Addressing decreasing water availability for the mining industry using cost-benefit analysis

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Introduction – Mining and water scarcity

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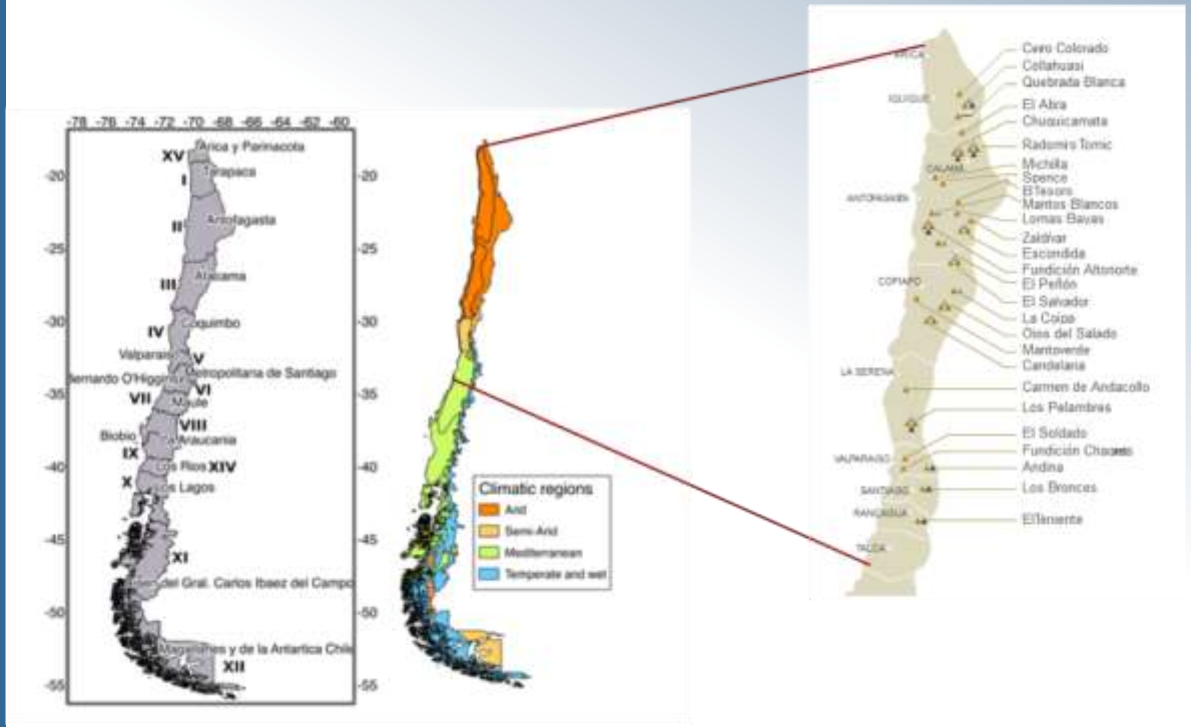

Figure 1. Copper mining operations in Chile

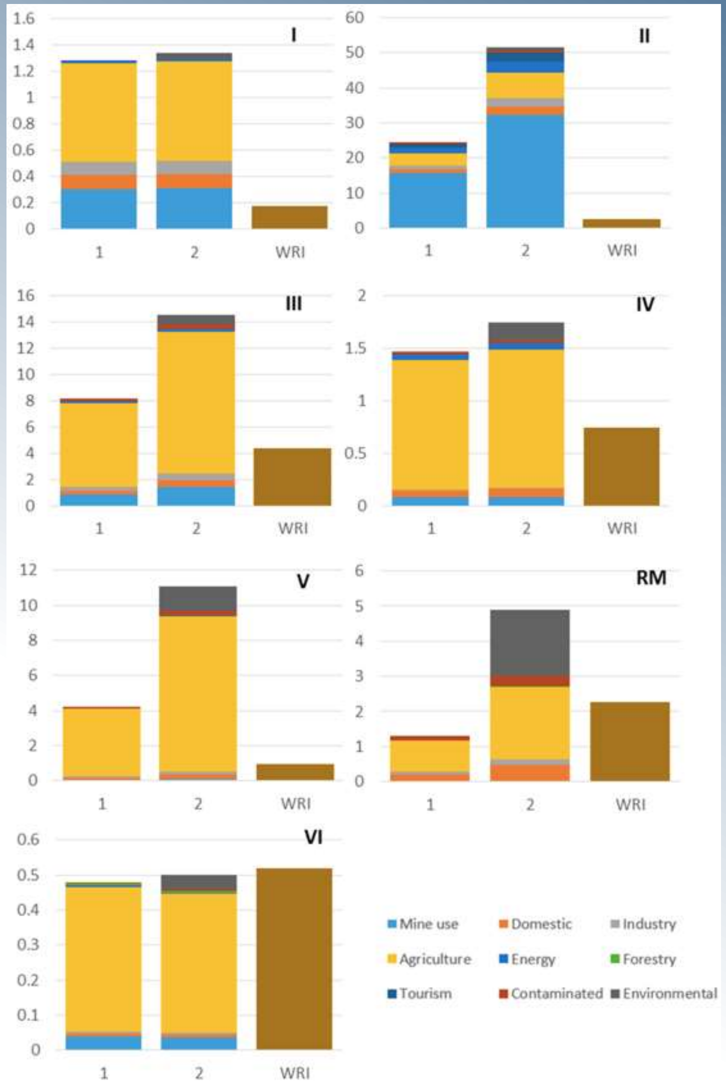

Figure 2. Water scarcity indices and allocation

Introduction – The upshot

Negative media coverage of the industry

Water use related issues have strongly affected the industry not just in Chile but around the world.

