

System Dynamics in Mining

Complex Ore Bodies - Project review

AppCo Team – JKMRC

Brunilde Verrier

Mohsen Yahyaei

Gordon Forbes

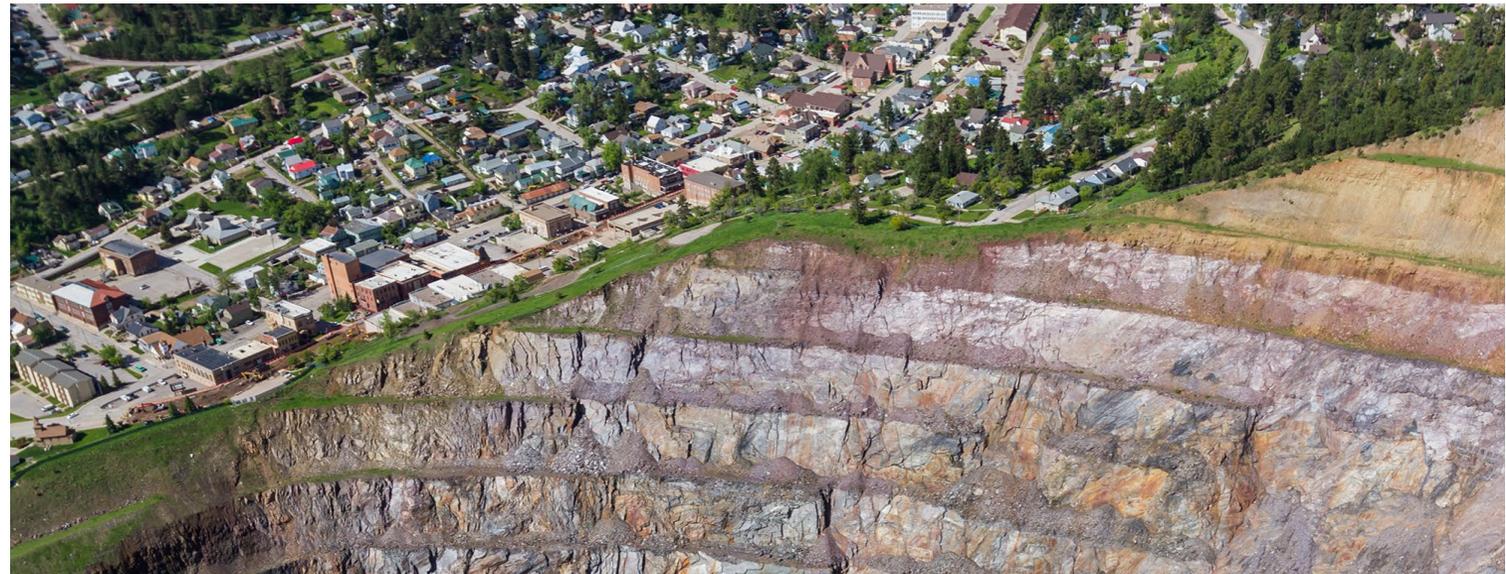
With Carl Smith (BS) and Kathy Witt (CCSG)

Outline

- I) Introduction: Sustainability challenges in Mining
- II) System dynamics (SD)
- III) SD and Mining
- IV) Current research - modelling
- V) Looking forward: main objectives and project development
- VI) Conclusion: Key messages

Sustainability challenges in Mining

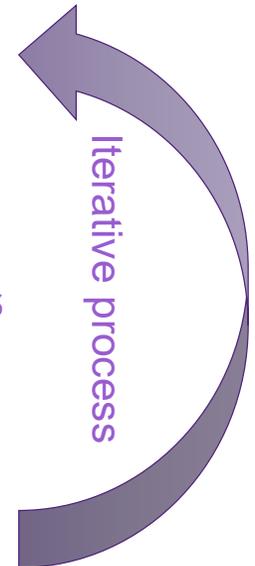
- The mining industry must sustain its supply of minerals and metals while facing rising socio-economic complexities and growing pressure to deliver value to society both locally and globally
- Looking beyond traditional planning methods to transform challenges into shared opportunities and contribute to a long-term positive legacy beyond mine closure



