MODELING OF THE INTERCIVILIZATION FAULT EFFECT ON THE CONFLICT INTENSITY THROUGHOUT THE WORLD

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Abstract. Using the mathematical apparatus of the multifactor regression analysis, the concept of faults between civilizations is verified, formalized and refined. The ethnocultural civilizational distribution of the countries is specified on the basis of the fuzzy cluster method. The mathematical model of fault lines between civilizations is elaborated, which affords the opportunity to estimate and analyze the quantitative values of these faults. Formally, the developed model offers the way to determine evolutionary regularities, systematize and econometrically verify the defining characteristics of actual civilizational clashes. The results of an analysis and comparison of modeling data of intercivilizational faults in 2008 and 2018 revealed the tendencies of individual civilizations to unite and clash, and the effect of these faults on the global conflict as well. The dependence of global threats on the proliferation of weapons and their individual components is assessed. The conflict effect on the socio-economic indicators of clashing civilizations is determined. The correspondence of the modeling outcomes to the real state of intercivilizational faults is verified by comparison with actual historical data. The results of the study encourage to form a comprehensive vision of the nature of modern clashes, whose emergence is caused by the faults between civilizations, and to determine their formal characteristics and regularities of their course.

Keywords: civilizations, clash of civilizations, conflicts, global threats, proliferation of weapons, multifactor regression analysis, fuzzy cluster method.

INTRODUCTION

Predictions and foresights of human development in the 21st century based on different methods, ideologies and paradigms, give almost identical conclusions. The vast majority of them confirms that the current century will be a turning point in the planetary history of humanity. Therefore, there is a need to form new scientific paradigms that most closely correspond to the present situation in the world and can be used as a basis for its study.

One of the common paradigms of human development is based on the concept of ethnocultural distribution of civilizations [1–11]. American political scientist S. Huntington laid the basis for this paradigm in [1; 2]. He concludes that the ideological confrontation that took place during the Cold War in the last century, grows into a clash of civilizations. Unions and groups that were linked by a common ideology in the 20th century, after the collapse of the Soviet Union

began to be replaced by civilizational clusters based on people's belonging to a common culture, traditions and value system.

It should be noted that S. Huntington was not the first and not the only one who used a civilizational approach to explain global processes and trends. English historian A. Toynbee is the classic of the civilization approach, he was the first to present it [3]. N. Ferguson [4], D. Kitsikis [5], C. Quigley [6], O. Spengler [7] should be noted among the followers of the concept. At the same time, due to the lack of formalized evidence, the concept is often criticized. Y. Harari [8], E. Henderson & R. Tucker [9], J. Fox [10], A. Mungiu-Pippidi & D. Mindruta [11] are among the critics of the concept.

According to S. Huntington's concept, it is the civilization which is determined by the common cultural affiliation of people, that becomes the dominant factor in world politics, and the world order configuration will be determined by civilization interaction or clashes. The author identified eight basic civilizations: Chinese, Japanese, Hindu, Muslim, Western, Orthodox, Latin American, African. He noted that their interaction will create a fundamentally different world order compared with the Cold War, where conflicts between different civilizations will prevail over conflicts within individual civilizations. And the most large-scale future conflicts will spread along the so-called fault lines between civilizations [2].

Due to the lack of evidential base, S. Huntington's concept is often criticized. Therefore, in the proposed study, this concept was used as a hypothesis. The following tasks are solved in the study on the basis of this hypothesis:

- to build a quantitative model of the global ethnocultural civilization distribution using mathematical tools of system and multifactor regression analysis;
- to quantify the "tension" of the fault lines between pairs of civilizations on the basis of the assessment of civilization cultural differences;
- to identify and actually confirm the regularities of the dynamics of the civilization tendency to unite and clash, basing on the results of analysis of the modeling data of 2008 and 2018;
- to study evolutionary tendencies and systematize and verify the defining characteristics of the clash of civilizations;
- to assess the level of the global threat of arms proliferation and analyze its relationship with the growing conflict in the world;
- to determine the effect of conflict on the socio-economic indicators of clashing civilizations.

MODELING OF GLOBAL ETHNOCULTURAL CIVILIZATION DISTRIBUTION

In order to analyze the interaction between civilizations and determine the characteristics of the faults between them, we performed modeling of ethnocultural civilizational distribution. This task was solved in several stages [12; 13].

Building a Model of Ethnocultural Distribution of Civilizations

Basing on the work of the group of experts [14], a system of eight basic criteria was formed, which to the fullest extent possible, characterize the cultural differences between civilizations (Table 1).

T a b l e 1. System of criteria that characterize the cultural differences between civilizations

Criterion number	Criterion denomination	Criterion code	Verbal description of the criteria value fluctuation range		
			Minimum value	(Average value)	Maximum value
1	Value of human life	VHL	Human life goes for nothing	Value of human life is determined by circumstances	Human life is the highest value
2	Personal freedom in society	PFS	Lack of freedom of movement, personal life, expression of own views, etc.	Regulated degree of freedom of movement, personal life, expression of own views, etc.	Absolute freedom of movement, personal life, liberalism of views, etc.
3	Status of women in society	SWS	Absolute male dominance	Gender parity	Absolute female dominance
4	Penetration of religion into people's lives	DRL	Religious and ecclesiastical institutions do not affect people's lives	Religious and ecclesiastical institutions have a moderate effect on people's lives	Religious and ec-clesiastical institutions completely dictate people's lives
5	Ethnic uniformity	EU	Lack of tolerance of interethnic relations in civilization	Controlled and regulated interethnic relations in civilization	Absolute tolerance of inter-ethnic relations in civilization
6	Open-mindedness of civilization to other cultures	OCC	Absolute closedness to the penetration of other cultures	Moderate controlled penetration of other cultures	Absolute openness to the penetration of other cultures
7	Traditionalism of culture and thinking	TCT	Variable upgradeable traditions and worldview	Modernized traditions and worldview	Unchanged traditions and worldview
8	Radicalism of political life	RPL	Uncertainty of po-litical course and instability of political life	Moderate variability of political course and political life	Rooted political course, stability of political life

The next step in the study consisted in clustering countries in terms of belonging to certain civilizations based on the assessment of cultural differences between them. A team of experts with many years of experience in international activities in the groups of the respective countries was formed, and the format of the expert questionnaire presented in Fig. 1 was developed.

