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Sustainable Development Global Simulation: Analysis of Quality and Security of Human Life

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1. Introduction

This research is based on the concept of "sustainable development" being the further development of studies of V. Vernadskij about noosphere (Vernadskij, 1944). It has been theoretically and practically proved that on the edge of the centuries studies about the noosphere appeared to be a necessary platform for the development of three-dimension concept of ecological, social and economic sustainable development (Summit Planet Earth, 1992) and (Johannesburg Summit, 2002).

Economic approach is based on the optimal usage of limited resources and application of natural-, power- and material saving technologies for creation of the gross income flow which would at least provide the preservation (not reduction) of the gross capital (physical, natural or human), with the use of which the gross income is created.

From the ecological point of view the sustainable development is aimed at provision of the integrity of both biological and physical natural systems as well as their viability that influences the global stability of the whole biosphere. The ability of such systems to renovate and adapt to the various changes instead of maintenance of the biological variety in the certain static state, its degradation and loss is becoming extremely important.

Social constituent is aimed at human development, the preservation of stability of social and cultural systems, as well as the decrease in the number of conflicts in the society. A human being shall become not the object but the subject of the development participating in the processes of his/her vital activity formation, decision-making and implementation of the decisions, in the control over their implementation. To meet such requirements it is important to fairly distribute the wealth between the people, to observe pluralism of thoughts and tolerate human relationships, to preserve cultural capital and its variety, including first of all, the heritage of non-dominant cultures.

Systemic coordination and balance of these three components is an extremely difficult task. In particular, the interconnection of social and ecological constituents causes the necessity to preserve equal rights of present and future generations to use natural resources. The interaction of social and economic constituents requires the achievement of equal and fair distribution of material wealth between people and help provision to the poor. And finally, the correlation of environmental and economic components requires the cost estimation of anthropogenic influences on environment. The solution of these tasks is the main challenge of the present time for the national governments, influential international organizations and all progressive people of the world.

In this research a Sustainable Development Gauging Matrix (SDGM) (Zgurovsky, 2007) within three abovementioned components is proposed and these processes are globally modeled in terms of quality and security of the human life. With the help of this Matrix the sustainable development processes have been globally modeled for a large group of world countries in terms of quality and security of the human life.

2. The methodology of sustainable development evaluation in terms of quality and security of the human life

2.1 Sustainable development as the quaternary functional of quality and security of the human life

The important issue in the process of implementation of the concept of sustainable development is the formation of the measurement system (Matrix) for the quantitative and qualitative assessment of this extremely complicated procedure.

The process of sustainable development will be characterized according to two main components: security (C_{sl}) and quality (C_{ql}) of the human life as it is shown in fig.1.

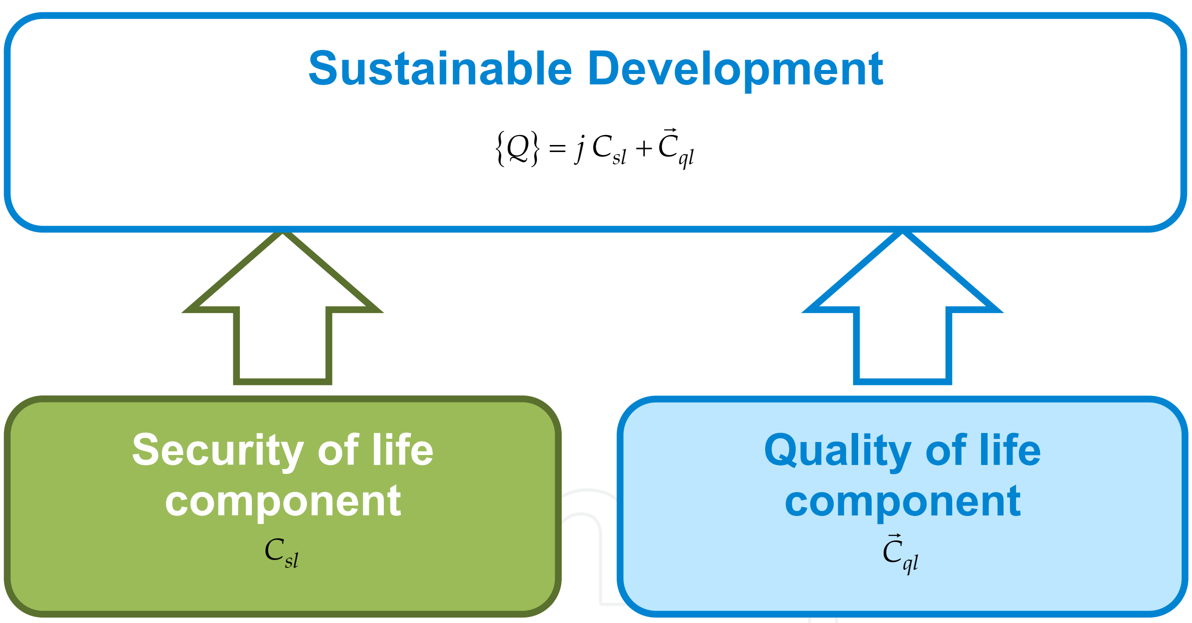

Fig. 1. Quaternary approach to the description of sustainable development process

Under this concept, the generalized measure (index) of sustainable development can be presented by means of the quaternion ***{Q}***:

$$\{Q\} = j\,C_{sl} + \vec{C}_{ql}(I_{ec}, I_e, I_s). \quad (1)$$

The quaternion ***{Q}*** includes an imaginary scalar part jC_{sl} which describes the security of human life and a real scalar part as a projection of the norm of vector radius $\vec{C}_{ql}$ to an ideal vector with coordinates (1;1;1) which describes the quality of human life within three dimensions: economic (***I****ec*), ecological (***I****e*) and socio-institutional (***I****s*). Under this condition ***j*** gains a value of a real unit for a normal regular state of society development at $C_{sl}>0$ and a value of an imaginary unit when a society enters conflict state ($C_{sl}=0$):

$$j=\begin{cases}1 \quad , \ for \ C_{sl}>0; \\ \sqrt{-1}, \ for \ C_{sl}=0 \quad (\text{conflict}).\end{cases}$$

2.1.1 Sustainable development estimation methodology in the context of quality of human life

For every country the Euclidean norm of vector radius of human life quality ($\vec{C}_{ql}$) is given in the following form:

$$\left\|\vec{C}_{ql}\right\|=\sqrt{I_{ec}^2+I_e^2+I_s^2}\ . \tag{2}$$

In this case the indicators and policy categories included are calculated as a weighted total:

$$I_i=\sum_{j=1}^{n} w_j x_{i,j}, i=\overline{1,m}, \sum_{j=1}^{n} w_j=1\ , \tag{3}$$

where I_i is a value of an indicator or a category of policy for i[th] country (the number of the countries is m), w_j is weight of the j[th] component of I index (the number of the components is n), $x_{i,j}$ is a value of the j[th] component for i^{th} country.

Such representation of integrated indices (indicators and categories of policy) envisages that components of $x_{i,j}$ in the formula (3) must be non-dimensional and vary within the same range.

Considering the fact that all data, indicators and indices included into the model are measured by virtue of different physical values, may be interpreted differently and change within the different ranges, they were aggregated to the standard form in such a way that all their variations would occur within the range from 0 to 1. The following formula was used:

$$l_{i,j}=\left(1+e^{\frac{\overline{x_j}-x_{i,j}}{\sigma(x_j)}}\right)^{-1}, \tag{4}$$

where $x_{i,j}$ and $l_{i,j}$ are respectively the initial and standard **j[th]** value for **i[th]** region, $\overline{x_j}$ is the average value of x_j at sampling and $\sigma(x_j)$ is the corresponding standard deviation. To calculate a mean value and a standard deviation value the following formulae are used:

$$\overline{x_j}=\frac{\sum_{i=1}^{m} x_{i,j}}{m}, \sigma(x_j)=\sqrt{\frac{\sum_{i=1}^{m}(x_{i,j}-\overline{x_j})^2}{m+1}}\ .$$

Such data setting provides that values of indicators being the worst from the point of view of sustainable development correspond to numerical values near to 0, and the best values approach 1.

This normalization gives the possibility to calculate each of I_{ec}, I_e, I_s indices and with the help of them the components with appropriate weighting coefficients. Then the quantitative value of human life quality can be identified as projection of the norm of this vector to an ideal vector with coordinates (1; 1; 1), (Fig.2):

$$C_{ql} = \sqrt{I_{ec}^2 + I_e^2 + I_s^2} \cdot \cos(\alpha). \quad (5)$$

The deviation angle **α** of the vector's radius C_{ql} from the ideal vector (1,1,1) is estimated on the basis of the values of dimensions I_{ec}, I_e, I_s in the following way:

$$\alpha = \arccos\frac{I_{ec} + I_e + I_s}{\sqrt{3} \cdot \sqrt{I_{ec}^2 + I_e^2 + I_s^2}}, \quad 0 \le \alpha \le \arccos\frac{1}{\sqrt{3}}. \quad (6)$$

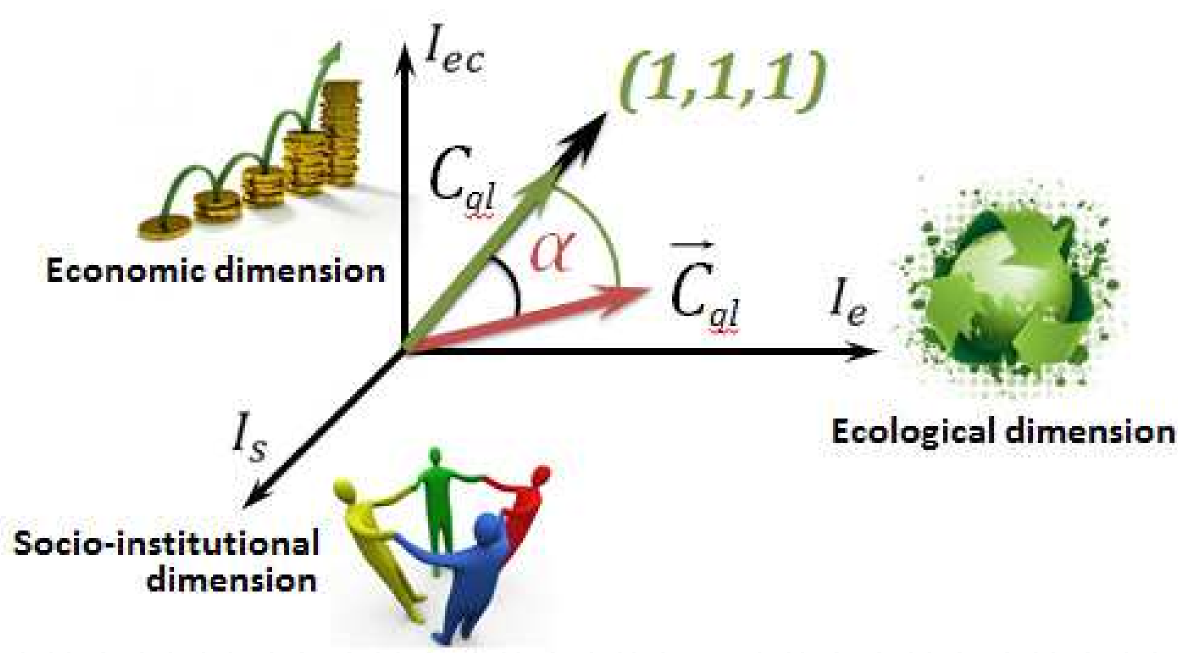

Fig. 2. Human life quality component (C_{ql}) and harmonization level ($G=1-a$)

Thus, the projection of the norm of the vector's radius $\vec{C}_{ql}$ to the ideal vector (1,1,1) characterizes the human life quality and the attitude position of the vector $\vec{C}_{ql}$ in the coordinate system (I_{ec}, I_e, I_s) characterizes the "harmonization" level of sustainable development. We should mention that when the angle α approaches 0, the harmonization level of sustainable development increases, i.e. the equidistance of the vector $\vec{C}_{ql}$ from each of coordinates (I_{ec}, I_e, I_s) will correspond to the highest harmonization value of sustainable development. If this vector approaches one of these coordinates, this will indicate the priority direction of the corresponding dimension development and neglect of two others. Let the value $G=1-a$ be the harmonization level of sustainable development. It will increase when G approaches 1 and decrease when G approaches 0.