System Dynamics

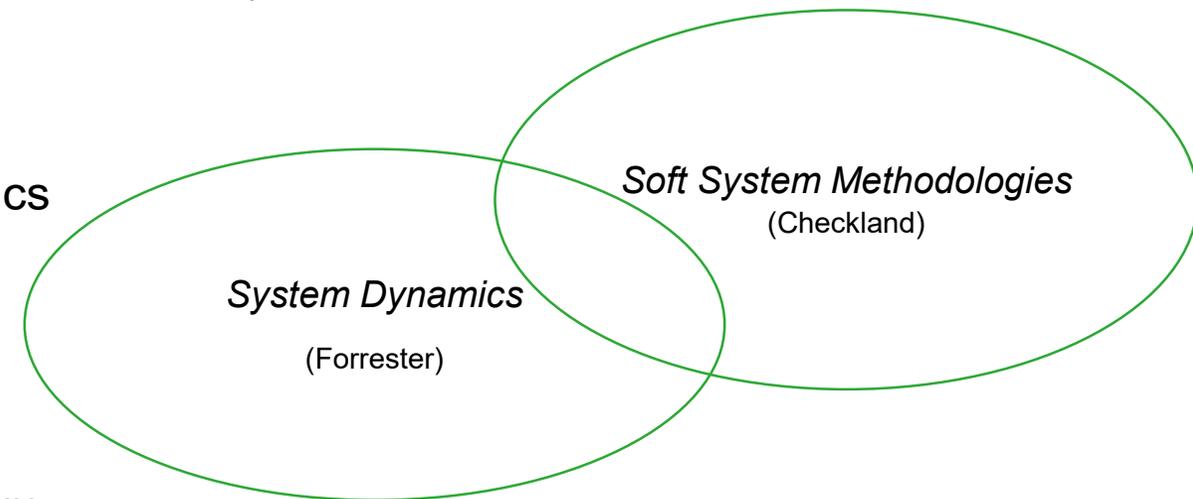
- A system thinking approach helping to represent and understand complex systems, simulate and observe behavioural trends over time
- From “The Limits to Growth” to topical application in sustainability spaces, mainly policy analysis and design
- Models features
 - Causal relationships (reinforcing or balancing)
 - Feedback loops and delays
 - Flows affecting “stocks” (accumulations)

Problem articulation
Identification of key variables
Definition of boundaries
Time horizon and reference modes
Causal loop diagram
Stock and flows diagram
Simulations and tests