The formation of the list of civilizations, defined by a set of identified clusters, was carried out by reaching a compromise between the historical and mental features of their cultures and identifying the most important features of each civilization. As a result, the civilizational distribution of countries proposed formerly by S. Huntington was clarified (Fig. 2).
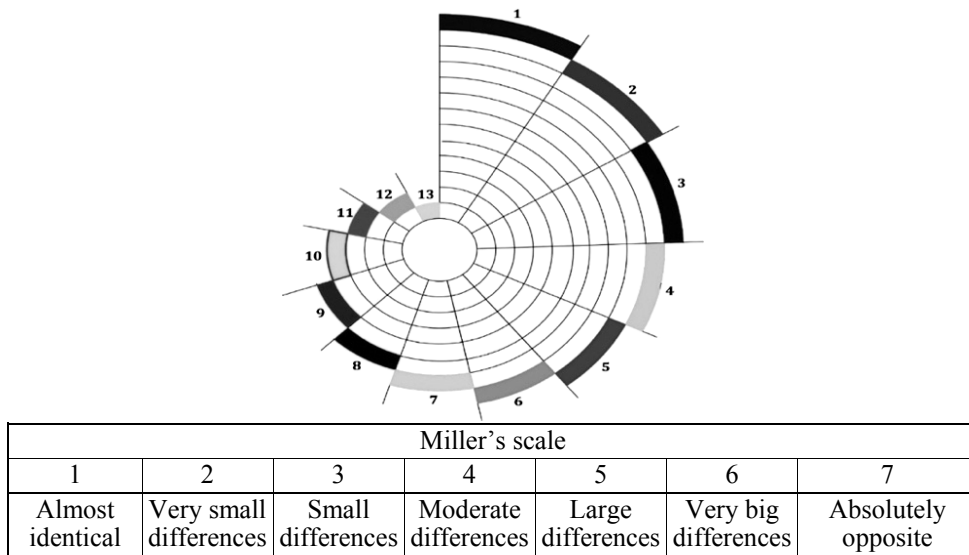
Miller's scale						
1	2	3	4	5	6	7
Almost identical	Very small differences	Small differences	Moderate differences	Large differences	Very big differences	Absolutely opposite

Fig. 1. Expert questionnaire for assessing cultural differences between civilizations

1. Western – North American
2. Western – European
3. Confucian
4. Japanese
5. Muslim – Arabic
6. Muslim – Turkic
7. Muslim – Malayan
8. Hindu
9. Slavic – Eastern Orthodox
10. Slavic – Central-Eastern European Orthodox
11. Slavic – Western-Catholic
12. Latin American
13. African

Fig. 2. The updated list of civilizations (compared with the S. Huntington's distribution [1; 2], where eight civilizations are singled out)

Expert Assessment of Cultural Differences Between Civilizations and Calculation of Quantitative Characteristics of Fault Lines Between Them

The task of formalizing the group expert evaluation of alternatives was considered on the basis of the intellectual analysis of data received from expert polls. Let $m = 18$ experts evaluate $n = 13$ objects by $l = 8$ indicators. The estimates are presented in the form x_{ij}^h, here i is the object number, j is the expert's number, and h is the number of the comparison index. Insofar as the evaluation of objects is performed by the method of sequential comparison, the values x_{ij}^h are numerical estimates (scores).

In order to obtain a group score, we use the average values of the scores given by experts for each pair of civilizations according to the relevant criteria:

$$x_i = \sum_{h=1}^{l} \sum_{j=1}^{m} q_h x_{ij}^h k_j \ \ (i = \overline{1,n}), \tag{1}$$

here q_h are coefficients of index weights, and k_j are coefficients of expert competences.

Using (1), group estimates of pairwise comparisons of thirteen civilizations were calculated according to eight criteria. The generalized tension measure, which determines the degree of fault between all pairs of civilizations according to the relevant criteria, is defined as a superposition:

$$J_{conf}^{civ(i,j)} = \Phi(J_{VYL}^{i,j}, J_{PFS}^{i,j}, J_{SWS}^{i,j}, J_{DRL}^{i,j}, J_{EU}^{i,j}, J_{OCC}^{i,j}, J_{TCT}^{i,j}, J_{RPL}^{i,j}).$$

Determine the Euclidean norm of the tension radius vector for each pair of civilizations:

$$\left\| J_{conf}^{civ(i,j)} \right\| = \Phi \times$$

$$\times \sqrt{(J_{VYL}^{i,j})^2 + (J_{PFS}^{i,j})^2 + (J_{SWS}^{i,j})^2 + (J_{DRL}^{i,j})^2 + (J_{EU}^{i,j})^2 + (J_{OCC}^{i,j})^2 + (J_{TCT}^{i,j})^2 + (J_{RPL}^{i,j})^2}.$$

Quantitative measure of tension is defined as the projection of the norm of this vector on an ideal vector with coordinates $(1;1;1;1;1;1;1)$:

$$J_{conf}^{civ(i,j)} = \Phi \times$$

$$\times \sqrt{(J_{VYL}^{i,j})^2 + (J_{PFS}^{i,j})^2 + (J_{SWS}^{i,j})^2 + (J_{DRL}^{i,j})^2 + (J_{EU}^{i,j})^2 + (J_{OCC}^{i,j})^2 + (J_{TCT}^{i,j})^2 + (J_{RPL}^{i,j})^2} \times$$

$$\times \cos \alpha.$$

The angle of deviation α of the tension radius vector from the ideal vector $(1; 1; 1; 1; 1; 1; 1; 1)$ is defined as:

$$\alpha = \arccos \times$$

$$\times \frac{(J_{VYL}^{i,j}, J_{PFS}^{i,j}, J_{SWS}^{i,j}, J_{DRL}^{i,j}, J_{EU}^{i,j}, J_{OCC}^{i,j}, J_{TCT}^{i,j}, J_{RPL}^{i,j})}{2\sqrt{2}\sqrt{(J_{VYL}^{i,j})^2 + (J_{PFS}^{i,j})^2 + (J_{SWS}^{i,j})^2 + (J_{DRL}^{i,j})^2 + (J_{EU}^{i,j})^2 + (J_{OCC}^{i,j})^2 + (J_{TCT}^{i,j})^2 + (J_{RPL}^{i,j})^2}}.$$

$$0 \leq \alpha \leq \arccos \frac{1}{2\sqrt{2}}.$$

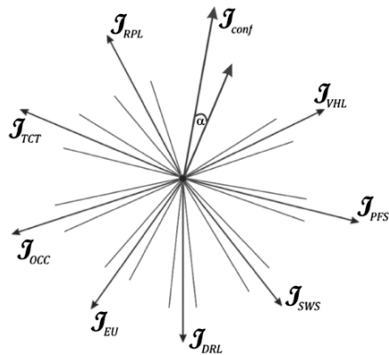The projection of the norm of the respective radius vector on the ideal vector characterizes the tension between the pairs of civilizations, which determines the degree of the fault. The spatial position of the vector characterizes the level of harmonization (see Fig. 3).

Applying the method of matching the set of group estimates of all pairs of civilizations on eight criteria to the integrated total quantitative values, we obtain a common matrix of tension coefficients that determine the faults between civilizations.

Fig. 3. Generalized measure of tension between pairs of civilizations

Analysis of Interaction Regularities and Assessment of the Civilization Propensity to Unite and Clash

The use of the proposed method encouraged us to calculate the conflict factors for each of the thirteen civilizations:

$$P_{conflict} = \min[d(civ_a, civ_b)].$$

The values of the conflict factors for each of the thirteen selected civilizational clusters are given in Table 2. These factors can be used as quantitative characteristics of fault lines between civilizations.

