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Factor Analysis of State Forest Territories Sustainable Development in Bulgaria

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Abstract. The forest territories are national resource with proven economic, social and ecological functions. Their maintaining is at the essence of the concept for sustainable forest management, which was affirmed at the beginning of nineties years of twenty century. The concept determines the directions of forest policy in Bulgaria and is reflected in current Forest Act. The sustainable forest management needs to be estimated. The assessment is a prerequisite for its improvement and implementation in practice. This encourages countries around the world to develop criteria and indicators systems to monitor and assess the process towards sustainable forest management [37, 46]. Pan-European indicators have been adopted in Republic of Bulgaria but they are not adapted to the country features and needs and make difficult to assess the process of sustainable forest management in the country. Due to this the papers goal is to justify a system of practically applicable indicators through which to generate a comprehensive assessment of the level of sustainable management of part of Bulgarian forest territories. Indicators should support management decision process for changes in forest policy and legislative framework [3, 30]. They must contribute also for realization of planned stewardship activities in forests, must be objective and easy for implementation in forestry practice. On the basis of the theoretically justified system of indicators and by means of factor analysis application is assessed the level of sustainable forest management of 35 territorial departments of Southwestern State Enterprises (SWSE), Blagoevgrad as of 2017.

Keywords: factor analysis, sustainable management, criteria, indicators, quantification.

1 Introduction

Bulgarian forest territories occupy 4.2 million ha. They provide nearly 3.6 billion m^3 drinking water, absorb from 10.7% to 17.9% from the greenhouse gas emissions in Bulgaria and are natural environment for recreation, tourism and activities, which generate employment [27]. It is obvious that forest territories are national resource with proven economic, social and ecological functions. Their maintaining is at the essence of the concept for sustainable forest management, which was affirmed at the beginning of nineties years of twenty century. The concept determines the directions of forest policy in Bulgaria and is reflected in current Forest Act. The criteria and indicators for sustainable forest management assessment [39] are the main tools for its implementation in practice [45]. Due to this the goals of current paper are: first, to justify a system of practically applicable indicators that characterize objectively the process of sustainable management of Bulgarian forest territories; second, on the basis of the justified indicators to quantify the level of sustainable management of Bulgarian state forest territories managed by 35 territorial departments of Southwestern State Enterprise (SWSE), Blagoevgrad by means of factor analysis.

The main reasons for the choice of state forest territories managed by territorial departments of SWSE are: firstly, wood resources are the main source of income in most of the municipalities on territory of SWSE; secondly, SWSE is the second largest in terms of area and timber volume in Bulgaria; thirdly, wood resources and physic-geographical characteristics typical for the forest territories of Bulgaria are presented on the territory of SWSE.

2 Overview of the Concept of Sustainable Forest Management

The concept of sustainable forest management is not defined clearly. There are numerous definitions related with different organizations and processes such as Helsinki Process, Montreal Process, the Tarapato Process, the UN Forest Forum, the International Tropical Timber Organization, the Food and Agriculture Organization etc. [5, 6, 7, 22, 23, 25, 28, 39, 40]. Significant for the sustainable management of Bulgarian forest territories is the pan-European process of dialogue and cooperation. It started in 1990 with the first Ministerial Conference on the Protection of Forests in Europe (MCPFE) held in Strasbourg. After that similar conferences are held in Helsinki (1993), Lisbon (1998), Vienna (2003), Warsaw (2007), Oslo (2011), Madrid (2015). Ministerial conferences are synonymous of the Helsinki Process and since 2009 have been known as the Pan-European Process Forest Europe. It develops a common strategy for the protection and sustainable management of forests in 46 European countries. In the context of the Pan-European Forest Process ‘sustainable forest management’ is defined as ‘stewardship and use of forests and forest territories in a manner and intensity that maintain their biodiversity, productivity, regenerative capacity, vitality and potential to fulfil now and in the future their ecological, economic and social functions at local, national and global level without causing damage to other ecosystems’ [25].