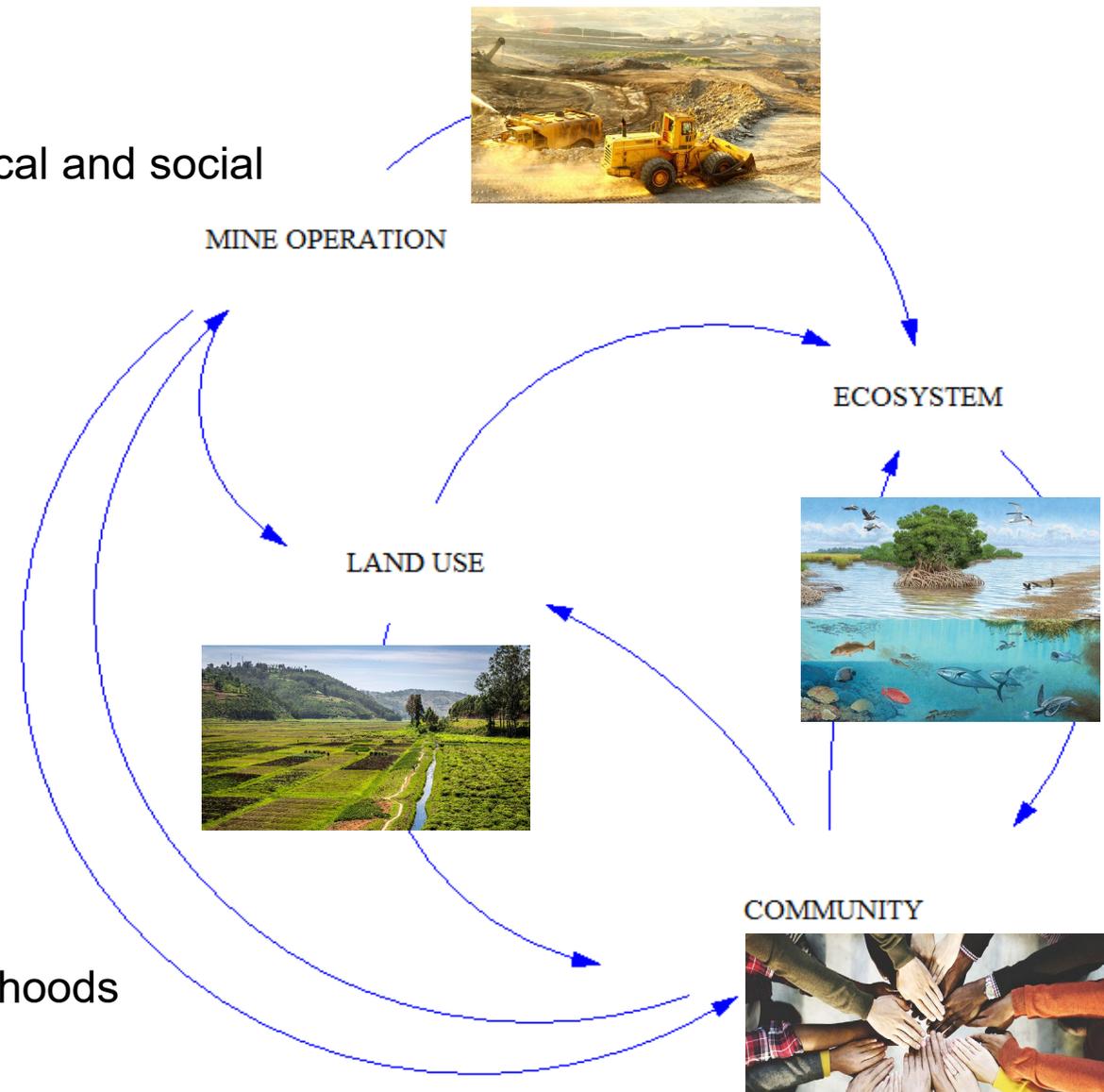
SD and Mining

- Interactions between operations, local governments, the environment and host communities are inherently complex and dynamic
- Mining companies increasingly recognize their operations as fully embedded within local socio-economic systems
- Business planning should encompass these dynamics over the entire life mine cycle
- The association of System Dynamics and Soft System methodologies is appropriate to deal with the multi-faceted societal complexities in mining



Current Research

- First models quantifying interrelated economic, technical and social dynamics of mining
- Priority concerns: Land use and environmental H&S (Mancini and Sala, 2018)
 - *Cyanide gold leaching*
Leaching technologies, potential contamination, community health and perception of hazard and social acceptance
 - *Mining induced displacement*
Commodity price, investments, footprint expansion, economic and physical displacements, disruption of livelihoods



Current Research

Modelling environment: *STELLA Architect*

- Causal loop diagrams
- Stock and flows modelling
- Sensitivity Analysis
- Simulation and user's story interface



