Quality estimation level of country's development

Dr. Gorkhmaz Imanov

Control Systems Institute of Azerbaijan National Academy of Sciences

Abstract. In order to determine the level of socio-economic development of a country, various indices have been proposed, such as Gross Domestic Product per capita, quality of life, sustainable development, inclusive development, human development etc. As known, the fourth industrial revolution is taking place in the world, the main resources of which are the knowledge, experience and skills of mankind. Taking this into account, in this paper proposes an index determining the level of development of a country, criteria's of which are the levels of macrostability, social and human capital and research, skills, knowledge and technology, and ecological civilization. In order to calculate this index, a fuzzy intuitionistic linguistic algorithm is applicated. This algorithm gives a possibility to determine not only the quantitative, but also the qualitative level of the country's development. The proposed methodology for calculating the index of the level of socio-economic development of the country is implemented on the basis of statistical information of Azerbaijan for 2015-2018 years.

Key words: macroeconomic stability, social and human capital, knowledge, skill, ecological civilization, country's development index, fuzzy intuitionistic linguistic number.

International Organizations and scientists around the world have proposed different indices such as as human development, quality of life, sustainable development criterias, inclusive development and so on, tor define level of country's development. Indicators of indices depend on the organization and purpose of scientists analyzing the level of development of the country. As the world enters the fourth industrial revolution in artificial intelligence, robotics and the Internet, humanity is faced with the challenge of increasing knowledge and skills in these areas. In the context of the fourth industrial revolution, when determining the level of development, it is necessary to take into account the level of knowledge and skills in the investigation process.

In this paper were propose index of estimation quality level country's development, Macroeconomic stability, Social Capital, Level of Skills, Human capital and Research, Knowledge and Technological outputs and Level of Eco-civilization indices were used for estimation. In the computational process, an intuitionistic fuzzy linguistic set was used.

1. Algorithm estimation of sub-indices

The sub-index estimation algorithm consists of the following steps:

1. Step -An intuitionistic linguistic number (***ILN)*** A in X is defined [1]. *As*

$$A = \{\langle x[h_{\theta(x)}, (\mu_A(x), \nu_A(x))]\rangle | x \in X\} \qquad (1.1)$$

here $h_{\theta(x)} \in S$ and $\mu_A(x)$ and $\nu_A(x)$ represent the membership degree and non-membership degree of the element x related to linguistic index $h_{\theta(x)}$, respectively. $0 \leq \mu_A(x) + \nu_A(x) \leq 1$, for all $x \in X$. For each ***ILN*** A in X, if

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x), \forall x \in X \qquad (1.2)$$

then $\pi_A(x)$ is called the indeterminacy degree or hesitation degree of x of linguistic index $h_{\theta(x)}$.

2. Step - For computational convenience, let $S = \{s_\alpha | \alpha = 0, 1, \ldots, l-1\}$ be a finite and totally ordered discrete term set, where l is the odd value and s_α represents a possible value for a linguistic variable. For example, when $l = 7$, a set S could be given as follows:

$S = \{s_0, s_1, s_2, s_3, s_4, s_5, s_6\} = \{very\ poor, poor, slightly\ poor, fair, slightly\ good, good, very\ good\}$

In this paper this set given as $S = \{S_1 - Low, S_2 - Middle, S_3 - High\}$.

3. Step - normalised indicators are converted into intuitionistic fuzzy numbers using the intuitionistic fuzzy triangular functions *iftrif* [2].
4. Step - A definite intuitionistic fuzzy triangular membership and non-membership function of A takes the form:

$$\mu_A(x) = \begin{cases} 0 & ; \\ \left(\frac{x-a}{b-a}\right) - \epsilon & ; \\ \left(\frac{c-x}{c-b}\right) - \epsilon & ; \\ 0 & ; \end{cases} \qquad \nu_A(x) = \begin{cases} 1-\epsilon & ; & x \le a \\ 1 - \left(\frac{x-a}{b-a}\right) & ; & a < x \le b \\ 1 - \left(\frac{c-x}{c-b}\right) & ; & b \le x < c \\ 1-\epsilon & ; & x \ge c \end{cases} \tag{1.3}$$

5. Step - Weights of indicators are estimated as the weights of decision makers as proposed by Boran et.al [3]. This concept is a more effective way to deal with vagueness of DMs, which may not be able to accurately express their satisfaction (or membership) degrees for alternatives, due to that (1) the decision-makers (DM) have not precise or sufficient information about the problem; (2) the DMs are unable to discriminate explicitly the superiority of an alternative to others [4].