As the researches of human life quality and security are conducted with the help of different methods and sets of initial data, it is worth performing them separately in three stages. At the first stage we will analyze the human life quality as one of the components of sustainable development. At the second stage we will investigate the human life security as another component of sustainable development. And at the third stage we will calculate the aggregate value of the Sustainable Development Index using two components and investigate this index.

In order to conduct the research of the life quality component of sustainable development, it is necessary to sample the data with the help of which each of three dimensions of sustainable development will be characterized in the most appropriate way. These data shall conform to the following important requirements: they have to be formed annually on continuing basis by respected and recognized international organizations.

Thus, the life quality component of sustainable development $\boldsymbol{C_{ql}}$ and the harmonization level of sustainable development $\boldsymbol{G=1-\alpha}$ are calculated on the basis of their constituents $\boldsymbol{I_{ec}}$, $\boldsymbol{I_e}$,$\boldsymbol{I_s}$. Considering the requirements to initial data mentioned above the value of every dimension $\boldsymbol{I_{ec}}$, $\boldsymbol{I_e}$, $\boldsymbol{I_s}$ will be calculated according to five global indices widely used in the international practice (Tab.1), being annually formed by the recognized international organizations. Let us consider all of them.

Life quality component C_{ql}	Global index	Constituents	Source
Economic (I_{ec})	$\boldsymbol{I_c}$—Global Competitiveness Index	12 policy categories, 25 indicators	World Economic Forum [www.gcr.weforum.org]
	$\boldsymbol{I_{ef}}$—Economic Liberty Index	10 indicators	Heritage Foundation &The Wall Street Journal [www.heritage.org/index/]
Ecological (I_e)	***EPI***—Environmental Performance Index	10 policy categories, 25 indicators	Yale and Columbia universities, USA [www.epi.yale.edu]
Socio-institutional (I_s)	$\boldsymbol{I_{ql}}$—Life Quality Index	9 indicators	International Living [www.internationalliving.com/]
	$\boldsymbol{I_{hd}}$—Human Development Index	3 policy categories, 4 indicators	UNDevelopment program [www.hdr.undp.org]

Table 1. Global indices used for calculationC_{ql} and $G=1-a$

The Economic Dimension Index ($\boldsymbol{I_{ec}}$) will be made of the two following global indices (Table 1.)

1. *The Global Competitiveness Index* ($\boldsymbol{I_c}$) was created by the organizers of the World Economic Forum. This index is annually estimated for 139 world economics and published in the form of so-called "Global competitiveness report" (World Economic Forum, n.d.). We will use the

data of such report for 2010-2011. The Global Competitiveness Index is formed of the following three groups of indicators: *1 – the group of indicators of basic requirements (Basic requirements); 2 – the group of indicators of efficiency enhancers (Efficiency enhancers) and 3 – the group of indicators of innovation and sophistication factors (Innovation and sophistication factors).*

The first group includes four complex categories of economic policy: *Institutions*; *Infrastructure*; *Macroeconomic stability* and *Health and primary education*. The second one consists of six policy categories: *Higher education and training*; *Goods market efficiency*; *Labor market efficiency*; *Financial market development*; *Technological readiness* and *Market size*. The third group involves two important complex indicators: *Business sophistication* and *Innovation*.

2. The Index of Economic Freedom (I_{ef}) was created by the Heritage Foundation (The Heritage Foundation, n.d.). This index is formed of the following ten indicators: a level of business freedom; a level of trade freedom; a level of fiscal freedom; a dependence degree of economics on the government; a level of monetary freedom; a level of investment freedom; a level of financial freedom; private property rights; a level of freedom from corruption; a level of labor-market freedom. These ten indicators are calculated according to the expert assessment and usage of different economic, financial, legislative and administrative data.

The Ecological Dimension Index (I_e) will be estimated with the help of EPI (Environmental Performance Index 2010 (Yale Center for Environmental Low& Policy, n.d.)). This index is formed by the **Yale Center** of Environmental Law and Policy together with Columbia University (USA) for 163 countries of the world.

To calculate this index the aggregation method is used according to which EPI 2010 index is formed of two categories of top-level environmental policy (Environmental health, being the sanitary state of environment, and Ecosystem vitality, which is the vital ability of the ecosystem), ten medium-level ecological indicators and 25 low-level indicators.

The presented index and its indicators identify the ability of every country to protect its environment both during a current period of time and also in long-term perspective, on the basis of availability of national environmental system, the ability to resist to environmental impacts and decrease in human dependence on environmental impacts, social and institutional resources of a country to meet the environmental challenges, possibility of global control over the environmental state of the country etc. Moreover, they can be used as a powerful tool for making decisions on the analytical basis including social and economic dimensions of sustainable development of the country.

The Social Dimension index(I_s) will be formed of two global indices:

1. *The Life Quality Index* (I_{ql}) which is created by the international organization International Living (International Living, 2009). This index is formed with the help of nine indicators: human life cost, leisure and culture of people, economic state of the country, environmental state of the country, human freedom, human health, an infrastructure state, life risks and safety, climate conditions.

2. *The Human Development Index* (I_{hd}), which is annually calculated under the UNO program 'United Nations Development Program' (UNDP) for the majority of countries which are members of this organization. It is formed on the basis of the aggregation method according to which three policy categories of human development are used on the top level i.e. health, education and welfare of the population of the country.

These policy categories are formed of four indicators that characterize peculiar features of the education system of a country, nation poverty factors, level of unemployment, human health-care activities, gender conditions in the country and other constituents of human development.

Table 2 shows the groups of policy categories and indicators used for global modeling of sustainable development processes in 2010.

Economic dimension		
1. ***Global competitiveness index*** I_c		
Object	*Policy category*	*Indicator*
1. Basic requirements	Institutional environment	1. Property right 2. Ethics and corruption 3. Improper influence 4. State inefficiency 5. Safety
	Economic infrastructure	6. Transport infrastructure 7. Power and communication infrastructure
	Macroeconomic stability	8. Macroeconomic stability
	Human health and basic education	9. Population health 10. Basic education
2. Effectiveness increase	Higher education and education system	11. Education quantity 12. Education quality 13. Correspondent education
	Goods market effectiveness	14. Competition 15. Demand condition quality
	Labor market effectiveness	16. Flexibility 17. Talent use effectiveness
	Financial market perfection	18. Effectiveness 19. Reliability and confidentiality
	Technological readiness	20. Technology adaptation 21. ICT usage
	Market scales	22. Domestic market volume 23. Foreign market volume
3. **Innovation**	Business perfection	24. Business perfection
	Innovations	25. Innovations
2. ***Economic Freedom index*** I_{ef}		
		1. Business freedom 2. Trade freedom 3. Fiscal freedom 4. Dependence of economics on government 5. Monetary freedom 6. Investment freedom 7. Financial freedom 8. Private property right 9. Freedom from corruption 10. Labor market freedom

Ecological dimension		
Ecological dimension index I_e, (EPI)		
Object	*Policy category*	*Indicator*
1. **Ecological health**	1.Ecological disease load	1.Ecological disease load
	2. Air pollution (influence on human)	2. Air pollution in facilities
		3. Dust pollution of city atmospheric air
	3. Water (influence on human)	4.Potable water availability
		5. Availability of sanitation means
2. **Ecosystem viability**	4. Atmospheric air pollution (influence on ecosystems)	6.Sulphur dioxide emissions 7. Nitrogen dioxide emissions 8. Non-methane organic volatiles emission 9. Surface ozone concentration (in ecosystems)
	5. Water (influence on ecosystems)	10. Water quality index 11. Water resources load index 12.Water resources deficiency index
	6. Biodiversity and natural habitat	13. Protected nature territories (biomes protection) 14. Marine protected areas 15. Index of Alliance against complete species extinction
	7. Forestry	16. Growth change of woodland coverage 17. Woodland area change
	8. Fishery	18. Marine trophic index 19. Trawling intensity
	9. Agriculture	20. Intensity of fresh water consumption for agricultural purposes 21. State-subsidizing of agriculture 22. Pesticides usage control
	10. Climate changes	23. Greenhouse gases emission per capita 24. Carbon dioxide emission per unit of generated energy 25. Intensity of industrial greenhouse gases emission

Socio-institutional dimension	
Life quality index I_{ql}	**Human development index I_{hd}**
Indicators	Category of policy, indicators
1.Life quality Life cost Leisure and culture State of economy State of environment Human freedom Human health State of infrastructure Life risks and safety Climate conditions	**1. Population health** Life expectancy index **2.Population education** Adults literacy index Education coverage index **3. Population welfare** GDP index

Table 2. Policy categories and indicators for global modeling of sustainable development processes in 2010

As it is shown in Table 1 and 2, life quality component of sustainable development C_{ql} and its harmonization degree $G = 1 - \alpha$ in the year 2010 were determined with the usage of twenty two categories of policy and 73 indicators.

On the basis of description of relations between different categories of policy and indicators reduced to common calculating platform, the mathematical SDGM model was developed, the structure of which is presented in Figure 3.

It was taken into account that all data, indicators and indexes included into model (Figure 3) are measured with the help of different physical quantities, may be interpreted differently

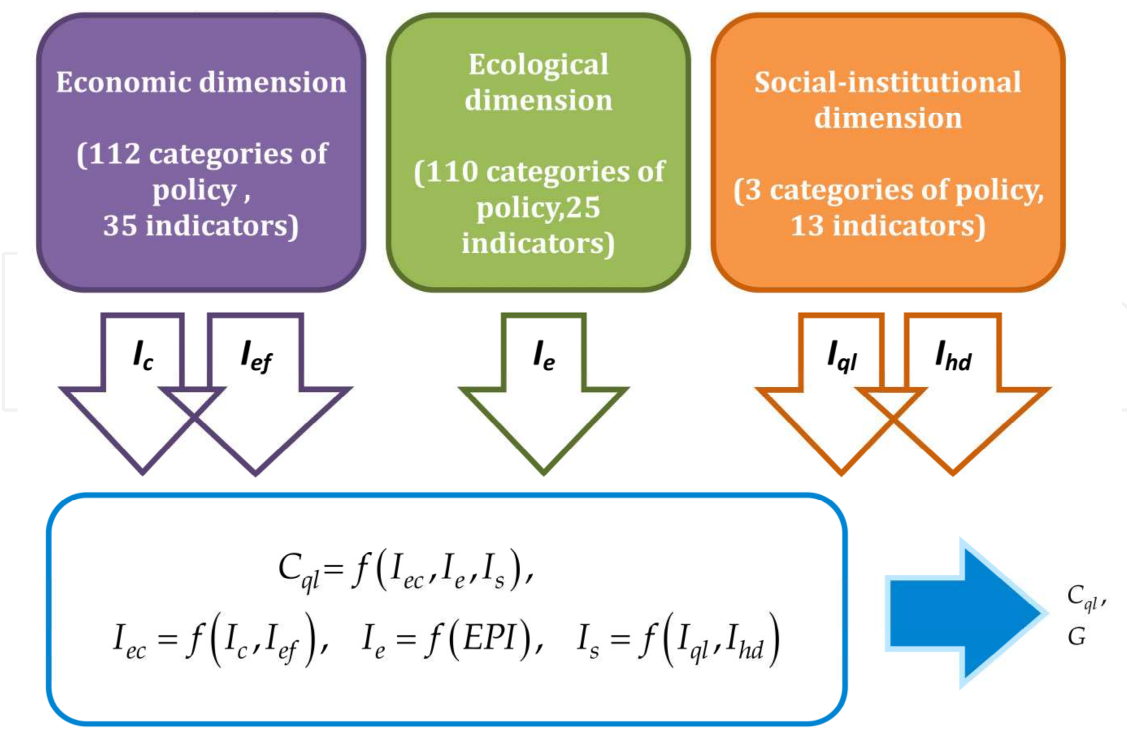

Fig. 3. The mathematical SDGM model for determination of life quality component of sustainable development and its harmonization degree

and change within different ranges. That is why they were normalized for their changes to occur within range from 0 to 1. In this case the worst values of mentioned indicators conform to numeral values close to 1. Such normalization gives the opportunity to calculate every index $\boldsymbol{I_{ec}}$, $\boldsymbol{I_e}$, $\boldsymbol{I_s}$ and component $\boldsymbol{C_{ql}}$ through their components with appropriate weight coefficients. In their turn the weight coefficients in the formula of calculation of life quality component of sustainable development $\boldsymbol{C_{ql}}$ are selected in order to give the possibility to provide equal values of economic, ecological and social dimension in the coordinate system ($\boldsymbol{I_{ec}}$, $\boldsymbol{I_e}$, $\boldsymbol{I_s}$).

