Mathematical and Computer Models of Settlements of Political Conflicts and Problems of Optimization of Resources

T. Chilachava and G. Pochkhu

Abstract—Nonlinear mathematical models of economic cooperation between two politically (non-military confrontation) mutually opposing sides (two countries or a country and its legal region) are proposed, which consider economic cooperation between parts of the population of the sides, aimed at rapprochement of the sides and peaceful settlement of conflicts. Mathematical models imply that the process of economic cooperation is free of political pressure, that is, the governments of opposing and external sides do not interfere in this process.

With some dependencies between constant model coefficients, the first integrals and exact analytical solutions are found. A theorem has been proven to optimize (minimize) the financial resources at which economic cooperation can peacefully resolve political conflict (in the mathematical model we assume that the conflict is resolved if at the same time more than half of the population of both sides support the process of economic cooperation, which promotes political reconciliation).

In general, with the variable coefficients of the mathematical model, a computer simulation in the MATLAB software environment was performed to numerically solve the Cauchy problem for a nonlinear dynamic system. Numerical solutions have been obtained, and appropriate graphs have been built. The minimum values of model coefficients (control parameters; optimization of financial resources) under which conflict resolution is possible have been found.

Index Terms—Computer modelling, mathematical models of resolution of conflict, optimization of resources.

I. INTRODUCTION

Synergetics gave a powerful push using of mathematical models in social sciences: sociology, history, demography, political science, conflicting science, globalization etc. Creation of mathematical models is more original in social sphere, because, they are more difficult to substantiate [1]–[5].

In 2005, mathematicians Robert Aumann and Thomas Schelling won the Nobel Prize in Economics for the scientific work cycle “Understanding of the problems of the conflict and cooperation through the game theory”.

Regarding to the conflict, the “repeated game” principle presents another important methodological aspect of mathematical modelling (game theory). According to this principle: the long-term relationship of subjects in competition can generate cooperation between them, for which, there cannot be found a sufficient basis in case of one time relationship (contact). In other words, long-term relationship generates common interests and preconditions for cooperation.

Lee Kuan Yew, author of the Singaporean “Economic Miracle”, noted: “If you want economic growth, do not break out the war with neighbors, establish trade relations with them, instead”.

Considering the existing conflict regions in the world, we consider this kind of mathematical models are very perspective and innovative, including computer simulation that can determine conditions (dependence between model parameters) for which conflict can be solved.

We created new nonlinear mathematical models of economic cooperation between two politically (not martial) inter conflicting sides (possible states or country and its legal region), which envisages economic or other type of cooperation between the part of population of the sides, direction towards the rapprochement of the sides and the peaceful resolution of the conflict [6]–[9].

II. MATHEMATICAL MODEL DESCRIPTION OF SETTLEMENT OF THE BILATERAL CONFLICT BY MEANS OF ECONOMIC COOPERATION

The nonlinear mathematical model (the dynamic system) of economic cooperation between two warring sides offered by us has an appearance:

\[
\begin{align*}
\frac{dN_1(t)}{dt} &= -\alpha_1(t)[a(t) - N_1(t)][b(t) - N_2(t)] + \beta_1(t)N_1(t)N_2(t) \\
\frac{dN_2(t)}{dt} &= -\alpha_2(t)[a(t) - N_1(t)][b(t) - N_2(t)] + \beta_2(t)N_1(t)N_2(t)
\end{align*}
\]

(1)

where \(N_1(t)\) - number of the citizens of the first side in time-point \(t\), wishing or already being in economic cooperation and inclined to the subsequent peaceful resolution of the conflict, \(N_2(t)\) - number of the citizens of the second side in time-point \(t\), wishing or already being in economic cooperation and inclined to the subsequent peaceful resolution of the conflict, \(\alpha_1(t), \alpha_2(t)\) - coefficients of aggression (alienation) of the sides, \(\beta_1(t), \beta_2(t)\) - coefficients of cooperation of the sides (financial support (investment) of international peacekeeping organizations, encouraging economic cooperation of the sides; parameters of management), \(a(t), b(t)\) - the population according to the first and second sides in time-point \(t\), \(N_1, N_2 \in C^1[0, T]\), \(T\) - time interval for model (conflict) consideration.