Sustainable forest management needs to be evaluated. Assessment is a prerequisite for its improvement and implementation in practice. This encourages countries around the world to develop criteria and indicators systems to monitor and assessed the process towards sustainable forest management [9, 18, 24, 37, 42, 46]. In its essence the criterion is a principle or standard on the basis of which a problem is evaluated and the indicator is a variable or component of the forest ecosystem that characterizes the relevant criterion. Each criterion is characterized on the basis of a system of quantitative or qualitative indicators that must be systematically monitored to estimate the effect of management interventions or lack of such in forests [3, 9, 32]. There are many criteria and indicators systems for assessing sustainable forest management, but the most popular are those adopted in the Montreal Process in 1995, the Pan-European (Helsinki) process in 1993, and by the International Tropical Timber Organization in 1992 [25, 28, 40]. The criteria developed in the framework of the above initiatives are recognized globally. They are the basis for subsequent international discussions and processes. Concerning the Pan-European criteria, which have been adopted in Republic of Bulgaria, should be mentioned that they are in the following areas: natural indicators characterizing forest resources; conservation and biological diversity; forest health and vitality; productive functions of forest resources; protective functions of forest resources and socio-economic functions [1, 3] (see table 1). It have to be noted that at national level the indicators from table 1 as well as these ones from the others globally recognized initiatives need to be adapted to the environmental, economic, social and institutional conditions of the respective country, as well as to the needs of its population [2, 3, 18, 41, 45]. Indicators at national level are essential as they provide an opportunity for: diagnosing a problem; checking the effectiveness of management practices; forecasting the future development of forest areas, based on established development trends; collecting data and transforming it into information etc. [19]. In other words the indicators give opportunities to policy-makers to take well-grounded management decisions through linking forest policy with science [3].

Table 1: Pan-European Indicators for Sustainable Forest Management as of 2016 [cited by 8]

Criteria	№	Indicators
Criterion 1: Maintenance and Appropriate Enhancement of Forests Resources and their Contribution to Global Carbon Cycles	1.1	Forest area
	1.2	Growing stock
	1.3	Age structure and/or diameter distribution
	1.4	Forest carbon
Criterion 2: Maintenance of Forest Ecosystem Health and Vitality	2.1	Deposition and concentration of air pollutants
	2.2	Soil condition
	2.3	Defoliation
	2.4	Forest Damage
	2.5	Forest land degradation
Criterion 3: Maintenance and Encouragement of Productive Functions of Forests (Wood and Non-Wood)	3.1	Increment and fellings
	3.2	Roundwood
	3.3	Non-wood goods
	3.4	Services
Criterion 4: Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystem	4.1	Diversity of tree species
	4.2	Regeneration
	4.3	Naturalness
	4.4	Introduced tree species
	4.5	Deadwood
	4.6	Genetic resources
	4.7	Forest fragmentation
	4.8	Threatened forest species
	4.9	Protected forests
	4.10	Common forest bird species
Criterion 5: Maintenance and Apropriate Enhancement of Protective Functions in Forest Management (notably soil and water)	5.1	Protective forests – soil, water and other ecosystem functions – infrastructure and managed natural resources
Criterion 6: Maintenance of other Socioeconomic Functions and Conditions	6.1	Forest holdings
	6.2	Contribution of forest sector to GDP
	6.3	Net revenue
	6.4	Investment in forests and forestry
	6.5	Forest sector workforce
	6.6	Occupational safety and health
	6.7	Wood consumption
	6.8	Trade in wood
	6.9	Wood energy
	6.10	Recreation in forests

Pan-European indicators are difficult to put into practice [1]. Only one third of them are used to assess the process to sustainable forest management [13]. The main reasons for this are: first, too many indicators are being adopted to meet the demands of different stakeholders [13]; second, the existing causal relationships between quantitative indicators are not taken into account [34]; third, there is no link between quantitative and qualitative indicators; fourth, there is a lack of harmonization of certain terms and definitions, which impedes interpretation and it is therefore not clear which development is perceived as positive, negative and acceptable [14]; Fifth, there are not complex indicators to reflect forest processes, which are characterized with multidimensional manifestations; sixth, the large number of indicators makes it difficult to be monitored, reported and processed by authorized agencies; seventh, there are different approaches for adapting pan-European indicators at national level and insufficiently developed guidelines [1]. The shortcomings of the pan-European indicators are significant and need to be overcome. They direct the research towards formulation of common requirements on the basis of which indicators for assessing sustainable forest management on national level and forestry unit level [1] will be developed. In this relation the requirements towards indicators are: relevance to the criterion they characterize; practicality associated with low cost of data collection; sensitivity to changes in forestry practices; predictability of future development; intelligibility not only from foresters but also from all stakeholders; objectivity and measurability; standardisation within certain limits, which allows to compare the results of management with the set goals [4, 33, 43, 44].

