

The RISK, PUBLIC LIABILITY, & ECONOMICS of TAILINGS STORAGE FACILITY FAILURES

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Figure 2.1 Increasing Severity of TSF Failures Globally 1940-2010

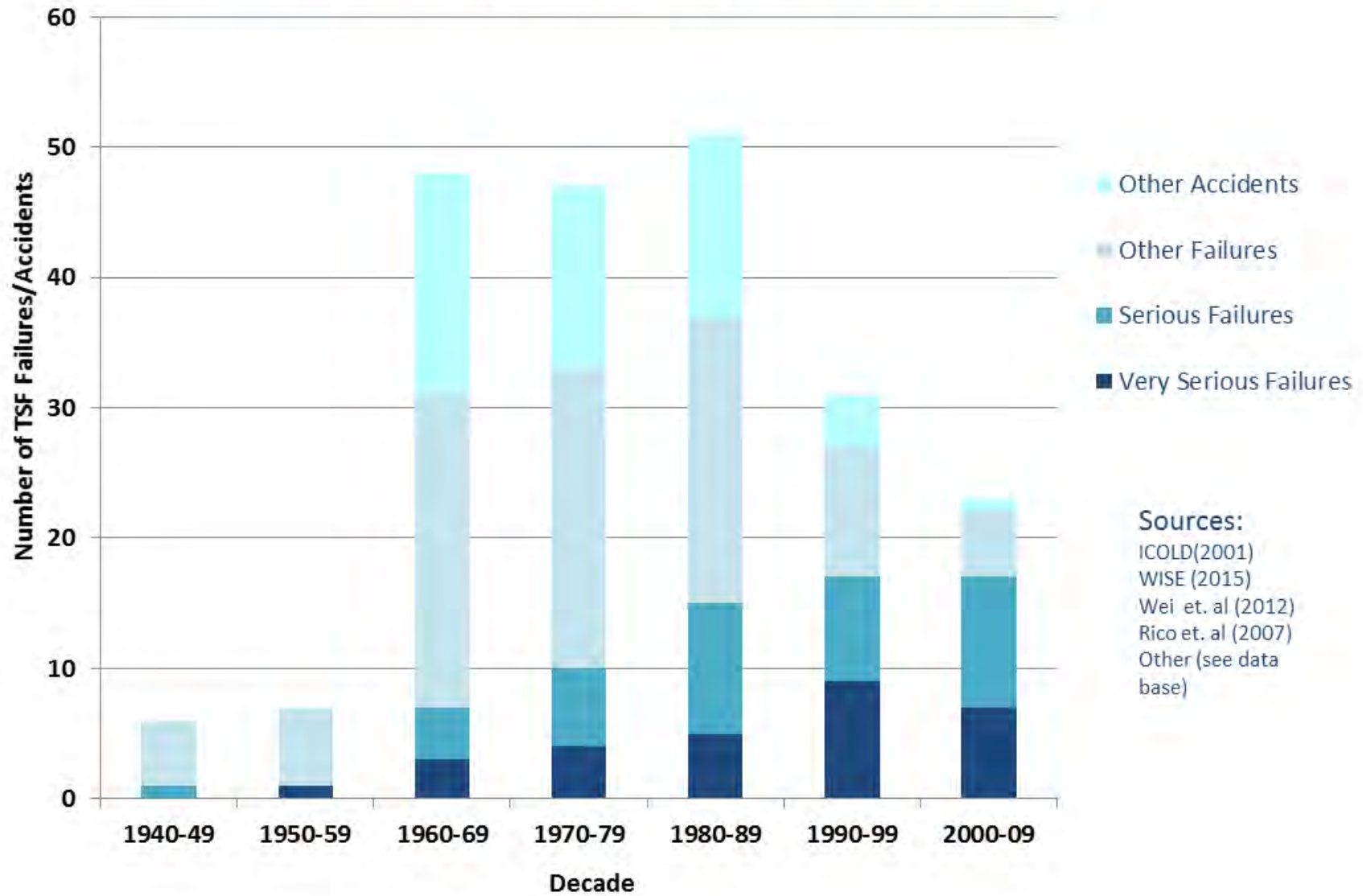


Figure 6.1 Failure Predictions By Trend Line

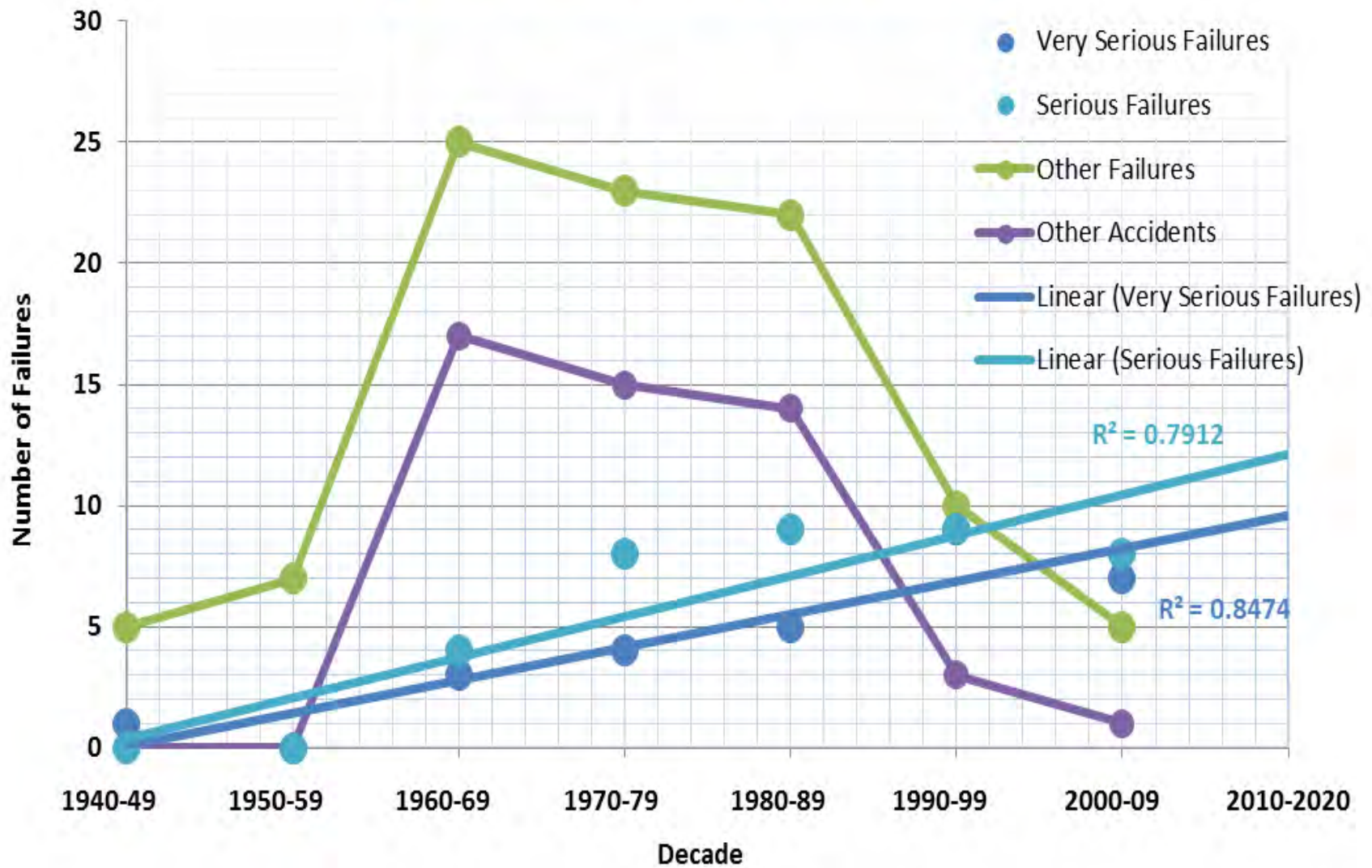


Figure 3.2 Mining Metric 1910-2010
Declining Prices Offset By Lower Production Costs

