

## Sensitivity of BAF's to System Speed and Productivity

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How sensitive are the BAF's to the speed of the system it is applied to? This analysis tests the sensitivity of the various BAF's to the base rate of losses from the reference and policy scenarios. The base rate of loss is defined by a rate-constant that accounts for the proportion being lost each year by processes such as respiration, leaching, erosion, combustion, and harvests other than those for biofuels. In a sense this rate-constant determines the speed of the system. The policy scenario differs from the reference in that it has an additional loss related to the harvest of carbon for bioenergy. In this case it was set to be 20% of the base rate-constant. To keep all the cases on the same scale in terms of carbon, the input into the system was increased by the same factor as the rate-constants of loss. This does not influence the time dynamics of the changes, but does eliminate the need to rescale the results. It should be noted that these are examples in which the policy scenario loses carbon. The same timing would have been evident had the policy decreased the losses by 20% although the sign would have been the opposite of these results. To be consistent, I set T to equal the time when the difference between the policy and reference scenarios reached 99% of its maximum value.

In Figure 1 we can see that the BAF's vary as the underlying base rate of losses is varied. However, despite a 32-fold range in the speed of the system, the BAF's are not changing their sign, nor are they changing their general magnitude. This is in contrast to T, the time at which the differences in stores between the two scenarios ceases to grow. T roughly decreases in a hyperbolic fashion as the base rate of losses is increased Figure 2. This completely agrees with ecological theory in that the timing of a systems response is governed primarily by the proportion being lost. As the proportion being lost decreases, the slower the system becomes and the greater the value of T.

There is also a question of whether the BAF's are sensitive to the relative productivity of the system being examined. Ecological theory would suggest no response, as does the fact the BAF is a ratio of NBE and PGE. Since both these terms should respond linearly to changes in productivity, the BAF should remain constant. This was checked by leaving the rate-constants of losses the same, but changing the inputs to the system (i.e., NPP). Reducing the NPP of both systems 10-fold and increasing it 10-fold resulted in a  $BAF_T$  of 0.243 and 0.241 as compared to an initial value of 0.241. For  $BAF_{zT}$ , the same range of NPP gave values of 0.371, 0.369, and 0.369 for the 10-fold reduction, initial value, and 10-fold increase. For the peak  $BAF_{\Delta t}$ , the values ranged from 0.971 to 0.972. Estimates of T ranged from 77 to 78 years. I suspect the small differences are related to rounding errors and not to any fundamental sensitivity of the BAF's to the inherent productivity of the systems being examined.

Conclusion: This analysis indicates that while the BAF value is sensitive to the dynamics of the system being examined, it is not extremely sensitive. While I would not suggest using the same BAF's for systems with very different time dynamics, this analysis indicates that errors in determining the underlying "speed" of the system are very small. For other cases in which the inputs to the system are varied the BAF's are completely insensitive, because a change in the input are cancelled out in the BAF calculations.