Therefore, the SDGM model gives the possibility to calculate life quality component of sustainable development $\boldsymbol{C_{ql}}$ and harmonization degree of this development $\boldsymbol{G = 1 - \alpha}$ for every country of the world for which data about global indexes and indicators exist (Table 2).

2.1.2 Methodology of sustainable development assessment in terms of the human life security

Let us consider the global threats to the sustainable development to be those determined in the beginning of the XXI century by such recognized international organizations as UNO, World Health Organization (WHO), international organizations "World Economic Forum, Transparency International", "Global Footprint Network", "International Energy Agency", "World Resources Institute", company "British Petroleum" and others. The analysis of every threat will give the possibility to determine the vulnerability level of different countries of the world to the influence of these aggregated threats. Let us analyze each of the global threats separately.

Threat 1. Global decrease in energy security (ES)

For the first part of the XXI century one of the main critical challenges to the mankind is the rapid decrease in organic fuel resources that are extracted from entrails of the earth, and the increase in consumption of such resources, first of all, by India and China. In the beginning of the 20-ies of the current century, the curves of energy consumption and production of energy from oil will be crossed (AlenkaBurja, n.d.). In other words, the "production-consumption" balance of energy, produced from oil, will change its value from positive to negative (Figure 4). The similar phenomena will occur for "production-consumption" balances of energy, made from gas in the beginning of 30-ies and for the energy generated from uranium-235 in the beginning of 50-ies, accordingly (Figure 4).

Thus, until the mankind invents the energy resources that could fully replace the organic types of fuel and nuclear energy, the energy security of a country in particular and the world in general, will decrease. In order to quantitatively estimate the energy security of different countries of the world let us introduce the energy security index (Energy Security Index, ES) that will be calculated by the formula

$$ES_i = \frac{Exhaustables_i + Renewables_i}{2}, i \in \{countries\},$$

$$Exhaustables_i = \frac{NuclearR_i + CoalR_i + OilR_i + GasR_i}{\max\limits_{\forall j \in \{countries\}} [NuclearR_j + CoalR_j + OilR_j + GasR_j]}, \quad (7)$$

$$Renewables_i = \frac{RenewablesUsed_i}{\max\limits_{\forall j \in \{countries\}} RenewablesUsed_j},$$

where:

- $ES \in [0;1]$, *{countries}* - set of explored countries,
- *Exhaustables* is the component that characterizes the dynamics of resource deflation;
- *Renewables* is the component that characterizes the volumes of usage of renewable sources in national energetic;
- *NuclearR, CoalR, OilR, GasR* –resources of uranium-235, coal, oil and gas (Nation Master, n.d.);
- *Renewables Used* – part of renewable energy produced and consumed by the country (at the expense of use of the energy of water, sun, wind, geothermal heat, biomass and rubbish burning) in percents from total energy consumption (Human Development Report 2007/2008, n.d.).

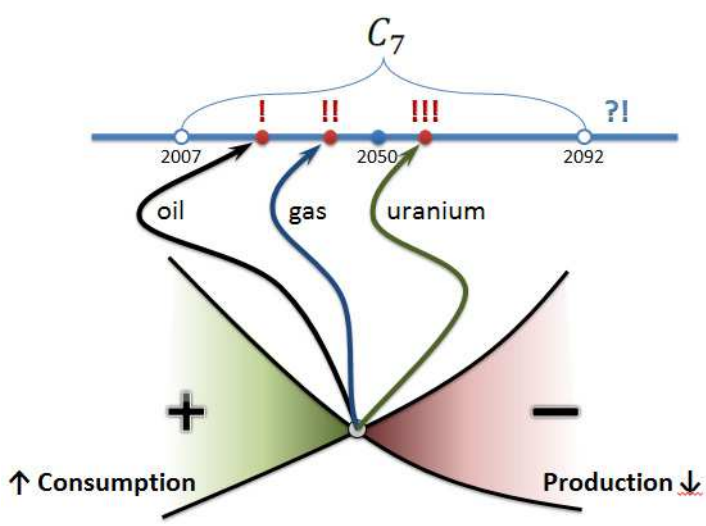

Fig. 4. Change in "production-consumption" balance from positive into negative for energy production from oil, gas and uranium-235, accordingly

Threat 2. The imbalance between biological abilities of the Earth and human needs in biosphere in terms of the change in the world demographic structure (BB)

In February 2011 the population of the planet has exceeded 7 million people living on the total area 510 072 000 km2. Daily growth of population is 211 467 people (GeoHive, n.d.). According to the method of arithmetic extrapolation the Earth population will have been 9,75 billion people by the year 2050. That is why the first threat appears being related to the fact that the Earth will be inhabited by the number of people that will exceed its abilities to sustain on the basis of the present natural resources. The Pentagon experts consider that the real problems for the mankind will have occurred by the year 2020, and will be connected with the catastrophic shortage of water, energy, foodstuff that can cause new conflicts on the Earth (Membrane, n.d.).

Nature can satisfy human requirements for business activity and only while this activity remains within the biosphere renewable capacity on the populated part of the planet. The calculation of ecologically disturbed area (Ecological Footprint) (Global Footprint Network, n.d.) gives the possibility to establish some limit according to which the ecological requirements to the world economics are within or exceed the biosphere abilities to supply the people with goods and services. This limit helps people, organizations and government to create strategies, establish the goals and provide the process according to the requirements of the sustainable development.

Ecologically disturbed territory (Ecological Footprint) determines which its part is necessary to preserve present population according to the present level of consumption, level of technological development and usage efficiency of natural wealth. The unit of measurement of this dimension is average (global on the whole Earth) hectare. The most substantial component of the Ecological Footprint is the territory of the Earth used for foodstuff production, forest area, biofuel amount, ocean (seas) territory, used for fishing and the most important element is the Earth area, necessary to support the life of plants absorbing the emissions of CO2 as a result of organic fuel burning.

Ecological Footprint envisages that in world economy the people use resources and ecological services from all over the world. Thus, the indicator for a country may exceed its actual biological possibilities. On the basis of it, the essence of Ecological Footprint for a country is the extent of its consumption and global impact on environment.

The same methodology can be used for calculation (in the same values) of biological abilities of the Earth, biological productivity of its territory. In 2011 biological abilities of the Earth were approximately 11.2 billion or 1.8 global hectares per capita (non-human species were not considered). Now the human need in biosphere, i.e. its global Ecological Footprint is 18.1 billion global hectares or 2.7 global hectares per capita. That is why, today global Ecological Footprint exceeds biological abilities of the Earth by 0.9 global hectares per capita or by 50%. This means that vital resources of the planet disappear faster than the nature can renew.

This threat has substantial correlation degree with demographic structure change of the planet population. For example, according to UNO (Human Development Report 2007/2008, n.d.) the biggest growth of population over a period of the following 50 years is expected in the poorest regions of the world: in Africa it will increase in 2 times, In Latin America and Caribbean basin will increase in 1.5 time, at the same time in Europe it will decrease in 0, 8 times. Essential threat is also uncontrolled increase in the urban population in underdeveloped countries. By the year 2050 it will have been doubled approximating to 10 billion people. It will lead to intensification of transport, ecological and social problems, an increase in criminality and other consequencess of chaotic urbanization.

The important tendency of the nearest decades is rapid change in the structure of religious groups of the Earth population. So, from 1980 to 2005 the number of Muslins will increase from 16,5% to 30%, the number of Christians will decrease from 13.3% to 3%, the number of Hindus will decrease from 13.3% to 10%, the number of Buddhists will decrease from 6.3% to 5%. The number of representatives of other religious groups will also decrease from 31.1% to 25% (Science Council of Japan, 2005). These changes will cause the necessity of searching new methods of tolerance coexistence of people on the Earth.

For estimation of increasing threats, connected with imbalance between biological capability of the Earth and human requirements in biosphere, in terms of demographic structure change of the world we will use the indicator which is ecological reserve ("+") or deficit ("-") in global hectares per capita for a country (Global Footprint Network, n.d.).

Threat 3.Growing inequality between people and countries on the Earth (GINI)

According to the World Bank data, in the year 1973 the difference in incomes between the richest and poorest countries were determined by ratio 44:1, and today it is 72:1. The assets of three world's richest people exceed the wealth of 47 countries of the world. Assets of the whole mankind are controlled by 475 richest people. Assets of 50 richest people of Ukraine which amount to 64,4 billion dollars in 2007 exceeded two national budgets of the country, in particular (Donbass Internet Paper. News.dn.ua, n.d.). The correlation between one fifth of the richest and one fifth of the poorest parts of the Earth population has reached 1:75. Wealth of civilization still remains unachievable for the poorest group. Its representatives spend less than two dollars a day; 700 million of them live in Asia, 400 million live in Africa and 150 in Latin America. The gap between the richest and the poorest groups of people of the Earth has risen approximately tenfold according to their living standards in the course of the last 20 years. The threat is considered to be dangerous due to the growing number of the world conflicts, growth of corruption, terrorism and crime, ecology deterioration, a decrease in the level of education and health service support.

In order to estimate the distribution inequality of economical and social boons for each country the SP-index (CIA, n.d.) which identifies these characteristics will be used.

Threat 4.The spread of global diseases (GD)

The World Health Organization considers such diseases as cancer, cardio ischemia, cerebrovascular disease (paralysis), chest troubles, diarrhea, AIDS, tuberculosis, malaria, diabetes to be the most dangerous for mankind as they may not only have bad consequences but also globally spread all over the world.

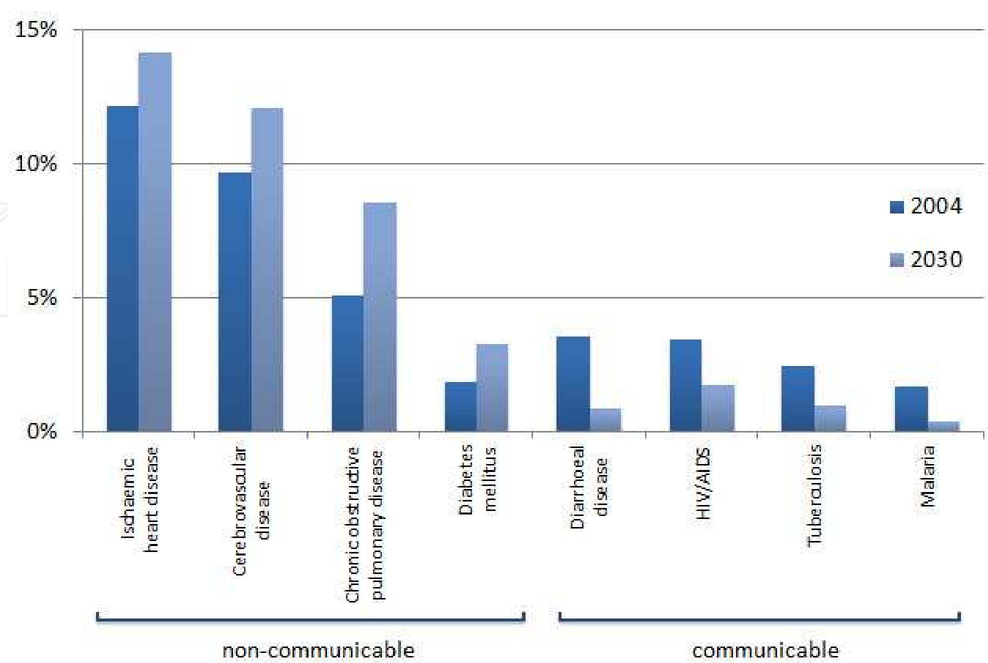

Fig. 5. Comparison of mortality factors, 2004 -2030 (Mathers, 2006)

During the next 20 years the sufficient increase in mortality caused by all non- infectious global diseases and decrease in mortality caused by AIDS, tuberculosis and malaria are expected. Such diseases as cardio ischemia, cerebrovascular disease, lung cancer and diabetes will become main global diseases during this period. At the same time the rate of total mortality from tobacco consumption will increase from 5.8 million people in the year 2009 to 6.4 million in the year 2015 and 8.3 million in 2030. Thus, tobacco is expected to kill by 50% people more than AIDS. Total human mortality on the Earth will be by 10% predetermined by the tobacco consumption.