Spending on water related infrastructure almost doubled from 2011 to 2014 ($7.7bn to $13.6bn) (WWI 2014)

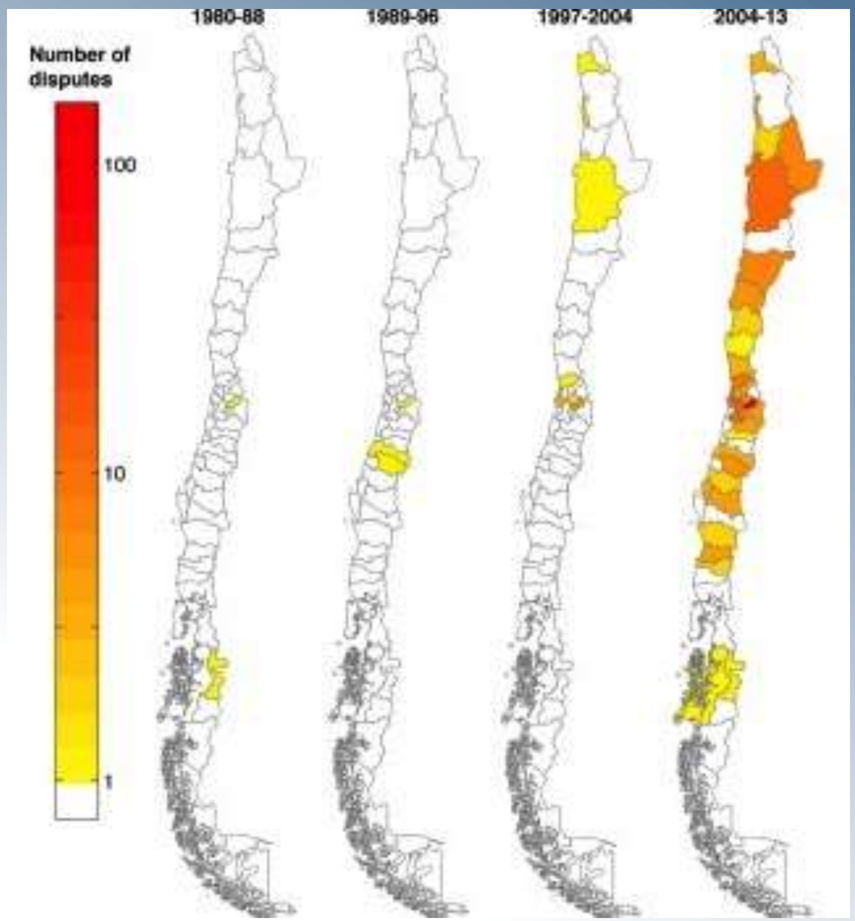

Figure 3. Number of disputes over water resources

Transition from freshwater to seawater

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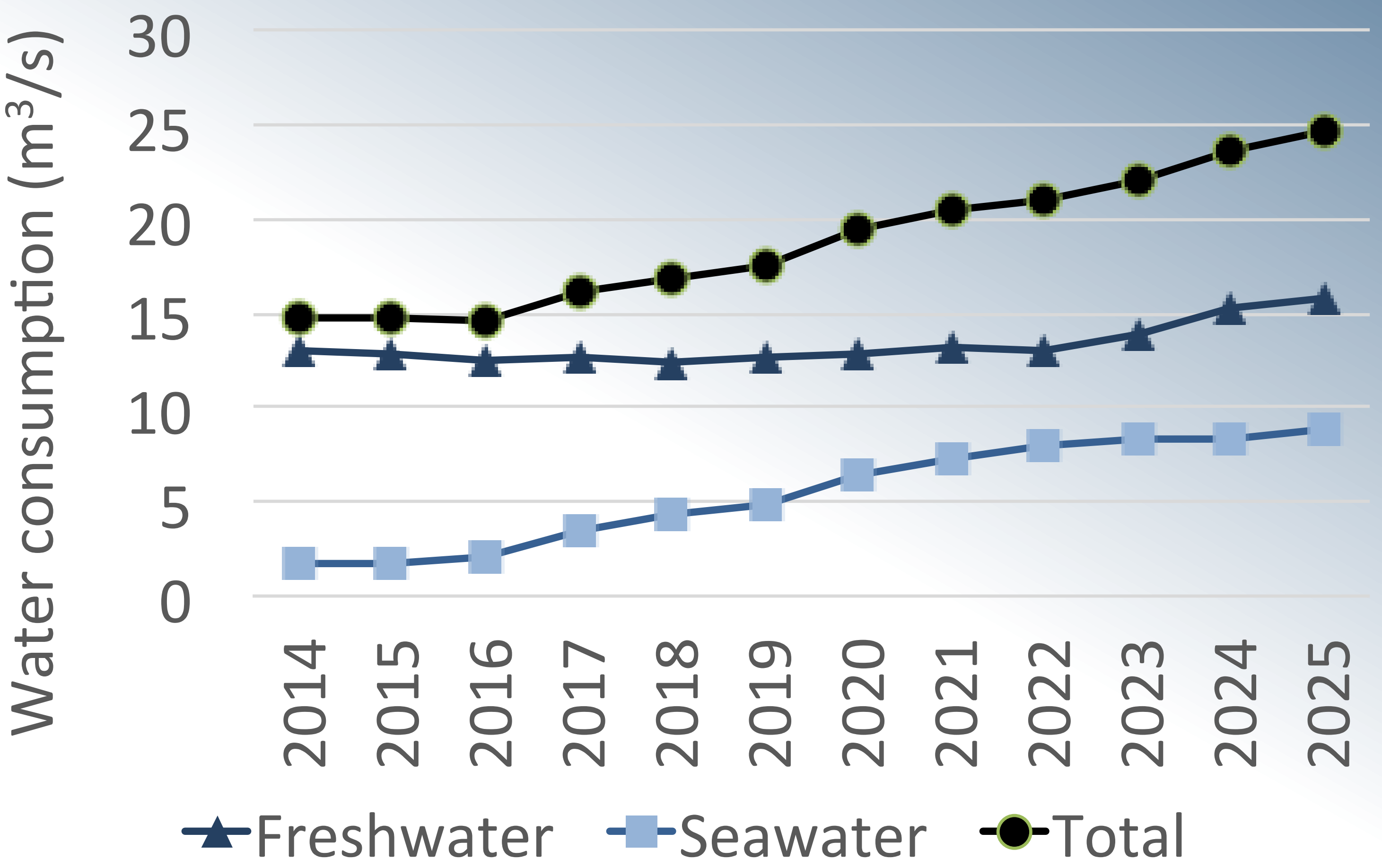

Figure 4. Projected levels of water consumption in the mining industry (COCHILCO 2016)

Research question – what's the most cost-effective way to replace freshwater?

