Discounting Models

Consider a future event in which a utility value is realized. The typical example is a possible future structural failure that is associated with the cost c_f. When a mitigation action at the present time is contemplated it is appropriate to discount the future cost to present value. Otherwise the impact of the potential future loss is overvalued. It is conventional to employ an exponential discounting function so that the present value is

$$c_p = c_f \cdot \exp(-r \cdot t) \tag{1}$$

where r is the annual real interest rate, i.e., the actual interest rate minus inflation, and t is the time, in years, from present to the time that the cost is incurred. Usually, both r and t are uncertain. The uncertainty in r is modelled by a random variable. The uncertainty in t is addressed by an occurrence model. If the Poisson occurrence model is employed then the time until the first occurrence is modelled by the exponential distribution, with probability density function

$$f(t) = \lambda \cdot \exp(-\lambda \cdot t) \tag{2}$$

where λ is the annual rate of occurrence of the Poisson process. If a long period of time is considered, i.e., approaching 100 years, then an approximation for the expected present value is

$$\begin{aligned} E[c_p] &= \int_0^\infty c_p \cdot f(t) \cdot dt \\ &= \int_0^\infty c_f \cdot \exp(-r \cdot t) \cdot f(t) \cdot dt \\ &= \int_0^\infty c_f \cdot \exp(-r \cdot t) \cdot \lambda \cdot \exp(-\lambda \cdot t) \cdot dt \\ &= c_f \cdot \frac{\lambda}{r + \lambda} \end{aligned} \tag{3}$$