Let $D_k = [\mu_k, \nu_k, \pi_k]$ be an intuitionistic fuzzy number for rating of k-th decision maker. Then the weight of k-th decision maker can be obtained as:

$$\lambda_k = \frac{(\mu_k + \pi_k(\frac{\mu_k}{\nu_k}))}{\sum_{k=1}^{l}(\mu_k + \pi_k(\frac{\mu_k}{\nu_k}))} \tag{1.4}$$

And $\sum_{k=1}^{l} \lambda_k = 1$.

6. Step - According to the following intuitionistic linguistic weighted average (ILWA) formula, the value of the sub-indexes is:

$$\boldsymbol{ILWA} = \langle S_{\sum_{k=1}^{t} \lambda_k \theta\left(a_{ij}^k\right)}, (1 - \prod_{k=1}^{t}(1 - \mu\left(a_{ij}^k\right))^{\lambda_k}, \prod_{k=1}^{t}(\nu\left(a_{ij}^k\right))^{\lambda_k} \rangle \tag{1.5}$$

2. Sub-indices level of macroeconomic stability

The European Union has defined macroeconomic stability in the law [5] as consisting of four criteria and five indicators: low and stable inflation; low long-term interest rates; low national debt relative to GDP; low deficits; and currency stability

In order to estimate sub-index of macroeconomic stability (**SIMS**) following indicators were used, which were proposed by International Monetary Fund (IMF):

- Real GDP growth (in percent) - **GDP**;
- Unemployment rate (in percent)- **UNE**;
- Consumer price index (period average) – **CPI;**
- Revenue (including grants, in percent of GDP) – **REV;**
- Expenditure (in percent of GDP) – **EXP;**
- General government gross debt (in percent of GDP) – **GGD;**
- Bank credit to the private sector (in percent of GDP) – **BCP;**
- Current account balance (in percent of GDP) – **CAB;**
- Foreign direct investment net inflows (in % GDP) – **FDI;**
- Gross international reserves (in months of non-oil imports) – **GIR;**

- Real Effective Exchange Rate (average, percentage change) - **REER.**

According to the steps of the algorithm, on the basis of the indicators of Table 1 and the International Economic Organization, the parameters of linguistic variables were determined, which are presented in Table 2.

Table 2.1. Macroeconomic Stability Indicators

Indicators	Periods		
	2016	2017	2018
GDP	-3.1	-0.3	1.4
UNE	5.0	5.1	5.0
CPI	12.4	12.8	2.3
REV	34.3	34.2	38.8
EXP	35.4	35.6	33.1
GGD	20.6	22.5	18.8
BCP	31	38	34
CAB	-3.6	4.1	12.9
FDI	7.6	11.9	7.0
GIR	4.2	5.1	4.7
REER	-27.0	3.3	5.6

Sources: IMF Executive Board Concludes 2019 Article IV Consultation with Republic of Azerbaijan, September 18, 2019, 6 p.[6]

Table 2.2. Linguistic values of macroeconomic indicators

Indicators	Periods		
	2016	2017	2018
	Low	Middle	High
GDP	[(-3)-(0.1)]	[0 – 2.6]	[2.5 – 5.0]
UNE	[0-10]	[9-5]	[4-0.5]
CPI	[6 – 4]	[4 – 2.1]	[2 – 0]
REV	[10-17]	[16-23]	[22-40]
EXP	[19-25]	[24-30]	[29-60]
GGD	[0-15]	[14-30]	[29-50]
BCP	[40-30]	[29-20]	[19-10]
CAB	[(-4)-0]	[(-1)-2]	[1-6]
FDI	[0-10]	[9.5-20]	19.5-100]
GIR	[0-2.9]	[2.8-3.0]	[3.0-7.0]
REER	[(-11)-(-4)]	[(-3)-4]	[1-10]

Then the fuzzy variables of macroeconomic stability were identified, which are shown in Table 2.3.