T a b l e 2. Conflict factors of civilizations

Civilization code	1	2	3	4	5	6	7	8	9	10	11	12	13
Conflict factor	0,56	0,40	0,41	0,46	0,48	0,46	0,42	0,47	0,53	0,42	0,40	0,46	0,39

It should be noted that the first assessment of conflict according to the described methodology was carried out in 2008 [15, 16]. Comparing the results of 2008 and 2018, we see the increase in the integrated level of the global conflict during this period (see Fig. 4).
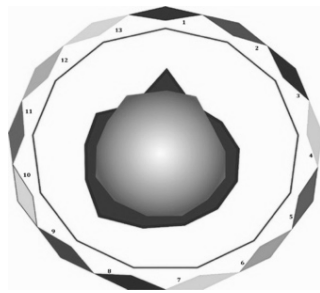

Fig 4. Visualization of the level of growth of the global integral conflict for the period 2008–2018

The next step in the study consisted in calculation of the civilizations propensity to unite. Upon determining the corresponding values as inverse to the maximum tension levels (faults) between the civilizations included in the corresponding cluster, we get

$$P_{union} = 1 - \max[d(civ_a, civ_b)].$$

Potential conflicts can occur between civilizations, mostly, along fault lines with maximum quantitative values. On the contrary, potential clusters of civilizations can occur along fault lines with minimum quantitative values.

Table 3 shows the level of propensity of individual civilizations to unite, which was determined in 2008 and 2018. Comparative analysis of research outcomes allows us to identify trends in the mood and nature of the relationship of civilizations during this period. The Table also presents the facts that confirm the identified trends according to modeling outcomes. The global propensity of civilizations to unite decreased. There is a significant decrease in the tendency to unite between the Confucian and Japanese civilizations and between the civilizations of the Muslim group; in both cases the decrease is about 21,0%. At the same time, there is a growing tendency to unite between Western – European and Slavic – Western – Catholic civilizations, and between African and all Muslim civilizations. Western – European and Slavic – Western – Catholic civilizations became the first pair in terms of the achieved level of propensity to unite and the third in terms of its growth rate for the period 2008–2018. African and Muslim civilizations showed the maximum increase in propensity to unite – by 9,0%.

T a b l e 3. The level of propensity of civilizations to unite

No	Civiliza-tional clusters	Propensity, % 2008	2018	Δ, %	Facts that confirm the identified trend
1	Western – European & Slavic – Western – Catholic	82,0	84,0	+2,0	Countries association through successive EU integration processes; increasing prospects for attracting new member states (Albania, Bosnia and Herzegovina, Kosovo, Macedonia, Montenegro, Serbia); new treaties on free economic zones; intensification of EU partnerships with associate members (+)
2	Western – North American & Western – European	97,0	81,0	–16,0	Participation of the USA, Canada and EU countries in the UN, OSCE; the USA and EU countries in NATO, EBRD, Transatlantic Trade and Investment Partnership, Anglo-Saxon Military Alliance of Australia, UK and USA (AUKUS) (+). Differences in national security issues (in the National Security Strategy of the United States of America, the EU is defined not as a political force, but as a trading partner); competition in the world market (–)
3	Muslim – Malayan & Hindu	76,0	75,0	–1,0	Association within the Organisation of Islamic Cooperation, Asia Cooperation Dialogue (+) Competitive wars in the world market (–)
4	Confucian & Hindu	73,0	74,0	+1,0	Association within the South Asian Association for Regional Cooperation, Association of South East Asian Nations (+)
5	Muslim – Malayan & Confucian	66,0	71,0	+5,0	Agreements between countries on the use of economically important territories (maintaining peace in the South China Sea) (+)
6	African & Muslim – Arabic, Muslim – Turkic Islamic – Malay	61,0	70,0	+9,0	Cooperation within the African Union, participation in pro-Islamic organizations: Organization of Islamic Cooperation (27 of the 54 sovereign African states are its members, and 1 country is an observer), Arab League, Maghreb and D-8 Organization for Economic Cooperation (–) "Re-Islamization" of Africa (+)
7	Confucian & Japanese	86,0	65,0	–21,0	Economic partnership (+) Historical conflicts between China and Japan, escalation of the conflict around the division of territories, including the islands of the Senkaku archipelago, which caused the military aggression (–)
8	Muslim – Arabic & Muslim – Turkic & Muslim – Malayan	88,0	65,0	–21,0	Association within the Organization of Islamic Cooperation (+). Competition for the extraction of resources in the Caspian region (Russia, Iran, Turkmenistan, Azerbaijan), disputes over the borders of the countries-descendants of the USSR (Kazakhstan, Tajikistan, Turkmenistan, Kyrgyzstan, Uzbekistan) (–)

Instead, the global propensity of civilizational clusters to confront increased. Among all conflicting civilizations, there is the same tendency of significant increase in propensity to confrontation – at the level of 8,0% to 21,0% (see Table 4). The maximum increase in confrontation is observed on the border of Western – North American and Slavic – Eastern – Orthodox civilizations: the fault between them is the biggest, both in terms of growth for the period 2008–2018, and the value reached – in ten years it increased by 21,0 % and reached 72,0%.

In all cases, the average propensity of civilizations to unite decreased by 5,3% in 2008–2018. While the average level of propensity of civilizations to confrontation increased by 13,2%. That is, integrally, a decrease in the propensity of civilizations to unite is observed over the last ten years, while their propensity to confront is growing rapidly.

T a b l e 4. The level of civilization propensity to confrontation

No.	Civilizational clusters	Propensity, %		Δ, %	Facts that confirm the identified trend
		2008	2018		
1	Western – North American & Hindu	51,0	72,0	+21,0	Operation Ocean Shield against Somali pirates (USA, India, Indonesia, Somalia); border conflict for the Aksai-Chin region (India and China); Roginja refugee crisis (Myanmar and Bangladesh); conflict over Jammu and Kashmir (India) (−)
2	Western – North American & Muslim – Arabic, Muslim – Turkic, Muslim – Malayan	58,0	66,0	+8,0	The Arab Spring, the intensification of operations by the US-led international coalition of forces in Libya and Iraq, the conflict in Syria; the civil war in Yemen; NATO's International Security Assistance Force operation against ISIS and the Taliban in Afghanistan; rivalry between the U.S.A., Saudi Arabia, and Iran over oil supplies; Israeli-Palestinian conflict; conflicts in Burkina Faso, Ethiopia, Kurdistan (−)
3	Slavic – Eastern – Orthodox &Hindu	47,0	61,0	+14,0	The Indo-Pakistani conflict with Russia's bilateral position, which is a strategic partner of India, but conducts "Friendship – 2018" military exercises with Pakistan; operation Ocean Shield against Somali pirates of (USA, NATO, Russia, Ukraine) (−)
4	Western – North American & Confucian, ` Japanese	46,0	59,0	+13,0	The Cold War between the United States and North Korea; territorial disputes between China and Japan concerning the islands of the Senkaku archipelago; the conflict between China and Taiwan with the prospect of the U.S.A. and Japan involvement; nuclear and missile tests in North Korea (−)
5	Slavic – Eastern – Orthodox & Muslim – Arabic, Muslim – Turkic, Muslim – Malayan	48,0	58,0	+10,0	Confrontation in Nagorny Karabakh; Turkish-Kurdish conflict; Georgia's conflict with South Ossetia; annexation of Crimea; anti-terrorist operation of Ukraine in Donbass with the participation of Russia (−)

EVOLUTIONARY TRENDS AND DEFINITIVE CHARACTERISTICS
OF GLOBAL CONFLICT

The analysis of statistical data on the number of military and paramilitary conflicts occurring at the national and international levels shows the growing trend of global conflict (see Fig. 5), which is found in the basis of modeling outcomes. The total number of conflicts in 2017–2021 grew monotonously. In 2008 there was a relative decline, however, in the following years the growth rate was multiples higher. Nowadays, humanity is gradually entering the second evolutionary phase of the last seventh wave of global systemic world conflicts [15].

