



DEVELOPMENT OF A COMPUTATIONAL ALGORITHM AND PROGRAMS FOR FLUID FILTRATION IN MULTILAYER STRATA

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INTRODUCTION

The motion of gas and oil to the chinks in the layer is very complicated. When the layer is multilayered, the process becomes even more complex. For the research of such tasks, certain number of works were dedicated and studied[2].

Based on the study of the problems in interacting layers, so-called intermediate model (IM) was proposed in the work. In the current article, this model is applied for the solution of three-layer interacting formation[8][10].

Filtration fluid flows in heterogeneous porous media are widespread in nature and technology and constantly attract increased interest of researchers[18]. A large number of works are devoted to the study of filtration in multilayer and heterogeneous soils (see [1]). In this case, it was assumed that the inhomogeneity of the medium is due only to the spatial gradients of the permeability of the medium, and the porosity was considered constant[17]. Relatively recently, works have appeared in which effects are considered due to the inhomogeneity of the porosity of the medium. For example, in [3][9], for such media, the emergence of an averaged flow in the presence of a periodic action was found.

PROBLEM STATEMENT

Setting tasks on general model.

It is supposed that there is a three-layer interacting stratum with the domain D, with medium one is well permeable and the two extremes are poorly permeable jumpers. Determining the continuous function of the pressure $P_i(x, y, z, t)$, which satisfies the system of differential equations, is required[4][6]

$$\begin{aligned} \frac{\partial}{\partial x} \left(K_i(x, y, z) \frac{\partial P_i}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_i(x, y, z) \frac{\partial P_i}{\partial y} \right) + \frac{\partial}{\partial z} \left(K_i(x, y, z) \frac{\partial P_i}{\partial z} \right) = \\ = M_i(x, y, z) \frac{\partial P_i}{\partial t} + F_i(x, y, z, t) \end{aligned} \quad (1)$$

With the initial

$$P_i(x, y, z, 0) = \varphi_i(x, y, z) \quad (2)$$

And the boundary conditions

$$\left. \frac{\partial P_i}{\partial n_0} \right|_r = 0 \quad (3)$$

here n_0 - is outward normal to G; G- is the surface of the area of the filtration D that is under consideration[7][12]. As a function of $\varphi_i(x, y, z)$, often constant value, which characterizes un-disturbance of

the stratum, is taken at the initial stage, neglecting the weight of the liquid column within the power of interlayer
i. According to the model Hantusha[5], instead of solution of problems (1)-(3), we get more simplified problem

$$\left. \begin{aligned} & \frac{\partial}{\partial x} \left(K_2 \frac{\partial \mathcal{G}_2}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_2 \frac{\partial \mathcal{G}_2}{\partial y} \right) = M_2 \frac{\partial \mathcal{G}_2}{\partial t} + \overline{F}(x, y, t) - q_{n2}; \\ & \mathcal{G}_2 = \frac{1}{h_2 - h_1} \int_{h_1}^{h_2} P_2(x, y, z, t) dz; \\ & \mathcal{G}_2|_{t=0} = \overline{\varphi}_2(x, y); \quad P_i|_{t=0} = \varphi_i(x, y, z); \\ & P_1|_{z=h_1-0} = \mathcal{G}_2|_{z=h_1+0}; \quad P_3|_{z=h_2+0} = \mathcal{G}_2|_{z=h_2-0}; \\ & q_{n2} = q_{n1} + q_{n3}, \quad q_{ni} = \frac{K_n}{h_i - h_{i-1}} \frac{\partial P_i}{\partial z} \Big|_{z=h_i}, \quad i = 1, 3; \\ & \frac{\partial P_i}{\partial n_0} \Big|_{h_0, h_1} = 0. \end{aligned} \right\} \quad (4)$$

Thus, instead of spatial initial problem (1)-(3), comparatively simple, quasi-three-dimensional problem (4) was obtained. In the work[6][15], the task was considered in this direction, methods of solving were provided in the test data, results were received and analyzed[18]. However, the researchers still face difficulties in solving the tasks with obtained models, occupying more memory and time. With this purpose, we apply more simplified models than the Hantusha intermediate model[7][21].