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Model developed to consider the use of:

1. Desalinated seawater
2. Raw seawater
3. Seawater precipitated with lime

Each water source with the implementation of water saving strategies:

a. Tailings thickening + synthetic dust suppression
b. Tailings filtration + synthetic dust suppression

Scenarios of operational models

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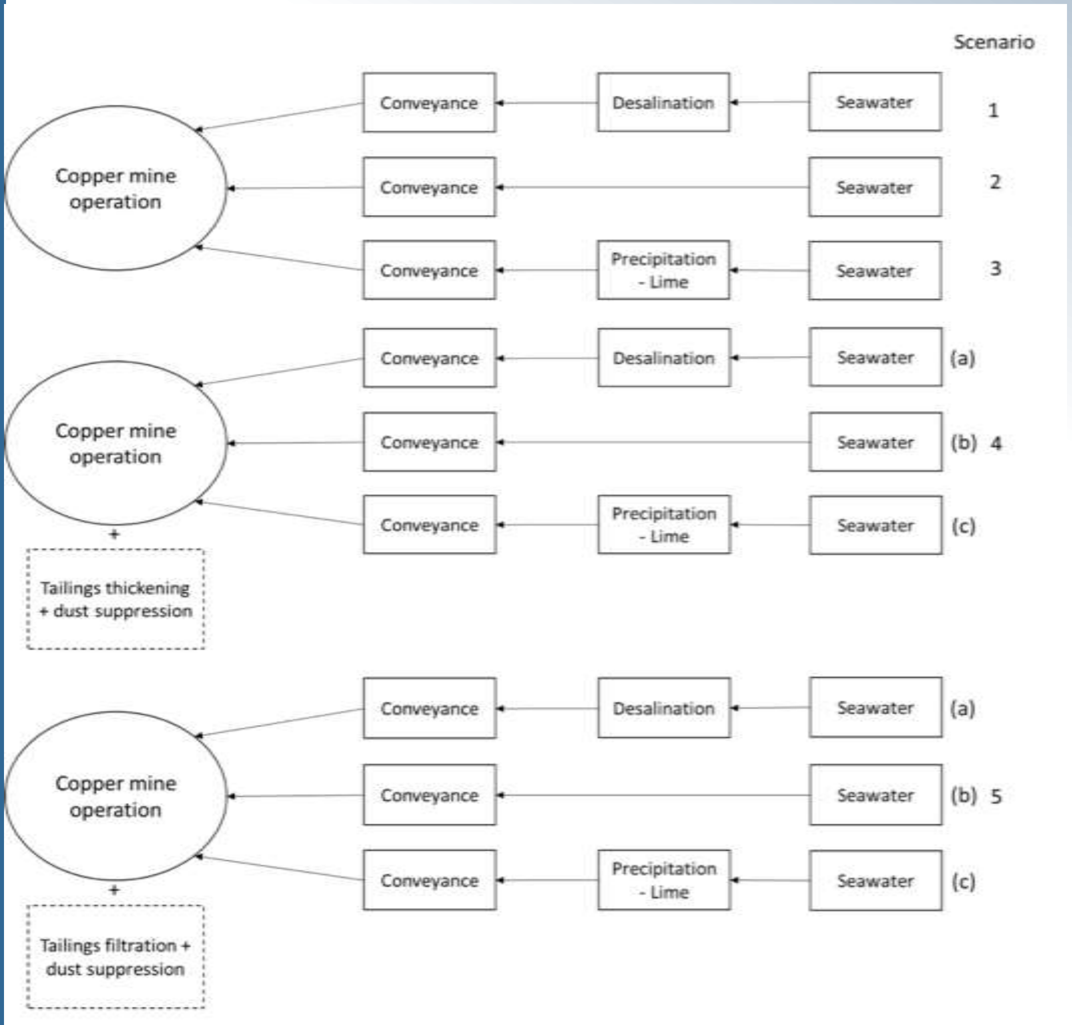


