This thesis aimed at developing individual and population models to extrapolate combined effects of toxicants and natural environmental stressors from the individual to the population level. The work consists of both empirical, i.e. concentration-effect, and theoretical mechanistic individual-level effect models. Matrix and Euler-Lotka models have been used as a framework for the extrapolations. The practical applicability of the models was demonstrated by integrating own experimental data and data collected from published scientific literatures. The first chapters of the thesis show how population models can be used to improve the design of ecotoxicological experiments. Then, stochastic density dependent matrix model is developed and a step by step mathematical procedure is presented for estimating combined effects of chemicals, temperature and population density on population dynamics of the model organism *Folsomia candida*. In the following chapters, the individual-level effect model based on Dynamic Energy Budget (DEB) theory is presented to provide a mechanistic interpretation for assessing combined effects of stressors on the vital rates of *F. candida*. This research shows the great potential of energetic-based models, like DEB, for the mechanistic interpretation of the combined effects of multiple stressors on individuals, and their advantages for developing population models to extrapolate effects to population-level. In recent time, a tendency has developed to integrate population models in ecological risk assessment (ERA) process, thus the model frameworks presented in this thesis can be potential tools to address the objectives of this new paradigm in ERA. The studies performed during this Ph.D. project were part of the project CREAM (Mechanistic Effect Models for Ecological Risk Assessment of Chemicals), funded by the European Commission within the 7th Framework Programme.