**NM-AIST Repository** 

https://dspace.mm-aist.ac.tz

Life sciences and Bio-engineering

Research Articles [LISBE]

2024-12-31

## Extinction and persistence of lumpy skin disease: a deep learning framework for parameter estimation and model simulation

Renald, Edwiga

Springer Nature Link

https://link.springer.com/article/10.1007/s40808-024-02208-8

Provided with love from The Nelson Mandela African Institution of Science and Technology

Extinction and persistence of lumpy skin disease: a deep learning framework for

parameter estimation and model simulation

Edwiga Renald, Jean M Tchuenche, Joram Buza, Verdiana G Masanja

To download the complete text, click that link.

DOI: https://link.springer.com/article/10.1007/s40808-024-02208-8

Abstract

Lumpy Skin Disease (LSD) of cattle, an infectious and fatal viral ailment, poses a significant

challenge to the farming sector due to its economic impact. A deterministic Susceptible-Exposed-

Infectious-Recovered-Susceptible (SEIRS) model, is utilized in developing a Physics-Informed

Neural Network—a deep learning framework for parameter estimation and simulation of LSD

dynamics. The deep learning structure is presented alongside an illustration of its application using

synthetic data on infectious cattle counts. To accommodate inherent variability in the model, the

deterministic version is extended to a stochastic model by introducing environmental noise,

assuming that biting rate is the primary source of randomness. Lyapunov second method is used

to prove the existence of a unique global positive solution for the stochastic model under specified

initial conditions. Subsequently, the stochastic model is employed to establish conditions for both

extinction and persistence. Results of the stochastic model simulation indicate potential eradication

of the disease when the environmental noise decreases. On the other hand the designed Physics-

Informed Neural Network for LSD demonstrates high efficiency in model prediction and

parameter estimation especially when few data is available. Analytical results underscore the

importance of implementing strategies to reduce biting such as biological control methods as a

means to mitigate the transmission of LSD.