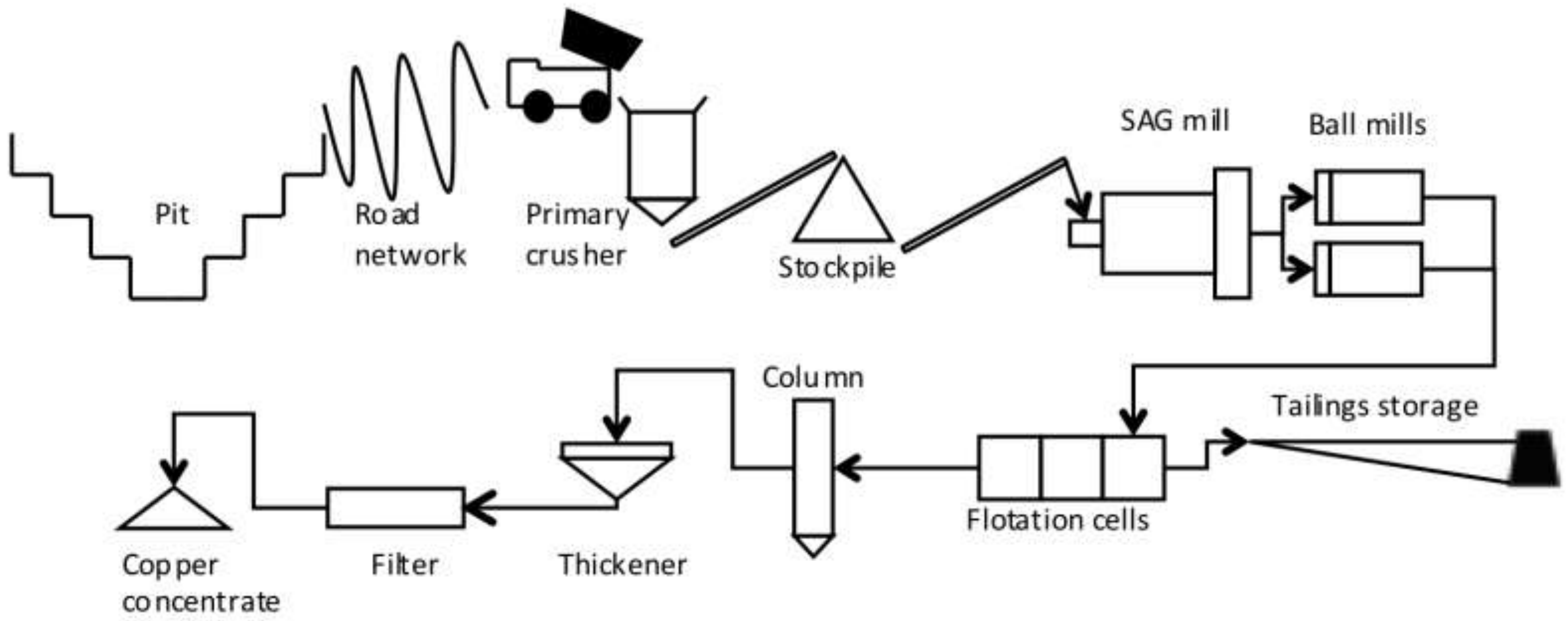
Figure 5. Operational models tested

1
2
3

a
b
c
4

a
b
c
5

Basic operational model and assumptions



Ore throughput: 150,000 tpd
Solids content of tailings: 32%
Distance to coastline: 160 km
Elavation: 0-4,000 m
Life span: 25 years

Desalination plant: 100,000 m^3 (Northern Chile)
Tailings solids content following thickening: 60%
Tailings solids content following filtration: 83.5%
Electricity cost: $0.15/kWh

