Dynamic computer Model of influence environmental factors on the spread of Asthma

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Abstract

In work [1] the influence of various single environmental factors in the nonlinear model of Asthma. In the present work, is presented a visualized computer model that allows investigate the influence of groups of factors on the distribution of asthma by changing the model parameters in certain ranges.

Keywords: computer model; program realization; visualization; asthma; environment; smoking; pollution.

1 Introduction

Asthma is a chronic lung disease in which air passages get inflamed [2]. When it happens, airways narrow and it is difficult for air to move from the nose and mouth to the lungs. Often the reason of sickness can be heredity or various polluting environment's factors. Studies reveal that tobacco smoke causes asthma, because the Cigarette smoke contains high concentration of irritants.

2 Mathematical Model

Mathematical model [1] is proposed as follows:

$$\begin{cases} \dfrac{dS(t)}{dt} = \Lambda - \mu S - \gamma SP - \beta SC \\ \dfrac{dE(t)}{dt} = \gamma SP + \beta SC - \lambda_1 EP - \lambda_2 EC - \mu E \\ \dfrac{dI(t)}{dt} = \lambda_1 EP + \lambda_2 EC + \theta_1 C + \theta_2 CP - \alpha I - \mu I \\ \dfrac{dC(t)}{dT} = Q - \theta_1 C - \theta_2 CP - \theta C - \mu C \\ \dfrac{dP(t)}{dt} = A(N) - \tau P + qC \\ \dfrac{dN(t)}{dt} = \Lambda + Q - \mu N - \alpha I - \theta C, \end{cases} \quad (1)$$

Where N(t) is total population divided in 4 classes:

- S(t) is sensitiv class; E(t) is injured class;
- I(t) is asthmatic class; C(t) is smokers class.

P(t) is the cumulative concentration of harmful substances (tobacco magnate) in the environment.

Sensitive people go to asthmatic class by the prolonged exposure to substances that pollute the air and two-step interaction with smokers (coefficient of transition γ and β). Then they become injured class from a long interaction with smokers and polluters (coefficient of transition λ_1 and λ_2).

Table 1: Transition from class to class.

Variable	Name in the system
α	Mortality rate in consequence of sickness
β	$S(t) \to E(t)$
γ	$S(t) \xrightarrow{P(t)} E(t)$
Λ	$E(t) \xrightarrow{P(t)} I(t)$
λ_1	$E(t) \xrightarrow{C(t)} I(t)$
λ_2	$E(t) \xrightarrow{P(t)} I(t)$
μ	Natural mortality
τ	Natural rate coefficient of environmental pollutants
θ	Rate at which smokers quit smoking
θ_1	Rate at which smokers become infected
θ_2	$C(t) \xrightarrow{P(t)} E(t)$
Q	Rate at which new members become smoker
q	Pollution's speed of environment through smokers
A	Initial concentration of contaminant

3 Programmatic realization of the mathematical Asthma's Model

The mathematical model (1) of asthma is programmatically simualted:

