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# RESEARCH OF A NONLINEAR CHANGING MODEL OF SIR TYPE

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Currently, the research of biological models is very important. This research will be closely related to the theory of differential equations. This is not surprising, because one of the important problems of mathematical ecology is the problem of the stability of ecosystems, the management of these systems. Management can be considered with the aim of transferring a system from one stable state to another, with the aim of using it or restoring an ecosystem [1].

In this work we consider a relevant problem related to the spread of infectious diseases. Our task is to consider various population models in epidemiology, analyze the methods of their research. One of the most common classes of models used in various fields of medicine is compartment or multi-chamber models [2]. The widespread use of compartment models is observed among quantitative methods for analyzing and predicting the dynamics of epidemics, since these models simplify the mathematical modeling of infectious diseases [3].

In this work, the SIR model was investigated, which allows calculating the optimal vaccination strategy for infectious diseases [4]. The following parameters are used: contact coefficient $\beta(t)$ such that $\beta(t) > 0$; vaccination coefficient $\psi(t)$ such that $\psi(t) > 0$; population growth rate *b*, such that $b \geq 0$; the exit coefficient (which is more related to the exit from the considered population than to mortality) $\mu$, such that $\mu \geq 0$; recovery coefficient $\alpha$, such that $\alpha \geq 0$.

Then the SIR model will look like:

$$\frac{d}{dt}S = b - \mu S - \psi(t)S - \beta(t)SI,$$

$$\frac{d}{dt}I = -\mu I + \beta(t)SI - \alpha I,$$

$$\frac{d}{dt}R = -\mu R + \psi(t)S + \alpha I.$$

Here *S(t)* (Susceptible) – the number of susceptible individuals in the population at time t, that is, individuals that can become infected with the disease; *I(t)* (Infectious) – the number of individuals in the population at time t that were infected with the disease and can spread the disease to those in the susceptible category *S(t)*; *R(t)* (Recovered) – the number of recovered individuals in the population at time t, that is, individuals that are immune to the disease and cannot transfer it to the susceptible category *S(t)*.

The analysis should take into account the key assumptions that make the model more realistic. It is assumed that after the administration of several doses of the vaccine, the uninfected will be resistant to repeated outbreaks of the disease. In addition, vaccination is aimed only at the receptive part of the population.

In this work, we looked at compartment models and how they can be used. For further analysis, a SIR model was formulated that allows calculating the optimal vaccination strategy for infectious diseases. Also in this work, the fixed points of the introduced model were found and analyzed.

## References

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