Table 2.3. Fuzzy Macroeconomic stability indicators

Indicators	Periods											
	2016				2017				2018			
	S_θ	μ	ν	π	S_θ	μ	ν	π	S_θ	μ	ν	π
RGG	1	0,1	0,01	0,89	1	0,2	0,78	0,02	2	0,79	0,12	0,09
UR	2	0,15	0,83	0,02	2	0,19	0,79	0,02	2	0,15	0,83	0,02
CPI	3	0,62	0,3	0,07	3	0,53	0,41	0,06	1	0,72	0,19	0,09
REV	3	0,54	0,4	0,06	3	0,03	0,39	0,58	3	0,11	0,87	0,01
EXP	3	0,35	0,61	0,04	3	0,42	0,53	0,05	3	0,22	0,75	0,03
GGGD	2	0,7	0,22	0,08	2	0,8	0,11	0,09	2	0,51	0,43	0,06
BCPS	3	0,17	0,81	0,02	3	0,34	0,62	0,04	3	0,68	0,24	0,08
CAB	1	0,1	0,89	0,01	3	0,51	0,43	0,06	3	0,51	0,43	0,06
FDI	1	0,41	0,54	0,05	2	0,39	0,56	0,05	1	0,51	0,43	0,06
GIR	3	0,51	0,43	0,06	3	0,81	0,1	0,09	3	0,72	0,19	0,09
REER	1	0,36	0,59	0,04	3	0,31	0,65	0,04	3	0,53	0,4	0,06

Result of computation are:

$$\boldsymbol{SMSI}\ (2016) = \langle S_{1.31}(0.23,0.16)\rangle - \text{L} - \text{M}$$

$$\boldsymbol{SMSI}\ (2017) = \langle S_{2.60}(0.65,0.24)\rangle - \text{M} - \text{H}$$

$$\boldsymbol{SMSI}\ (2018) = \langle S_{2.26}(0.65,0.86)\rangle - \text{M} - \text{H}$$

As can be seen from the results of calculating the sub-indices, the level of quality macroeconomic stability in Azerbaijan in 2016 was above than low.

In 2017, this indicator was close to a high level, and in 2018, this indicator slightly decreased compared to the previous year.

Sub-index level of Social capital

Different definitions broadly define social capital as the institutions, relationships, attitudes, and values that govern interactions among people and contribute to economic and social development [7].

Social capital is defined by the OECD as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups". In this definition, we can think of networks as real-world links between groups or individuals. Think of networks of friends, family networks, networks of former colleagues, and so on. Our shared norms, values and understandings are less concrete than our social networks. Sociologists sometimes speak of norms, as society's unspoken and largely unquestioned rules. Norms and understandings may not become apparent until they are broken. If adults attack a child, for example, they breach the norms that protect children from harm. Values may be more open to question; indeed societies often debate whether their values are changing. And yet values – such as respect for people's safety and security – are an essential linchpin in every social group. Put together, these networks and understandings engender trust and so enable people to work together [8].

Solability joint venture Swiss-Korean found define the Social Capital of a nation as the sum of social stability and the well-being (perceived or real) of the entire population. Social Capital generates social cohesion and a certain level of consensus, which in turn delivers a stable environment for the economy, and prevents natural resources from being over-exploited. Social Capital is not a tangible value and therefore hard to measure and evaluate in numeric values [9]. Definitions vary but generally boil down to those networks of relationships among people who live and work in a particular society, who show trust in and solidarity with one another, all while enabling that society to cooperate and function effectively.

In order to define sub-index Social Capital (**SISC**) indicators were used, which proposed by UN Basel Institute of Commons and Economics [10**]** and we also add to this list of indicators – Healthcare and Corruption:

1. Social climate (psychological climate, social context) is typically defined as the perceptions of a social environment that tend to be shared by a group of people [9] – **SC**
2. The trust among people – to believe that someone is good and honest and will not harm you, or that something is safe and reliable **– TR:**

3. Willingness to co-finance public goods by austerity measures – an indicator of how much a person values a good, measured by the maximum amount he or she would pay to acquire a unit of the good – **PG**.

4. Willingness to co-finance public goods by taxes and contribution – financing local public goods, characterized by social enforcement and the involvement of public officials – **PT** [10].
5. Willingness to invest in local economy, SME and cooperatives – sub-central, regional and local levels of government support by loans, tax concessions and grants to local economy SME (small and medium-sized enterprises) and cooperatives – **IE**.
6. Helpfulness among people – the property of providing useful assistance, and (2) friendliness evidenced by a kindly and helpful disposition [11] – **HE**.
7. Friendliness among people – The quality of a person to be friendly and pleasant towards anyone – FR
8. Hospitality among people- friendly, welcoming behavior towards guests or strangers. - **HO**.
9. Healthcare- Health care is the total societal effort, organized or not, whether private or public, that attempts to guarantee, provide, finance, and promote health – **HL**. [11]
10. Corruption is a serious crime that undermines social and economic development and weakens the fabric of modern-day society – **CO** [12]

    By using expert opinions and steps of algorithms were define meaning of variables social capital (Table 2.5).

