

Budget Worksheet

A typical material budget for an ecosystem:

$$S_{t+1} = S_t + (I - k S_t - X)\Delta t$$

Or

$$\text{Change in standing stock} = S_{t+1} - S_t = (I - k S_t - X)\Delta t$$

S is standing stock of the material, I is input, X is export, and k is a loss term that is proportional to S (e.g. a chemical reaction or, in an aquatic system, sedimentation).

S has units of mass (or mass/area, or mass/volume). I and X are fluxes, mass/time (or mass/(area x time), or mass/(volume x time)). Units of k are 1/time.

Budget term	Ecosystem 1	Ecosystem 2
I	5	5
k	0.5	0.25
X	1	3

What are the steady-state values of S?	
What is the turnover rate at steady state?	
What is the residence time at steady state	

<p>Which ecosystem will recover the fastest from a perturbation of S?</p>	

Real-world example:

Budget term	Lake Mendota	Hubbard Brook
I	0.8 g m ⁻² y ⁻¹	0.01 g m ⁻² y ⁻¹
k	0.75 y ⁻¹	4x10 ⁻⁵ y ⁻¹
X	0.18 g m ⁻² y ⁻¹	0.002 g m ⁻² y ⁻¹
S*	0.83 g m ⁻²	200 g m ⁻²
Turnover rate	~1 y ⁻¹	5x10 ⁻⁵ y ⁻¹
Residence time	~1 y	20,000 y