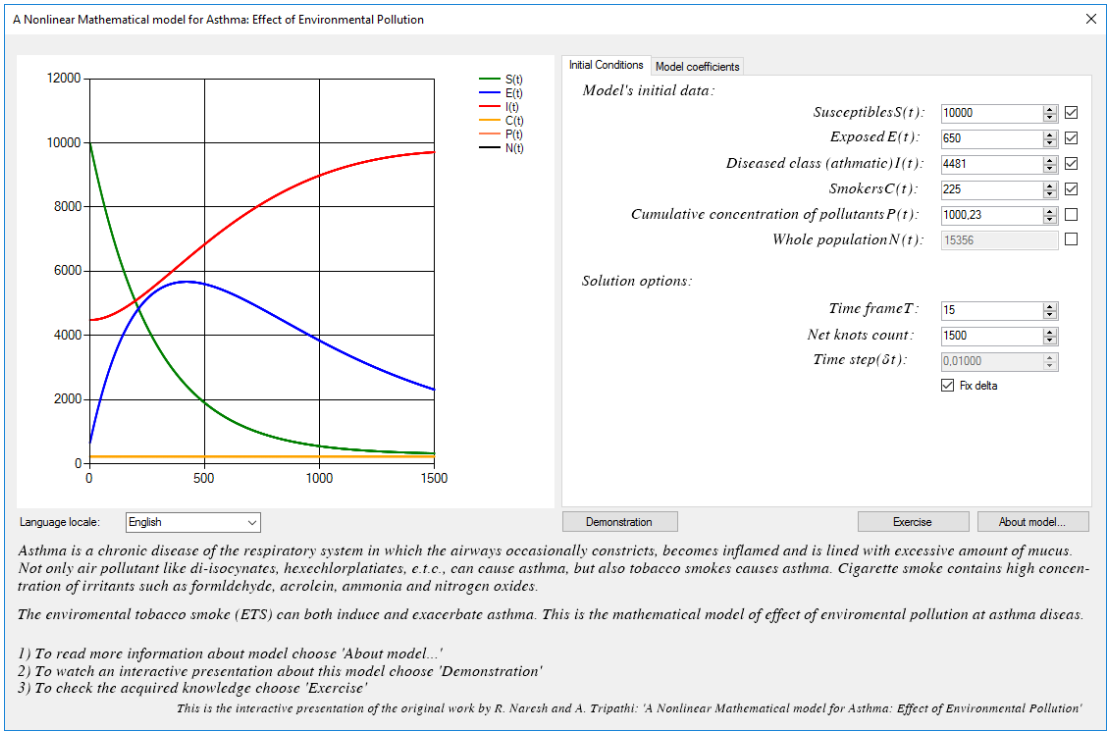

Figure 1: Visualizing of the Asthma's Model

Visualizing of the mathematical model enables to follow the changes of different population's classes by changing the model parameters in given ranges.

The main objective of the work is to visually through a mathematical model the impact of such factors as smoking and environmental pollution to the spread of asthma among the population The feasibility of some parameters is also important.

During the analysis, we will set the initial conditions (Table 1) and change the parameters of the Model.

Table 1: Initial conditions of the Model

S(t)	*E(t)*	*I(t)*	*C(t)*	*P(t)*	*N(t)*
10000	650	4481	225	1000,23	15356

At first, it's necessary to evaluate influence of smoking to asthmatic's number.

In Figure 2 smoking-related factors are selected.