Table 2.5. Fuzzy indicators Social Capital

Indicators		**SC**	**TR**	**PG**	**PT**	**IE**	**HE**	**FR**	**HO**	**Hl**	**CO**
Expert opinions		6	6	5	5	7	9	8	9	6	7.5
Parameters of Fuzzy numbers	μ	0,28	0,28	0,76	0,76	0,32	0,46	0,78	0,46	0,28	0,55
	ν	0,68	0,68	0,16	0,16	0,15	0,49	0,13	0,49	0,68	0,38
	π	0,03	0,03	0,09	0,09	0,53	0,05	0,09	0,05	0,03	0,07
Weights of criterias	λ	0.04	0,04	0,15	0,15	0,19	0,07	0,17	0,07	0,04	0,08

In computational process terms with following intervals were used: Low [1-3.3] Middle [3.0-6.6] High [6.3-10].

As seen from result - $\langle S_{2.58}(0.61,0.22)\rangle$, quality of social capital is high. In future, this value of the quality of social capital will be applicate in future computation process.

3. Sub-indices level of human capital and research

One of the main factors of sustainable development of the country is national human capital.

Human capital is defined by the OECD as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being." [13].

Cornell University, INSEAD, and the World Intellectual Property Organization has estimated indicators for Azerbaijan (table 3.1) measuring Human Capital, knowledge and technology [14].

Table 3.1. Human Capital & Research

Indicators	**Periods**				
	2015	**2016**	**2017**	**2018**	**2019**
ED	105	125	119	123	84
TE	83	84	73	74	82
RE	69	70	79	90	91

Source: [6]

In order to estimate Human Capital and Research sub-index (**SHCR**) information from Global innovation index was used:.

1. Education – **ED**, Government expenditure on education (% of GDP), Government funding per secondary student (% of GDP per capita), School life expectancy, primary to tertiary education, both sexes (years), PISA average scales in reading, mathematics, and science | 2018 PISA is the OECD's (Organization for Economic Co-operation and Development) Programme for International Student Assessment. PISA measures 15-year-olds' ability to use their reading, mathematics and science knowledge and skills. Results from PISA indicate the quality and equity of learning outcomes attained around the world. The 2018 PISA survey is the seventh round of the triennial assessment, the number of pupils enrolled in secondary school divided by the number of secondary school teachers (regardless of their teaching assignment).

2. Tertiary education – **TE**, Tertiary enrolment School enrolment, tertiary (% gross), Graduates in science and engineering Tertiary graduates in science, technology, engineering, and mathematics (% of total tertiary graduates), Tertiary inbound mobility rate (%).

3. Research & development (R&D) –**RE**, Researchers, full-time equivalent (FTE) (per million population), Gross expenditure on R&D, Global R&D companies, average expenditure, top 3, QS university ranking score of top 3 universities,

To estimate the SHCR, a sub-index scoring algorithm was used, the steps of which are shown above.

According to steps, this algorithm firstly define Linguistic variables, Human Capital and Research: Low= [1-45], Middle= [44-88], High= [87-131] for all indicators. Result of computation of intuitionistic linguistic indicator and their weights given in tab. 7 and 8.

Table 3.2. Intuitionistic linguistic indicators Human capital and Research

Indicators	Periods															
	2015				2016				2017				2018			
	θ	μ	ν	π	θ	μ	ν	π	θ	μ	ν	π	θ	μ	ν	π
ED	1	0.69	0.22	0.09	1	0.23	0.74	0.04	1	0.23	0.48	0.29	1	0.31	0.65	0.046
TE	2	0.19	0.78	0.03	2	0.15	0.82	0.03	2	0.57	0.35	0.08	2	0.54	0.39	0.07
RE	2	0.73	0.18	0.1	2	0.69	0.22	0.09	2	0.34	0.6	0.05	1	0.12	0.86	0.03