SOLUTION METHOD

In the task (4), averaging motion by spatial variables for determining values of the flow among the layers and the change of the value of the pressure in the jumpers are obtained by so-called the model of material balance (MB)[3][11]

$$\frac{\partial}{\partial z} \left(K_{ni}(z) \frac{\partial W_i}{\partial z} \right) = M_i(W_i) \frac{\partial W_i}{\partial t}, \quad h_{i-1} < z < h_i, \quad t > 0, \quad (5)$$

$$W_i|_{t=0} = f_i(z), \quad z \in [h_{i-1}, h_i], \quad i = 1, 3, \quad (6)$$

$$\frac{\partial W_i}{\partial n} \Big|_{z=h_0, h_3} = 0, \quad W_i|_{z=h_1, h_2} = \overline{W}_2. \quad (7)$$

The change of the area of the pressure in the well permeable layer is determined by the solution of the equation

$$\frac{\partial}{\partial x} \left(K_2 \frac{\partial \mathcal{G}_2}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_2 \frac{\partial \mathcal{G}_2}{\partial y} \right) = M_i \frac{\partial \mathcal{G}_2}{\partial t} + \overline{F}_i(x, y, t) - q_{n2} \quad (8)$$

with appropriate initial and boundary conditions[6][16].

For the calculation of the problem, we move to the dimensionless variables:

$$\overline{K} = \frac{K}{K_x}, \quad \overline{\mu} = \frac{\mu}{\mu_x}, \quad \overline{x} = \frac{x}{L_x}, \quad \overline{y} = \frac{y}{L_y}, \quad \overline{z} = \frac{z}{L_z}, \quad \overline{P} = \frac{P}{P_x}, \quad Q = A \sum_{i=1}^N \delta(x - x_i, y - y_i) q_i,$$

$$A = \frac{L_x \mu_x}{K_x P_x L_y L_z}, \quad t = \tau \frac{K_x}{\mu_x L_x^2}, \quad Qp_x = \frac{L_x \mu_x}{K_x P_x L_y L_z} q_{n2} \quad (9)$$

For convenience, we omit the dashes on the variables.

Here, q_{n2} - is the function that acts as an evenly distributed internal drainage.

Thus, the complexity of the original problem (4) is reduced to successive solution of one-dimensional and two-dimensional problems[9][17].

For the solution of the problems (5)-(9), we apply the method of the longitudinal cross-circuit and streaming version of the sweep method[19]. The limits of applicability of this model and estimates of values $\|P_i - \mathcal{G}_i\|_c$; $\|\mathcal{G}_i - W_i\|_c$; $\|P_i - W_i\|_c$; were provided in the work. For the analysis of the results of intermediate model compared with the calculation results obtained[22].

Discussion. Hantusha model on the basis for calculation, the following initial data are received:

$$P_i|_{t=0} = 1; m_1 = m_2 = m_3 = 0.2; k_2 = 0.2; k_1 = k_3 = 0.05; h_0 = 0; h_1 = 1/12; h_2 = 11/12; h_3 = 1; \varphi_0 = 1; \mu = 2; \Delta x = 0.01; \Delta y = 0.01; \Delta z = 0.02; \tau = \frac{Lx \cdot Lx}{86400}; Lx = 1000m;$$

The values of selections and the location coordinates of the wells are provided in table 1[4].

Table 1

№	X, m	Y, m	m^3 / day	№	X, m	Y, m	m^3 / day
1	250	250	18000	6	250	350	18000
2	150	150	18000	7	350	150	18000
3	150	250	18000	8	350	250	18000
4	150	350	18000	9	350	350	18000
5	250	150	18000				

Distribution of the pressure on well permeable layer and the values of flow from jumpers due to the symmetry of the arrangement of selected points (wells) are symmetrical with respect to the medium reservoir[17]. For this reason, in tables 2 and 3 respectively, their values are provided in the quarter of the field[13]. For a complete understanding of their values, they are presented in the form of the contour maps at $T = 720$ a day in Fig.1[23].