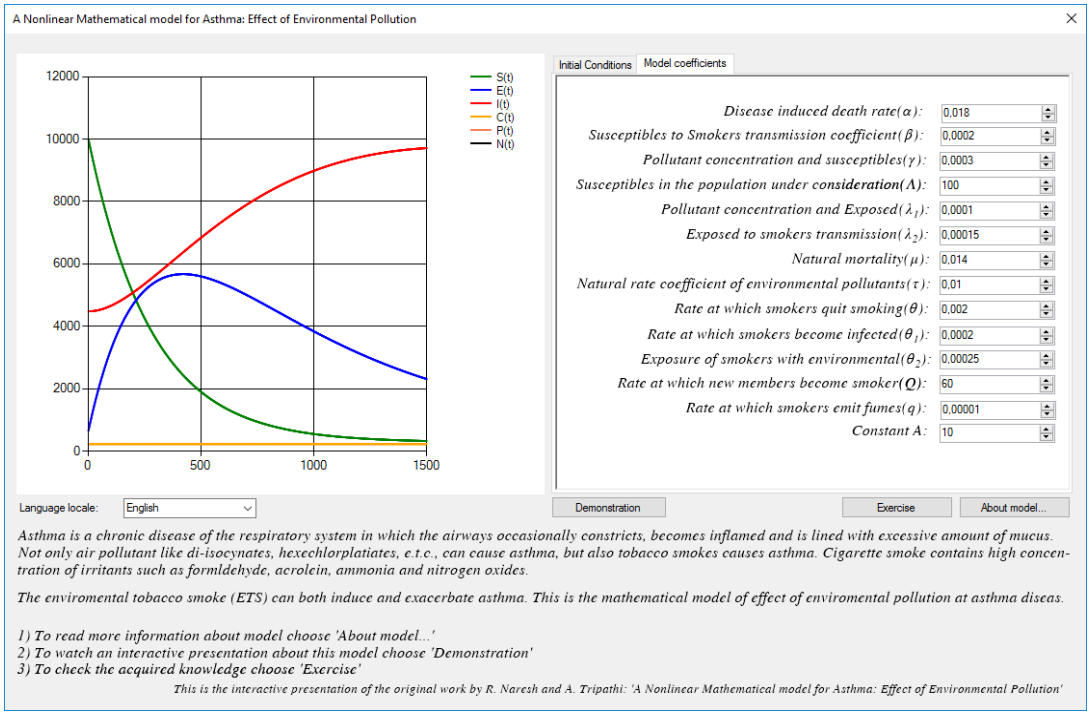

Figure 3: Impact of smoking on population

With the increase in smoking rates (Figure 4), the populations from the class exposed moves to the class susceptibles.

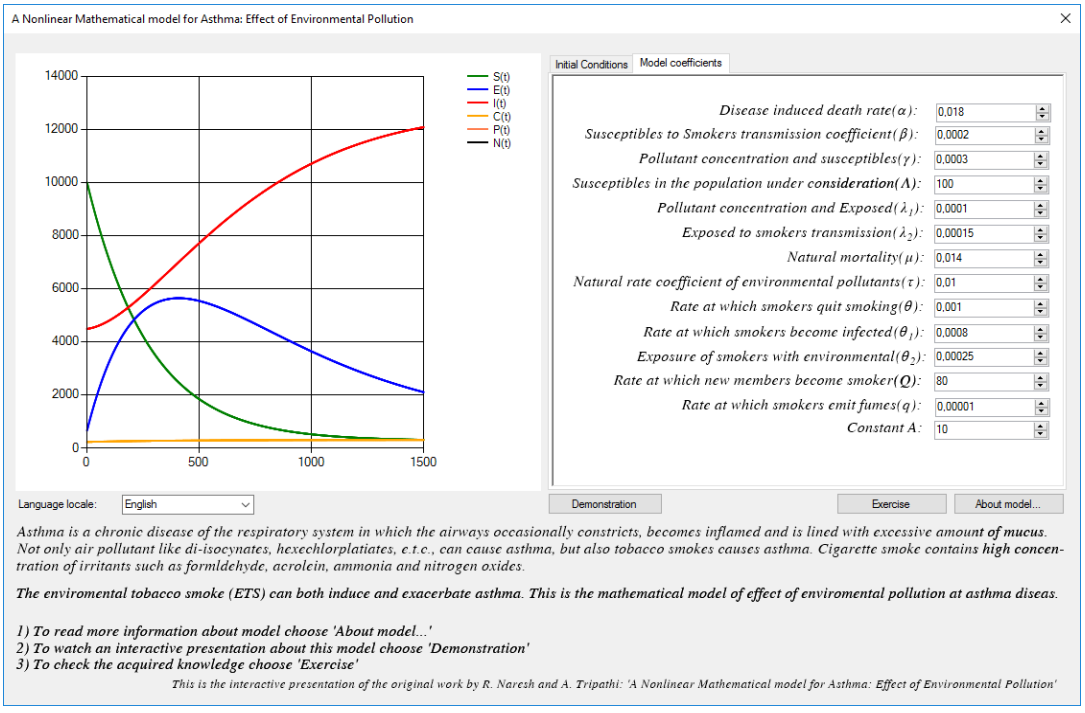

Figure 4: Impact of smoking on population

Smoking affects the number of asthmatic class, so the state needs to take measures to reduce the number of smokers and to protect the population from smokers (Figure 4).