Table 3.3. Weights of indicators

Indicators	Periods			
	2015	2016	2017	2018
ED	0.426	0.175	0.256	0.302
TE	0.088	0.115	0.486	0.588
RE	0.488	0.709	0.258	0.109

Results of computation of sub-indices

$\mathbf{SHCR}_{2015} = < S_{1.578},\ 0.683,\ 0.221 >$ L-M
$\mathbf{SHCR}_{\mathbf{2016}} = < S_{1.823},\ 0.59,\ 0.317 >$ L-M
$\mathbf{SHCR}_{2017} = < S_{1.744},\ 0.446,\ 0.436 >$ L-M
$\mathbf{SHCR}_{2018} = < S_{1.587},\ 0.44,\ 0.496 >$ L-M

Results of computation of **SHCR** shows, that in 2015, 2018 were same above than low, and in 2016, 2017 years were close to middle.

4. Sub-index Level of skill

A country's skills system delivers enhanced skills to its population through compulsory education, and post-compulsory education and training. The skills system includes a variety of formal and informal training and education, secondary, further (continuing) and higher education, and both academic and vocational education and training (VET). It also includes lifelong learning, including on-the-job training and the acquisition of competences accrued through years working in a job. It also includes the activation of skills of different groups into the labour force to increase the skills base of the economy. [15]

In order to estimate sub-index level of skill – **SILS the** following indices were choosen:

- Skill index – **SKI**, describe by mean years of schooling years, Extent of staff training , Quality of vocational training, Skillset of graduates, Digital skills among active population, Ease of finding skilled employees ,School life expectancy years, Critical thinking in teaching, Pupil-to-teacher ratio in primary education ratio [16].

- Human Development Index (change in percent) – **HDI,** the Human Development Index (HDI) is a summary measure of achievements in three key dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living [17];

- Labour productivity – total production for per employee (in thous.USD) – **LPR**.

To calculate SILS based on statistical information and algorithm steps, fuzzy parameters of the skill level were evaluated, which are presented in tables 4.1-4.4.

Table 4.1. Level of skills

Indicators	Periods			
	2015	**2016**	**2017**	**2018**
LPR	35.3	25.0	26.8	30.3
HDI	0.727	0.724	0.729	0.733
SKI	61.0	65.0	67.8	69.8

Table 4.2. Intervals and Linguistic level of skill

Indicators	Periods		
	2015	**2016**	**2017**
	Low	Middle	High
LPR	[1-67]	[66-134]	[133-200]
HDI	[0-0.33]	[0.32-0.67]	[0.66-1.00]
SKI	[0-34]	[33-67	[66-100]

Table 4.3. Fuzzy Level of skills

Indicators	Periods															
	2015				**2016**				**2017**				**2018**			
	S_θ	μ	ν	π	S_θ	μ	ν	π	S_θ	μ	ν	π	S_θ	μ	ν	π
LPTP	1	0,82	0,09	0.10	1	0,62	0,31	0.07	1	0,66	0,26	0.07	1	0,75	0,16	0.09
HDI	3	0,34	0,63	0.04	3	0,32	0,64	0.04	3	0,35	0,61	0.04	3	0,37	0,59	0.04
SI	2	0,30	0,66	0.04	2	0,10	0,89	0.01	3	0,09	0,90	0.01	3	0,19	0,79	0.02

Table 4.4. Weights

Indicators	Periods			
	2015	2016	2017	2018
LPTP	0,72	0,63	0,65	0,58
HDI	0,15	0,28	0,28	0,28
SI	0,13	0,08	0,07	0,15

$$\textbf{SILS}\ (2015) = \langle S_{1.43}(0.73,0.15)\rangle - \text{L} - \text{M}$$

$$\textbf{SILS}\ (2016) = \langle S_{1.65}(0.52,0.42)\rangle - \text{L} - \text{M}$$

$$\textbf{SILS}\ (2017) = \langle S_{1.69}(0.57,0.36)\rangle - \text{L} - \text{M}$$

$$\textbf{SILS}\ (2018) = \langle S_{1.85}(0.62,0.29)\rangle - \text{L} - \text{M}$$

Results of computation **SILS** in 2015-2017, shows, that equal to above than low and in 2018 - close to middle.