On the grounds of disadvantages of Pan-European indicators mentioned above, the requirements towards them as well as the specific environmental, economic, social and institutional conditions in Bulgaria in current article are adapted the following indicators characterizing sustainable forest management: value of the timber sold on temporary storage; value of the sold standing timber (on root); forest and other wooded land; growing stock in forest and on other wooded land; net annual increment; index of non-realized contracts for sales of timber from temporary storage; index of non-realized contracts for sales of standing timber; number of employees; costs for wages; costs for social and health securities. The meaning of these indicators is shortly discussed below.

Forest and other wooded land (ha), **Growing stock in forest and on other wooded land (timber volume, m^3)** and **Net annual increment** (**m^3**)**.** These indicators describe forest resources of the respective territorial department of SWSE. They are basis for production of timber and non-timber products and services. The three indicators determine to high extent the values of some other Pan-European indicators as the number of forest holdings, contribution of forest sector to GDP, wood consumption, trade in wood, wood energy and so on.

Index of non-realized contracts for sales of timber from temporary storage and index of non-realized contracts for sales of standing timber. Both indexes characterize the percent of non-realized timber from state forest territories and are calculated by means of formula (1). In territorial departments of SWSE the annual timber harvesting is determined by Forestry Management Plans (FMS). On their basis the contracts for timber sales with forest users are signed. The sales of wood may be realized from temporary storage or as a standing timber [30]. No matter

1 Forestry unit means an area with clearly defined boundaries in which forests predominate. Their management is aimed at achieving the specific goals set in the long-term management plan. The area of the forestry unit varies from one hundred hectares to hundreds of thousands of hectares [32].

of the way of selling here should be underlined that on the grounds of the signed contracts timber cuttings are performed. They are silvicultural activities, which are carried out in order to improve state of forests, restoration, conservation of genetic resources, timber use, as well as preservation and increasing of main forest functions [29]. Usually the quantity of timber contracted for sale exceeds the quantity of actually realized timber. Due to this the negative value of the Index of non-realized contracts for sale of timber is indicator of risk from deterioration of forests health and vitality. Besides that both indexes of non-realized contracts can be used for characterization of institutional framework as well as the abilities of the management of the territorial departments of SWSE to identify the changes in market situation and to adapt to them.

$$I = (-1).\frac{C - R}{C}.100, \qquad (1)$$

where I is the index of non-realized contracts for sales of timber from temporary storage or as a standing timber on root, %;

C – the quantity of timber contracted for sale, m^3;

R – the quantinty of realized timber, m^3.

Value of the timber sold on temporary storage (BGN) and Value of the sold standing timber (BGN). The first indicator is computed as the quantity of timber sold on temporary storage (m^3) is multiplied by its price (BGN/m^3), respectively the second indicator is computed as the quantity of timber sold on root (m^3) is multiplied by its price (BGN/m^3). In 2018 timber harvesting in Bulgaria provides 95.15% from state forest territories' revenues [26]. Because of that the values of sold timber on root and from storage are accepted as an indicator for the revenues of territorial departments.

Number of employees, **Costs for wages and Costs for social and health securities**. The first indicator presents the number of employed in territorial departments of SWSE. At the same time the second and the third indicators present the costs of territorial departments of SWSE for salaries, social and health securities of the employees. To some extent these three indicators characterize the social functions of forests, especially in hilly and mountains regions of Bulgaria where forestry is one of the main sources of employment and revenues.