Water losses for each scenario

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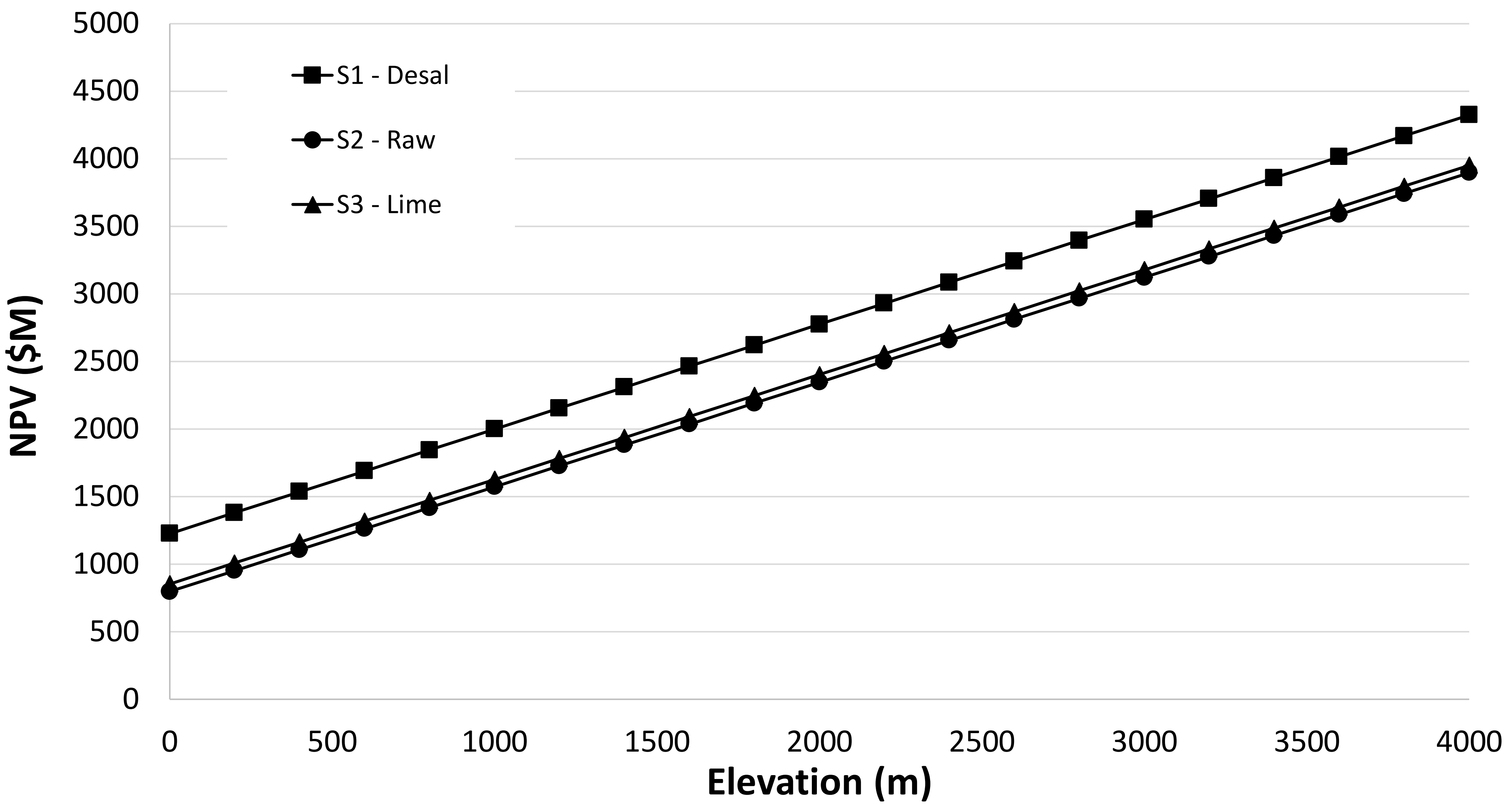
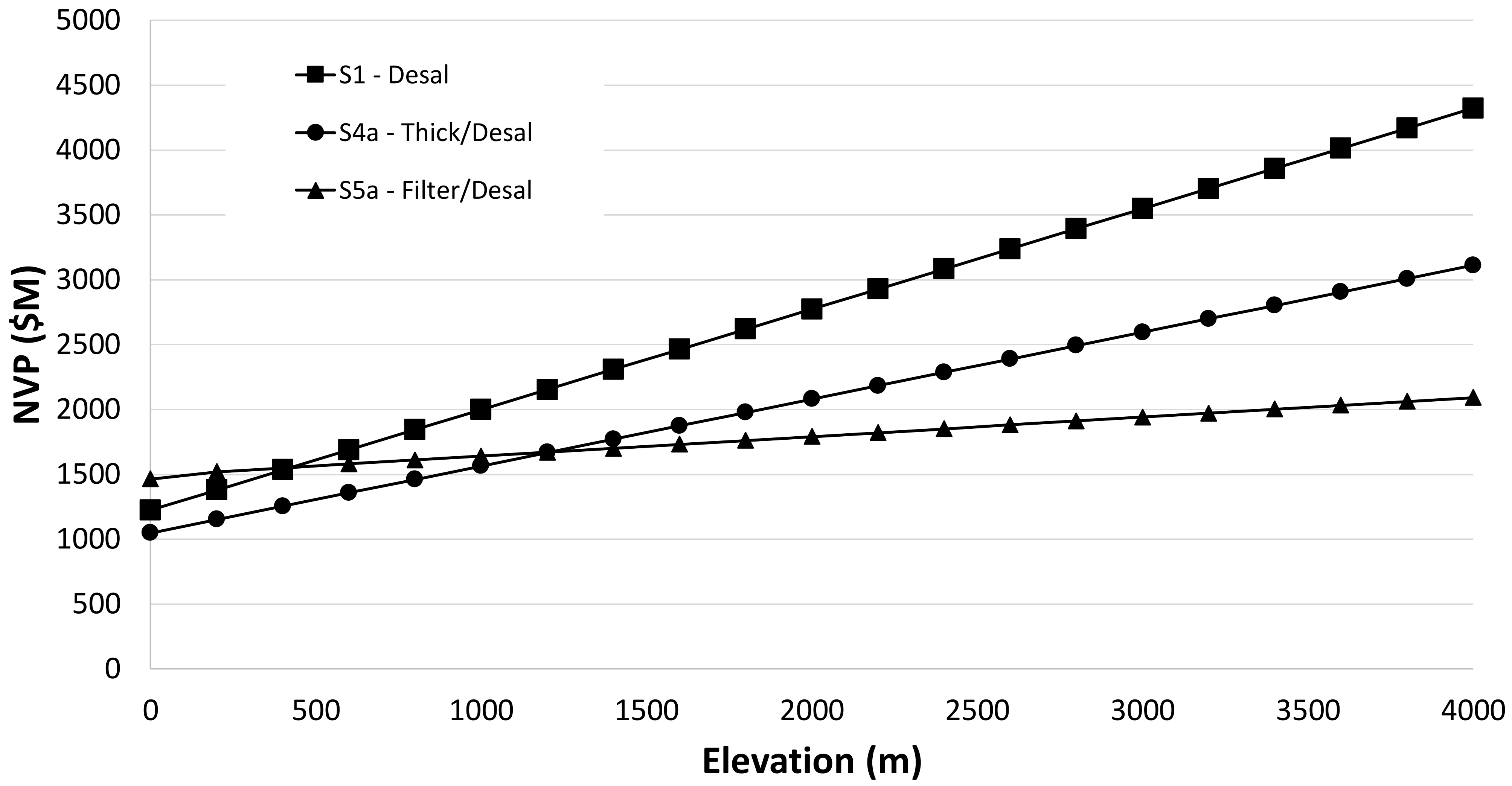
Process	Base case - S1, S2 & S3 (m^3/day)	Scenario 4 (m^3/day)	Scenario 5 (m^3/day)
Road dust suppression	10,560	1,620	1,620
Human consumption	174	174	174
Raw water evaporation	6.6	6.6	6.6
Process water tank evaporation	10.2	10.2	10.2
Primary crusher	1080	1080	1080
Stockpile	360	360	360
Flotation cell	20.1	20.1	20.1
Concentrate thickener	3.6	3.6	3.6
Final concentrate	267	267	267
Tailings storage facility	96,076	78,036	29,164
Tailings thickener	-	52	-
Total losses	108,558	90,570	32,706

