Indicative solution of the Mineral/Metal Scarcity II case (EN)

dr. Erik Pruyt

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[Case questions 1.1 and 1.2:] First, students need to make an incomplete simulation model about the extraction/use/recycling of these metals (see Figure 1(a)), and draw a detailed *causal loop diagram* of this incomplete model (see Figure 1(b)).

[Case question 2.1:] Then students are asked to complete the simulation model by adding structures and variables related to the intrinsic demand, price-driven demand, the demand for recycling, etc (see Figure 2), to simulate the model, and make graphs of the *expected price-driven demand*, the *relative price*, the *reserves*, and an output indicator *fraction supplied of intrinsically demanded* (see Figure 3).

[Case questions 2.2 and 2.3:] Then students need to validate and test the sensitivity of the model (more specifically the *fraction delivered of intrinsically demanded* and the *reserves*) for small changes in the *price effect supply shortage*, the *initial reserves*, and the *fraction available of desired recycling*.

[Case questions 2.4 and 2.5:] Finally, students are asked to make an aggregated CLD to show the main feedback loops (see Figure 4), and explain the link between structure and behaviour.

Building blocks addressed in this case include stock-flow modelling and causal loop diagramming of aging chains and recycling structures, formulating (too) many special functions (lookup functions, time series, MIN/MAX functions, well-thought-out flows, delays, and avoiding simultaneous equations), exploring model behaviour, and aggregating and communicating complex feedback loop structures.
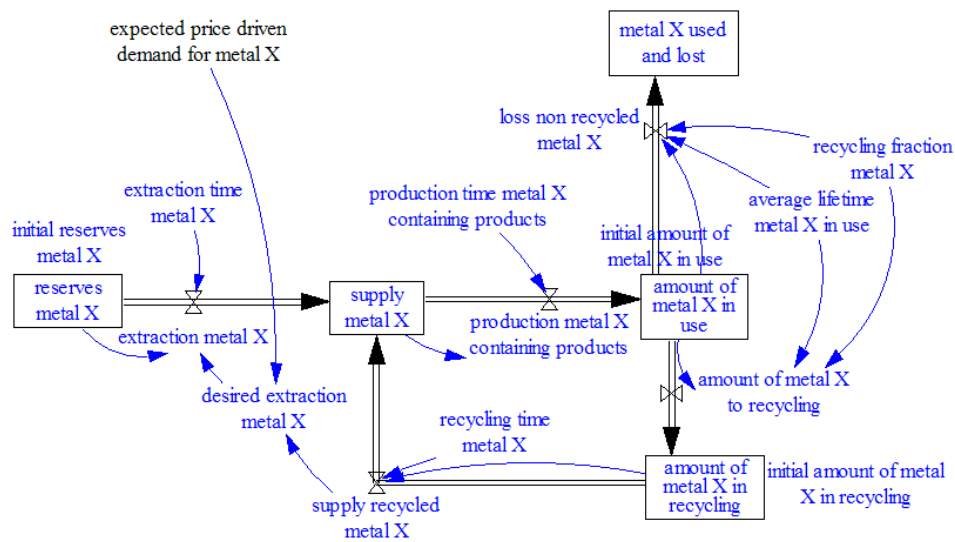
(a) Stock-Flow Diagram of the Incomplete Metal Scarcity Model
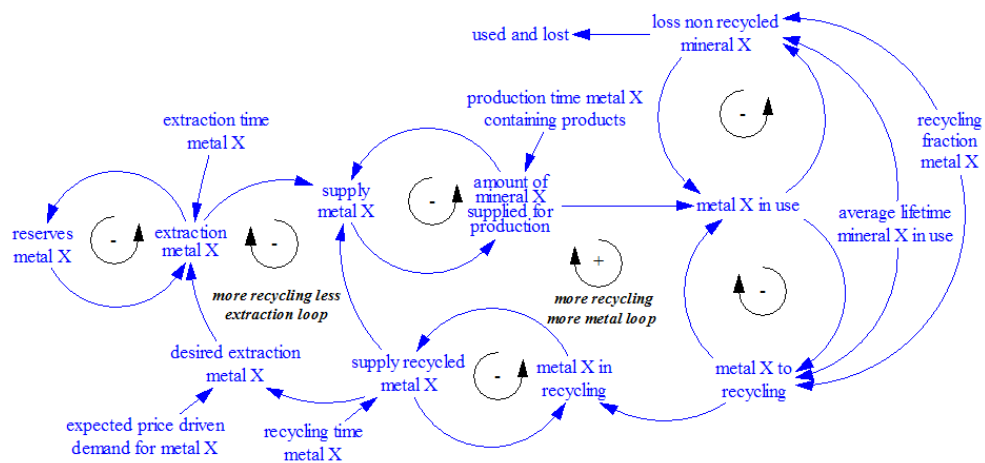
(b) Detailed Causal-Loop Diagram of the Incomplete Metal Scarcity Model