The indicators discussed above are quantative, objective and clear for understanding by all stakeholders. They are monitored, reported and processed by territorial departments of SWSE at low costs and reflect the casual links with many of the quantative Pan-European indicators. All this permits analysis of the results and set goals and scientifically sound decisions taking. Finally should be underlined that when a complex indicator (like sustainable forest management) with multifaceted dimensions is quantified it is not possible to put terms for including all indicators as some parts of the studied phenomenon are not possible to be revealed [17].

3 Assessment of Sustainable Forest Management through Factor Analysis

Besides the weaknesses of the indicators mentioned in point 2, another significant issue related with the assessment of sustainable forest management process is that the indicators are used independently. For this reason, the assessment of sustainable forest management process is descriptive of its individual features, but not a complex assessment measuring the process towards sustainable forest management as a whole [1, 11]. In this study the latter problem is solved by application of factor analysis. The steps for computation of composite index of the process towards sustainable forest management are as follows: verification of data for adequacy of factor analysis application; identification of number of factors necessary to represent the dataset; rotation of factors; construction of the weights; aggregation of intermediate composite indicators to final composite indicator [31, 35, 36]. The essence of this approach is discussed in the lines bellow.

By means of factor analysis a set of correlated variables is converted into a new set of non-correlated fewer latent factors that explains as much as possible of the total variation of the raw data. In this way is achieved reduction in the number of initial variables through grouping those that correlate with each other into a common factor and dividing the non-correlated into different factors [12]. The factor analysis goal is to extract not many common 'latent' factors, which account for the correlation in initial set of indicators [47]. The analytical model of factor analysis is presented through formula (2) [21, 31]:

$$\begin{aligned} z_{i(1)} &= b_{1(1)}F_{i1} + b_{1(2)}F_{i2} + ... + b_{1(m)}F_{im} + e_{i(1)} \\ z_{i(2)} &= b_{2(1)}F_{i1} + b_{2(2)}F_{i2} + ... + b_{2(m)}F_{im} + e_{i(2)} \\ &... \\ z_{i(p)} &= b_{p(1)}F_{i1} + b_{p(2)}F_{i2} + ... + b_{p(m)}F_{im} + e_{i(p)} \end{aligned} \qquad (2)$$

where $z_{i(j)}$ are the standardized value of the j-th indicator at the i-th territorial department.
$F_{i(q)}$ – the values of the factors;
m – the number of the factors;
p – the number of initial indicators;
n – the number of observations;
$b_{j(q)}$ – factor loading. It is the coefficient of correlation between the j-th initial indicator and q-th factor;
$e_{i(j)}$ – unique factors, which present the unique part in each initial variable.

The standardized values are calculated through formula (3) [15, 17, 31, 38]:

$$z_{i(j)} = \frac{x_{i(j)} - \bar{x}_j}{\sigma_j}, \qquad (3)$$

where $z_{i(j)}$ is the standardized value of the j-th indicator at the i-th territorial department;
$x_{i(j)}$ – the value of the j-th indicator at the i-th territorial department;
$\bar{x}_j$ – the average for the relevant j-th indicator;
σ_j – the standard deviation of the j-th indicator,

The square of the factor loading ($b^2_{j(q)}$) is a coefficient of determination, which measures the variation of the j-th indicator explained with the q-th factor influence. The sum of the squares of factor loadings is known as communality (see formula (4)). It presents the contribution of each indicator towards all factors formation in the factor's scheme [21].

$$b_j^2 = \sum_{q=1}^{m} b_{j(q)}^2, \quad j = 1 \ldots p, \tag{4}$$

where b_j^2 is communality of the j-th indicator towards all factors formation in the factor's scheme.

The extraction of factors is done by the method of Principal Component Analysis (PCA) and unit criterion of Kaiser. According to it as factors have to be extracted only these main components with eigenvalues higher than 1. The eigenvalue measures the proportion of variance in the indicators explained by the respective factor. The eigenvalue is computed by means of formula (5) [10, 21]. In this paper the PCA is accepted as it extracts maximum variance from the data set with each component and in this way reduce a large number of variables into a smaller number of components [47], which corresponds with the goal of the study and permits ease of interpretation. In this relation should be noted that 'in reality researchers often use more than one extraction and rotation technique based on pragmatic rather than theoretical reasoning [47]:

$$l_q = \sum_{j=1}^{p} b_{j(q)}^2, \quad j = 1 \ldots p, \tag{5}$$

where l_q is the eigenvalue of the q-th factor.