On the one hand, the regularity of rapid growth of tension and conflict in the world is caused by a change in the nature of ethnocultural interaction of civilizational clusters, as it is formally defined above. On the other hand, it can be considered as a confirmation of the historical theory of solar activity cycles. Moreover, the described approaches are interrelated, they substantiate and confirm the correctness of specific regularities.

Fig. 5. Number of conflicts in the world at the national and international levels [15]

The theory of cycles of solar activity was formulated by the outstanding Soviet biophysicist A. Chizhevsky. The scientist argues that the life of the biosphere and social rhythms depend on the solar rhythms. According to his research, solar activity contributes to the accumulation of enormous "collective", "mental" and "social" energy on the planet, and later it results in its release in the form of aggression and conflict [16]. The best known and most examined cycles of solar activity are cycles lasting about eleven years, caused by changes in the magnetic field of the star. The Sun rotation differs from the rotation of solid bodies: its different regions have different speeds, which determines the magnitude of the field. Each cycle is characterized by a change in the polarity of the magnetic field It was in 2008 that the 24th eleven-year cycle of solar activity began; its peak falls on the period 2012–2015, i.e., it coincides with the peak of escalation of military and paramilitary conflicts in the world during this period (see Fig. 6).
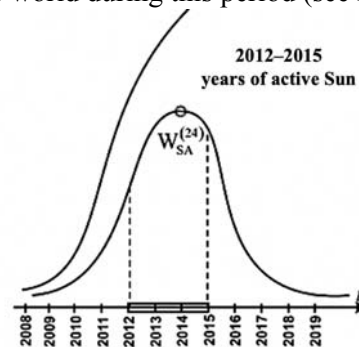

Fig. 6. The solar cycle $W_{SA}^{(24)}$, which corresponds to the evolutionary phase of generation of the last seventh wave of global systemic world conflicts

According to A. Chizhevsky's theory of solar cycles, today the world is on the verge of a systemic crisis caused by a surge of "collective", "mental" and "social" energies, which causes the escalation of conflict. The determining factors of such conflict are ideological, not material ones [16]. S. Huntington [1; 2] and his followers [4–7] noted that the same specific features which are inherent in conflicts that take place along the fault lines between civilizations. We came to similar

conclusions on the basis of the results of modeling and comprehensive analysis of the ethnocultural distribution of civilization. Experts-practitioners also emphasize changes in the global nature of conflicts. These changes are evidenced by statistics and the results of large-scale international observations [17–19]. The study allows us to systematize the characteristic features of conflicts:

a) conflicts are hybrid in nature, they cover all levels and spheres of societal life, and are conducted using various, often non-standard, means;

b) conflicts are practically limited neither in time nor in space;

c) a large number of participants are involved in conflicts;

d) conflicts more frequently arise on ethnic, religious, cultural or gender grounds;

e) conflicts occur between separate groups within one state not less often, than between the states;

f) a large number of conflicts arise around the formed zones of instability, which mainly appear along the fault lines between civilizations;

g) the growing number of conflicts is outpacing the world's ability to stop them and fight against their consequences;

h) modern conflicts are accompanied by fewer human losses;

i) arms proliferation fuels conflicts and organized crime;

j) conflicts caused by faults between civilizations, on the one hand, deplete the participating countries and worsen their socio-economic situation, and on the other hand, they exacerbate meanwhile such conditions deteriorate.

The validity of the first seven characteristics (a)–(g) is verified and confirmed by the results of the theoretical analysis, and model analysis. The structural analysis of statistics on the number of deaths caused by organized violence in the period 1995–2020 was used to verify the declining trend in the number of human losses caused by conflicts (h) (Fig. 7–9) [20, 21].
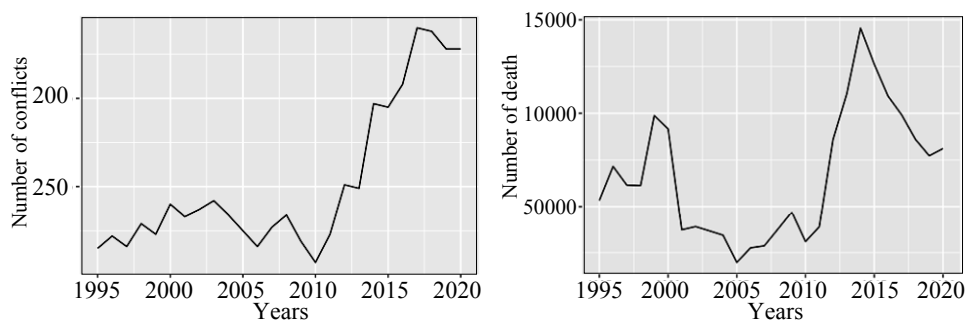

Fig. 7. Number of conflicts in the world and deaths caused by them in the period 1995–2020, aggregated by year

Fig. 7 shows that in the period 1995–2010, a relatively small number of conflicts was accompanied by a relatively large number of human losses (correlation coefficient is 0,059). In the period 2010–2015, the dynamics of the number of conflicts fully corresponds to the dynamics of number of victims (correlation coefficient is 0,949). In the period 2015–2020, the correlation was inverse, the rapidly increasing number of conflicts was accompanied by a decrease in the number of victims (correlation coefficient is 0,785). Such dynamics indicate a change in the nature of conflicts and the reasons that cause them. Moreover, in our opinion, it is partly caused by the use of high-tech weapons in paramilitary conflicts, which

reduces the total number of human losses. In general, these trends clearly demonstrate and confirm the growing level of conflict at the global level, which is accompanied by a relative decrease in mortality due to its civilizational nature.