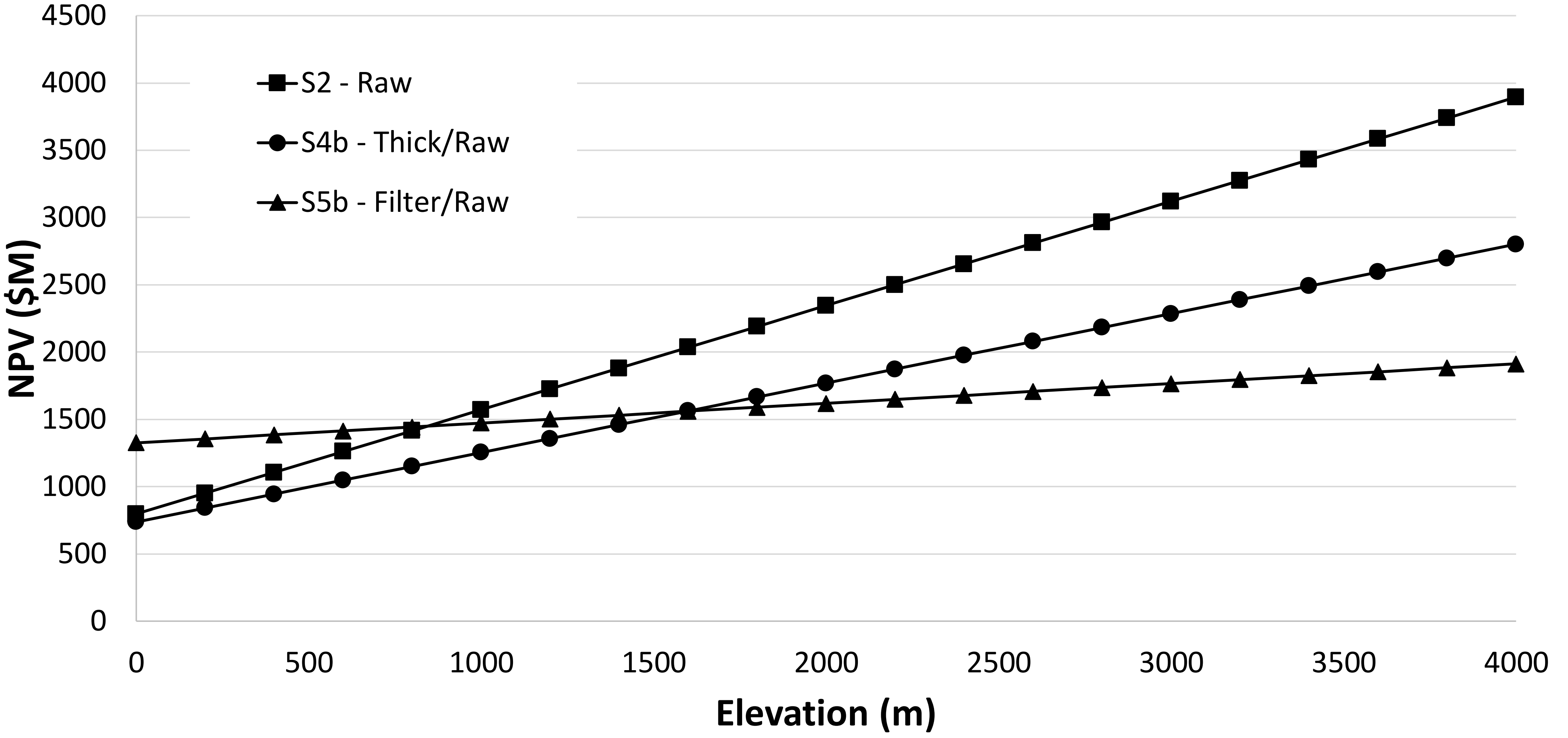
Net present values of scenarios 1, 2 and 3



