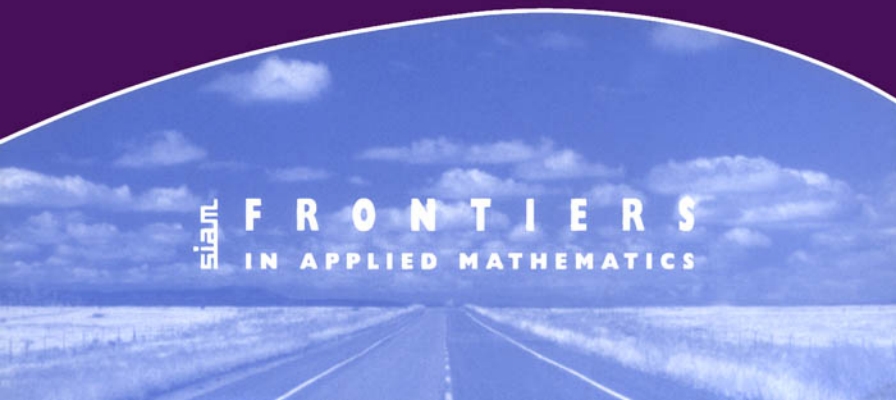
Bioterrorism

Mathematical Modeling Applications in Homeland Security

Edited by

H. T. Banks
Carlos Castillo-Chavez



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Mathematical Modeling Applications in Homeland Security

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Preface

The Centers for Disease Control established and developed intelligence epidemiological services in the early 1950s. This decision, driven by national concerns on the potential use of biological agents as a source of terror, was one of the first systematic responses to bioterrorism. The horror of September 11 and the events that followed have shown that the delivery of biological agents can be carried out by the systematic use of humans as well as by nontraditional means (such as mail).

Recent acts using anthrax have highlighted the use of biological and toxic agents as weapons of mass destruction as well as psychological agents of terror. Speculative discussions on the possible impact of the deliberate release of viruses such as smallpox into unsuspecting human populations have taken place from time to time over the years. The possible genetic manipulation of highly variable viruses such as influenza, for which society might not have an effective vaccine in storage, and their deliberate release are sources of great concern. The current SARS epidemic and its social and economic impact have revived the fears and concerns that were experienced during the anthrax scare of 2001. The avian flu epidemic (in April 2003) in the Netherlands has sent a strong reminder that we must now be prepared to live in a world where the impact of local "perturbations" is felt almost instantly everywhere.

Globalization and the possibility of bioterrorist acts have increased the demand for the development of theoretical and practical frameworks that can anticipate and predict the effects of initiation and considered response to acts of destabilization. Theoretical frameworks and the development of models to respond to specific focused questions will be useful to identify key pressure points in the system, to test for robust system features, and to look at the importance of system modularity and redundancy in addressing threats to various systems. Modeling and system interrogation in the presence of uncertainty have also become key areas of investigation, in which much work remains to be done.

The use of models is not limited to the biological sciences but in fact must be deeply connected to the social, behavioral, and economic sciences. For example, impact of bioterrorist acts on national and cultural behavioral norms has to be of great concern to those in charge of our national and homeland security as well as to economic and financial leaders. Current efforts to understand the mechanisms behind the spread of SARS, approaches to develop models that identify response strategies that minimize the impact associated with the potential deliberate release of biological agents in various topologies, the use of epidemiological approaches to model the spread of fanatic ideologies, and the development of mathematical and statistical approaches that can help in the building of biological and epidemiological "sensors" are but some of the currently hot areas of application that have benefited from recent advances in the fields of theoretical, mathematical, and computational epidemiology.

This volume brings the contributions of a selected group of experts from various fields who have begun to develop models to tackle some of the current challenges raised in biosurveillance, agroterrorism, bioterror response logistics, and assessment of the impact of the deliberate release of biological agents and the social forces that maintain groups of terror. Most of the contributors met first at a DIMACS workshop in March 2002 sponsored by NSF and DIMACS that led to a report co-authored by Fred Roberts and Carlos Castillo-Chavez (see http://dimacs.rutgers.edu/Workshops/WGDeliberate/). The idea of bringing the contributions together in book form came to fruition later in special sessions organized for the SIAM 50th Anniversary Annual Meeting in Philadelphia in July 2002.

Naturally, this volume gives a limited view of the challenges, possibilities, and opportunities that may be tackled with the use of mathematical and computational approaches. Our hope is that the contributions in its 10 chapters may inspire and stimulate research at the interface of homeland security and the mathematical and statistical sciences.

The editors would like to thank April Schilpp and the SIAM publication staff for their help and extreme efficiency in putting this volume together in such a short time. Their efforts and this publication epitomize the goals of the Frontiers series in bringing thoughtful and well-written considerations of emerging scientific issues to the community through rapid publication.

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