Stella[®] Architect

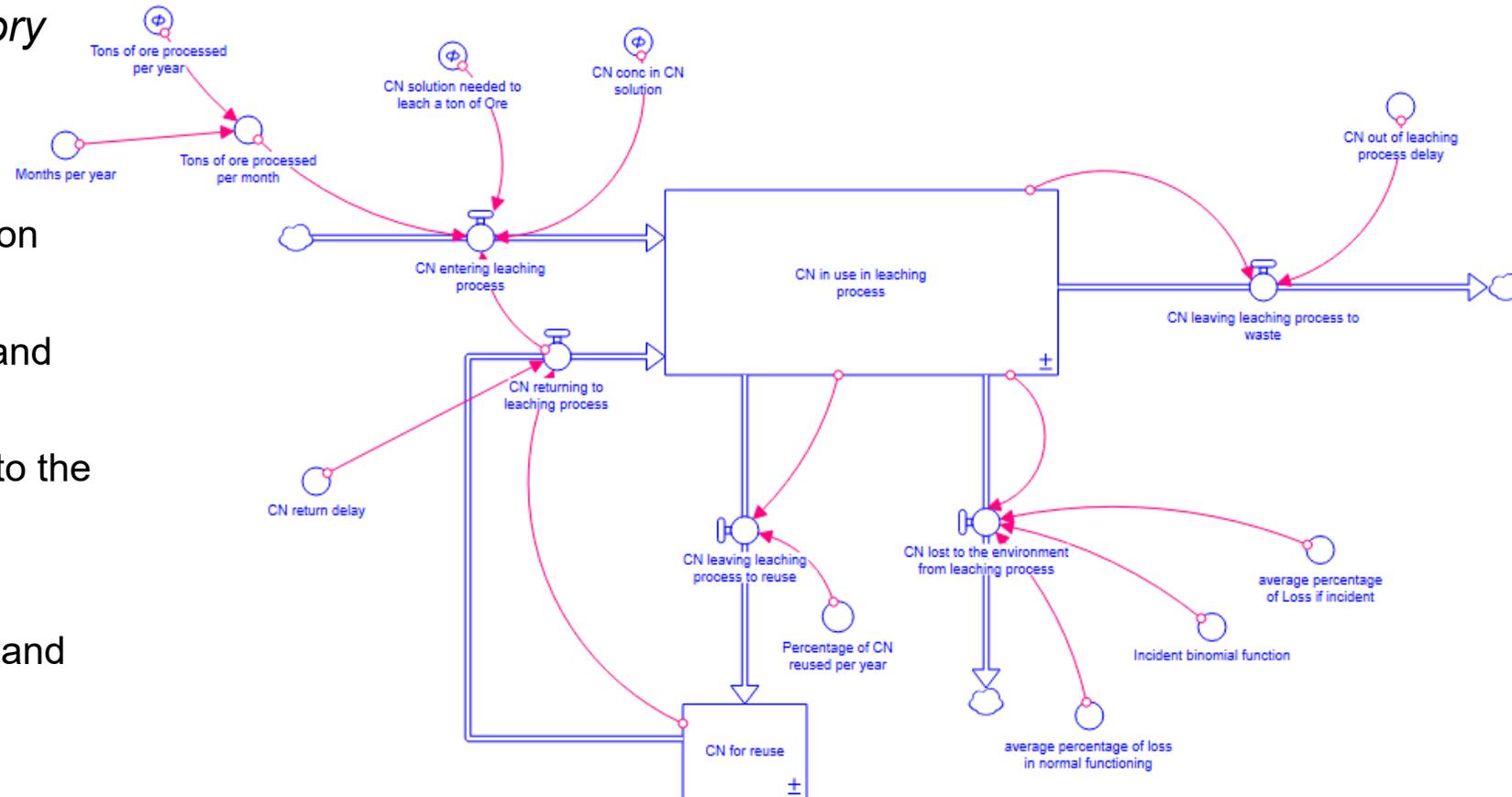
Premium modeling and interactive simulations