Table 2

520	1.000	1.000	1.000	1.000	0.998	0.994	0.998	0.999	0.996	0.994	0.996
500	1.000	1.000	1.000	1.000	0.998	0.985	0.998	0.999	0.994	0.985	0.994
480	1.000	1.000	1.000	1.000	0.998	0.994	0.998	0.999	0.996	0.994	0.996
420	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.999	0.999	0.999	0.999
360	1.000	1.000	1.000	1.000	0.999	0.998	0.999	0.999	0.998	0.998	0.998
300	1.000	1.000	1.000	1.000	0.998	0.985	0.998	0.999	0.994	0.985	0.994
240	1.000	1.000	1.000	1.000	0.999	0.998	0.999	0.999	0.998	0.998	0.998
180	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
120	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Y X	0	60	120	180	240	300	360	420	480	500	520

Table 3

520	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
500	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
480	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
420	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
360	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
300	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
240	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
180	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
120	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
60	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
0	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516	0.0516
Y X	0	60	120	180	240	300	360	420	480	500	520

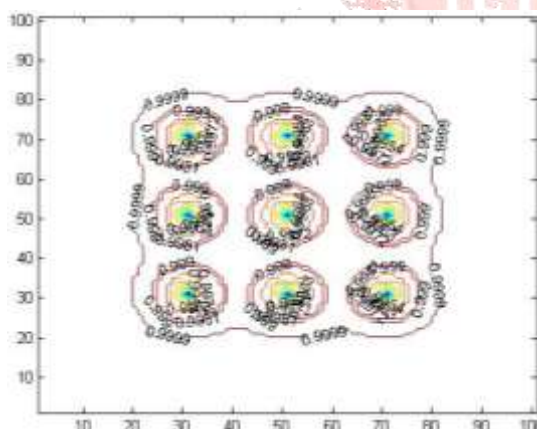


Fig.1

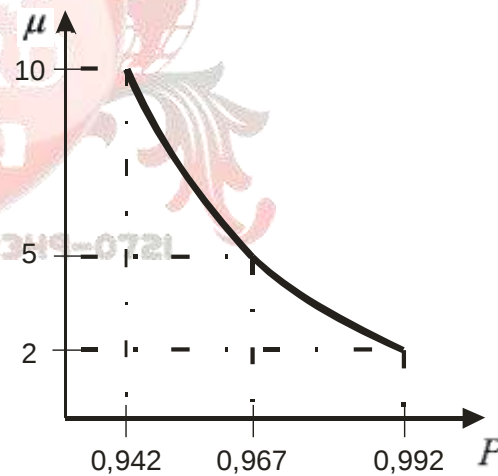


Fig.2

Based on the provided results, the following conclusions can be made[14]. When all wells have equal debits with an increase in the viscosity, pressure is also reduced (fig.2), for $\mu = 2$ the value of the central well is less than that of other wells[2][20].

Now let's see how the value of pressure around the well is changing over time[24]. Bearing in mind the symmetry of the results, we'll see one of the neighboring points to the well at different values of the viscosity coefficients of the two models (fig.4).

Table 4

t day	$\mu = 2$				$\mu = 5$			
	Intermediate model		Hantusha Model		Intermediate model		Hantusha Model	
100	0,998	0,989	0,998	0,989	0,998	0,978	0,998	0,978
200	0,997	0,988	0,997	0,988	0,995	0,974	0,995	0,974
500	0,995	0,986	0,995	0,986	0,991	0,969	0,991	0,969
720	0,994	0,985	0,994	0,985	0,990	0,967	0,990	0,967

CONCLUSION

It is possible to make the following conclusions from the values presented in the above table. The values of pressure are almost the same on both models in the considered example. That is why it is appropriate to apply the intermediate model for these data, because intermediate model is optimal in terms of efficiency of computer time and memory consumption of computational technology.