But for estimation of the level of protection of the countries against quickly-spreading diseases it is reasonable to use the data on infectious diseases. In the further modeling the data on total mortality of the population of the world countries (million per year) caused by the totality of infectious diseases such as diarrhea (the most common mortality factor in underdeveloped countries), AIDS, tuberculosis, malaria and others will be used (Mathers, 2006).

Threat 5. Child mortality (CM)

The child mortality rate or under-5 mortality rate is the number of children who die by the age of five, per thousand live births per year. According to the data of United Nations Children's Fund 11 million children aged less than 5 die every year. Poverty which leads to bad health of mothers, insufficient nutrition and unsatisfactory sanitary is the reason of child mortality. Such factors as infectious diseases, poor health care and conflicts also increase child mortality. Africa, for example, has high rates of child mortality which are connected with AIDS epidemic, poor sanitary conditions and bad nutrition. The increase in child mortality in Iraq and Afghanistan is mostly caused by the conflicts.

According to UNICEF, most child deaths (and 70% in developing countries) result from one the following five causes or a combination thereof: acute respiratory infections, diarrhea, measles, malaria, malnutrition.

There is a significant difference in the indices of child mortality for different countries. In western industrially developed countries from 4 to 7 out of 1000 children die under the age of 5 years. The average rate of child mortality in developing countries is 158. In Sierra Leone, for example, every fourth child dies at infant age. Every tenth child doesn't live to 5 years in Iraq.

The rate of child mortality in the countries of the former Soviet Union in 10-12 times exceeds the rate of child mortality in the countries of Western Europe. It is particularly high in Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

Leaders of the countries took the responsibilities to decrease the rate of death of children aged under 5 years by two thirds by the year 2015. The United Nations Children's Fund now warns that 98 countries of the world will not be able to succeed in the specified task.

One of the UN Millennium Development Goals (MDGs) is to reduce child mortality, and the target is to "Reduce by two thirds, between 1990 and 2015, the under-five mortality rate". According to the UN MDG Report 2010 child deaths are falling, but not quickly enough to reach the target. Revitalizing efforts against pneumonia and diarrhoea, while bolstering nutrition, could save millions of children. Recent success in controlling measles may be short-lived if funding gaps are not bridged.

Such tendencies signify another global threat due to marginalization of social and economic processes, a decrease in ecological and sanitary standards, impoverishment of people in the majority of countries of the world. In the further modeling, the data on the child mortality rate or under-5 mortality rate will be used. This data is collected by World Health Organization (WHO) and published in WHO Annual Reports and Statistical Information System. That data is also accessible at World Data Center for Geoinformatics and Sustainable Development (WDC-Ukraine).

Threat 6. The growth of corruption (CP)

Corruption is the biggest obstacle to the economic and social development of society. It endangers every change. Corruption has become not only one of the main reasons of poverty but also a source which prevents its overcoming. Although corruption had existed for a long time it became more widely spread in the process of globalization at the end of the 20th at the beginning of 2the 1th centuries.

Corruption in one country had negative impact on the development of other countries which means that countries with the high level of corruption are not limited to the Third World. The process of liberalization in the former socialist countries was accompanied by unprecedented position abuses in 90-ies. Thus, Financial Times proclaimed 1995 to be "the year of corruption". The following years were marked with the spread of this phenomenon almost throughout all countries of the world and corruption itself became of global and international character.

Wellbeing did not become the prerequisite of successful elimination of corruption. The analysis of long-term tendencies revealed by the international organization «Transparency International» showed that during last 12 years the level of corruption has decreased in such countries as Estonia, Columbia, Bulgaria. Nevertheless, the growth of corruption occurs in such developed countries as Canada and Ireland. Such factors of risks as opacity of state authorities, excessive influence of separate oligarchic groups, violation in financing of political parties, etc. exist both in poor and rich countries and unfortunately, tendencies in increase of corruption scale are the same.

Usually, the structure of corruption is different in different countries of the world. Figure 6 illustrates countries and segments of society with the highest level of corruption according to (Transparency International, n.d.).

Figure 7 shows average indices of corruption in different segments of society according to (Transparency International, n.d.).

To estimate the influence of corruption on socio-economical and cultural development of different countries of the world we will use "the index of corruption perception" established by the international organization "Transparency International" (Report on the Transparency International Global Corruption Barometer 2007, 2007).

Threat 7. Limited access to drinking-water (WA)

According to the data of the WHO **and** the UNICEF (Corruption Perception Index 2008, 2008) the world is under the threat of increase of limited access to drinking-water and sanitary facilities. The fifth part of all mankind (11 billion people) does not have access to drinking-water and 2,4 billion of people do not have minimal sanitary facilities. That is why

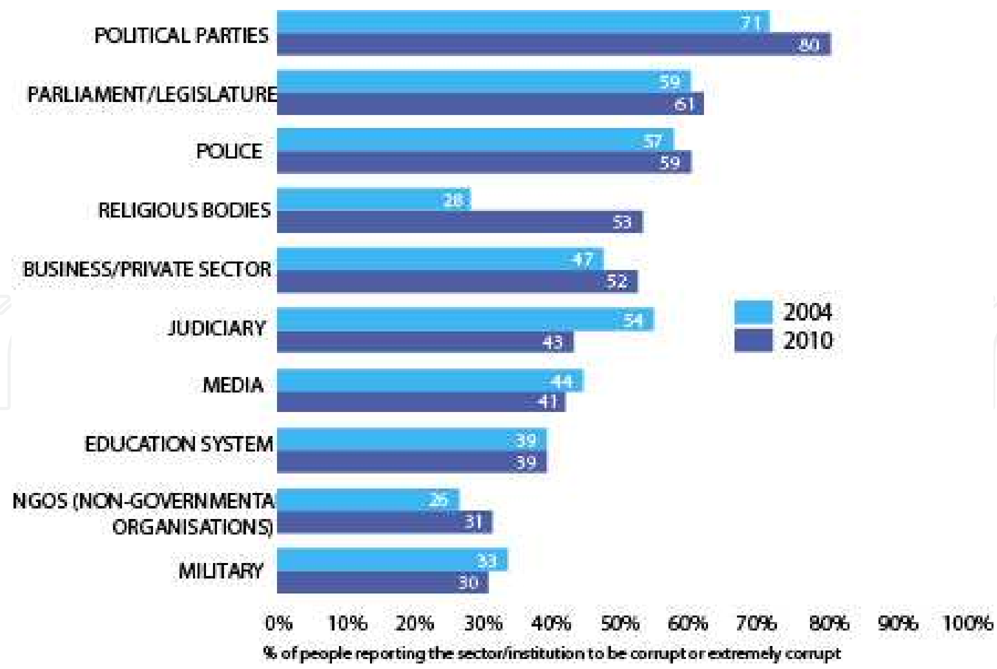

Fig. 6. The structure of corruption according to the data of «Transparency International» (Transparency International, n.d.)

2003 was proclaimed as year of drinking water by the General Assembly of UNO. The period of 2005-2015 starting from the International Day of Water Recourses (22nd of March, 2005) was proclaimed as International decade of actions "Water for life".

The urban regions of underdeveloped countries have complicated situation where due to the rapid increase in the population the problem is exacerbating rapidly. These factors negatively influence the children health. According to the data of the WHO in the year 2005, 1,6 million children aged under 5 (4500 children per day approximately) died as a result of consumption of the dangerous water and inappropriate sanitary facilities.

The more the population of the planet increases, especially in underdeveloped countries, the more struggle for the control of drinking-water recourses will exacerbate another global threat for mankind.

The limited access to the drinking- water will be estimated by the inversed magnitude to the indicator of the access to drinking water (Human Development Report 2007/2008, n.d.).

Threat 8. Global warming (GW)

Global warming is the process of gradual increase in the average annual temperature of the Earth and World Ocean. According to conclusions of the International UNO Expert Group in Climate Control (UNICEF Joint Monitoring Programme for Water Supply and Sanitation, n.d.) and National Academies of Sciences of the Group of Eight, from the end of 19th century the average temperature of the Earth has risen by 1°C and "the major part of warming observed during the last 50 years had been caused by human activities" preliminary by gas emissions which cause green-house effect (carbon dioxide, $CO2$) and methane ($CH4$).

Estimates obtained with the climate models and cited by the International UNO Expert Group in Climate Control show that the average temperature of the Earth can increase from one to several °C (in different regions of the world or in the Earth in average) in 1990-2080 years. The warming is expected to cause other climate changes such as an increase in the level of Word Ocean by 0,1-5 m. (probably, in 30-40 years), the appearance of new viruses and also the change of atmospheric condensation and their distribution. This may result in an increase in such natural disasters as floods, draughts, hurricanes etc; a decrease in harvests of agricultural crops, the emergence of new epidemic diseases and the extinction of many biological species. As a result of the control over decreasing natural resources the struggle not only between countries but also between separate groups of population can exacerbate. This process will cause new global conflicts. The influence of carbon dioxide emissions on the global warming is much higher than the corresponding influence of methane. That is why the danger of global warming will be estimated by the amount of carbon dioxide emissions CO_2 in metric tons per capita.

Data about emissions is obtained by WDC-Ukraine from Carbon Dioxide Information Analysis Center (CDIAC). It can be obtained with data extraction tool (http://wdc.org.ua/en/data). Original data is only the amount of Carbon (C) and calculation has been done to convert Carbon into Carbon Dioxide (CO2): values were multiplied by according coefficient (12+16*2)/12. Per capita emission data is based on calculations: CO2 emission / population for each country correspondingly.

Threat 9. The state fragility (SF)

After the end of Cold War and Soviet Union collapse (1991) the world has entered the era of new dramatic geopolitical processes. The following 18 years were marked with the blistering growth of globalization. Technical revolution in the field of information-communication technologies has made the world policy more transparent and led to an increase in changes influence which occurred in one region and affected the other parts of the planet. Due to these new qualities of the globalized world it became clear that new geopolitical system is full of unstable, unsuccessful and weak countries. The weakening of retaining mechanisms peculiar to bipolar world and conflict exacerbation between fundamental values of different countries caused a new wave of oppositions, terrorism, violence, territorial claims and irregular development.

Uncontrolled spread of nuclear, chemical and biological weapon, rebuilding of nuclear energetics in such unstable, unbalanced world significantly increases the threat to sustainable development and global security of mankind.

Under such conditions the stabilization of world development becomes possible due to the international cooperation, investments and support to the weak countries and planet regions by the progress of new paradigm of “tolerant, peaceful world”. In order to accomplish such global, stabilizing policy the recognized international organizations and scientific centers began to develop analytical instruments for the estimation of new developing tendencies of the world since the beginning of this century. The first attempt to control the tendencies of the global development was a series of reports “The world and the conflict” which were published in the University of Maryland State (USA) in 2001. Reports devoted to the global tendencies of world development were also published in many countries such as Spain, Canada, and Germany etc.