We assume that rather weak condition of resolution of conflict are (in the mathematical model we assume that the
conflict is resolved if at the same time more than half of the population of both sides support the process of economic cooperation, which promotes political reconciliation:

\[
\begin{align*}
\frac{a(t)}{2} < N_1(t) &\leq a(t), \quad t \geq t_1, \\
\frac{b(t)}{2} < N_2(t) &\leq b(t).
\end{align*}
\]

Let's consider a special case of constant coefficients of mathematical model (1):

\[
\alpha_i(t) = \alpha_i = \text{const} > 0, \quad \beta_i(t) = \beta_i = \text{const} > 0, \quad i = 1, 2.
\]

In (1) mathematical model \(\beta_1, \beta_2\) are coefficients (factors) of cooperation of the sides, depending on financial support (investments) of international peacekeeping organizations, promoting the process of economic cooperation of the sides, i.e. are parameters of management.

It is natural and interesting to find the minimum value of these factors at which the conflict can be resolved, i.e. to find the minimum values of external investments that facilitate the process of cooperation between the sides, in order to resolve the conflict.

The following theorem minimizes these factors in which a political conflict can be resolved.

**Theorem:** If the ratios are fair

\[
\frac{\beta_1}{\alpha_1} = \frac{\beta_2}{\alpha_2} = \frac{1}{p} > 1,
\]

\[
\beta_i > \alpha_i \left(1 - \frac{a}{N_{10}} - \frac{b}{N_{20}} \right)
\]

Then the exact analytical solution to the Cauchy’s problem

\[
\begin{align*}
\frac{dN_1(t)}{dt} &= -\alpha_1 [a - N_1(t)][b - N_2(t)] + \beta_1 N_1(t) N_2(t), \\
\frac{dN_2(t)}{dt} &= -\alpha_2 [a - N_1(t)][b - N_2(t)] + \beta_2 N_1(t) N_2(t),
\end{align*}
\]

\[N_1(0) = N_{10}, \quad N_2(0) = N_{20},\]

Meets conditions

\[
\begin{align*}
\frac{a}{2} < N_1(t_1) &\leq a, \\
\frac{b}{2} < N_2(t_1) &\leq b,
\end{align*}
\]

when

\[
t_1 = \max \left\{ \frac{1}{\sqrt{\epsilon^2 + 4\delta^2 (1 - p)\beta_2}} \ln \left[ \frac{a}{2} \frac{N_{13}}{N_{10} - N_{14}} \right], \frac{1}{\sqrt{\epsilon^2 + 4\delta^2 (1 - p)\beta_2}} \ln \left[ \frac{s - N_{13}}{s - N_{14}} \frac{N_{10} - N_{14}}{N_{10} - N_{13}} \right] \right\},
\]

\[
s = \beta_1 \left( \frac{b}{2} - N_{20} \right) + N_{10},
\]

\[\delta^2 = p\beta_2 N_{10} + (b - N_{20})\beta_2, \quad \epsilon = \beta_1 p + \beta_2 p + \beta_2 (1 - p) N_{20} - (1 - p)\beta_2 N_{10}, \]

\[N_{13} = -\frac{\epsilon}{2(1 - p)\beta_2} + \frac{\sqrt{\epsilon^2 + 4\delta^2 (1 - p)\beta_2}}{2(1 - p)\beta_2} > 0, \]

\[N_{14} = -\frac{\epsilon}{2(1 - p)\beta_2} - \frac{\sqrt{\epsilon^2 + 4\delta^2 (1 - p)\beta_2}}{2(1 - p)\beta_2} < 0. \]

A. Computer Modelling

In the general case of the mathematical model (1) the exponential functions are taken as variable coefficients and computer modelling are performed \(t \in [0, T]\).

The calculations are performed during the model review period.

Computer modelling (simulations), depending on the variable coefficients of the model, produce two different results:

There exists time \(t_1: 0 < t_1 \leq T\), for which system (2) is completed (the conflict is resolved).

The system (2) is not completed with \(t \in [0, T]\) segment (the conflict is not resolved).