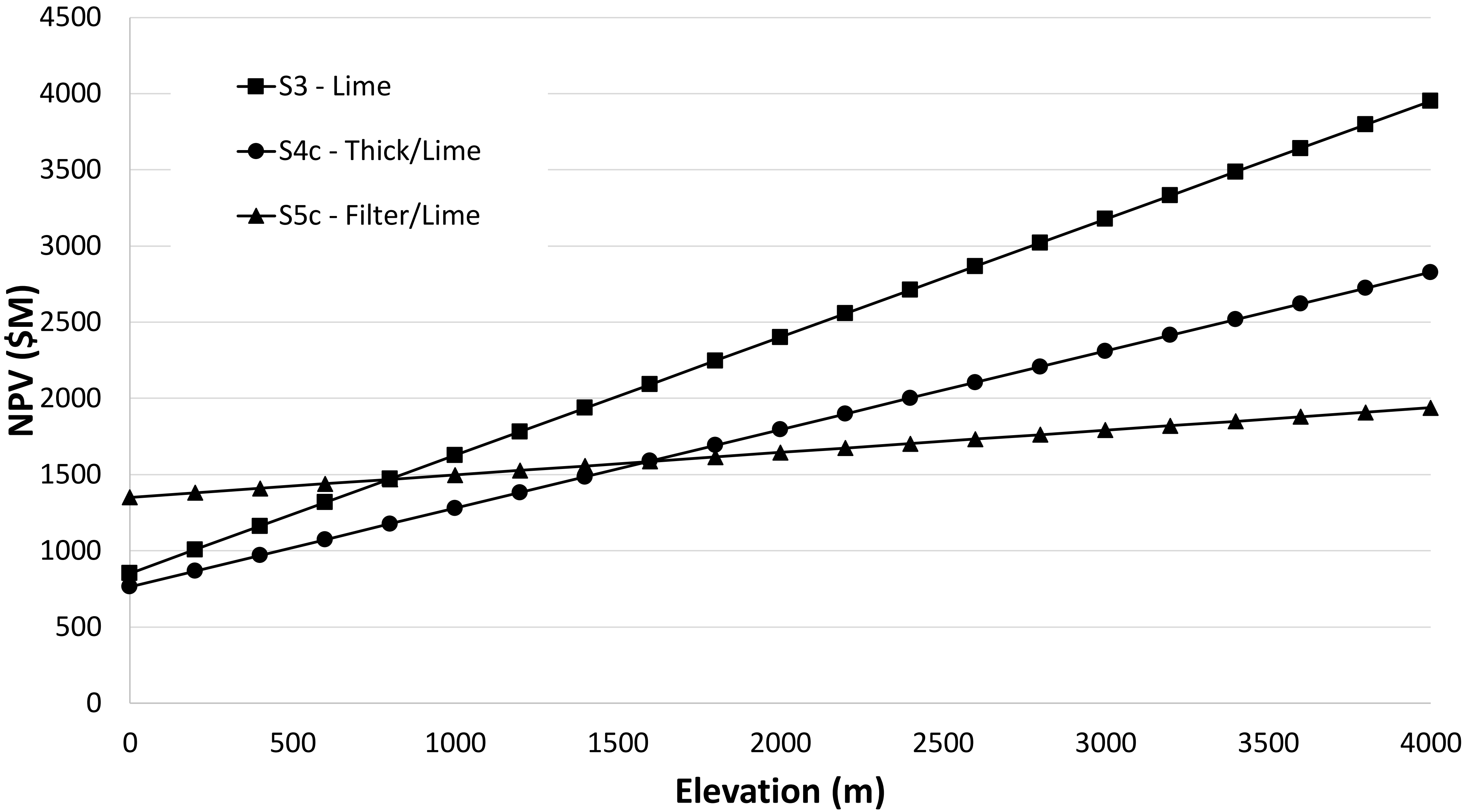
Net present values for scenarios 1, 4a and 4b