United States and then NATO in Libya, have provoked a new round of instability, which has resulted in the intensification of numerous terrorist and criminal groups.
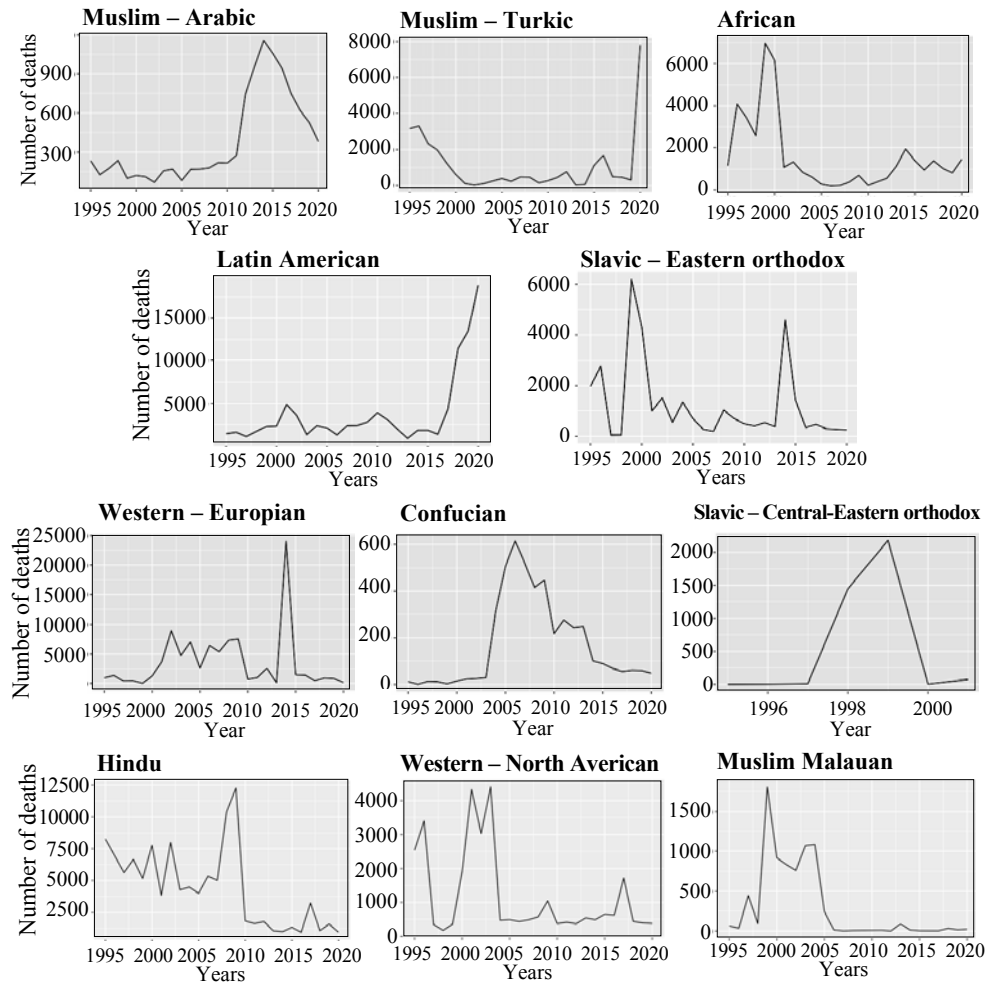

Fig. 8. Number of deaths, caused by conflicts in the territory of specific civilizations in the period 1995–2020, aggregated by year
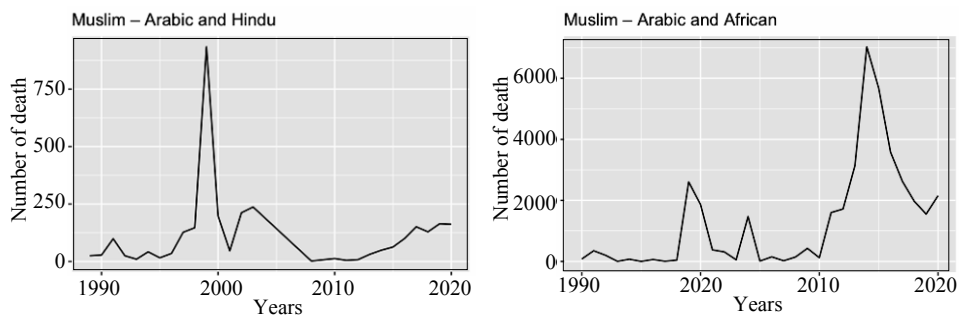

Fig. 9. Annual number of deaths caused by conflicts between Muslim – Arabic and Hindu civilizations and Muslim – Arabic and African civilizations

Since 2014, there has been an increase in the number of conflicts in Asia and Eastern Europe. The war was the bloodiest in Afghanistan, where the number of victims has quadrupled in ten years since 2008, from 5 thousand to 25 thousand.

The conflict in Syria was the bloodiest in the Middle East. It is estimated that more than 570 thousand people died in this country during the war. The conflict in Iraq is in the second place in terms of the number of victims. The operation by the international coalition led by the United States, with codename "Iraqi Freedom", provoked a wave of conflicts between religious groups and terrorist clans and plunged the country into the state of the permanent war. The global trend of decrease in number of victims was not observed in these regions due to easy access to, and proliferation of weapons.

The armed conflict in eastern Ukraine (Donbass region), which began in 2014 and continues to this day, has become bloody. According to the Office of the UN High Commissioner for Human Rights, this conflict claimed 13,2 to 13,4 thousand people as of June 30, 2021. According to the UN Office for the Coordination of Humanitarian Affairs, during the seven years of the war in Donbass more than 3,5 thousand civilians were killed, up to 10,0 thousand people were injured; 1,5 million people became internally displaced; 3,5 million people need help.

ASSESSMENT OF THE WEAPONS PROLIFERATION THREAT EFFECT ON THE CONFLICT INTENSITY THROUGHOUT THE WORLD

A study by the World Data Center for Geoinformatics and Sustainable Development [22] quantified the effect of the complex of global threats on the conflict intensity in the world in the first half of the 21st century. It was found that despite the changing nature of conflicts, the weapons proliferation always fuels them, invites organized crime and terrorism. The examples of human losses in various world conflicts given in Section 2 confirm this conclusion.

Let's analyze the relationship between the conflict intensity of civilizations and the level of weapons proliferation in their territories during 2007–2019. Let's use the comprehensive Non-proliferation Index, which aggregates four components that characterize the levels of development of science, state, armaments and militarization of a certain country. Each of these components is evaluated using an individual sub-index, which is an indicator of the relevant sphere.

The methodology for calculating the Non-Proliferation Index and its sub-indices is presented in Table 5. The Non-Proliferation Index for ten countries with its highest values and ten countries with its lowest values is given in Table 6. Visually, the Non-Proliferation Index for countries and civilizations in 2019 is shown in Fig. 10.

From these data, we see that the emerging economies and African countries belonging to civilizational clusters that experience an increase in armed conflicts and increased mortality caused by them, have low values of the Non-Proliferation Index and, respectively, the high level of military conflicts threat. Thus, Mali, Mozambique, India, Uganda, Russian Federation, Central African Republic, Cote d'Ivoire, Gambia, Ghana and Ethiopia are the countries of proliferation concern.