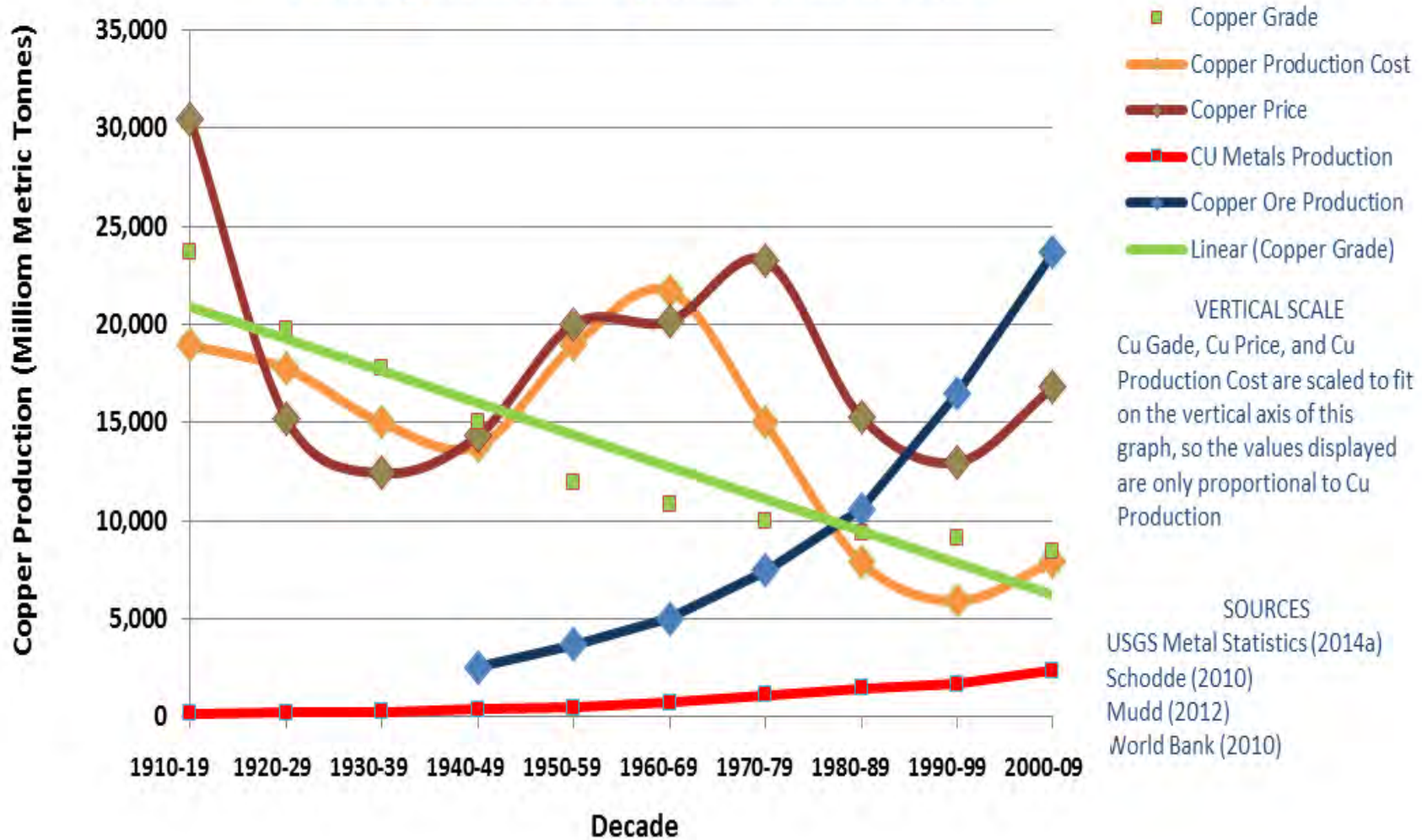


Table 3.1 Correlation Between Failure Severity and Mining Metric Indicators

	Cu Ore Production	Cu Metal Production	Cu Grade	Cu Prod Cost	Cu Price
Very Serious Failures	0.860	0.881	-0.794	-0.788	-0.427
Serious Failures	0.720	0.826	-0.884	-0.682	-0.126
Other Failures	-0.265	-0.099	0.298	0.300	0.489
Other Accidents	-0.216	-0.050	-0.312	0.281	0.485

Abbreviations:

Cu Prod Cost = Cost to produce copper concentrate from copper ore, including waste disposal

Cu Grade = grade of copper in the ore

Cu Prod = copper ore production

Other Failures = tailings dam failures and incidents other than Serious or Very Serious Failures

Serious Failures = Serious tailings dam failures

Very Serious Failures = Very Serious tailings dam failures

Sources: USGS Metal Statistics (2014), Schodde (2010), ICOLD (2001),
WISE (2015) & additional