After the extraction of factors and their orthogonal rotation by Varimax method the calculation of composite indicator of sustainable forest management demands the establishement of the weights with which the indicators participate in it (the composite indicator). For this purpose the weighting method developed by Nicoletti et al. is applied [31, 35, 36]. The approach is based on the following steps: First, grouping the individual indicators with the highest factor loadings into intermediate composite indicators; Second, determining the weights of the variables in the intermediate composite through squaring the factor loadings of the variables and scaling it to the eigenvalue of the q-th factor within each intermediate composite index. The square of factor loadings represents the proportion of the total unit variance of the variable explained by the respective factor; Third, assignment of weight to each intermediate composite indicator or weight of respective factor is established as the eigenvalue of the j-th factor (explained variance) is divided by total variance of each factor. Fourth, through multiplication of variable weight (established at the second step) and the weight of the respective factor (established at the third step) and through rescaling the results from the multiplication to sum up to one the final weights (w_j) are obtained [31, 35, 36]. On their basis by means of linear aggregation the index of sustainable forest management (I_{sfm}) of the i-th territorial department is computed through formula (6) [16, 31]:

$$I_{sfm(i)} = \sum_{j=1}^{p} z_{i(j)} w_j, \tag{6}$$

At the end of this point should be stated the requirements for factor analysis application: First, the recommended number of observations is at least 50; Second, in factor analysis are included correlating variables. If a variable is not correlated with the others it must be excluded from factor analisys; Third, a measure of whether values distribution is adequate for factor analysis realization. It is done through Kaiser-Mayer-Olkin (KMO) coefficient for sample adequacy and Bartlett Test of Sphericity. In statistical literature there is a scale for KMO coefficient interpretation in correspondence with the requirements for factor analysis realization: KMO < 0.5 – unacceptable; 0.5 < KMO < 0.6 – miserable; 0.6 < KMO < 0.7 – mediocre; 0.7 < KMO < 0.8 – middling; 0.8 < KMO < 0.9 – meritorious; KMO < 0.9 – marvellous. Regarding the Bartlett Test of Sphericity it should be noted that it is a measure of the multivariate normality distribution of the set of variables. A significance value < 0.05 means that the data are approximately multivariate normal and suitable for factor analysis [10, 12, 21].

4 Estimation of the Level of Process towards Sustainable Forest Management of 35 territorial departments of SWSE

The values of the indicators discussed in point 2 are presented in table 1 as of 2017 for thirty five territorial departments of SWSE.

Table 1: Indicators Characterizing Sustainable Forest Management of Territorial Departments of SWSE as of 2017