The final aim of the development of new analytical instruments was the attempt to estimate the ability of different countries to act in such important dimensions as conflict, state administration, economic and social development. Among all these instruments "The index of ability of the peaceful society development" that belongs to the series of reports "The world and conflict", "Indicators of the world management" developed by the World Bank and "Index of unsuccessfulness of the countries" developed by The Fund of Peace can be mentioned.

For the quantitative estimation of the sustainable development threat in our research the State Fragility Index will be used (The Intergovernmental Panel of Climate Change, n.d.). This index is calculated as average arithmetic value between political and economical instability of the country. Data concerning these values are given in the paper (Marshall, 2008).

Threat 10. Natural Disasters (ND)

*Natural disasters are the threat which is not so directly dependent on the human activity comparing to the other threats mentioned above. But, taking into account last reports of the international organizations on climate changes (*World Economic Forum, *2010) we cannot state that a human being is beside the point of the dynamics of the natural disasters.* For the quantitative estimation of the degree of vulnerability of the world countries to the natural disasters the index of vulnerability to natural cataclysms was developed. The data of the International Disasters Database (Kotlyakov, 2001) and the Centre for Research on the Epidemiology of Disasters (CRED) of the World Health Organization (WHO) are used for its calculation.

Experts of UNO and WDC-Ukraine determined 6 major natural disasters (in the order of danger decrease): draughts, floods, hurricanes, extreme temperatures, earthquakes and tsunami (UNDP, n.d.; Aivazian, 1983).

Index is calculated as follows:

1. The summarized total of people suffered from the natural cataclysms in a year in a country is calculated*:*

$$DisastersAffected_{year,\,state} = DroughtAffected_{year,\,state} + FloodAffected_{year,\,state} +$$
$$+ StormAffected_{year,\,state} + ExtremeTemperatureAffected_{year,\,state} + EarthquakeAffected_{year,\,state} +$$
$$+ TsunamiAffected_{year,\,state}, \quad \forall year, state .$$

2. Then the summarized total of people affected DisastersAffected is divided by the amount of population in the country and in the given year*:*

$$DisastersAffected'_{year,\,state} = \frac{DisastersAffected_{year,\,state}}{Population_{year,\,state}}, \quad \forall year, state .$$

3. After that the obtained data are normalized by the logistic norm:

$$\left\| DisastersAffected'_{year,\,state} \right\| = \left[1 + e^{-\frac{DisastersAffected'_{year,\,state} - M\left[DisastersAffected'\right]_{year}}{s\left[DisastersAffected'\right]_{year}}} \right]^{-1},$$

where M[.], s[.] – are approximate average and standard deviation values respectively per year in all countries.

As consequences of the natural disasters usually make a long-term influence on the country, gradually disappearing only with time, the final value of vulnerability index on the natural disasters will be defined as Exponential Weighted Moving Average, EWMA, which has the potential smoothing factor $\alpha = 0,25$

$$ND_{year,state} = 1 - \alpha \cdot \sum_{1 \le t \le T_{\max}} (1-\alpha)^{t-1} \cdot \left\| DisastersAffected'_{year-t,state} \right\| . \quad (8)$$

The value of the coefficient α was chosen by the experts on the basis of the estimation of the average time and level of the impact of disasters on the country. For convenience of calculations only the last significant *Tmax = 25* years will be considered. At the same time the significance of time series will amount to $\varepsilon = e^{T_{\max} \cdot \ln(1-\alpha)} = 0,0007525 \le 10E - 3$

The values of vulnerability index for the countries to the natural disasters during 1995-2010 were calculated according to the given methodology.

2.1.3 Determination of the aggregate impact of the total global threats on different countries and their groups

The total impact of the total global treats to different countries and their groups will be determined by the component of human security C_{sl} *being the part of index of sustainable development in formula* **(1).**

Let us formalize this in the following way. Let every **j** country corresponds to the vector In correspondence with each country **j** a vector

$$\vec{Tr}_j = \left(ES, BB, GINI, GD, CM, CP, WA, GW, SF, ND \right) \quad (9)$$

the coordinates which characterize the degree of the development of the relevant threats, where:

***ES** is a global decrease in energy security* **(**determined by the index of energy security calculated by the formula 7);
BB is misbalanced biological capacity of the Earth and needs of the mankind in the biosphere in terms of changing world's demography (measured in global hectares per person);
***GINI** is growing inequality between people and countries of the Earth (measured by* Gini-index which changes within the range from 1 to 100; where 0 is a minimum inequality, 100 is maximum inequality);
GD is the spread of global infectious diseases (measured by the total quantity of the people [millions per year] died from diarrhea diseases, AIDS, tuberculosis and malaria);
CM is child mortality (measured by the number of children who died under 5 per 100 newborn)
CP is the growth of corruption (measured by the index of corruption perception varying within the range from 0 to 10; where 0 is a maximum corruption level and 10 – minimum corruption level);
WA I s the *limited access to drinking-water* (the percentage of the population which has no access to drinking-water);
***GW** is global warming* (measured by the quantity of carbon dioxide emissions in metric tones);

SF *is state fragility* (measured by State Fragility Index (The Intergovernmental Panel of Climate Change, n.d.), which changes in the range from 0 to 23, where 0 - minimum fragility; 23 – maximum fragility);
ND *is* index of vulnerability to natural disasters (calculated by the formula (8)).

The source data for each danger are normalized by the formula (4) and in the case of necessity converted for the maximum threat to correspond to 0 and minimum threat to correspond to 1. Thus, after normalization the more each threat approaches its zero value it becomes the most "likely to occur" in each specific country. But the more its value approaches 1 it becomes more 'unlikely to happen' in that country.

After the normalization for all global threats, the normalized vector is obtained:

$$\vec{Tr}_j^0 = \left(ES^0, BB^0, GINI^0, GD^0, CM^0, CP^0, WA^0, GW^0, SF^0, ND^0\right) , \tag{10}$$

Let us calculate the value for each component of life security C_{sb}, *which is norm of Minskoski, which* is formed of normalized threats according to $P = 3$, $n = 10$:

$$C_{sl} = \left\|\vec{T}r_j\right\| = \sqrt[3]{\sum_{l=1}^{n}\left(\vec{T}r_{jl}^0\right)^3}. \tag{11}$$

It should be mentioned that in practice the parameter P is mostly chosen to be equal 2. An increase in this parameter increases the model sensitivity for each part of the vector and vice versa its decrease smoothes (reduces) this sensitivity. That is why on the basis of the data analysis of the mentioned threats it is advisable to enlarge parameter P from the value 2 to 3, to increase sensitivity of the models to the threats being insignificant by their quantitative values if compared to the other models but being important by their substantial values.

Let us also introduce the value of vulnerability of the country to the total of the global threats which is the inverse value to the component of the life securityy C_{sl}:

$$I_{vul} = \sqrt[3]{10} - C_{sl}. \tag{12}$$

Thus, the SDGM model (1-12) combines a lot of indicators and indexes included in it by mathematical correlations making their algebraic convolution. This model combines the data of different nature i.e. economic, ecological and socio-institutional one. Thus, it shows the reverse connection and balance between three integral spheres of society development. With the help of this model it is possible to obtain the numerical value for every dimension of the quality of life and also its single matrix that considers all three dimensions together.

3. The mathematical simulation of sustainable development processes

3.1 Computation for general simulation

The mathematical simulation of sustainable development processes can be performed in three stages. At the first stage we will perform the estimation of life quality dimension C_{ql} as the component of sustainable development index in the formula (1) using Sustainable Development Gauging Matrix (SDGM) (chapter 2.1.). At the second stage we will calculate the total impact of global threats totality on different countries and world countries groups in the form of human life security component C_{sl} as the component of sustainable development index in the formula (1) (chapters 2.1.2, 2.1.3). At the final third stage we will calculate the value of quaternion **{*Q*}** according to the formula (1) as the quantitative dimension of sustainable development which considers the human life security and quality of life.

3.1.1 The estimation of human life quality as index of the sustainable development

Calculation of the life quality component C_{ql} of sustainable development and the level of its harmonization $G = 1-a$ will be performed with the use of the mathematical model *SDGM* (chapter 2.1) and global indices (tables 1 and 2).The initial data for the *SDGM* model will be taken from the annual reports of such international organizations as UNO, Heritage Foundation, World Economic Forum, International Living, Environmental Law and Policy Center of Yale University, the University of Columbia (USA).

In order to perform comparative global analysis of the life quality component of the sustainable development let us choose five countries of the world: Countries leading by the quality of life component; group of Eight (G8); the Group of giant rapidly developing countries including Brazil, Russia, India, China (BRIC countries); the group of post-socialistic countries; the countries of Africa.

It should be mentioned that owing to its geographical position and economic status Russia enters the 2nd, 3rd and 4th group simultaneously, while Germany, France and Great Britain belong to the 1st and 2nd groups.

1. Ten leading countries in the year 2010 by the life quality component of sustainable development are presented in table 3. This group includes 9 European countries and 1 country of Oceania. Considering the results of the research it can be seen that countries which in 2005-2010 were 5 world leaders by the index of their sustainable development were not superpowers with dominating ideologies and economies. Basic industries of such

Rate Cql	ISO	Country	Life quality component Cql	Economic dimension Iec	Ecological dimension Ie	Socio-institutional dimensionIs	Harmoni-zation degree G
			CLUSTER 1("VERY HIGH")				
1	*CHE*	Switzerland	1,498	0,872	0,917	0,806	0,947
2	*SWE*	Sweden	1,398	0,796	0,895	0,730	0,917
3	*NOR*	Norway	1,379	0,731	0,847	0,810	0,939
4	*NZL*	New Zealand	1,365	0,816	0,739	0,810	0,956
5	*ISL*	Iceland	1,357	0,730	0,942	0,678	0,855
6	*AUT*	Austria	1,343	0,751	0,810	0,765	0,967
7	*FIN*	Finland	1,342	0,804	0,761	0,760	0,974
8	*DEU*	Germany	1,338	0,770	0,736	0,812	0,960
9	*FRA*	France	1,320	0,664	0,812	0,810	0,909
10	*GBR*	Great Britain	1,319	0,803	0,753	0,729	0,960

Table 3. Ten leading countries according to the life quality component of sustainable development, 2010

countries are not oriented towards the usage of significant natural recourses and cheap workforce. The characteristic feature of these countries is domination of intellectual and highly-technological labor in the additional cost of their economies. All these countries are the world leaders by the ecological dimension of the world. Their innovative activity is of high level; over 4% of their GNP is spent for research and development.

Since the beginning of 1990-s they have been actively working in order to implement the model of the 'environmental economy' and knowledge-based economy. They started large-scale production of new knowledge, 'ecosystem' products and services and in the course of the following few years they included social assets into their strategy as another productive factor of the development. That is why now these counties are the countries with well-harmonized life quality components of the sustainable development i.e. economic, ecological and social ones. These countries have become the closest to the model of the 'smart' society which is the highest form of the developed, knowledge-based society.

2. The Group of Eight countries (table 4), in the year 2010 takes from 8th to 24th positions in the list by the quality of life component in sustainable development (except Russia).

Rate Cql	ISO	Country	Life quality component Cql	Economic dimension Iec	Ecological dimension Ie	Social-institutional dimensionIs	Harmonization degree G
CLUSTER 1 ("VERY HIGH")							
8	*DEU*	Germany	1,338	0,770	0,736	0,812	0,960
9	*FRA*	France	1,320	0,664	0,812	0,810	0,909
10	*GBR*	Great Britain	1,319	0,803	0,753	0,729	0,960
13	*CAN*	Canada	1,293	0,845	0,608	0,786	0,866
14	*JPN*	Japan	1,290	0,789	0,725	0,719	0,957
16	*USA*	The USA	1,268	0,851	0,546	0,801	0,819
CLUSTER 2 ("HIGH")							
24	*ITA*	Italy	1,169	0,525	0,734	0,767	0,843
CLUSTER 3 ("AVERAGE")							
69	*RUS*	Russian Federation	0,740	0,358	0,497	0,427	0,868

Table 4. The Group of Eight according to the component of the life quality of sustainable development, 2010

Although they have leading GNP indices in the world they are still on 20-30 places in the world list by quality characteristics of their economic, renewable environmental resources and development of their social assets.