Table 7.1 Documented TSF Very Serious Natural Resource Losses 1990 – 2010

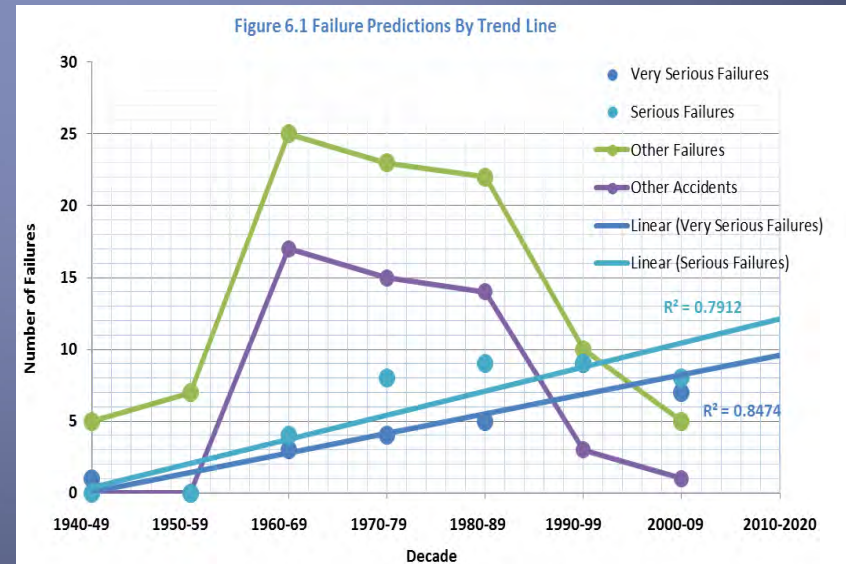
<u>TSF Failure</u>	<u>Year</u>	<u>Original Currency (Millions)</u>	<u>Failure Year M US\$</u>	<u>2014 M US\$</u>	<u>Ore</u>	<u>Release (M m³)</u>	<u>Run Out (km)</u>	<u>Deaths</u>
Kingston Fossil Plant, Harriman, Tennessee, USA	2008	US 1,200	\$1,200	\$1,300	Coal	5.4	4.1	
Taoshi, Linfen City, Xiangfen, Shanxi Province, China	2008	US 1,300	\$1,300	\$1,429	Fe	0.19	2.5	277
Baia Mare, Romania	2000	US 179	\$179	\$246	Au	0.1	5.2	
Los Frailes, Spain	1998	EU 275	\$301	\$437	Zn/Cu /Pb	4.6	5	
Marinduque Island, Philippines	1996	P 180 + US 114	\$123	\$185	Cu	1.6	27	
Omai, Guyana	1995	US 100	\$100	\$156	Au	4.2	80	
Merriespruit, South Africa	1994	R 100	\$29	\$46	Au	0.6	2	17
				=====				
Average US\$2014: \$543				\$3,799				

Table 6.1 Predictions 2010-2020 From Historic Failure Rates

Basis	Very Serious failures		Serious failures		Other Failures		Other Accidents	
	Rate	Pred.	Rate	Pred.	Rate	Pred.	Rate	Pred.
Last 3 Decade Ave	0.0004	15.9	0.0006	21.0	0.0010	35.1	0.0005	18.8
Last Decade	0.0003	10.8	0.0003	12.3	0.0002	7.7	0.0000	1.5
50-50 Weighting	0.0004	13.3	0.0005	16.7	0.0006	21.4	0.0003	10.1
Chart		9.5		12.0				

Rate = number of failures per million metric tonnes (MMt) ore mined

Pred = number of predicted failures in the period 2010 - 2019



Major Mt Polley Expert Panel Recommendations:

- Tailings dam fail at a rate approximately 10 times that of water supply reservoir dams. (Expert Panel Report, App. I, p. 13)
- Safety, not economics, should be the primary consideration in tailings dam design. (Expert Panel Report, p. 125)
- TSFs should not be used for excess water storage. (Expert Panel Report, p. 121)
- No wet closures for tailings impoundments. (Expert Panel Report, p. 125)
- For acid-generating and metals leaching material long-term water treatment is preferable to wet closure. (Expert Panel Report, p. 122)
- “The Panel firmly rejects any notion that business as usual can continue.” (Expert Panel Report, p. 118)

Major findings from Bowker-Chambers:

- Data on tailings dam failures is very, very poor... and data on the cost of these failures is even worse.
- There is a statistical correlation between copper ore production and catastrophic tailings dam failures.
- The number of catastrophic TSF failures (the rate is constant) is increasing because more large TSFs are being built and operated by companies under financial stress.
- We predict ≈ 11 catastrophic TSF failures in the decade 2010-2019 (there have been 4 catastrophic failures since 2010).
- The cost of these catastrophic failures could be \approx \$6 billion.
- There is no funding mechanism, other than owner responsibility, to cover the cost of catastrophic failures.

QUESTIONS?

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