T a b l e   5 . Components of the Non-Proliferation Index and methods of their calculation

Subindexes	Components of subindexes	Indicators for calculation	Formulas for calculating subindexes
Weaponization index (I_W)	—	Share of military expenses in the GDP (I_{ME}) [23. 24]	$I_W =$ $= \dfrac{I_{ME} + I_{NW} + I_{EP} + I_{GU} + I_{WE} + I_{WI}}{6}$
		Total capacity of nuclear weapons in the country (I_{NW}) [25, 26, 27]	
		Share of electricity production from nuclear sources in total production (I_{EP}) [23]	
		Global uranium production (I_{GU}) [28]	
		Weapons exports (I_{WE}) [23]	
		Weapons imports (I_{WI}) [23]	
Research index (I_R)	Innovative component (I_E)	Export of high-tech goods (I_{HTE}) [23]	$I_R = \dfrac{I_I + I_E + I_S}{3}$, де $I_I = \dfrac{I_{SEE} + I_{GEE}}{2}$, $I_E = \dfrac{I_{BBO} + I_{ДBO}}{2}$, $I_S = \dfrac{I_{RDE} + I_{NSR}}{2}$
		Number of patent applications submitted by residents (I_{PR}) [23]	
	Educational component (IE)	Share of government expenses on higher education in GDP per capita (I_{SEE}) [23]	
		Government expenses on education (I_{GEE}) [29]	
	Scientific component I_S	Share of research and development expenses in the GDP (I_{RDE}) [23]	
		Number of scientists and researchers (per mill I_{SR}) [23]	
State Development Index (I_{SD})	—	Transparency of public policy, corruption (I_{PC}) [23]	$I_{SD} =$ $= \dfrac{I_{PC} + I_{EC} + I_{ED} + I_{GDP} + I_{GNI} + I_{IV} + I_{IR} + I_{LE}}{8}$
		Energy consumption (I_{EC}) [23]	
		External debt (I_{ED}) [23]	
		Gross Domestic Product (I_{GDP}) [23]	
		Gross National Income (I_{GNI}) [23]	
		Industry value added (I_{IV}) [23]	
		Inflation rate (I_{IR}) [23]	
		Life expectancy at birth (I_{LE}) [23]	
Index of the country militarization (I_{CM})	—	Participation in international organizations and treaties (I_{IOP})	$I_{CM} = \dfrac{I_{IOP} + I_{CBC} + I_{CNB} + I_{TL} + I_{AF}}{5}$
		Conflict barometer for the country (I_{CBC}) [18]	
		Conflict barometer for the country and neighbors (I_{CBN}) [18]	
		Level of terrorism (I_{TL}) [30]	
		Armed forces (I_{AF}) [23]	

Japan, the Republic of Korea, the USA, Germany, China, Israel, Austria, Sweden, Canada and the Netherlands have the lowest proliferation rates. In general, democratic advanced economies with high levels of economic, scientific and technological development have a low level of proliferation threat. Between 2007 and 2019, the world average percentage change in the value of the Non-Proliferation Index was 5,7 points, indicating that humanity is aware of the dangers of this threat and encourages disarmament.

T a b l e 6. Top 10 countries with the highest and lowest values of the Non-Proliferation Index (ranking by indicators of 2019)

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mali	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,09	0,09	0,09
Mozambique	0,08	0,08	0,08	0,08	0,08	0,08	0,09	0,09	0,09	0,09	0,09	0,09	0,09
India	0,08	0,08	0,08	0,08	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Uganda	0,10	0,10	0,10	0,09	0,09	0,10	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Russian Federation	0,09	0,09	0,08	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09
Central African Republic	0,11	0,10	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,11	0,09	0,10
Cote d`Ivoire	0,10	0,10	0,10	0,10	0,11	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,10
Gambia	0,11	0,09	0,09	0,10	0,09	0,09	0,10	0,09	0,09	0,09	0,11	0,09	0,10
Ghana	0,09	0,10	0,10	0,10	0,09	0,10	0,10	0,09	0,09	0,09	0,09	0,09	0,10
Ethiopia	0,09	0,09	0,10	0,09	0,09	0,09	0,10	0,10	0,10	0,09	0,09	0,09	0,10
…	…	…	…	…	…	…	…	…	…	…	…	…	…
Netherlands	0,16	0,16	0,15	0,15	0,17	0,16	0,17	0,17	0,17	0,17	0,17	0,17	0,15
Canada	0,15	0,17	0,16	0,17	0,16	0,17	0,17	0,17	0,17	0,18	0,17	0,16	0,15
Sweden	0,15	0,16	0,15	0,15	0,15	0,15	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Austria	0,14	0,15	0,15	0,15	0,15	0,15	0,16	0,16	0,16	0,16	0,16	0,16	0,16
Israel	0,15	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16
China	0,17	0,18	0,18	0,19	0,19	0,19	0,20	0,20	0,20	0,20	0,20	0,20	0,16
Germany	0,21	0,21	0,21	0,21	0,22	0,21	0,22	0,22	0,22	0,22	0,22	0,22	0,19
United States of America	0,21	0,21	0,20	0,20	0,21	0,21	0,21	0,21	0,21	0,21	0,21	0,22	0,20
Republic of Korea	0,24	0,24	0,24	0,24	0,25	0,25	0,26	0,26	0,26	0,26	0,26	0,26	0,23
Japan	0,26	0,26	0,26	0,26	0,26	0,25	0,25	0,25	0,25	0,25	0,25	0,26	0,24

Non-proliferation index
0,236

0,086
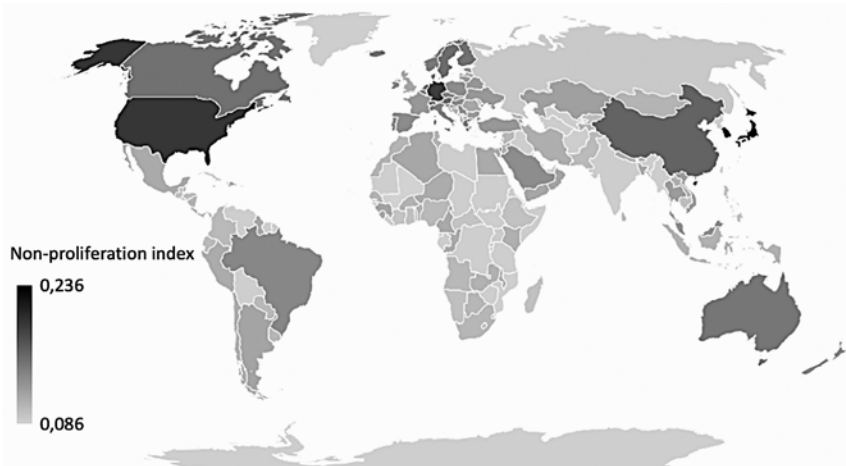
На платформе Bing
© Australian Bureau of Statistics, GeoNames, Microsoft, Navinfo, TomTom, Wikipedia

Fig. 10. Visual representation of the Non-Proliferation Index in 2019

Disarmament and technological modernization of weapons, in its turn, contributes to reducing conflict-related mortality. Poland (with 16,6% mortality), Nigeria (16,7%), Malawi (16,9%), Kenya (18,8%), Serbia (20,6%), Zambia

(20,8%), Algeria (20,9%), Saudi Arabia (24,3%) are the most successful countries. At the same time, the group of countries: Angola (–14,5%), Central African Republic (–12,4%), France (–12,1%), Montenegro (–12,1%), Singapore (–11,7%), Mali (–11,4%), Germany (–10,9%), Rwanda (–10,6%), worsened the value of the Non-Proliferation Index over the years, hence, the respective threat increased.