5. Sub-indices level of knowledge and technology outputs

To assess the sub-indices of Knowledge and technology outputs - **KNTO**, the indicators of the Global Innovation Index [14] were used, such as:

1. Knowledge creation – **KC**, Number of resident patent applications filed at a given national or regional patent office (per billion PPP$ GDP), Number of Patent Cooperation Treaty applications (per billion PPP$ GDP), Number of resident utility model applications filed at the national patent office (per billion PPP$ GDP), Number of scientific and technical journal articles (per billion PPP$ GDP), The H-index is the economy's number of published articles (H) that have received at least H citations.

1. Knowledge impact – **KI**, Growth rate of GDP per person engaged (%, three-year average), New business density (new registrations per thousand population 15–64 years old), Total computer software spending (% of GDP), ISO 9001 Quality management systems—Requirements: Number of certificates issued (per billion PPP$ GDP), High-tech and medium-high-tech manufacturing (% of total manufacturing output).
2. Knowledge diffusion – **KD**, Charges for use of intellectual property, i.e., receipts (% total trade, three-year average), High-tech net exports (% of total trade), Telecommunications, computers, and information services exports (% of total trade), Foreign direct investment (FDI), net outflows (% of GDP, three-year average).

Results of computation by statistical information algorithm were define parameters intuitionistic fuzzy linguistic number of **KNTO,** which demonstrated in tables 5.1-5.3.

Table 5.1. Knowledge & Technology outputs

Indicators	Periods		
	2016	2017	2018
KC	3	3.3	3.6
KI	28.2	16.7	19.8

KD	21.6	26.1	27.8

Table 5.2. Fuzzy parameters of the Knowledge and Technology Outputs

Indicators	Periods											
	2016				2017				2018			
	S_θ	μ	ν	π	S_θ	μ	ν	π	S_θ	μ	ν	π
KC	1	0.8	0.09	0.11	1	0.80	0.09	0.11	1	0.84	0.84	0.84
KI	1	0.84	0.05	0.11	1	0.80	0.09	0.11	1	0.77	0.77	0.77
KD	1	0.77	0.14	0.10	3	0.31	0.65	0.04	2	0.27	0.27	0.27

Table 5.3. Weights

Indicators	Periods		
	2016	2017	2018
KC	0.299	0.454	0.624
KI	0.468	0.459	0.309
KD	0.232	0.087	0.066

Results of computation sub-index $\boldsymbol{KNTO}$ for 2016-2018 are:

$$\boldsymbol{KNTO}(2016) = \langle S_{0.999}, 0.81, 0.08 \rangle$$

$$\boldsymbol{KNTO}(2017) = \langle S_{1.17}, 0.80, 0.11 \rangle$$

$$\boldsymbol{KNTO}(2018) = \langle S_{1.00}, 0.64, 0.26 \rangle$$

Results of computation show, that in 2016-2018-th years $\boldsymbol{KNTO}$ were low.

6. Sub-indices level of Ecological Civilization

R.Morrison in [18] wrote: An ecological civilization is based on diverse life ways sustaining linked natural and social ecologies. Such a civilization has two fundamental attributes. First, it looks at human life in terms of a dynamic and sustainable equilibrium with a flourishing living world: humanity is not at war with nature, but exists within nature. Second, an ecological civilization means basic change in the way we live: it depends on our ability to make new social choices. An ecological civilization is not a prescription for order, but a description of the arrangement of disparate societies, of the exquisitely complex web of relationships with one another and with the biosphere.

An operational definition of an ecological civilization is to make economic growth mean ecological improvement. In an ecological economic and political order, an increase in finance capital means the protection and regeneration of natural capital.

An ecological order is all encompassing. It means fundamental and transformative changes in energy and industrial production, in agriculture, forestry, fishing, aquaculture, water use, that must go hand in hand with the protection and restoration of habitat and ecosystems. According to above mentioned definitions in order to construct Eco-civil sub-index – **ECSI** following indicators were taken:

- Renewable fresh water resources per 1000 inhabitants (mln m^3) – **RFW;**
- Expenses for protection of environment - % of GDP (thousand AZN) –**EPE**;
- Reforestation land in total forest area, in % - **RLF;** [19]
- Total protected areas as share of national territory, in % - **TPA;**
- Share of total renewable energy supply in total energy consumption, in percent – **SRE;**

- Environmental performance index – **EPI;** [20]
- Share of organic agricultural land – **OAL;**[21]

  By using Azerbaijan Statistical and International Organization information [22] Eco-civil indicators for 2016-2018 were constructed, which are demonstrated in table 6.1.