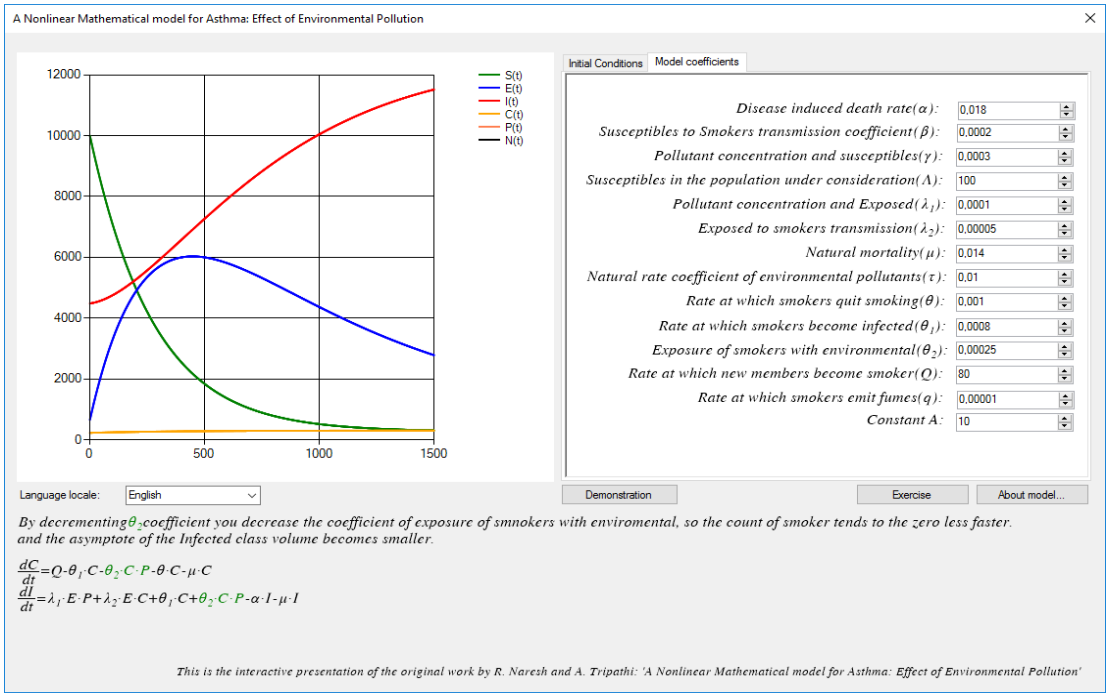

Figure 4: Impact of the smokers contact with the population

It is also worth noting that, in the interaction of smokers with the environment (fresh air, etc.), the number of patients is declining (Figure 5).