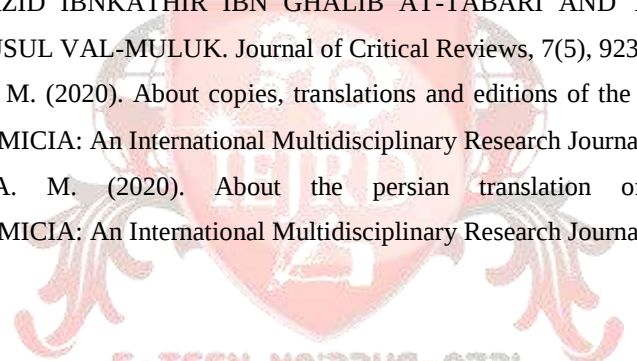
REFERENCES

1. Аренс В.Ж. Физико-химическая геотехнология / Учеб. пособие. - М.: Изд-во Московского государственного горного университета, 2001. - 656 с.
2. Ravshanov N., Shafiev T.R. Nonlinear mathematical model for monitoring and predicting the process of transfer and diffusion of finedispersed aerosol particles in the atmosphere // Journal of Physics: Conference Series. – 2019. - Vol. 1260. – Pp. 102014. – doi:10.1088/1742-6596/1260/10/102013.
3. Тухтаназаров, Д. С. (2017). Решения задачи фильтрации жидкости в многослойных пластах по методом потоковой прогонка. In ИНФОРМАТИКА: ПРОБЛЕМЫ, МЕТОДОЛОГИЯ, ТЕХНОЛОГИИ (pp. 450-456).
4. Алимов, И., & Тухтаназаров, Д. С. (2016, January). Вычислительный алгоритм для решения задач фильтрации жидкости в многослойных пластах по модели хантуша. In ПРОБЛЕМЫ АНАЛИЗА И МОДЕЛИРОВАНИЯ РЕГИОНАЛЬНЫХ СОЦИАЛЬНО-ЭКОНОМИЧЕСКИХ ПРОЦЕССОВ (pp. 17-22).
5. Алимов, И., & Тухтаназаров, Д. С. (2016). Модели и методы решения задачи фильтрации жидкости в многослойных пластах. Проблемы вычислительной и прикладной математики, (1), 5-12.
6. Тухтаназаров, Д. С., & Алимов, И. И. Вычислительный алгоритм для решения задач фильтрации жидкости в многослойных пластах по модели Хантуша.
7. Тухтаназаров, Д. С. (2017). Computer models for process management of developing oil and gas fields. Проблемы вычислительной и прикладной математики, (2), 41-46.
8. Тухтаназаров, Д. С., & Суннатов, М. С. (2018). ВЫЧИСЛИТЕЛЬНЫЙ АЛГОРИТМ И ПРОГРАММА ДЛЯ ОПРЕДЕЛЕНИЯ ПОКАЗАТЕЛЕЙ СКВАЖИН НА ОСНОВЕ ОБРАБОТКИ ИНФОРМАЦИИ НЕФТЯНЫХ МЕСТОРОЖДЕНИЙ. In Современные технологии в нефтегазовом деле-2018 (pp. 315-318).