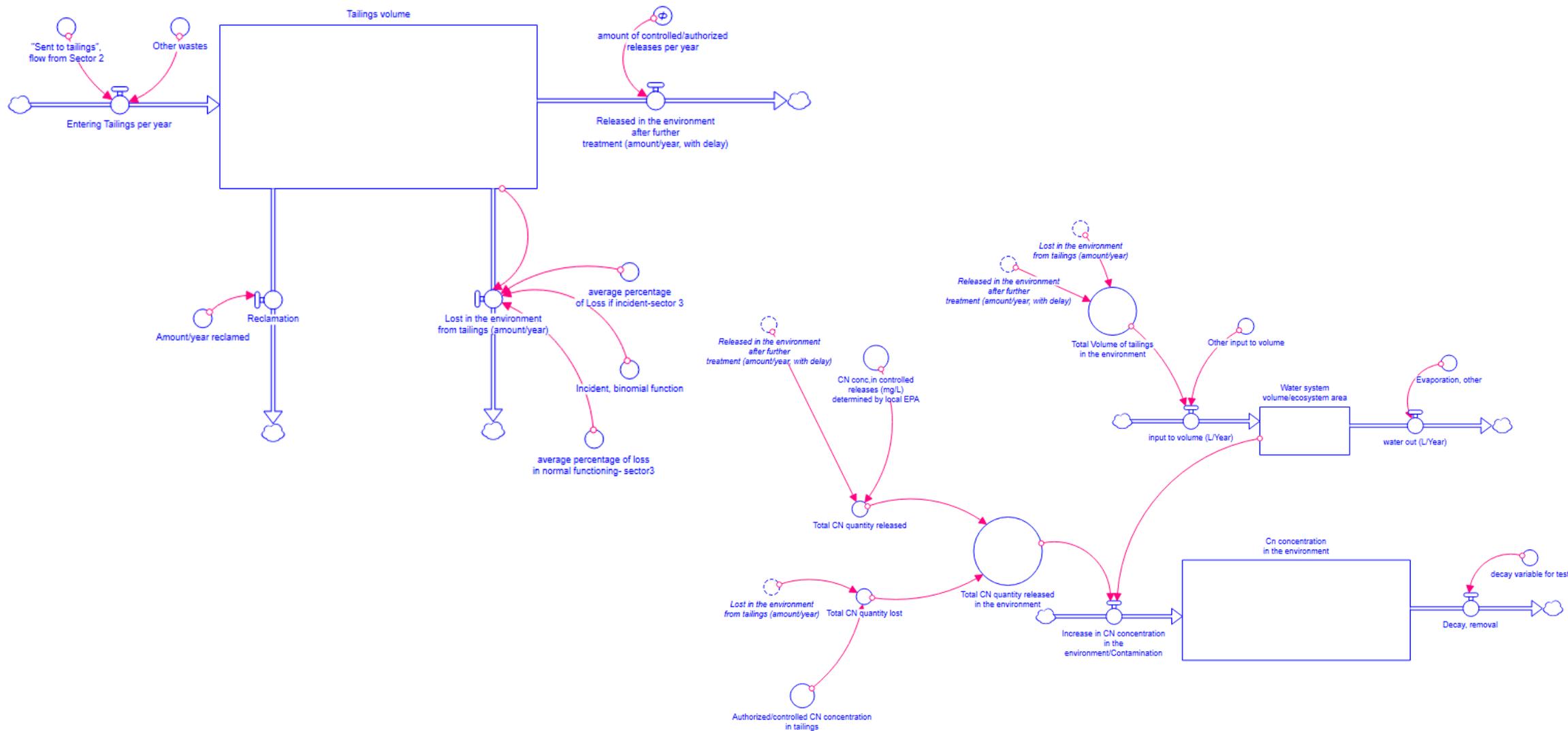
Current Research

Cyanide leaching process, the story

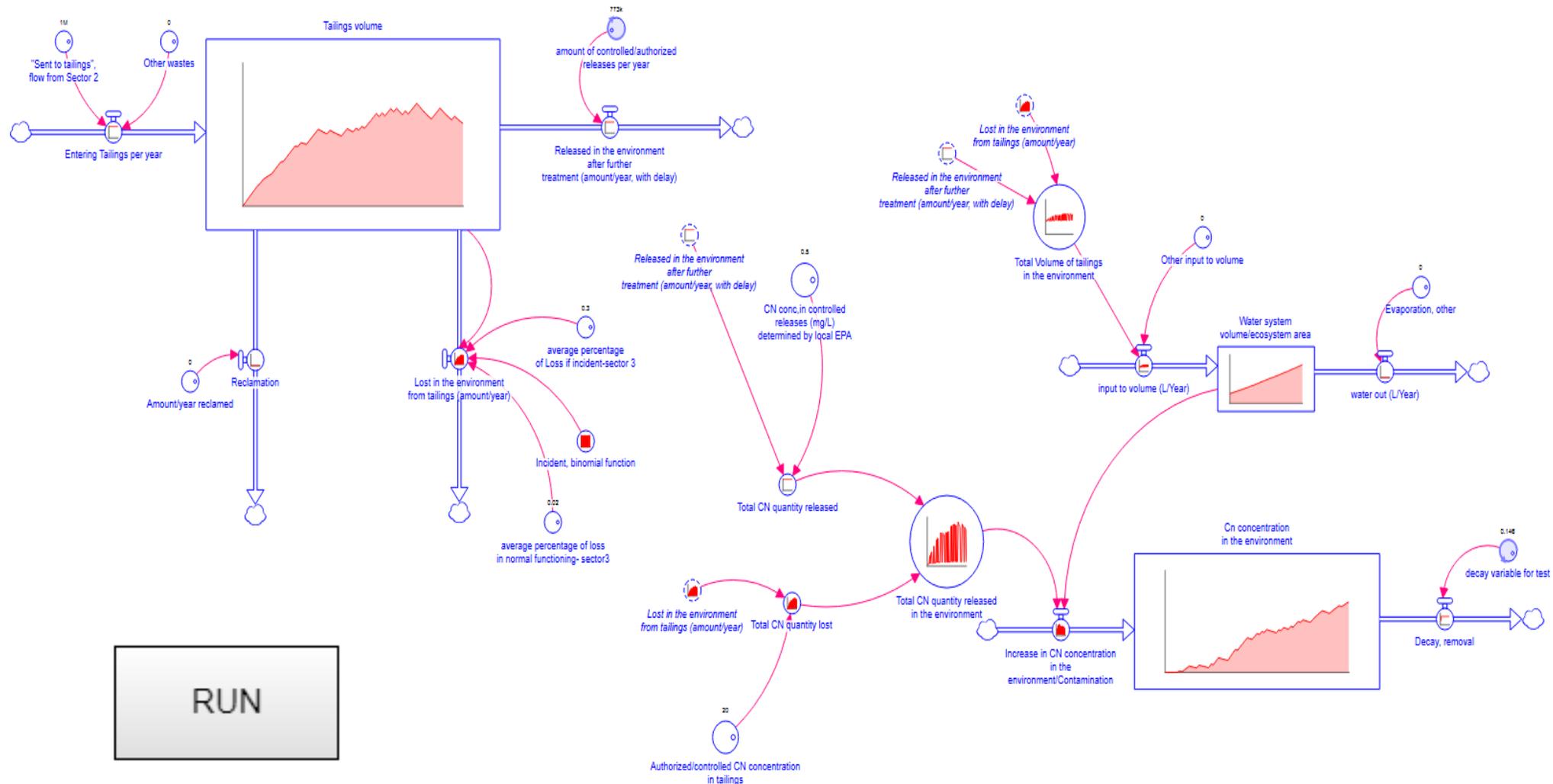
➤ Heap leaching process

- amount of ore processed/year
- cyanide solution and concentration needed to leach a ton of ore
- type and number of regulations and good practices applied