For certainty, below we use the following increasing or non-decreasing exponential functions:

\[
a(t) = a_0 e^{-\frac{\epsilon}{10}}, \quad b(t) = b_0 e^{-\frac{\epsilon}{10}},
\]

\[
\alpha_1(t) = \alpha_{10} e^{-\frac{\epsilon}{10}}, \quad \alpha_2(t) = \alpha_{20} e^{-\frac{\epsilon}{10}}, \quad \beta_1(t) = \beta_{10} e^{-\frac{\epsilon}{10}}, \quad \beta_2(t) = \beta_{20} e^{-\frac{\epsilon}{10}}, \quad (3)
\]

where

\[a_0 = 2 \cdot 10^5\] - the population of first side (at start point in time, start of process),

\[b_0 = 4 \cdot 10^6\] - the population of second side (at start point in time, start of process),

\[N_{10} = 2 \cdot 10^4 - 10\%\] of the population of first side (at start point in time, start of process),

\[N_{20} = 8 \cdot 10^5 - 20\%\] of the population of second side (at start point in time, start of process),

\[n_1, n_2\] - the coefficients of demographic factors,

\[n_3, n_4\] - the coefficients of aggression,

\[n_5, n_6\] - the coefficients of cooperation.

For clarity we allow that \(T = 120\) or \(T = 240\) months.

Computer simulations of the system of differential equations (1), in case (3) resulted in the following results:

with zero demographic factors of the sides, in cases 1, 3, 5, 10, 13, 15, 16 (see corresponding Figs. 1, 3, 5, 10, 13, 15, 16), the conflict is resolved (system (2) is completed), and in cases 2, 4, 6-9, 11, 12, 14 (see corresponding Figs. 2, 4, 6-9, 11, 12, 14) - the conflict is not resolved (system (2) is not completed).

With non-zero demographic factors of the sides in cases 19, 20 (see corresponding Figs. 19, 20), the conflict is resolved, and in cases 17, 18 (see corresponding Figs. 17, 18), the conflict is not resolved.

**Case 1:**

\[\alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is resolved \((t = t_1 = 120)\) (the system (2) is completed).

\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 12 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

**Case 2:**
\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

**Case 3:**
\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7.33 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The have founded minimum \(\beta_{20}\) when the conflict is resolved \((t = t_1 = 120)\), others parameters in case 1, 2 and 3 are unchanged (the system (2) is completed).

**Case 4:**
\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 0.982 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The have founded minimum \(\beta_{10}\) when the conflict is resolved \((t = t_1 = 120)\) (the system (2) is completed).

**Case 5:**
\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

We have changed the power for \(\alpha_{10}\) and \(\alpha_{20}\) coefficients.

The conflict is not resolved (the system (2) is not completed).

**Case 6:**
\[ \alpha_{10} = 4 \cdot 10^{-10}, \alpha_{20} = 1 \cdot 10^{-10}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

**Case 7:**
\[ \alpha_{10} = 1 \cdot 10^{-10}, \alpha_{20} = 6 \cdot 10^{-10}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

**Case 8:**
\[ \alpha_{10} = 8 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 4 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

**Case 9:**
\[ \alpha_{10} = 8 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 4 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 2.5. \]

We have increased the coefficient. The conflict is not resolved (the system (2) is not completed).

**Case 10:**
\[ \alpha_{10} = 8 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 4 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 1, \ n_4 = 1, \ n_5 = 1, \ n_6 = 1.999. \]

The conflict is not resolved (the system (2) is not completed).

**Case 11:**
\[ \alpha_{10} = 8 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 4 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 4, \ n_4 = 1, \ n_5 = 1, \ n_6 = 3. \]

The conflict is not resolved (the system (2) is not completed).

**Case 12:**
\[ \alpha_{10} = 8 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 8 \cdot 10^{-8}, \]
\[ n_1 = 0, \ n_2 = 0, \ n_3 = 4, \ n_4 = 1, \ n_5 = 1, \ n_6 = 3. \]

The conflict is not resolved (the system (2) is not completed).
Case 13:

\[ \alpha_{10} = 5.5 \cdot 10^{-11}, \alpha_{20} = 2 \cdot 10^{-11}, \beta_{10} = 1.1 \cdot 10^{-8}, \beta_{20} = 8 \cdot 10^{-8}, \]

\[ n_1 = 0, \quad n_2 = 0, \quad n_3 = 0, \quad n_4 = 2.5, \quad n_5 = 1, \quad n_6 = 4. \]

The conflict is resolved \((t = t_1 = 71)\) (the system (2) is completed).