EFFECT OF PRONENESS TO CONFLICT ON SOCIO-ECONOMIC INDICATORS OF CONFLICTING CIVILIZATIONS

In order to study the impact of the conflict level on the socio-economic indicators of conflicting civilizations, let's determine the conditional distance between civilizations using the formula of Euclidean metrics in a multidimensional parametric space.

As parameters, we will take a set of the basic social and economic indicators used by the World Bank for monitoring [23]:
- agriculture, forestry, and fishing, value added (current USD) – P_1;
- industry (including construction), value added (current USD) – P_2;
- gross domestic product, GDP (constant 2010 USD) – P_3;
- gross domestic product, GDP (constant 2010 USD) – P_3;
- foreign direct investment (current USD) – P_4;
- total reserves (includes gold, current USD) – P_5;
- exports of goods and services (current USD) – P_6;
- imports of goods and services (current USD) – P_7;
- market capitalization of listed domestic companies (current USD) – P_8;
- hospital beds (units per 1 000 people) – P_9;
- the infant mortality rate (units per 1 000 people) – P_{10};
- total life expectancy at birth (years) – P_{11};
- mortality rate, neonatal (cases per 1 000 people) – P_{12};
- government expenditure on education (% GDP) – P_{13};
- literacy rate, adult total (% of people) – P_{14};
- school enrollment, primary (% gross) – P_{15};
- mobile cellular (subscriptions per 100 people) – P_{16}.

We aggregate the indicators $P_1 - P_{16}$ for each of the thirteen civilizations for each year according to the following logic:
- indicators $P_1 - P_{8}$ are aggregated as the sum of the values of individual indicators of countries belonging to a particular civilization, which is reduced per person;
- indicators $P_9 - P_{16}$ are aggregated as the average value of individual indicators of countries belonging to a particular civilization.

All these indicators $P_1 - P_{16}$ were normalized according to the formula:

$$P_{i,norm}^{year,c} = \frac{P_i^{year,c} - \min_{year,c}(P_i^{year,c})}{\max_{year,c}(P_i^{year,c}) - \min_{year,c}(P_i^{year,c})},$$

here *year* is the number, c is the civilization number.

After normalization, the distances between thirteen civilizations were found in pairs according to the Euclidean distance formula:

$$d_{i,j}^{year} = \sqrt{\sum_{k=1}^{16} (P_k^{year,i} - P_k^{year,j})^2},$$

here *year* is the year number, i, j is the civilization number.

The distances obtained on the basis of indicators of 2019, are shown in Table 7. We see that the Japanese civilization since 1995 has not been involved in any armed conflict. It is maximally, equally distant from all other civilizations. The non-existence of armed conflicts and related human victims within the territory of this civilization for a long time allowed it to achieve and anchor one of the highest levels of socio-economic development in the world.

T a b l e 7. Conditional distances between civilizations in multidimensional parametric space (as of 2019)

Civilizations	Japanese	Slavic – Western catholic	Confucian	Slavic – Central–Eastern orthodox	Muslim – Malayan	Hindu	Western – North American	Slavic – Eastern orthodox	Latin American	African	Western – European	Muslim – Turkic
Muslim – Arabic	1,88	1,21	0,82	0,99	0,60	0,52	1,57	0,73	0,71	0,96	1,86	0,71
Muslim–Turkic	1,81	0,94	0,52	0,58	0,34	0,53	1,38	0,46	0,50	0,80	1,65	
Western–European	1,72	1,03	1,50	1,24	1,72	1,89	1,28	1,62	1,65	2,14		
African	2,16	1,52	1,20	1,25	1,01	0,72	1,70	1,09	0,93			
Latin American	1,81	1,03	0,72	0,76	0,55	0,63	1,35	0,60				
Slavic–Eastern orthodox	1,61	0,76	0,61	0,53	0,45	0,78	1,38					
Western–North American	1,64	1,31	1,38	1,30	1,47	1,61						
Hindu–	1,97	1,28	0,73	0,97	0,53							
Muslim – Malayan	1,87	1,01	0,39	0,66								
Slavic – Central – Eastern orthodox	1,65	0,45	0,64									
Confucian	1,79	0,92										
Slavic–Western catholic	1,49											

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It is also obvious that Muslim civilizations are close to each other and more distant from Western-European and Western-North American. An interesting result is the relatively small distance between the Hindu civilization and the Muslim countries.

For the purposes of our study, the analysis of distances between civilizations in dynamics is indicative. Accordingly, their values were calculated using the indicators of 1991–2019 (see Fig. 11). Upon analyzing the dynamics of distances

between civilizations, we see that 46 pairs of civilizations increased the distance between them by an average of 50.0% compared to 1991, and 28 pairs of civilizations decreased it by 24,8%, while 4 pairs almost did not change the distances. Among the latter there are African and Slavic – Western Catholic, African and Hindu, Muslim – Arabic and Slavic – Central-Eastern Orthodox, Slavic – Eastern Orthodox and Slavic – Western Catholic pairs.
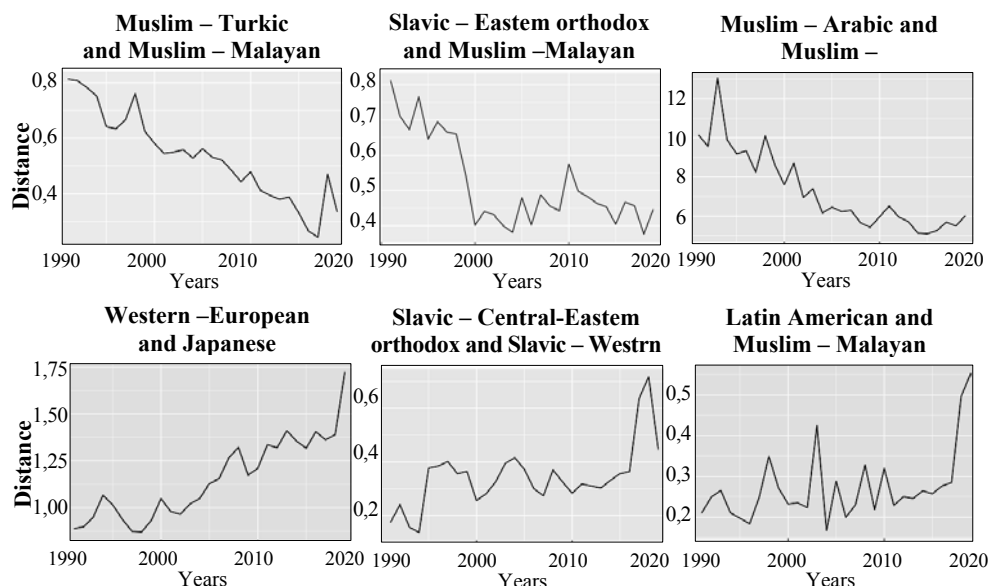

Fig. 11. Dynamics of changes in distances between civilizationson socio-economic indicators basis

Hence, we can conclude that the developed Eastern civilizations are getting closer to each other over time, while the distance between the Western ones increases.