Figure 1: Stock-Flow Diagram and Detailed Causal Loop Diagram of the Incomplete Metal Scarcity Model
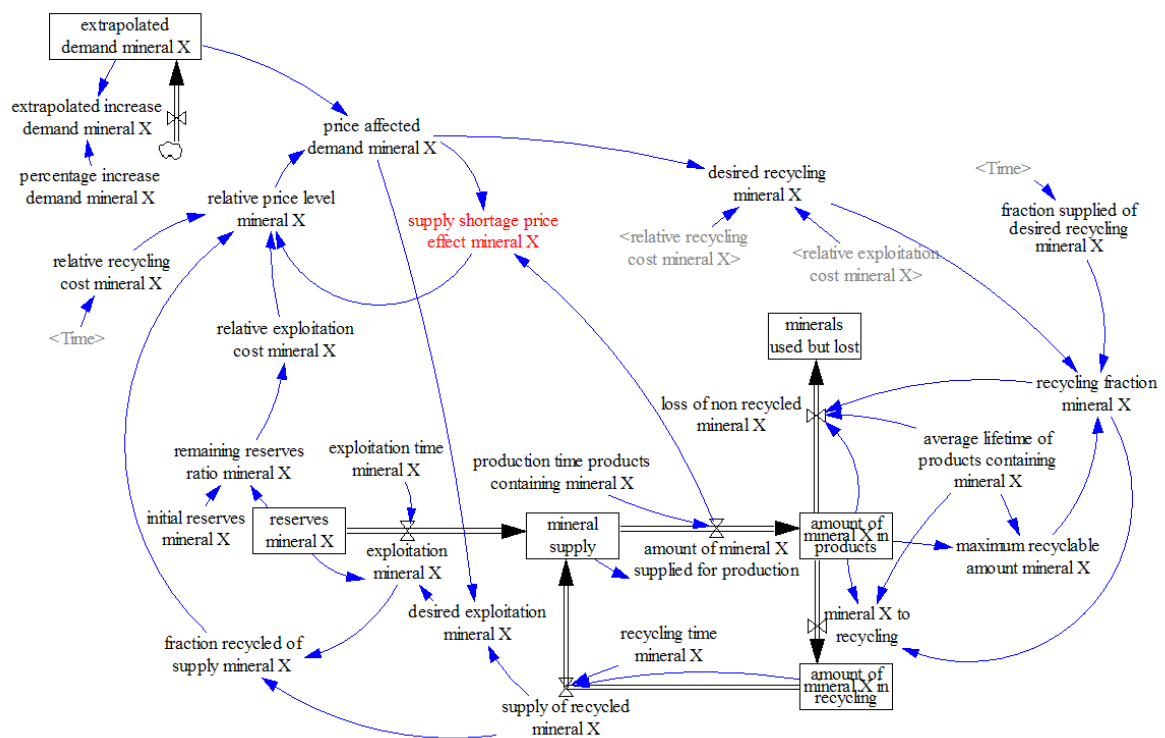
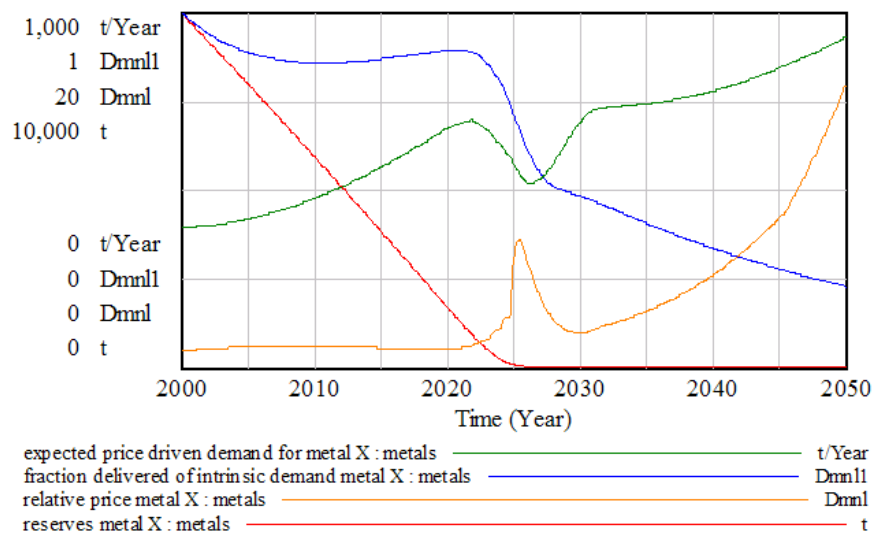Figure 2: Stock-Flow Diagram of the Metal Scarcity Model
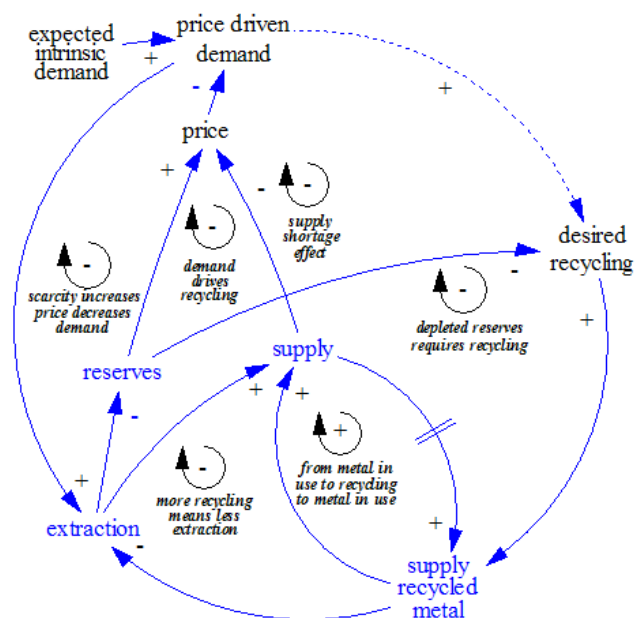

Figure 3: Behaviour of the Metal Scarcity Model

Figure 4: Aggregated Causal Loop Diagram of the Metal Scarcity Model