Case 14:

In case 7 we have increased the period.

\[ \alpha_{10} = 1 \cdot 10^{-10}, \alpha_{20} = 6 \cdot 10^{-10}, \beta_{10} = 1.1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]

\[ n_1 = 0, \quad n_2 = 0, \quad n_3 = 1, \quad n_4 = 1, \quad n_5 = 1, \quad n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

Case 15:

In case 14 we have changed \(n_3, n_6\) coefficients.

\[ \alpha_{10} = 1 \cdot 10^{-10}, \alpha_{20} = 6 \cdot 10^{-10}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]

\[ n_1 = 0, \quad n_2 = 0, \quad n_3 = 1, \quad n_4 = 1, \quad n_5 = 0.5, \quad n_6 = 3.5. \]

The conflict is resolved \((t = t_1 = 208)\) (the system (2) is completed).

Case 16:

\[ \alpha_{10} = 1 \cdot 10^{-10}, \alpha_{20} = 6 \cdot 10^{-10}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 9 \cdot 10^{-8}, \]

\[ n_1 = 0, \quad n_2 = 0, \quad n_3 = 1, \quad n_4 = 0.1, \quad n_5 = 0.5, \quad n_6 = 3.5. \]

In case 15 we have founded minimum \(n_4\) when the conflict is resolved \((t = t_1 = 206)\) (the system (2) is completed).

Case 17:

In case 1 we have changed \(n_1\) coefficient.

\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]

\[ n_1 = 0.5, \quad n_2 = 0, \quad n_3 = 1, \quad n_4 = 1, \quad n_5 = 1, \quad n_6 = 1. \]

The conflict is not resolved (the system (2) is not completed).

Case 18:

In case 17 we have increased the period.

\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]

\[ n_1 = 0.5, \quad n_2 = 0, \quad n_3 = 1, \quad n_4 = 1, \quad n_5 = 1, \quad n_6 = 1. \]

The conflict is not resolved \((t = t_1 = 166)\) (the system (2) is not completed).

Case 19:

In case 18 we have changed \(n_2\) coefficient.

\[ \alpha_{10} = 4 \cdot 10^{-11}, \alpha_{20} = 1 \cdot 10^{-11}, \beta_{10} = 1 \cdot 10^{-8}, \beta_{20} = 7.5 \cdot 10^{-8}, \]

\[ n_1 = 0.5, \quad n_2 = 0.2, \quad n_3 = 1, \quad n_4 = 1, \quad n_5 = 1, \quad n_6 = 1. \]

The conflict is resolved \((t = t_1 = 166)\) (the system (2) is completed).
both sides support an economic cooperation process that promotes political reconciliation.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

The idea of creating a general mathematical model describing the possibility of conflict resolution, as well as the mathematical formulation of the problem belongs to the prof. Temur Chilachava. He also owns the formulation and proof of the resource optimization theorem in the case of constant coefficients of the model. Doctoral candidate George Pochkhua in the general case, for various variable coefficients of the mathematical model, carried out computer modelling in the software environment MATLAB, made numerous numerical calculations, by means of which optimized parameters (control parameters) of the model for conflict resolution.

