Abstract

Population models with diverse types of catastrophes can be experienced in many real-life situations. In this thesis, we analyze a number of discrete as well as continuous-time population models which are subjected to mild catastrophes such as *binomial* and *geometric*. As the population models involve different forms of arrival (birth) process of individuals as well as of catastrophes, we use the supplementary variable technique to formulate the steady-state governing equations of the models. For further analysis, we use the difference equation and roots method. The steady-state population size distributions at various epochs are presented in terms of the roots of the associated characteristic equation. The methodology used throughout the thesis is analytically tractable and easily implementable which is illustrated by means of several diversified numerical examples.

This thesis consists of seven chapters where the first chapter is the introductory and covers the background material, literature survey, methodologies and the motivation behind the work done. In Chapter 2, we study a discrete-time binomial catastrophe model in which individuals arrive in batches and catastrophes occur as per the renewal process. In Chapter 3, a discrete-time population model subject to geometric catastrophes under the late arrival system with delayed access and the early arrival system is investigated. Here, individuals in the population arrive according to a batch renewal process and the catastrophes occur according to the Bernoulli process which has a sequential impact on the population. In Chapter 4, we consider a discrete-time geometric catastrophe model wherein the catastrophes occur according to the renewal process and the individuals arrive as per the discrete-Markovian arrival process (D-MAP). A fascinating continuous-time population model with geometric catastrophe is studied in Chapter 5. Here, the population grows according to the batch Markovian arrival process (BMAP) and catastrophes occur as per the Markovian arrival process (MAP). Further, in Chapter 6, we analyze a continuous-time population model subject to binomial catastrophes in which individuals arrive according to the MAP and the catastrophes occur according to the renewal process. Finally, in Chapter 7, we make the concluding remarks and provide some future scope of study along this direction.

Keywords: Batch Bernoulli process; Batch Markovian arrival process; Binomial distribution; Catastrophes; Discrete-time; Early arrival; Geometric catastrophes; Geometric distribution; Late arrival; Markovian arrival process; Phase-type; Population; Population size; Renewal process.