9. Алимов, И., Пирназарова, Т. Е., & Тухтаназаров, Д. С. (2016). Вычислительный алгоритм и программное средство для определения остаточных запасов нефти при разработке нефтяных месторождений. Проблемы вычислительной и прикладной математики, (4), 95-99.
10. Пирназарова, Т. Е., & Тухтаназаров, Д. С. (2015). Математическое моделирование двумерных задач фильтрации несжимаемых жидкостей. In ИНФОРМАТИКА: ПРОБЛЕМЫ, МЕТОДОЛОГИЯ, ТЕХНОЛОГИИ (pp. 374-376).
11. Mavlyuda Xodjayeve, Rustam Kabulov, Rano Djuraeva, Alimjon Dadamuhamedov, Alisher Mukhammadiev. (2019). Personality-Oriented Learning Technologies, International Journal of Recent Technology and Engineering, 8(4), 7706-7708. DOI: <https://doi.org/10.35940/ijrte.D5369.118419>
12. Djuraeva Rano. (2020). Using the system "Virtual Psychologist" in determining the psychological and pedagogical readiness of students for professional education. Damkheda, Bhopal (Madhya Pradesh)-462037, India. Revised Manuscript Received on International Journal on Integrated Education, 3(3)
13. Irgashevich Alimjon Dadamuhamedov. (2020). Cloud technologies in islamic education institutions. The Light of Islam, 2(23), Available at: <https://uzjournals.edu.uz/iiu/vol2020/iss2/23>
14. Mirzaev, N. M., Radjabov, S. S., & Jumaev, T. S. (2008). O parametrizatsii modeley algoritmov raspoznavaniya, osnovannix na osenke vzaimosvyazannosti priznakov. Problemi informatiki i energetiki, (2-3), 23-27.
15. Irgashevich Alimjon Dadamuhamedov. (2020). Cloud technologies in islamic education institutions. The Light of Islam, 2(23). Available at: <https://uzjournals.edu.uz/iiu/vol2020/iss2/23>
16. Ubaydullayev Shokirjon Zokirjon o'g'li, Xodjayeve Mavlyuda, Jumayev Turdali, Alimjon Dadamuhamedov. (2020). CREATION OF ELECTRONIC RELIGIOUS PROGRAMS ON ISLAMIC SUBJECTS. SCIENCE , RESEARCH ,DEVELOPMENT, 2(26), 40-43.
17. Dadamuhamedov Alimjon. (2019). The role of information and communications technologies in pilgrimage tourism in Uzbekistan. The Light of Islam, 1(17). Available at: <https://uzjournals.edu.uz/iiu/vol2019/iss1/17>
18. Saminjonovich Jumayev Turdali, Irgashevich Alimjon Dadamuhamedov. (2020). Creation of electronic programs on the sanctuary of al-Hakim al-Termizi. The Light of Islam: 1(30). Available at: <https://uzjournals.edu.uz/iiu/vol2020/iss1/30>
19. Saminjonovich Jumayev Turdali, Irgashevich Alimjon Dadamuhamedov. (2020). Creation of electronic programs on the sanctuary of al-hakim al-Termizi. The Light of Islam, 1(30), Available at: <https://uzjournals.edu.uz/iiu/vol2020/iss1/30>
20. Irgashevich, D. A. (2020). Development of national network (tas-ix). Academicia: An International Multidisciplinary Research Journal, 10(5), 144-151. Article DOI : 10.5958/2249-7137.2020.00254.2
21. Жумаев Т. С., Мирзаев Н. С., Махкамов А. С. Алгоритмы сегментации цветных изображений, основанные на выделении сильносвязанных элементов // Исследования технических наук. – 2015. – №. 4. – С. 22-27.
22. Мирзаев Н. М., Раджабов С. С., Жумаев Т. С. Выделение характерных признаков изображений лица в задачах распознавания личности // Нейрокомпьютеры и их применение. – 2016. – С. 76-А.
23. Saminjonovich, J. T., Irgashevich, A. D. (2020). Creation of electronic programs on the sanctuary of al-Hakim al-Termizi. The Light of Islam, 2020(1), 215-222.