The only exception in this group is Russia (69th position) which being formally included into the Group of Eight is at the same time "excluded" frotm it by the qualitative characteristics. Dependence of Russian economy on the energy sector is extremely high. This field provides the country with almost 25% of GDP and 50% of national export that makes Russia rather sensitive to and dependent on global market conditions. These results in narrowing the diversification of economic interests of Russia, which in its turn, provides aggressive state-monopoly foreign policy of the country in energy field.

3. BRIC-country group (Brazil, Russia, India and China) is characterized by rapid increase in their economies development that annually reaches 8-12 %. This is provided both due to the growth of innovational, highly-technological components of the development of these countries and by intensive use of their own natural and environmental resources, involvement of cheap labor, giant consumption of organic types of fuel (oil, gas and coil).

In spite of the rapid economic growth these countries hold from the 48th (Brazil) to 85th (India) positions in the rating table by the life quality component of sustainable development (Table 5).

This can be explained by the low level of harmonization of sustainable development for this group of countries at the expense of prior economic development and at the same time substantial backlogs in environmental and social spheres. The countries of this group are characterized by the decrease in ecological results, increase in inequality between people, high corruption levels that tend to increase. These and other factors of ecological and social character restrain harmonized sustainable development of the group of BRIC-countries.

Rate Cql	ISO	Country	Life quality componentCql	Economic dimension Iec	Ecological dimension Ie	Socio-institutional dimensionIs	Harmoni-zation level G
CLUSTER 3 ("AVERAGE")							
48	*BRA*	Brazil	0,902	0,424	0,544	0,594	0,864
69	*RUS*	Russian federation	0,740	0,358	0,497	0,427	0,868
CLUSTER 4 ("LOW")							
79	*CHN*	China	0,647	0,459	0,255	0,406	0,773
85	*IND*	India	0,572	0,418	0,245	0,328	0,789

Table 5. Group of BRIC countries according to the life quality component of sustainable development, 2010

4. Post-socialist countries (Table 6) turned out "scattered" from the 29th to 99th positions of the rating table by the life quality component in 2010. The leaders in this group were the countries of the Central Europe and Baltic, which outstripped the countries of the East Europe and Middle Asia.

For the countries of this group it is not current position by the life quality component of sustainable development that is of great importance but the dynamics of the qualitative changes and differentiation scale that have been observed for the last 15-20 years. From the approximately equal initial conditions in the late 80-ies of the last century, the countries of this group have passed through very different political, economic and mental changes for historically short period of time. The best examples of successful development were shown by the countries of the Baltic, Central and Eastern Europe, and the worst ones were shown by the countries of the Central Asia and North-Caucasian countries of the former USSR.

5. African countries listed by the life quality component of sustainable development are shown in Table 7. Except for South Africa, Tunis and Algeria, they belong to the poorest countries in the world, the GDP per person of which is lower than 5000 dollars.

According to the data of the International Organization "Transparency International", these countries have the highest levels of corruption, and according to the World Health Organization they have the highest levels of spreading global diseases, such as AIDS, tuberculosis and malaria. In 2010 the characteristics of these countries (except Tunis) greatly decreased in comparison with the previous years, not only by the life quality component in general, but also by all three dimensions of this component. The positive tendency of the sustainable development of Tunis can be explained by significant improvement of innovation climate especially in the sphere of information technologies after the UNO World Summit on Information Society was held in this country in 2005.

Rate Cql	ISO	Country	Life quality component Cql	Economic dimension Iec	Ecological dimension Ie	Socio-institutional dimension Is	Harmoni-zation level G
CLUSTER 2 ("HIGH")							
21	*CZE*	Czech Republic	1,214	0,669	0,709	0,725	0,967
23	*SVK*	Slovakia	1,176	0,611	0,757	0,669	0,912
26	*LTU*	Lithuania	1,125	0,615	0,646	0,686	0,955
27	*EST*	Estonia	1,121	0,703	0,553	0,686	0,896
29	*HUN*	Hungary	1,112	0,553	0,662	0,711	0,898
30	*LVA*	Latvia	1,095	0,526	0,724	0,646	0,872
32	*SVN*	Slovenia	1,083	0,591	0,577	0,707	0,907
37	*POL*	Poland	1,009	0,535	0,538	0,675	0,888
38	*HRV*	Croatia	1,000	0,435	0,653	0,645	0,827
43	*ALB*	Albania	0,984	0,470	0,705	0,529	0,826
CLUSTER 3 ("AVERAGE")							
40	*ROU*	Rumania	0,992	0,510	0,620	0,589	0,920
47	*BGR*	Bulgaria	0,932	0,472	0,525	0,617	0,890
56	*ARM*	Armenia	0,817	0,506	0,480	0,430	0,933
65	*AZE*	Azerbaijan	0,761	0,474	0,451	0,394	0,923
69	*RUS*	Russian Federation	0,740	0,358	0,497	0,427	0,868
CLUSTER 4 ("LOW")							
72	*KAZ*	Kazakhstan	0,720	0,464	0,413	0,370	0,907
73	*UKR*	Ukraine	0,714	0,294	0,432	0,511	0,786
74	*BIH*	Bosnia and Herzegovina	0,707	0,318	0,383	0,523	0,794
78	*KGZ*	Kyrgyzstan	0,653	0,359	0,463	0,308	0,830
83	*MDA*	Moldova	0,619	0,146	0,445	0,481	0,602
CLUSTER 5 ("VERY LOW")							
92	*TJK*	Tajikistan	0,493	0,264	0,295	0,296	0,948
99	*UZB*	Uzbekistan	0,411	0,247	0,160	0,305	0,755

Table 6. Post-socialist countries ranked by the quality-of-life component of sustainable development, 2010

On the whole, comparing the group of African countries (table 7) with the leading countries by the life quality component of the sustainable development (table 3) and the Group of

Eight (table 4) it is possible to state that in the year 2010 as compared to the year 2006 the gap between the developed countries of the world and the countries of Africa increases both by standard of living (GDP per capita) and by the life quality component of the sustainable development. This is an alarming symptom due to the increase in inequality in the world, spreading of global diseases, a growing number of global and regional conflicts, the growth of corruption and crime.

Rate Cql	ISO	Country	Life quality component Cql	Economic dimension Iec	Ecological dimension Ie	Social-institutional dimensionIs	Harmoni-zation degree G
CLUSTER 3 ("AVERAGE")							
55	*TUN*	Tunis	0,835	0,509	0,483	0,455	0,954
57	*DZA*	Algeria	0,796	0,393	0,628	0,358	0,745
60	*NAM*	Namibia	0,792	0,472	0,455	0,445	0,975
64	*MAR*	Morocco	0,774	0,434	0,591	0,315	0,753
CLUSTER 4("LOW")							
68	*ZAF*	Southern Africa	0,746	0,532	0,286	0,474	0,760
71	*EGY*	Egypt	0,734	0,433	0,514	0,324	0,818
76	*BWA*	Botswana	0,668	0,579	0,150	0,429	0,568
CLUSTER 5 ("VERY LOW")							
89	*MDG*	Madagascar	0,508	0,391	0,258	0,231	0,767
90	*KEN*	Kenya	0,508	0,354	0,296	0,229	0,828
91	*UGA*	Uganda	0,496	0,393	0,268	0,198	0,726
93	*GMB*	Gambia	0,473	0,372	0,278	0,170	0,706
94	*MWI*	Malawi	0,462	0,281	0,298	0,221	0,878
95	*ZMB*	Zambia	0,453	0,335	0,224	0,225	0,803
96	*TZA*	Tanzania	0,450	0,353	0,237	0,189	0,742
98	*MOZ*	Mozambique	0,414	0,276	0,293	0,147	0,732
100	*SEN*	Senegal	0,411	0,339	0,161	0,212	0,693
103	*BEN*	Benin	0,380	0,315	0,132	0,213	0,672
104	*NGA*	Nigeria	0,375	0,343	0,138	0,168	0,604
105	*CMR*	Cameroun	0,371	0,274	0,190	0,179	0,804
106	*ETH*	Ethiopia	0,323	0,253	0,171	0,135	0,743
107	*ZWE*	Zimbabwe	0,227	0,073	0,236	0,084	0,482

Table 7. The countries of Africa ranked by the life quality component of sustainable development, 2010

3.1.2 The estimation of human life security as the component of sustainable development index

Using the method of estimation of the total impact of the global threats totality on different countries and world countries groups represented in chapter 2.1.2. (formulae 7-12) let us calculate the life security component C_{sl} for every country considered in this research. On the basis of the calculation of the standard value of Minkovski threats vector $C_{sl} = \left\| \vec{T}r_j \right\|$ let us introduce for every j country the correlation between the clusters of the countries:

$$K_k \prec K_j \Leftrightarrow \left\| \vec{T}r_k \right\| \le \left\| \vec{T}r_j \right\| . \quad (13)$$

The calculations will be performed for the 5 groups of countries mentioned above. Table 8 rpresents the list of ten leading countries by the life security component of sustainable development in 2010.

Rate Csl	ISO	Country	Life security component, Csl	Biological balance, BB	Child mortality, CM	Corruption perception , CP	Energy safety , ES	Global diseases, GD	Inequalities between countries and people, GINI	Global warming, GW	Natural disasters, ND	State instability, SI	Limited access to potable water, WA
CLUSTER 1(''VERY HIGH'')													
1	*AUS*	Australia	1,549	0,916	0,666	0,874	0,931	0,642	0,562	0,143	0,564	0,624	0,670
2	*ISL*	Iceland	1,527	0,678	0,682	0,874	0,785	0,644	0,958	0,437	0,576	0,358	0,670
3	*NZL*	New Zealand	1,483	0,858	0,667	0,905	0,478	0,646	0,543	0,663	0,574	0,640	0,670
4	*FIN*	Finland	1,480	0,872	0,679	0,884	0,412	0,642	0,717	0,268	0,576	0,708	0,670
5	*CAN*	Canada	1,478	0,916	0,663	0,874	0,627	0,642	0,615	0,178	0,575	0,635	0,670
6	*SWE*	Sweden	1,473	0,766	0,681	0,897	0,466	0,642	0,748	0,498	0,576	0,669	0,670
7	*NOR*	Norway	1,451	0,511	0,679	0,869	0,621	0,642	0,735	0,661	0,576	0,640	0,670
8	*LUX*	Luxemburg	1,434	0,347	0,683	0,847	0,278	0,634	0,958	0,071	0,576	0,689	0,670
10	*DNK*	Denmark	1,397	0,284	0,674	0,901	0,377	0,642	0,752	0,353	0,576	0,722	0,670
CLUSTER 3(''AVERAGE'')													
9	*PRY*	Paraguay	1,398	0,918	0,537	0,258	0,975	0,586	0,227	0,644	0,546	0,515	0,425

Table 8. Ten leading countries by the life security component of sustainable development, 2010

All leading countries, except Paraguay, are in the cluster with very high values of life security index of sustainable development (table 8). It should be noted that Canada is the only representative of G8 group included in the list of ten leading countries.

Among G8 countries (Table 9) Italy has the worst values (43rd place). It should be mentioned that Russia in spite of rather low values of separate indices (''Corruption perception'', ''People inequality'', ''Global Warming'') is on the 16th place which is due, first of all, by a large amount of natural resources.