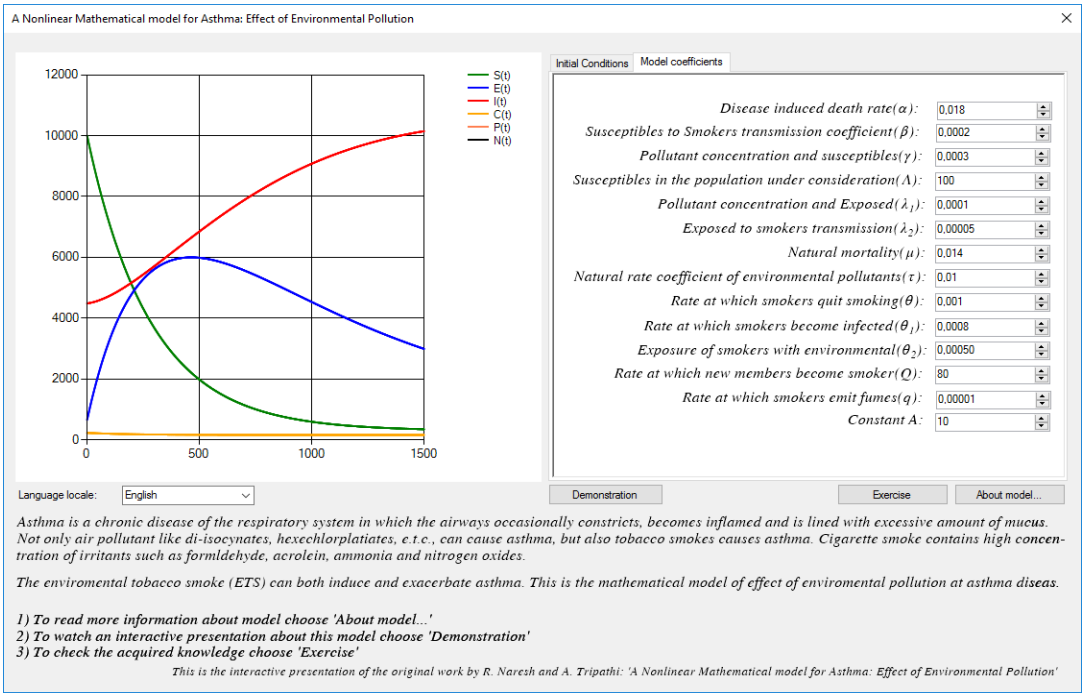

Figure 5: Impact of coefficient (θ_2) on population

Another factor influencing the number of asthmatic class is the number of pollutants. With the increase in the number of pollutants, patients are increasing.

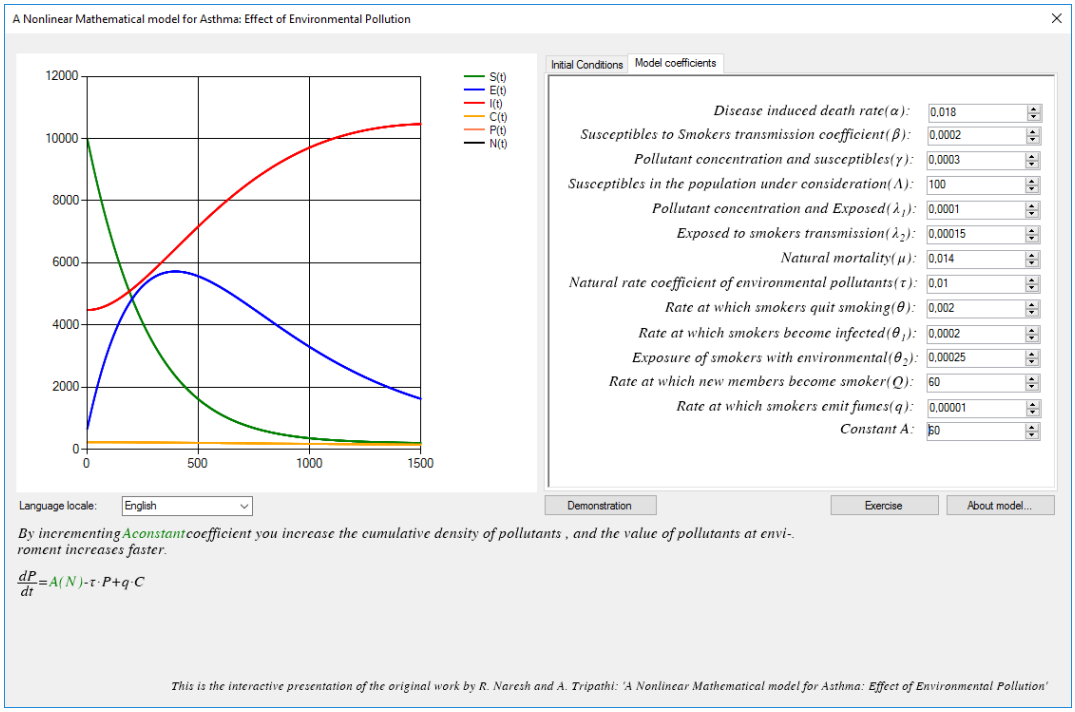

Figure 6: Increase in the number of patients with increased pollutants

Conclusion

The obvious factor influencing the growth in the number of patients is a constant smoking. The interaction of smokers with quality environment reduces the number of asthmatics, but increases the number injured. In addition, the increase of pollutants in the atmosphere increases the number of asthmatic and injured.

Computer visualizing of the mathematical model [1] give possibility to efficient exploring of influence's degree of factors of environment for changes in population.

References

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