Territorial departments of SWSE	Forest and other wooded land, ha	Growing stock in forest and on other wooded land, m^3	Net annual incrementm, m^3	Index of non-realized contracts for sales of timber from temporary storage, %	Index of non-realized contracts for sales of standing timber, %	Value of the timber sold on temporary storage, BGN	Value of the sold standing timber, BGN	Number of employees	Costs for wages, BGN	Costs for social and health securities, BGN
DLS Aramlietz	9779	2204115	37887	-0.71	-22.61	916640	256849	33	490979	92922
DGS Belitza	11536	2475410	57776	-32.62	2.31	683711	217893	38	383911	72041
DGS Belovo	23428	6097820	86171	-18.01	-46.90	763894	1370784	29	792517	145095
DGS Blagoevgrad	26577	5050510	108966	-16.42	-50.31	1027839	455300	54	710323	135310
DGS Breznik	10932	2554860	61311	-1.37	-46.97	1812974	275206	26	423117	81987
DGS Dobrinishte	11319	2246630	49609	6.93	-22.46	421611	598129	29	500049	95476
DGS Dupnitza	28139	4757872	109107	-11.44	-26.13	2134746	324744	40	564533	12004
DGS Eleshnitza	16644	3781084	72695	-25.46	-54.93	866390	560499	36	585157	111827
DGS Elin Pelin	21703	3685090	74255	-13.31	-33.35	1318495	534942	41	585217	112349
DGS Etropole	23353	5116385	89941	0.00	-20.48	83924	164866	37	419952	81841
DGS Gotze Delchev	29917	5621888	128569	-6.86	2.01	803934	1230234	57	918710	172411
DLS Gurmen	26571	7873524	135306	-19.88	42.97	3960505	17988	69	1164604	227162
DGS Ihtiman	25269	4190798	81592	-13.46	7.23	628426	679241	25	389389	76152
DLS Iskar	3875	893755	18121	-23.82	-12.06	394015	127894	44	646934	134479
DGS Katuntzi	26620	5126310	88577	-6.04	-16.91	1109350	471364	40	572915	105462
DGS Kostenetz	21606	4005415	88826	0.00	-11.46	280497	447039	16	297568	54645
DGS Kresna	18487	4317427	84351	-29.96	-34.68	909516	242899	27	478041	89385
DGS Nevestino	23837	5005765	111670	3.22	-30.70	1424204	495425	31	379369	74353
DGS Osogovo	24105	5005765	111670	-8.39	-12.31	1633632	23914	54	748720	142649

DGS Petrich	11212	2735389	51856	-14.92	-30.08	215973	535235	40	425391	82792
DGS Pirdop	44766	9377859	161356	-30.28	-47.14	509821	568864	50	870827	165859
DGS Purvomai	17801	3027800	71995	-21.27	-44.69	1170963	635257	32	348104	71758
DGS Radomir	21550	3850860	96269	3.15	4.15	1270334	331606	29	433221	83328
DGS Razlog	17400	5032217	93878	0.17	-28.06	1859709	210967	49	736919	142496
DGS Rilsky manastir	21968	4115480	65451	-45.07	-49.76	219545	352778	31	340658	68162
DGS Samokov	71991	15271920	269854	-9.25	-13.76	1804473	876907	71	1213832	231231
DGS Sandanski	20395	4510258	83875	-47.81	-22.24	117562	532529	36	451622	87414
DGS Simitly	33086	6223605	124806	-31.17	-26.62	2186953	1158693	44	849635	162008
DGS Slivnitza	18479	2739115	74764	-8.98	-23.71	835178	204612	21	348860	62663
DGS Sofia	35512	7171305	142490	3.56	-46.30	1275402	279427	35	549099	105857
DGS Strumyani	20776	3701378	89869	-39.15	-47.55	83718	669463	41	499083	97828
DGS Teteven	19541	2329970	43846	-15.85	-42.57	758334	279312	16	209743	40591
DGS Trun	32664	7146587	151804	-5.51	-47.33	1512474	241112	25	505770	94138
DGS Yakoruda	22114	5706125	99562	-22.87	-19.45	814226	945235	47	758220	145149
DGS Zemen	17774	2486995	65082	-23.77	-50.54	1144507	282021	24	434232	80314

Source: SWSE

On the basis of KMO coefficient and Bartlett Test of Sphericity can be concluded that the initial data are adequate for conducting factor analysis. The value of the first one is 0.761 and the significance level of Bartlett Test is 0.000 for Approx. Chi-Square of 345.854 and 45 degrees of freedom.

By means of PCA are extracted three components (factor) with eigenvalues higher than one. They explained 79.406% from the total variance of the data. The extraction of three factor, that explain such a large part of the indicators variance means that the selected variables are appropriate for assessment of the process towards sustainable forest development of 35 territorial departments.