24. Jumayev T. S., Mirzayev N. S., Makhkamov A. S. Algorithms for segmentation of color images based on the allocation of strongly coupled elements //Studies of technical sciences. – 2015. – №. 4. – С. 22-27.
25. Irgashevich, D. A. (2019). Development of national network and corporate networks (in the case of Tas-IX network). International Journal of Human Computing Studies, 1(1), 1-5.
26. Dadamuhamedov, A. (2019). The role of information and communications technologies in pilgrimage tourism in Uzbekistan. The Light of Islam, 2019(1), 17.
27. Дадамухамедов, А. И. (2017). РАЗВИТИЕ НАЦИОНАЛЬНОЙ СЕТИ И КОРПОРАТИВНОЙ СЕТИ (НА ПРИМЕРЕ СЕТИ IX). Актуальные научные исследования в современном мире, (3-2), 133-137.
28. Irgashevich, D. A. (2020). Development of national network (tas-ix). ACADEMICIA: An International Multidisciplinary Research Journal, 10(5), 144-151.
29. Irgashevich, D. A. (2019, February). THE ROLE OF INNOVATIVE, INFORMATION AND COMMUNICATIONS TECHNOLOGIES IN PILGRIMAGE TOURISM IN UZBEKISTAN. In International Scientific and Practical Conference" Innovative ideas of modern youth in science and education" (pp. 262-265).
30. Dadamuhamedov, A. (2019). THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE DEVELOPMENT OF RELIGIOUS AND EDUCATIONAL PROGRAMS ON ISLAMIC SUBJECTS. The Light of Islam, 2019(4), 34.
31. IRGASHEVICH, D. A. (2020). METHODS OF USING CLOUD TECHNOLOGIES IN ISLAMIC EDUCATION INSTITUTIONS. METHODS, 7(5).
32. Ilkhomovich, S. E. (2020). The development of electronic trade and its role in general trade activities. ACADEMICIA: An International Multidisciplinary Research Journal, 10(3), 128-132.
33. Abraqulovich, I. G., Salaxuddinovna, K. Z., Uytalovich, N. U., & Matlubovich, T. O. (2020). THE IMPACT OF THE ORGANIZATION OF A COTTON-TEXTILE CLUSTER ON THE SOCIO-ECONOMIC DEVELOPMENT OF THE REGIONS. International Engineering Journal For Research & Development, 5(4), 5-5.
34. ugli Khurramov, A. M. (2020). The role and role of digital economy and information technology in the agricultural sector. International Journal on Integrated Education, 3(2), 42-44.
35. Khurramov, A. (2020). DIGITAL ECONOMY-A NEW ERA OF DEVELOPMENT. Студенческий вестник, (12-5), 53-54.
36. Abdurakhmanova, G., Shayusupova, N., Irmatova, A., & Rustamov, D. (2020). The role of the digital economy in the development of the human capital market. Архив научных исследований, (25).
37. Rustamov, D. J. (2020). THE ROLE OF EXPORT POTENTIAL IN ATTRACTING FOREIGN INVESTMENT. Экономика и социум, (3), 103-104.
38. Rustamov, D. J. (2020). WAYS OF IMPROVING OF ATTRACTION FOREIGN INVESTMENTS IN THE ECONOMY OF THE REPUBLIC OF UZBEKISTAN. Экономика и социум, (2), 52-58.
39. Jamshido'g'li, R. D., RakhmonjonZokirjono'g'li, O., & Kholdorovna, R. F. (2020). Changes in market relations in the period of market economy and their classification. South Asian Journal of Marketing & Management Research, 10(4), 120-129.

40. Rustamov, D. (2019). STAGES OF BUDGET SYSTEM AND BUDGET RELATIONS IN THE REPUBLIC OF UZBEKISTAN. Студенческий вестник, (36-2), 73-75.
41. Rustamov, D. J. (2019). THE ROLE OF INVESTMENT IN SMALL BUSINESS AND PRIVATE ENTREPRENEURSHIP. Столица Науки, 29.
42. Ganiev, I., Djanibekov, N., Hasanov, S., & Petrick, M. (2017). The state of doctoral research in Uzbekistan: Results of a survey of doctoral students in agricultural economics (No. 164). Discussion Paper, Leibniz Institute of Agricultural Development in Transition Economies.
43. Hasanov, S., Sanaev, G., & Ganiev, I. (2014). An Establishment of Agroclusters as a key for the development of Agro-Processing Industry in Uzbekistan (No. 922-2016-72868).
44. Hasanov, S., Ahmed, M. N., Ganiev, I., & Murtazaev, O. (2012). Cotton in our Ears: Water, Agriculture, and Climatic Change in the Post Aral Context'. Michael R. Edelstein Astrid Cerny Abror Gadaev (ed.) Disaster by Design: The Aral Sea and its Lessons for Sustainability (Research in Social Problems and Public Policy, Volume 20). Emerald Group Publishing Limited, 187-195.
45. Ganiev, I. (2016). Regional Innovation Centers and Reforms in Samarkand Agricultural Institute (No. 923-2016-72945).
46. Mirtoxirovna, A. M. (2020). THE SCIENTIFIC LEGACY OF ABU JA'FAR MUHAMMAD IBN JARIR IBN YAZID IBN KATHIR IBN GHALIB AT-TABARI AND THE IMPORTANCE OF TARIKH AR-RUSUL VAL-MULUK. Journal of Critical Reviews, 7(5), 923-925.
47. Mirtoxirovna, A. M. (2020). About copies, translations and editions of the work "tarikh ar-rusul val-muluk". ACADEMICIA: An International Multidisciplinary Research Journal, 10(4), 754-758.
48. Mirtoxirovna, A. M. (2020). About the persian translation of "tarikh ar-rusul val-muluk". ACADEMICIA: An International Multidisciplinary Research Journal, 10(6), 416-419.



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