Net present values of scenarios 2, 4b and 5b



Net present values of scenarios 3, 4c and 5c



Comparison of cost-effectiveness between water saving strategies

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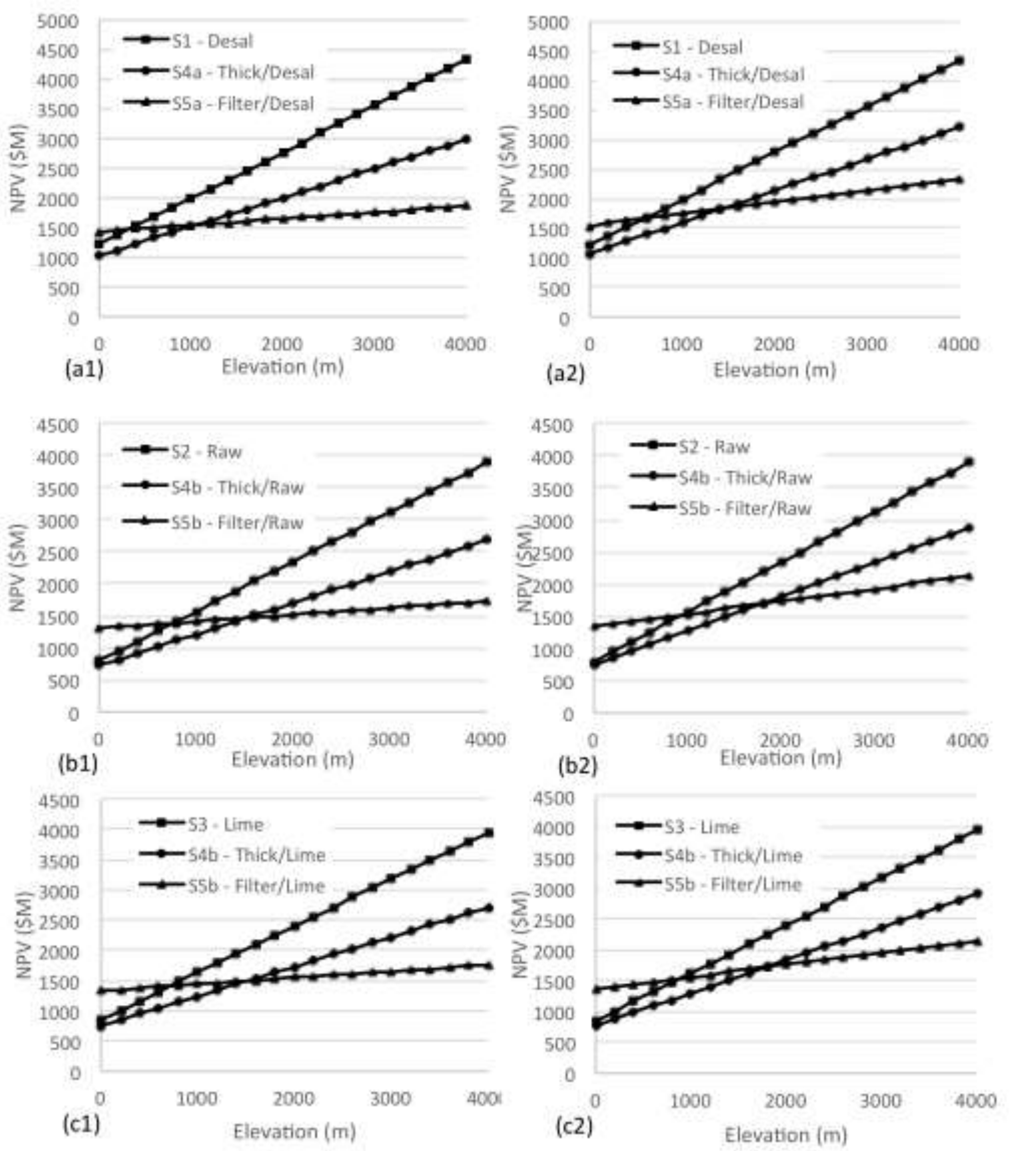
	Dust suppressant	Tailings thickening	Tailings filtration
Water saved (m^3/day)	8,940	235,574	315,208
NPV ($M)	13.7	459	1,912
NPV/m^3 ($/$m^3$)	0.17	0.21	0.41

Sensitivity analysis of Net Present Values

Low High



Desalinated seawater

Raw seawater

Lime precipitated seawater

Conclusions

The use of seawater in copper mining is costly but ultimately necessary in many mining areas

Desalination is expensive – raw seawater or simple treatment is preferred

Thickening of tailings is the most cost-effective water saving option at low levels of elevation

Filtration of tailings is the most cost-effective option at elevations greater than 1,600 m

Further research

Further experimental analysis of lime precipiation and copper recovery rates

Analysis of the impact upon operational profitability of the proposed scenarios

Analysis of the environmental impacts and risks of the proposed scenarios

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