- amount of controlled released into the environment per year
- risk of incident
- public perception, sense of trust and support

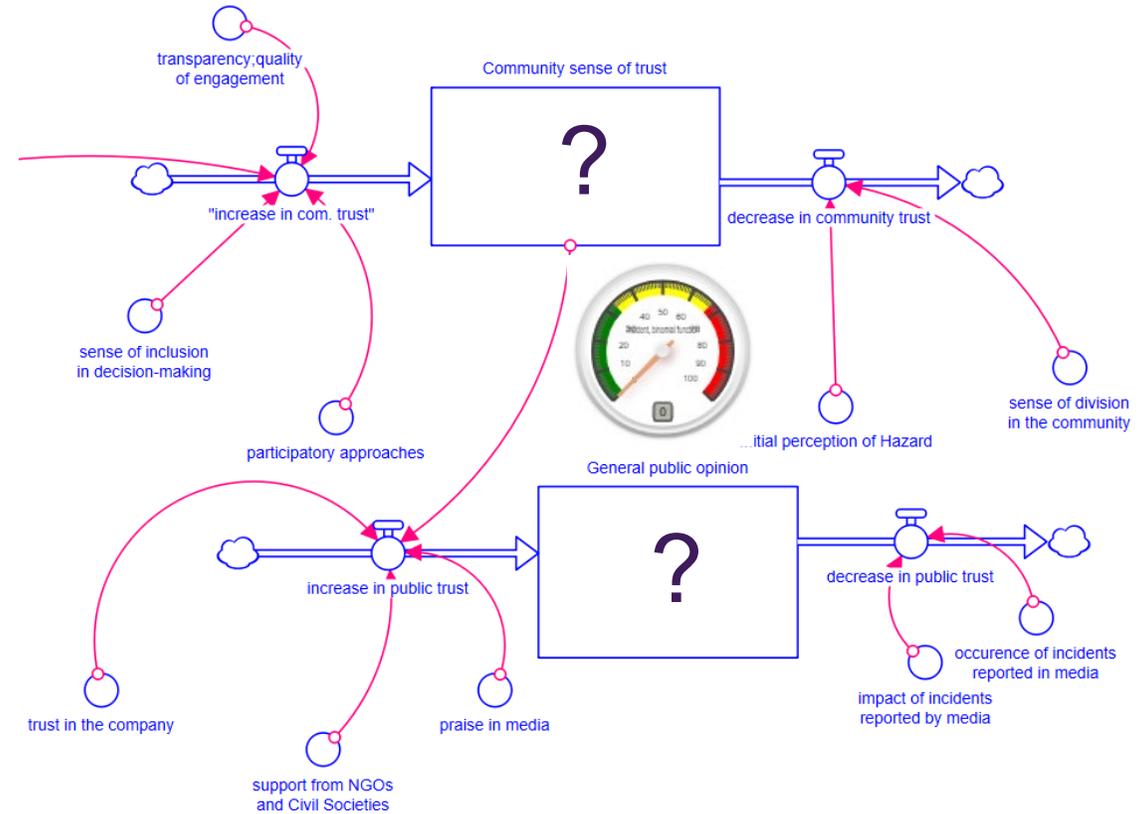
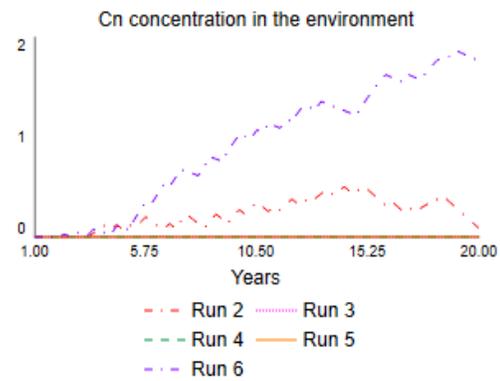
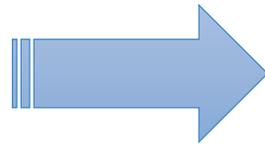
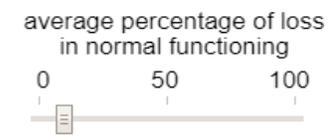
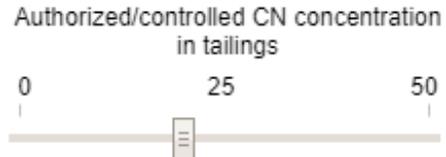
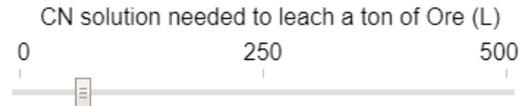




