frontiers | Frontiers in Applied Mathematics and Statistics

TYPE Editorial
PUBLISHED 04 January 2024
DOI 10.3389/fams.2023.1346541



OPEN ACCESS

EDITED AND REVIEWED BY
Raluca Eftimie,
University of Franche-Comté, France

*CORRESPONDENCE
Bapan Ghosh
✉ keshab.bapan@iiti.ac.in

RECEIVED 29 November 2023
ACCEPTED 11 December 2023
PUBLISHED 04 January 2024

CITATION
Ghosh B, Djilali S and Supriatna AK (2024) Editorial: Justified modeling frameworks and novel interpretations of ecological and epidemiological systems.
*Front. Appl. Math. Stat.* 9:1346541.
doi: 10.3389/fams.2023.1346541



# Editorial: Justified modeling frameworks and novel interpretations of ecological and epidemiological systems

Bapan Ghosh[1]*, Salih Djilali[2] and Asep K. Supriatna[3]

[1]Differential Equations, Modeling, and Simulation Group, Department of Mathematics, Indian Institute of Technology Indore, Indore, India, [2]Department of Mathematics, Faculty of Exact Sciences and Informatics, University of Chlef, Chlef, Algeria, [3]Department of Mathematics, Padjadjaran University, Bandung, West Java, Indonesia

KEYWORDS

**fractional order differential equations, global stability, optimal control theory, fuzzy environment, stochastic environment, predator-prey dynamics, dengue dynamics, COVID-19 pandemic**

Editorial on the Research Topic
Justified modeling frameworks and novel interpretations of ecological and epidemiological systems

Nowadays, researchers have paid significant attention to developing new modeling frameworks using differential equations combined with statistical tools and scientific computations. The present Research Topic has invited researchers to submit their high-quality and well-motivated contributions to modeling and analysis of ecological and epidemiological processes.

Upon a thorough review of all the submitted manuscripts based on the novelty of the contribution we present ten research articles in this article Research Topic. The accepted articles can be categorized into three important subtopics: predator-prey dynamics, disease modeling, and other biological processes. In particular, four articles focused on harvesting, cannibalism, refuge, and foraging behavior in the context of various ecological interactions. The remaining six articles explored dengue dynamics, controlling the spread of COVID-19, preventing illness exposure in susceptible children from pneumonia, and developing mechanisms for tissue repair. The main results of all these articles are discussed in more detail below.

In the first sub topic, Panigoro et al. have proposed a fractional order predator-prey system with two stages for predator species. The authors have assumed harvesting in the prey species. The model has shown that a lower prey harvesting rate could maintain the viability of the species. Moreover, an intermediate harvesting rate could either maintain coexistence or lead to extinction, while an excessive harvesting rate causes extinction of prey species following a saddle-node bifurcation. Meanwhile, Rayungsari et al. have considered a fractional order Rosenzweig-MacArthur type predator prey model incorporating cannibalism among predators. A consecutive Hopf bifurcation has appeared with respect to the cannibalism as well as refuge parameters, leading to a bubble structure in the bifurcation diagram.

The environment is uncertain. This fact makes the parameters in a model also so. With this consideration, Sukarsih et al. proposed the well celebrated Rosenzweig-MacArthur system using fuzzy theoretic framework for possibilistic uncertain parameters and initial conditions. The authors studied the qualitative behavior of the model using the fifth order Runge-Kutta method, which was modified for the fuzzy system using the Zadeh extension principle. This contribution uncovered that when the initial populations of prey and predators are uncertain, the behavior of the fuzzy model would be qualitatively the same as the crisp model. Prakash and Vamsi have implemented a time optimal control for a predator-prey system in continuous white noise and discontinuous Levy noise modeling framework to understand the trade-off between quality and quantity of additional food to predators.

In the second subtopic, Aldila et al. have used Quasi-Steady State Approximation (QSSA) method in a SIR-UV vector-borne disease model in order to make the complicated and coupled SIR-UV system into a simple IR-model. This investigation potentially revealed that dengue would periodically appear at least every year in Jakarta. Another vector-borne disease model (Coffield Jr. et al.), uncovers the dynamics of Chagas disease transmission in neighbouring villages. They reported that the effects of human travel and passive vector migration are unlikely to play a significant role in the overall dynamics and in the number of human infections. Hence, control strategies related to travel will also unlikely yield meaningful benefit.

We have witnessed the dramatic loss of human life and the collapse of the world economy due to COVID-19. The COVID-19 patients faced more challenges when they had other diseases prior to COVID-19 infection. Rois et al. proposed a COVID-19 model with comorbidity to estimate cumulative cases infected with COVID-19 from 1 November 2020 to 19 May 2021 in Indonesia. The number of COVID-19 infections can reduce significantly by means of two optimal controls, namely public education and increased medical care. In the same line, Teklu and Terefe developed a new COVID-19 and syphilis co-infection mathematical model with ten distinct classes of the human population. The model analyses showed that the COVID-19 and syphilis co-infection spread could be under control whenever the basic reproduction number is less than unity. They also demonstrated that the protections and treatments are the two fundamental control aspects. Legesse et al. developed a mathematical model to understand the impact of exclusive versus inclusive nursing on baby mortalities and morbidities from conception to 6 months. The main conclusion of this study is that limiting pneumonia transmission to prevention alone during an outbreak is the most cost-effective approach.

Finally, in the third sub section, Mulk et al. implemented inverse finite element (FE) techniques and optimized algorithms to examine the mechanical properties of PVA-C specimens. The mechanism in designing and characterizing soft tissue materials is a novel contribution in this research.

The Research Topic successfully presents genuine, recent, and important results in modeling and analysis of ecological and epidemiological processes. The results can be summarized as follows Panigoro et al. contribution leads to interesting guidelines in fishery management and biological conservation. The bubble formation in the context of fractional predator-prey systems (Rayungsari et al.) is also a new phenomenon. How biological-interaction and stochastic environmental processes affect the dynamics of predator-prey systems are nicely explained by Sukarsih et al. and Prakash and Vamsi. As proposed, the articles in this Research Topic accomplished either numerical simulation, case studies, experimental data, or field observations to illustrate and validate their theories, principles, and results (Aldila et al.; Rois et al.; Teklu and Terefe; Legesse et al.; Coffield Jr. et al.). For instance, combining mathematical models and real-data, Aldila et al. concluded that dengue in Jakarta will periodically appear at least every year. They suggested some action plans to control the disease. Rois et al. and Teklu and Terefe formulated COVID-19 models independently. They proposed some control tactics in reducing the COVID-19 cases. All the contributions, along with mathematical, statistical, and numerical tools, are able to explain new ecological dynamics and suggest prudent disease control strategies.

## Author contributions

BG: Conceptualization, Project administration, Resources, Supervision, Visualization, Writing – original draft, Writing – review & editing. SD: Conceptualization, Supervision, Visualization, Writing – review & editing. AS: Conceptualization, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing.

## Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

## Acknowledgments

We are grateful to all the eminent authors for publishing their valuable contributions to this Research Topic. We would like to thank the reviewers for their thoughtful comments and efforts towards improving the content for all the manuscripts. We sincerely appreciate all helps and suggestions received from Frontiers team over time.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Publisher's note