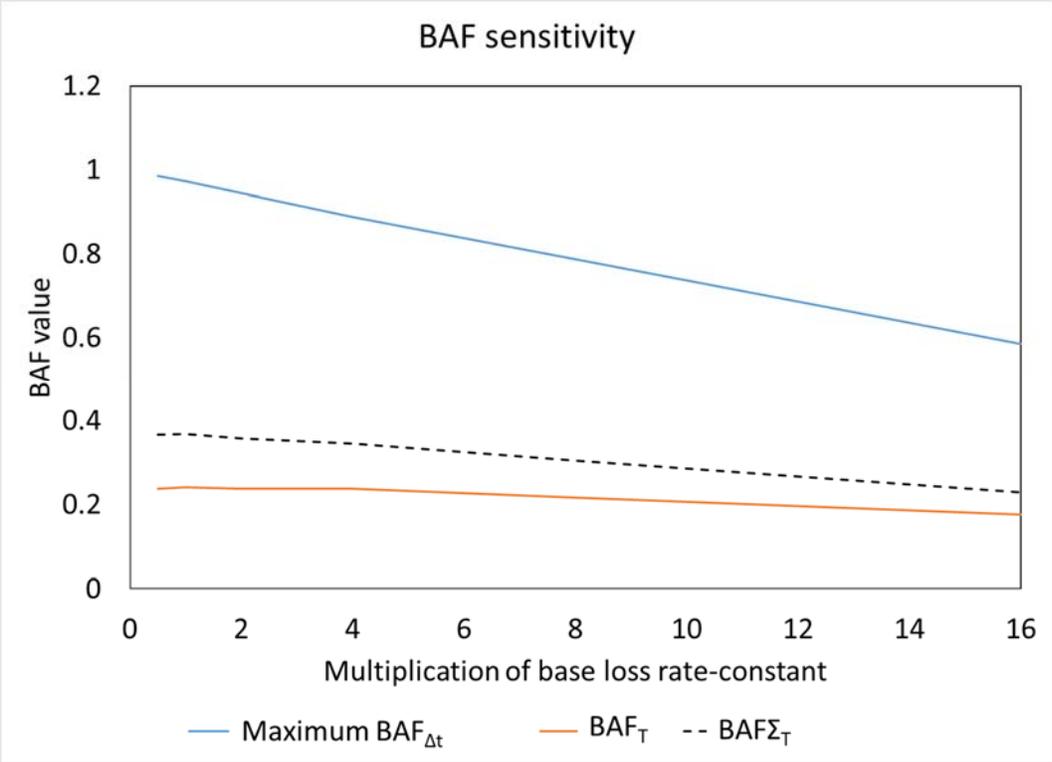


Figure 1. The sensitivity of BAF's to varying the base rate of losses.

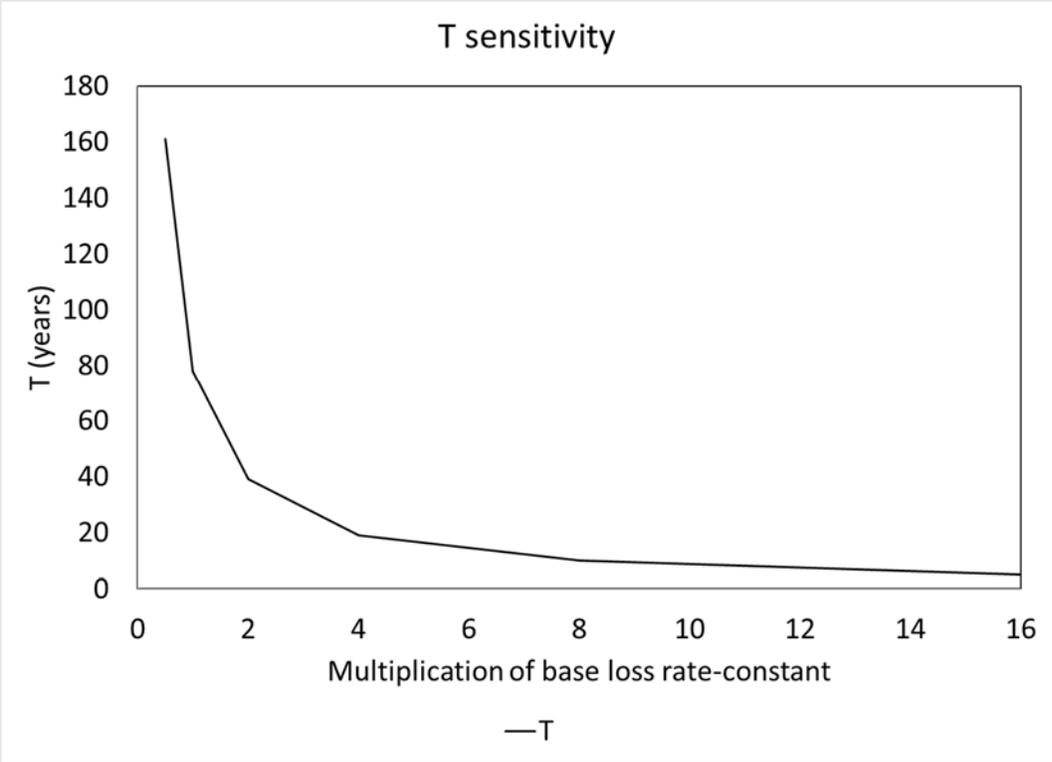


Figure 2. Sensitivity of T to varying the base rate of losses from the policy and reference systems.