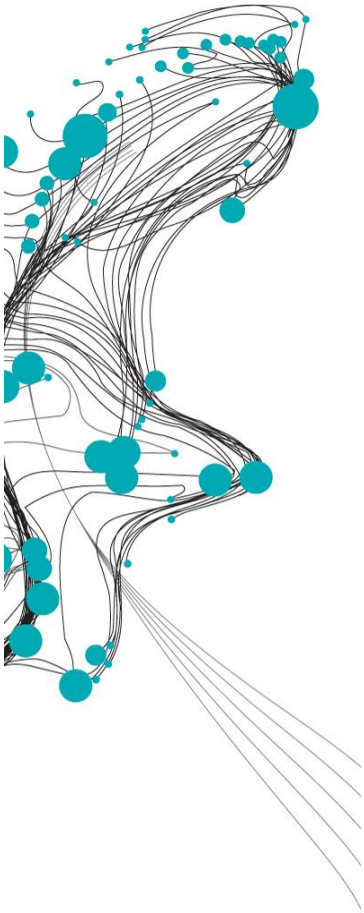
THE DYNAMICS OF ENVIRONMENTAL SYSTEMS

INVESTIGATING SUSTAINABILITY BEHAVIOR



In this master thesis an investigation is done about the environmental sustainability behavior of three renewable environmental systems by using a system dynamic modeling approach. Environmental sustainability often include two simple sustainability rules. These rules imply that harvest rates should be within the systems regenerative capacity and that waste emissions should be kept within the systems assimilative capacity. Due to natural outflows and inflows in environmental systems, these rules are actually defined too wide. However, these rules also indicate that environmental sustainability is directly dependable on the systems regeneration/assimilative capacity.

The three environmental systems that are investigated are groundwater in an aquifer, biomass in a forest and pollution in a lake. These environmental systems are modeled in software program Netlogo according to the system dynamic modeling approach. All the environmental systems have four parameters that represent the circumstances of the environmental system and two environmental sustainability criteria. The environmental sustainability criteria may be in the form of relative criterion, absolute reduction criterion or fixed absolute criterion. On the basis of the environmental sustainability criteria the maximum sustainable yield or load (MSY/MSL) can be determined. Firstly, a quantitative investigation is done about how the MSY or MSL is changing when the circumstances of the environmental systems changes. This will give insight in the sensitivity of the MSY or MSL on parameter variability. The environmental sustainability criteria that gives the lowest MSY or MSL is the decisive criterion. How the decisiveness of both environmental sustainability criteria react on the parameter variability is also investigated in the quantitative part. In the second part the three environmental systems are compared on their qualitative behavior and characteristics. Inflow behavior minus outflow behavior will give a the systems behavior line. The shape of this line determines how a yield or load disturbance will affect the environmental systems. From this behavior line also the stability of the environmental system can be determined. Finally, how the MSY and MSL are changing on variability in regeneration/assimilative capacity for different types of environmental sustainability criteria is investigated.

The environmental sustainability is not always dependable on the systems regeneration/assimilative capacity. In this study two exceptions were found whereby the MSY or MSL will stay constant when varying the regeneration or assimilative capacity of the system. The exceptions depend on the stability and linearity of the system (behavior line), type and place of criteria and the way variability in regeneration/assimilative capacity is incorporated.

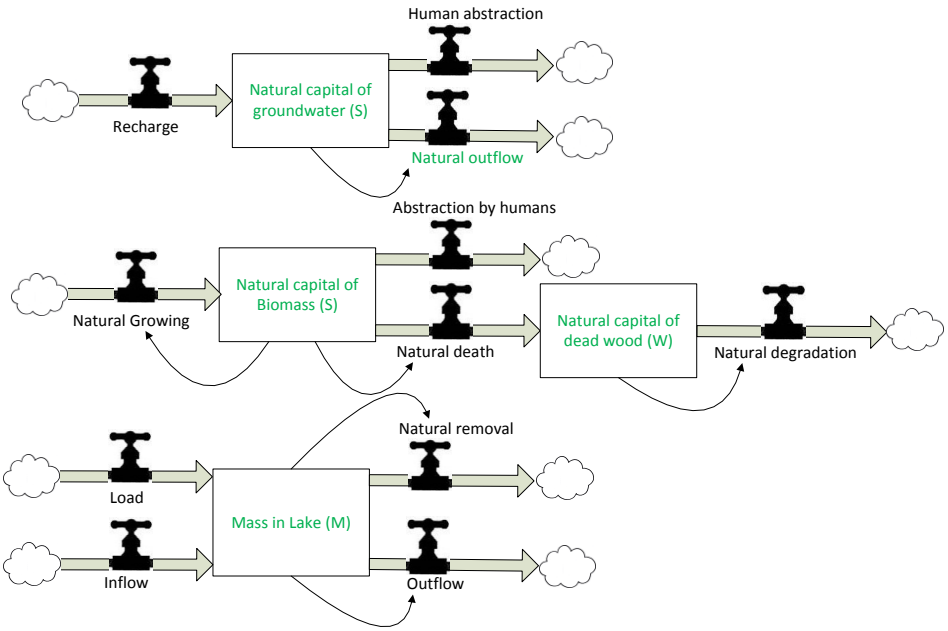


Figure 1: System diagrams of the three environemental systems

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