In the group of BRIC countries (Table 10) we can see that Brazil and Russia have the significantly better results by human life security component while China and India the

Rate Csl	ISO	Country	Life security component Csl	Biological balance, BB	Child mortality, CM	Corruption perception, CP	Energy safety , ES	Global diseases, GD	Inequalities between countries and people, GINI	Global warming, GW	Natural disasters, ND	State instability, SI	Limited access to potable water, WA
CLUSTER 1 ("VERY HIGH")													
5	*CAN*	Canada	1,478	0,916	0,663	0,874	0,627	0,642	0,615	0,178	0,575	0,635	0,670
13	*USA*	The USA	1,368	0,244	0,656	0,801	0,908	0,634	0,448	0,128	0,505	0,619	0,654
20	*DEU*	Germany	1,315	0,296	0,674	0,835	0,328	0,642	0,693	0,357	0,575	0,569	0,670
21	*FRA*	France	1,312	0,374	0,676	0,754	0,304	0,639	0,611	0,476	0,571	0,701	0,670
23	*JPN*	Japan	1,281	0,244	0,679	0,815	0,282	0,632	0,750	0,345	0,570	0,146	0,670
30	*GBR*	Great Britain	1,246	0,272	0,667	0,815	0,282	0,633	0,547	0,370	0,566	0,455	0,670
CLUSTER 2 ("HIGH")													
43	*ITA*	Italy	1,210	0,255	0,678	0,485	0,306	0,644	0,545	0,411	0,575	0,671	0,670
CLUSTER 3 ("AVERAGE")													
16	*RUS*	Russian Federation	1,353	0,611	0,625	0,267	0,977	0,614	0,391	0,320	0,570	0,679	0,603

Table 9. The G8 countries ranked by the life security component of sustainable development, 2010

Rate Csl	ISO	Country	Life security componentCsl	Biological balance, BB	Child mortality, CM	Corruption perception, CP	Energy safety , ES	Global diseases, GD	Inequalities between countries and people, GINI	Global warming, GW	Natural disasters, ND	State instability, SI	Limited access to potable water, WA
CLUSTER 3 ("AVERAGE")													
15	*BRA*	Brazil	1,353	0,865	0,576	0,418	0,695	0,574	0,202	0,628	0,549	0,720	0,621
16	*RUS*	Russian Federation	1,353	0,611	0,625	0,267	0,977	0,614	0,391	0,320	0,570	0,679	0,603
CLUSTER 4 ("LOW")													
79	*CHN*	China	1,115	0,431	0,584	0,407	0,713	0,605	0,433	0,533	0,145	0,472	0,478
83	*IND*	India	1,100	0,489	0,306	0,385	0,646	0,430	0,530	0,644	0,408	0,577	0,460

Table 10. BRIC countries group ranked by the life security component of sustainable development, 2010

rates of people life security practically coincide with the positions of these countries in the life quality rating of sustainable development.

For the group of post-socialistic countries (table 11) the main feature is the growth of difference by the value of human life security component. Thus, in 2010 the positions for this group vary from 16 (Russian) to 102 (Uzbekistan).

Rate Csl	ISO	Country	Life security component Csl	Biological balance, BB	Child mortality, CM	Corruption perception, CP	Energy security , ES
CLUSTER 2 ("HIGH")							
24	*SVN*	Slovenia	1,278	0,328	0,677	0,728	0,324
28	*EST*	Estonia	1,271	0,597	0,667	0,728	0,326
29	*HRV*	Croatia	1,267	0,431	0,666	0,463	0,306
33	*SVK*	Slovakia	1,232	0,416	0,655	0,508	0,296
36	*LVA*	Latvia	1,230	0,625	0,649	0,508	0,460
38	*POL*	Poland	1,226	0,361	0,661	0,564	0,312
39	*LTU*	Lithuania	1,225	0,496	0,658	0,553	0,314
40	*HUN*	Hungary	1,216	0,460	0,663	0,575	0,300
42	*CZE*	Czech Republic	1,211	0,309	0,677	0,553	0,301
53	*ALB*	Albania	1,179	0,445	0,620	0,364	0,395
CLUSTER 3 ("MIDDLE")							
16	*RUS*	Russian Federation	1,353	0,611	0,625	0,267	0,977
41	*ARM*	Armenia	1,212	0,438	0,570	0,313	0,295
44	*AZE*	Azerbaijan	1,199	0,438	0,490	0,276	0,292
46	*BGR*	Bulgaria	1,197	0,374	0,639	0,429	0,296
84	*ROU*	Rumania	1,099	0,467	0,622	0,429	0,345
CLUSTER 4 ("LOW")							
50	*KAZ*	Kazakhstan	1,187	0,481	0,527	0,313	0,651
65	*UKR*	Ukraine	1,152	0,438	0,613	0,267	0,388
77	*KGZ*	Kyrgyzstan	1,121	0,525	0,480	0,241	0,540
81	*BIH*	Bosnia and Herzegovina	1,109	0,438	0,618	0,343	0,318
87	*MDA*	Moldova	1,094	0,467	0,602	0,375	0,276
94	*TJK*	Tajikistan	1,069	0,489	0,330	0,249	0,514
CLUSTER 5 ("VERY LOW")							
102	*UZB*	Uzbekistan	1,038	0,460	0,477	0,225	0,319

Table 11. Post-socialistic countries ranked by the life safety component of sustainable development, 2010

Rate CsI	ISO	Country	Life security component CsI	Biological balance, BB	Child mortality, CM	Corruption perception, CP	Energy safety , ES	Global diseases, GD	Inequalities between countries and people, GINI	Global warming, GW	Natural disasters, ND	State instability, SI	Limited access to potable water, WA
CLUSTER 3 ('AVERAGE")													
32	*NAM*	Namibia	1,242	0,839	0,459	0,508	0,495	0,202	0,049	0,684	0,505	0,710	0,533
49	*TUN*	Tunis	1,189	0,452	0,580	0,474	0,347	0,540	0,448	0,615	0,573	0,727	0,568
64	*MAR*	Morocco	1,155	0,474	0,489	0,375	0,286	0,586	0,446	0,684	0,574	0,736	0,339
98	*DZA*	Algeria	1,057	0,445	0,461	0,323	0,320	0,526	0,560	0,555	0,564	0,586	0,373
CLUSTER 4 ("LOW")													
37	*EGY*	Egypt	1,227	0,438	0,569	0,323	0,313	0,579	0,623	0,620	0,576	0,713	0,654
56	*BWA*	Botswana	1,171	0,597	0,522	0,630	0,409	0,062	0,135	0,593	0,569	0,689	0,586
104	*ZAF*	Southern Africa	1,009	0,431	0,035	0,530	0,494	0,153	0,168	0,370	0,527	0,691	0,514
CLUSTER 5("VERY LOW")													
45	*TZA*	Tanzania	1,198	0,503	0,161	0,304	0,826	0,133	0,574	0,683	0,542	0,689	0,068
47	*ETH*	Ethiopia	1,192	0,489	0,145	0,313	0,833	0,179	0,667	0,685	0,394	0,653	0,022
57	*CMR*	Cameroon	1,169	0,583	0,090	0,267	0,743	0,180	0,374	0,681	0,573	0,731	0,236
59	*GMB*	Gambia	1,167	0,354	0,154	0,333	0,764	0,326	0,323	0,681	0,568	0,694	0,533
62	*MOZ*	Mozam-bique	1,158	0,597	0,093	0,294	0,848	0,156	0,326	0,644	0,372	0,701	0,042
66	*ZMB*	Zambia	1,150	0,618	0,062	0,343	0,825	0,037	0,265	0,681	0,396	0,659	0,101
69	*MWI*	Malowi	1,138	0,518	0,174	0,375	0,764	0,059	0,484	0,685	0,399	0,666	0,323
71	*BEN*	Benin	1,136	0,489	0,113	0,333	0,677	0,256	0,493	0,675	0,544	0,724	0,250
76	*UGA*	Uganda	1,122	0,467	0,083	0,294	0,764	0,123	0,412	0,684	0,482	0,691	0,157
92	*KEN*	Kenya	1,076	0,481	0,097	0,267	0,784	0,138	0,316	0,676	0,375	0,616	0,095
93	*SEN*	Senegal	1,071	0,525	0,146	0,343	0,577	0,301	0,481	0,676	0,562	0,600	0,177
95	*NGA*	Nigeria	1,069	0,496	0,026	0,294	0,853	0,153	0,405	0,392	0,574	0,509	0,089
96	*MDG*	Madagascar	1,064	0,611	0,153	0,343	0,764	0,339	0,324	0,683	0,454	0,121	0,028
106	*ZWE*	Zimbabwe	0,991	0,489	0,188	0,267	0,728	0,003	0,275	0,659	0,443	0,147	0,356

Table 12. Countries of Africa ranked by the life security component of sustainable development, 2010

For the countries of Africa (Table 12) we have the average (Namibia, Morocco, Tunis, Algeria), low (Egypt, Botswana, South Africa) and very low values of life security component of sustainable development. This results in permanent political and military conflicts in this region.

Analyzing Ukraine by its vulnerability to the global threats we see that in comparison with 2009 the rate of its national security has become slightly better, but still remains significantly low (by the human life security index Ukraine has reached the 65th position from 78th position). For Ukraine the worst threats still are the following: level of spreading of global diseases, especially AIDS and tuberculosis, which is one of the highest in the world; very high level of corruption; low level of energy security; high child mortality; high level of state fragility.

3.1.3 The estimation of sustainable development index as quarter functional of human life security and quality

Having obtained the values of life quality component of sustainable development C_{ql} (tables 3-7) and component of human life security Csl (table 8-12), let us calculate the value of sustainable development index I_{sd}, as a quarter functional by the formula (1) according to the SDGM methodology. The results of calculations for 5 groups of countries are shown in Tables 13-17 accordingly. All countries have been distributed into 5 clusters by the sustainable development index: ''Very high"", ''High", "Average'', ''Low'' and ''Very low''.

According to table 13, ten countries with the highest values of sustainable development index include 7 European countries (Iceland, Sweden, Norway, Switzerland, Finland, Denmark and Luxemburg), one country of Northern America (Canada) and the countries of Oceania (Australia and New Zealand). They are characterized by low level of vulnerability to the global threats (high level of national security), high indices of human life quality in the economic, ecological and social dimensions, high harmonization level of sustainable development (figure 8).

Cluster 1 (''Very low'') contains the group of the most ''successful'' countries of the world, including the G8 countries, except Russia; they have the highest rates of life quality and lowest rate of vulnerability to the impact of global threats totality according to Table 13, 14.

On the contrary cluster 5 (''Very low'') contains the countries with low values of life quality component of sustainable development and these countries are more vulnerable to the impact of global threats totality. Ukraine together with China, India, South Africa and other countries has been included to cluster 4 (''Low'') with low level of sustainable development. Most of these countries have average and low values of life quality and security components of sustainable development. This means that there is the definite correlation between vulnerability to the global threat totality (global saecurity) and life quality component of sustainable development of these countries.

BRIC countries group hold the following rating positions: Brazil – the 35th position, Russia – the 49th position, China – the 78th position, India – the 86th position.

Rate Isd	ISO	Country	Sustainable development index Isd	Life quality component Cql	Life security component Csl
CLUSTER 1 ("VERY HIGH")					
1	*ISL*	Iceland	2,883	1,357	1,527
2	*SWE*	Sweden	2,870	1,398	1,473
3	*AUS*	Australia	2,859	1,310	1,549
4	*NZL*	New Zealand	2,848	1,365	1,483
5	*NOR*	Norway	2,830	1,379	1,451
6	*CHE*	Switzerland	2,827	1,498	1,329
7	*FIN*	Finland	2,823	1,342	1,480
8	*CAN*	Canada	2,771	1,293	1,478
9	*DNK*	Denmark	2,707	1,310	1,397
10	*LUX*	Luxemburg	2,691	1,257	1,434

Table 13. Ten leading countries ranked by sustainable development index, 2010

Rate Isd	ISO	Country	Sustainable development index Isd	Life quality component Cql	Life security component Csl
CLUSTER 1 ("VERY HIGH")					
8	*CAN*	Canada	2,771	1,293	1,478
12	*DEU*	Germany	2,654	1,338	1,315
13	*USA*	The USA	2,636	1,268	1,368
14	*FRA*	France	2,631	1,320	1,312
16	*JPN*	Japan	2,571	1,290	1,281
17	*GBR*	Great Britain	2,565	1,319	1,246
CLUSTER 2 ("HIGH")					
26	*ITA*	Italy	2,380	1,169	1,210
CLUSTER 3 ("AVERAGE")					
49	*RUS*	Russia	2,093	0,740	1,353

Table 14. G8 countries ranked by sustainable development index, 2010

G8 countries are "scattered" in the table from the 8th (for Canada) to the 49th position (for Russia) (Table 14).