REFERENCES

[1] T. Chilachava, “Research of the dynamic system describing globalization process,” Springer Proceedings Mathematics & Statistics, Mathematics, Informatics, and their Applications in Natural Sciences and Engineering, AMINSE 2017, Tbilisi, Georgia, December 6-9, vol. 276, pp. 67–78, 2019.
[2] T. Chilachava, “Nonlinear mathematical model of dynamics of voters of two political subjects,” in Proc. Seminar of I. Vekua Institute of Applied Mathematics, 2013, vol. 39, pp. 13–22.
[3] T. Chilachava, "About some exact solutions of nonlinear system of the differential equations describing three-party elections," Applied Mathematics, Informatics and Mechanics, 2016, vol. 21, no. 1, pp. 60-75.
[4] T. Chilachava and T. Gvinjilia, “Research of the dynamic systems describing mathematical models of training of the diplomated scientists,” Seminar of I.Vekua Institute of Applied Mathematics, Reports, 2017, vol. 43, pp. 17–29.
[5] T. Chilachava and T. Gvinjilia, “Research of three and two-dimensional nonlinear dynamical systems describing the training of scientists,” Applied Mathematics, Informatics and Mechanics, 2017, vol. 22, no. 1, pp. 3–20.
[6] T. Chilachava, “Mathematical model of economic cooperation between the two opposing sides,” I in Proc. X International Conference of the Georgian Mathematical Union, 2018, Batumi, pp. 96-97.
[7] T. Chilachava and G. Pochkhua, “Research of the dynamic system describing mathematical model of settlement of the conflicts by means of economic cooperation,” GESI: Computer Science and Telecommunications, 2018, no. 3, vol. 55, pp. 18-26.
[8] T. Chilachava and G. Pochkhua, “About a possibility of resolution of conflict by means of economic cooperation,” in Proc. The XXVI International Conference Problems of Management of Safety of Difficult Systems, Moscow, 2018, pp. 69–74.
[9] T. Chilachava and G. Pochkhua, “Research of the nonlinear dynamic system describing mathematical model of settlement of the conflicts by means of economic cooperation,” in Proc. 8th International Conference on Applied Analysis and Mathematical Modelling, ICAAMM 2019, 2019, pp. 183–187.

CONCLUSION

Thus, with some dependence between constant coefficients of the mathematical model, conditions on control parameters are analytically found to optimize (minimize) financial resources under which economic cooperation can peacefully resolve political conflict. In the case of variable model factors, computer simulations have found minimum values of management factors (optimization of financial resources) in which conflicts can be resolved (more than half of the population of both sides support an economic cooperation process that promotes political reconciliation).
Sokhumi State University; He was a scientific supervisor of 8 doctoral dissertations; He is the author of books: Mathematical modelling, mathematical models in ecology and medicine; Mathematical Models in Economics; Mathematical and Computer Modelling in Social Sciences; Mathematical Modelling in Astrophysics and Acoustics.

Professor Temur Chilachava is a member of Academy of Natural Sciences of Georgia; A member of Academy of Educational Sciences of Georgia; The vice-president of Academy of Sciences of Tskhum-Abkhazia; The expert in the field of mathematics of National Academy of Sciences of Georgia; Board member of the Union of mathematicians of Georgia, Member of Program Committee; Editor of proceedings of Academy of Sciences of Tskhum-Abkhazia, series of exact and natural sciences.

George Pochkhua was born in Georgia, Sokhumi, in 1972; He received the master from Sokhumi Branch of Ivane Javakhishvili Tbilisi State University, in 1994; He received his bachelor from Georgian Technical University, in 2000; He is a PhD student in applied mathematics of Sokhumi state University. His main area of research are in applied mathematics, mathematical modelling, computer modelling.

He is an author of following articles: “Research of the nonlinear dynamic systems describing mathematical models of settlement of the conflicts by means of economic cooperation”, the 8th International Conference on Applied Analysis and Mathematical Modeling, ICAAMM Proceedings Book; “About a possibility of resolution of conflict by means of economic cooperation”, Problems of management of safety of difficult systems. The XXVI International Conference, Proceedings Book, 2018; “Research of the dynamic system describing mathematical model of settlement of the conflict by means of economic cooperation”, ISSN 1512-1232 GESJ: Computer Science and Telecommunications, No.3(55), 2018.

George Pochkhua has participated in the following scientific events: Problems of management of safety of difficult systems, the XXVI International Conference on Applied Analysis and Mathematical Modeling, ICAAMM2019, Istanbul, Turkey; XXXIII International Enlarged Sessions of the Seminar of Ilia Vekua Institute of Applied Mathematics, Tbilisi, Georgia, 2019; International Conference on Differential & Difference Equations and Applications, ICDDEA2019, Lisbon, Portugal, 2019; X International Conference of the Georgian Mathematical Union, Batumi, Georgia, 2019.