On average, the total distance between civilizations in the world is growing. Fig. 12 shows the dynamics of the calculated total distance. Its increase for the period 1991–2019 is 17,0%.

The lowest value of the total distance was observed in 2002, then it increased until reaching a local maximum during the global economic crisis of 2008. In general, since 2002 there has been a trend of increase in total distance, and the absolute maximum was reached in 2019 with a tendency to further increase.

In general, there is a direct relationship between the level of global conflict in the world and the total

Fig. 12. Dynamics of total distance between the world civilizations

distance between world civilizations, determined by socio-economic indicators. This fact confirms the conclusion that the conflict level and the socio-economic condition of civilization clusters and the countries that form them are interconnected and interdependent. In particular, conflicts caused by faults between civilizations, on the one hand, deplete the participating countries and worsen their socio-economic situation, and on the other hand, exacerbate as the socio-economic situation deteriorates.
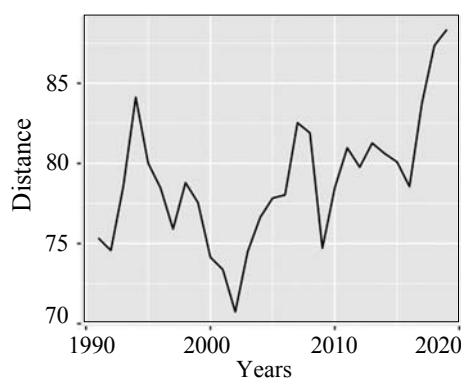
CONCLUSIONS

The concept of faults between civilizations is examined and formally verified in the paper, which is considered as one of the important factors in the emergence and course of actual world conflicts that have a civilizational nature and, as a result, change the vector of global development.

Based on the results of modeling the global ethnocultural civilizational division, the concept of faults between S. Huntington's civilizations is verified and confirmed, the number of ethnocultural civilizations of the world is expanded, the civilizational nature of modern world conflicts is proved and formally determined.

Evolutionary trends and regularities of growth of the global conflict level are systematized and identified. The regularity of the abrupt increase in the number of conflicts is substantiated using several independent approaches:

- based on the concept of civilizational faults;
- based on the theory of solar activity cycles;
- based on the results of modeling the global distribution of civilizations;
- based on the results of the application of structural statistical analysis;
- according to the results of econometric modeling.

The regularities defined in different ways generally coincide, and the described approaches explain and substantiate each other, which collectively proves the relevance of the formulated conclusions.

The conclusion is made about the gradual growth of cultural and socio-economic differences between individual civilizations, which contributes to the growth of the number of world armed conflicts. The described trends of growing conflict pose new challenges and cause large-scale risks to humanity. In order to meet new, more complex, hybrid threats, it is important to understand their nature and take non-standard and decisive response measures, to improve cooperation between states at international level, and between the state and society as well, at national level.

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МОДЕЛЮВАННЯ ВПЛИВУ МІЖЦИВІЛІЗАЦІЙНИХ РОЗЛОМІВ НА ІНТЕНСИВНІСТЬ КОНФЛІКТІВ У СВІТІ / М.З. Згуровський, М.О. Кравченко, І.О. Пишнограєв, М.М. Перестюк

Анотація. За допомогою математичного апарату багатофакторного регресійного аналізу перевірено, формалізовано та доповнено концепцію розломів між цивілізаціями. На основі методу нечітких кластерів уточнено етнокультурний цивілізаційний розподіл країн. Розроблено математичну модель розломів між цивілізаціями, яка надала можливість оцінити та проаналізувати кількісні показники цих розломів. У роботі подано результати аналізу та порівняння даних моделювання 2008 та 2018 років. Моделювання дозволило формально підтвердити еволюційні закономірності, систематизувати та економетрично перевірити змінення характеристик цивілізаційних розломів. Зокрема, виявлено тенденції окремих цивілізацій до об'єднання та зіткнення, а також вплив цих розломів на глобальну конфліктність. Наведено оцінку залежності глобальних конфліктів від рівня поширення зброї. Визначено вплив конфліктів на соціально-економічні показники цивілізацій, що конфліктують. Відповідність результатів моделювання реальному стану міжцивілізаційних розломів перевірено порівнянням з фактичними історичними даними. Результати дослідження дозволили сформувати комплексне бачення природи сучасних конфліктів, виникнення яких обумовлено розломами цивілізацій, а також визначити їх формальні характеристики та закономірності.

Ключові слова: цивілізації, цивілізаційні розломи, конфлікти, глобальні загрози, поширення зброї, багатофакторний регресійний аналіз, метод нечітких кластерів.

МОДЕЛИРОВАНИЕ ВЛИЯНИЯ МЕЖЦИВИЛИЗАЦИОННЫХ РАЗЛОМОВ НА ИНТЕНСИВНОСТЬ КОНФЛИКТОВ В МИРЕ / М.З. Згуровский, М.О. Кравченко, И.А. Пышнограев, М.Н. Перестюк

Аннотация. С помощью математического аппарата многофакторного регрессионного анализа проверена, формализована и дополнена концепция разломов между цивилизациями. На основе метода нечетких кластеров уточнено этнокультурное цивилизационное распределение стран. Разработана математическая модель разломов между цивилизациями, которая дала возможность оценить и проанализировать количественные показатели этих разломов. В работе представлены результаты анализа и сравнения данных моделирования 2008 и 2018 годов. Моделирование позволило формально подтвердить эволюционные закономерности, систематизировать и эконометрически проверить изменение характеристик цивилизационных разломов. В частности, выявлены тенденции отдельных цивилизаций к объединению и столкновению, а также влияние этих разломов на глобальную конфликтность. Представлено оценку зависимости глобальных конфликтов от уровня распространения оружия. Определено влияние конфликтов на социально-экономические показатели конфликтующих цивилизаций. Соответствие результатов моделирования реальному состоянию межцивилизационных разломов проверено путем сравнения с фактическими историческими данными. Результаты исследования позволили сформировать комплексное видение природы современных конфликтов, возникновение которых обусловлено разломами цивилизаций, а также определить их формальные характеристики и закономерности.

Ключевые слова: цивилизации, цивилизационные разломы, конфликты, глобальные угрозы, распространение оружия, многофакторный регрессионный анализ, метод нечетких кластеров.