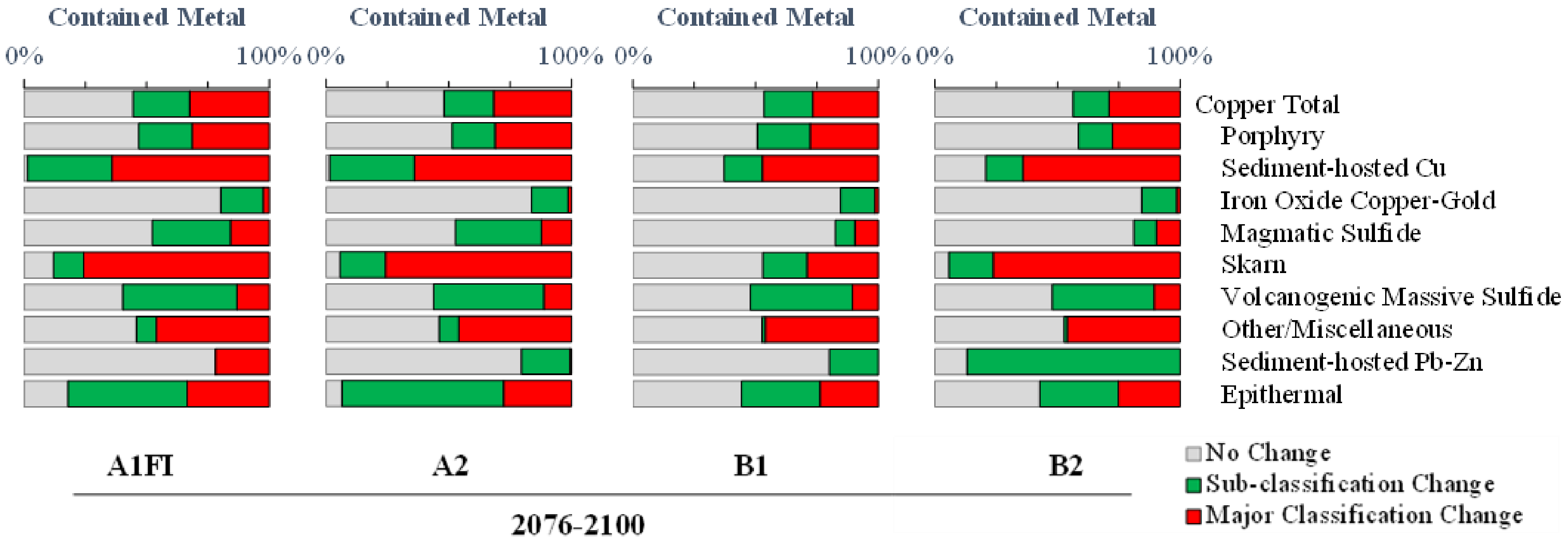
Different sub-sectors of the industry may be exposed differently



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Acknowledgements

CSIRO Mineral Resources primarily funded this work

RMIT University
Gavin Mudd
Tim Werner
Zhehan Weng

CSIRO
Nawshad Haque
Mark Cooksey
Roy Lovel

Universitat Autonoma de Barcelona
Cristina Madrid Lopez

University of Nevada, Las Vegas
Simon Jowitt

Monash University
Mohan Yellishetty

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Northey et al. (2013). Journal of Cleaner Production, 40, 118-128. http://dx.doi.org/10.1016/j.jclepro.2012.09.027

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Thanks for Listening!

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Topics Covered

Variability in Mine Site Water Use

Water Scarcity Risks

Climate

Questions?