Table 6.1. Eco-civil indicators

Indicators	Periods											
	2015			2016			2017			2018		
	S_θ	μ	ν	S_θ	μ	ν	S_θ	μ	ν	S_θ	μ	ν
RFWR	S_1	0,22	0,76	S_1	0,24	0,73	S_1	0,170	0,81	S_1	0,230	0,74
EPE	S_1	0,36	0,59	S_1	0,39	0,574	S_1	0,414	0,546	S_1	0,734	0,196
RLFA	S_1	0,05	0,95	S_1	0,05	0,956	S_1	0,054	0,956	S_1	0,054	0,956
TPA	S_1	0,79	0,12	S_1	0,79	0,122	S_1	0,796	0,124	S_1	0,796	0,124
SRESE	S_1	0,15	0,83	S_1	0,14	0,852	S_1	0,125	0,875	S_1	0,145	0,855
EPI	S_3	0,32	0,65	S_3	0,50	0,443	S_3	0,505	0,445	S_3	0,54	0,405
SOAL	S_2	0,24	0,47	S_2	0,24	0,73	S_2	0,24	0,73	S_2	0,24	0,73

Eco-civilization fuzzy indicators

The parameters of linguistic variables, intuitionistic fuzzy set and indicator weights are shown in Tables 6.1- 6.4, respectively.

Table 6.2. Parameters linguistic variables Eco-civil index

Indicators	Low	Middle	High
RFW	[1-8]	[7-14]	[13-21]
EPE	[0.1-0.8]	[0.7-1.4]	[1.3-2.0]
RLF	[0-38]	[34-72]	[68-100]
TPA	[1-21]	[20-40]	[39-60]
SRE	[1-11]	[10-20]	[19-29]
EPI	[20-40]	[35-50]	[45-100]
OAL	[0.1-0.8]	[0.7-1.4]	[1.3-2.0]

Table 6.3. Fuzzy variables of Eco-civil index

Indicators	Periods		
	2016	2017	2018
RFW	2.0	1.7	1.96
EPE	0.26	0.27	0.40
RLF	0.98	0.98	0.98
TPA	10.3	10.3	10.3
SRE	1.8	1.7	1.8
EPI	83.78		62.33
OAL	0.8	0.8	0.8

Table 6.4. Weights of eco-civil indicators

Indicators	Periods			
	2015	2016	2017	2018
RFWR	0,081	0,083	0,058	0,063
EPE	0,140	0,137	0,149	0,281
RLFA	0,019	0,017	0,018	0,014
TPA	0,493	0,451	0,461	0,370
SRESE	0,057	0,048	0,042	0,039
EPI	0,120	0,184	0,189	0,166
SOAL	0,090	0,080	0,083	0,066

Results of computation of eco-civil sub-indices for 2015-2018 years are as follows

ECSI (2015) = $\langle S_{1.33}(0.61, 0.29)\rangle$;

ECSI (2016) = $\langle S_{1.45}(0.62, 0.29)\rangle$;

ECSI (2017) = $\langle S_{1.46}(0.63,0.29)\rangle$;

ECSI (2018) = $\langle S_{1.40}(0.68,0.24)\rangle$

As seen from results of computation of eco-civil sub - indices eco-civil situation in 2015-2018 were middle.

7. Aggregated index quality level country's development

Using results of computation of sub-indices - **SMSI, SISC, SHCR, SILS, KNTO, ECSI** and intuitionistic linguistic weighted average formula (***ILWA),*** aggregated indices quality level country's development (**AIQD**) for 2016-2018 were computed:

$\mathbf{AIQD}\ (2016) = \langle S_{1.55}, (0.64,0.18)\rangle$- above low

$\mathbf{AIQD}\ (2017) = \langle S_{1.85}, (0.67,0.22)\rangle$- above low

$\mathbf{AIQD}(2018) = \langle S_{1.82}, (0.62,0.27)\rangle$- near middle

As seen from the results quality level of country's development in three years was middle.

Conclusion

As seen from the approach to problem of defining level of country's development in this paper were investigated many indicators such as macroeconomic stability, social capital, human capital and research, levels of skills and eco-civilization give possibility to define level of development taking in to account processes that take place in the modern conditions of fourth industrial revolution. Proposed approach gives possibility to decision makers estimate optimal parameters of the management of quality level of country's development.

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