Current Research



Untitled	
	Value
Entering Tailings per year	
Decay, removal	
amount of controlled/authorized releases per year	772.58971880



Objectives – Looking forward

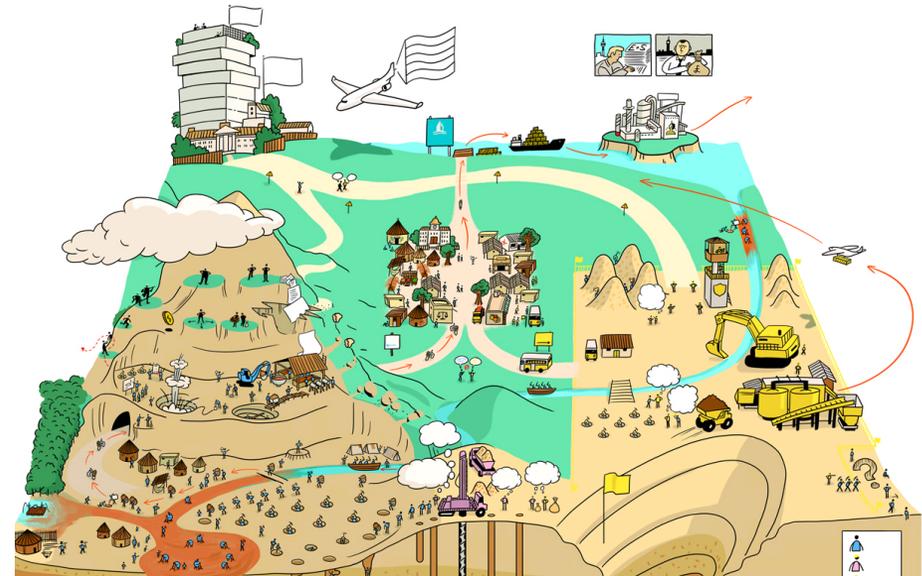
- Case studies
- Stakeholder and community engagement
- Concrete outcomes for mining companies to inform decision-making in sustainable planning
- Develop innovative courses and trainings

- Sustained collaborations
 - UQ Business School
 - Participation to APSDC 2020



Key messages

- A new multi-disciplinary approach to help solve complex problems and reduce uncertainties
- A tool to facilitate stakeholders's involvement, enriching decision-making through different and better informed perspectives (Bosch et al., 2007)
- A humble approach: a model is a continuous improvement process, must include different mental models, and serve a useful purpose



Thank you

Dr Brunilde Verrier | Postdoc Research Fellow
JKMRC - SMI

b.verrier@uq.edu.au



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Don't hesitate to contact us, we'll be happy to answer your questions!!