Rate Isd	ISO	Country	Sustainable development index Isd	Life quality component Cql	Life security component Csl
CLUSTER 3 ("AVERAGE")					
35	*BRA*	Brazil	2,256	0,902	1,353
49	*RUS*	Russia	2,093	0,740	1,353
CLUSTER 4 ("LOW")					
78	*CHN*	China	1,762	0,647	1,115
86	*IND*	India	1,672	0,572	1,100

Table 15. BRIC countries group ranked by sustainable development index, 2010

Post-socialistic countries also took different positions by sustainable development index (table 16). The clusters with very high and high value of sustainable development index contain Slovenia, Lithuania, Estonia, Slovakia, Croatia, Latvia, Hungary, Poland, Czech Republic, Bulgaria.

Rate Isd	ISO	Country	Sustainable development indexIsd	Life quality componentCql	Life security component Csl
CLUSTER 2 ("HIGH")					
22	*CZE*	Czech republic	2,425	1,214	1,211
23	*SVK*	Slovakia	2,408	1,176	1,232
24	*EST*	Estonia	2,393	1,149	1,244
29	*SVN*	Slovenia	2,360	1,083	1,278
31	*LTU*	Lithuania	2,350	1,125	1,225
32	*HUN*	Hungary	2,327	1,112	1,216
33	*LVA*	Latvia	2,325	1,095	1,230
34	*HRV*	Croatia	2,268	1,000	1,267
38	*POL*	Poland	2,235	1,009	1,226
43	*ALB*	Albania	2,163	0,984	1,179
CLUSTER 3 ("AVERAGE")					
45	*BGR*	Bulgaria	2,129	0,932	1,197
49	*RUS*	Russia	2,093	0,740	1,353
50	*ROU*	Rumania	2,091	0,992	1,099
54	*ARM*	Armenia	2,029	0,817	1,212
60	*AZE*	Azerbaijan	1,961	0,734	1,227
CLUSTER 4 ("LOW")					
64	*KAZ*	Kazakhstan	1,907	0,720	1,187
68	*UKR*	Ukraine	1,889	0,854	1,036
73	*BIH*	Bosnia and Herzegovina	1,816	0,707	1,109
75	*KGZ*	Kyrgyzstan	1,774	0,653	1,121
CLUSTER 5 ("VERY LOW")					
83	*MDA*	Moldova	1,713	0,619	1,094
97	*TJK*	Tajikistan	1,562	0,493	1,069
104	*UZB*	Uzbekistan	1,450	0,411	1,038

Table 16. Post-socialistic countries ranked by sustainable development index, 2010

Russia, Rumania, Georgia, Moldova, Armenia have been included into the cluster with average values of sustainable development index. The countries with low and very low value of sustainable development index include Ukraine, Azerbaijan, Kyrgyzstan, Tajikistan and Uzbekistan.

All countries of Africa, except for Namibia, Morocco, Tunis and Algeria, are in the clusters with low and very low value of sustainable development index.

Rate Isd	ISO	Country	Sustainable development index Isd	Life quality component Cql	Life security component Csl
CLUSTER 3 (''AVERAGE'')					
53	*NAM*	Namibia	2,034	0,792	1,242
55	*TUN*	Tunis	2,024	0,835	1,189
62	*MAR*	Morocco	1,929	0,774	1,155
70	*DZA*	Algeria	1,859	0,761	1,098
CLUSTER 4 (''LOW'')					
61	*EGY*	Egypt	1,961	0,761	1,199
71	*BWA*	Botswana	1,853	0,796	1,057
80	*ZAF*	Southern African Republic	1,755	0,746	1,009
CLUSTER 5(''VERY LOW'')					
88	*TZA*	Tanzania	1,648	0,450	1,198
89	*UGA*	Uganda	1,640	0,473	1,167
90	*ZMB*	Zambia	1,618	0,496	1,122
92	*MWI*	Malaya	1,600	0,541	1,059
93	*KEN*	Kenya	1,600	0,462	1,138
94	*GMB*	Gambia	1,584	0,508	1,076
95	*MDG*	Madagascar	1,572	0,508	1,064
96	*MOZ*	Mozambique	1,571	0,414	1,158
98	*CMR*	Cameroon	1,540	0,371	1,169
99	*BEN*	Benin	1,517	0,380	1,136
100	*ETH*	Ethiopia	1,514	0,323	1,192
101	*SEN*	Senegal	1,482	0,411	1,071
105	*NGA*	Nigeria	1,443	0,375	1,069
107	*ZWE*	Zimbabwe	1,218	0,227	0,991

Table 17. Countries of Africa ranked by sustainable development index, 2010

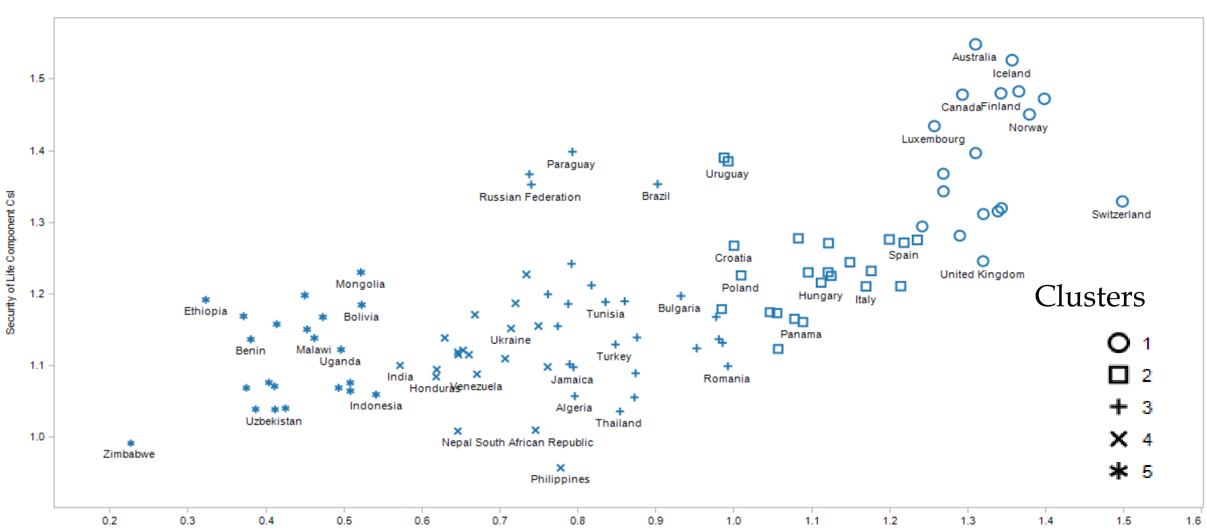

Fig. 6. Clusterization of countries in the coordinates of life quality and security

3.2 Country profiles construction on example of Ukraine

One of the main applications of the Sustainable Development Gauging Matrix (SDGM) is using actual data on indicators and parameters of sustainable development for a given country with the purpose of decision-making at various levels of the country's governance.

Using the country profiles service (http://wdc.org.ua/en/services/country-profiles-visualization) provided by WDC-Ukraine one can easily obtain dashboard for each world country to perform further in-depth analysis.

For 2010 results Ukraine has Isd=1,889, Cql=0,854, Csl=1,036 with rankings #68, #73, #65 correspondingly. Each sustainable development component and its can be displayed in a dimension diagram (Fig. 7).

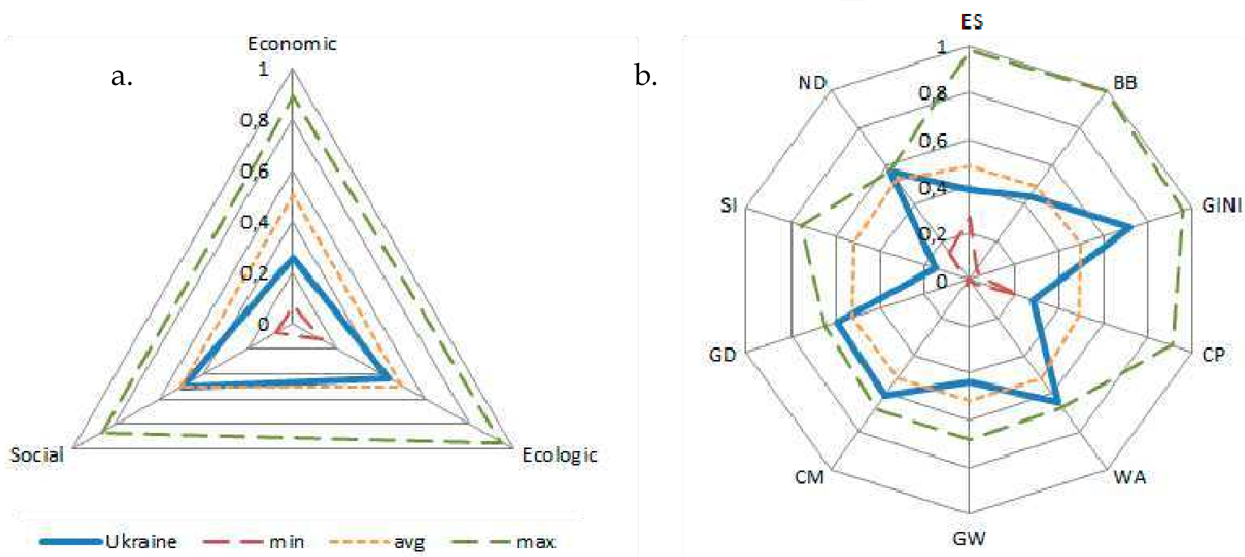

Fig. 7. Dimension diagrams for Ukraine's quality of life(a) and security of life (b).

Given figure gives possibility to handle visual analysis of the strengths and weaknesses of Ukraine through comparison of the values for certain indicators with their extreme and average meanings.

Considering the quality of life diagram one can point out, that Ukraine has better developed social dimension and poorer economic dimension. Analyzing the security of life component we can name as strengths indicators which values are better than average: people inequality (GINI), access to potable water (WA), health (CM, GD) and natural disasters (ND). Accordingly weaknesses are energy security (ES), biological balance (BB), corruption perception (CP), CO2 emissions (GW) and state instability (SI). The most critical situation is with corruption and state instability that corresponds to the evaluations of experts from many international organizations like World Economic Forum, World Bank, etc. about Ukraine development problems.

4. Conclusion

In this research the system of indexes and indicators has been developed and the gauging matrix for sustainable development processes (SDGM) in three dimensions: economic, ecological and socio-institutional has been offered. Using this matrix and initial data, obtained by the recognized international organizations we have developed the mathematical model that gives the possibility to calculate the components of human life quality and security as the components of sustainable development index and harmonization level of this development for every country. The global modeling of sustainable development processes for the large group of the countries in terms of human life quality and security has been performed. The results of modeling have been explained in details for every dimension of the sustainable development.

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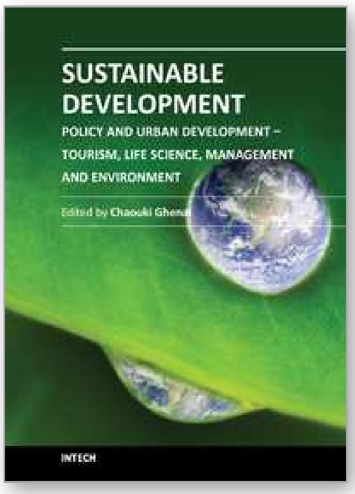

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The technological advancement of our civilization has created a consumer society expanding faster than the planet's resources allow, with our resource and energy needs rising exponentially in the past century. Securing the future of the human race will require an improved understanding of the environment as well as of technological solutions, mindsets and behaviors in line with modes of development that the ecosphere of our planet can support. Sustainable development offers an approach that would be practical to fuse with the managerial strategies and assessment tools for policy and decision makers at the regional planning level.