Table 2: Total Variance Explained

Component	**Initial Eigenvalues**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	5.111	51.111	51.111	3.646	36.457	36.457
2	1.603	16.034	67.145	2.858	28.582	65.040
3	1.226	12.261	79.406	1.437	14.366	79.406
4	.787	7.874	87.280			
5	.578	5.778	93.058			
6	.443	4.435	97.493			
7	.157	1.568	99.061			
8	.038	.381	99.442			
9	.032	.318	99.760			
10	.024	.240	100.000			

In table 3 are presented communalities and rotated factor loudings. Through factor loadings and formula (3) are computed communalities. From the values of communalities is obvious that the highest contribution for factor extraction has the indicators ‘Growing stock in forest and other wooded land’ (0.951) and ‘Net Annual Increment’ (0.950). These results are not random as both indicators characterize forest resources and as it was mentioned in point 2 they determine to high extent the values of some other indicators in concrete study – number of employees, costs for wages, costs for social and health securities, annual use of timber.

Table 3: Communalities and Rotated Factor Loadings

Indicators	Communalities	Rotated Factor Loadings		
		Factor 1	Factor 2	Factor 3
Forest and other wooded land	0.932	**0.956**	0.133	-0.018
Net annual increment	0.950	**0.936**	0.263	0.069
Growing stock in forest and on other wooded land	0.951	**0.927**	0.302	-0.030
Number of employees	0.844	0.399	**0.803**	-0.201
Costs for wages	0.937	0.561	**0.762**	-0.203
Costs for social and health securities	0.867	0.490	**0.747**	-0.262
Index of non-realized contracts for sales of standing timber	0.607	-0.144	**0.712**	0.281
Value of the timber sold on temporary storage	0.639	0.253	**0.620**	0.437
Index of non-realized contracts for sales of timber from temporary storage	0.668	0.159	-0.054	**0.800**
Value of the sold standing timber	0.546	0.415	-0.053	**-0.609**
Expl. Var (l_q)		3.646	2.858	1.437
Expl./Tot ($l_q/\sum l_q$)		0.459	0.360	0.181

The indicators in bold in table 3 are grouped into intermediate composite indicators. After that following the other steps of weighting method developed by Nicoletti et al. in table 4 are computed the final weights (w_j). They are used in formula (6) through which the indexes of the process towards sustainable forest management (I_{sfm}) of territorial departments of SWSE are obtained and presented in table 5.

Table 4: Final Weights

Indicators	Squared factor loading (scaled to eigenvalue of the q-th factor)			Final weights(w_j)
	Factor 3	Factor 2	Factor 1	
Forest and other wooded land	**0.2507**	0.0062	0.0002	**0.1443**
Net annual increment	**0.2403**	0.0242	0.0033	**0.1383**
Growing stock in forest and on other wooded land	**0.2357**	0.0319	0.0006	**0.1356**

Number of employees	0.0437	**0.2256**	0.0281	**0.1018**
Costs for wages	0.0863	**0.2031**	0.0287	**0.0917**
Costs for social and health securities	0.0659	**0.1952**	0.0478	**0.0881**
Index of non-realized contracts for sales of standing timber	0.0057	**0.1773**	0.0549	**0.0800**
Value of the timber sold on temporary storage	0.0176	**0.1345**	0.1329	**0.0607**
Index of non-realized contracts for sales of timber from temporary storage	0.0069	0.0010	**0.4454**	**0.1010**
Value of the sold standing timber	0.0472	0.0010	**0.2581**	**0.0585**

Table5: Quantitative Estimation of the Level of the Process towards Sustainable Forest Management of Territorial Departments of SWSE as of 2017

№	Territorial Departments of SWSE	Index of sustainable forest management (I_{sfm})
1	DGS Samokov	2.5744
2	DLS Gurmen	1.3737
3	DGS Gotze Delchev	0.8975
4	DGS Pirdop	0.7455
5	DGS Simitly	0.6980
6	DGS Sofia	0.4327
7	DGS Osogovo	0.3411
8	DGS Trun	0.2933
9	DGS Yakoruda	0.2916
10	DGS Razlog	0.2421
11	DGS Belovo	0.2351
12	DGS Katuntzi	0.1684
13	DGS Blagoevgrad	0.1559
14	DGS Dupnitza	0.1134
15	DGS Nevestino	0.0820
16	DGS Radomir	0.0619
17	DGS Ihtiman	-0.0579
18	DGS Elin Pelin	-0.0782
19	DGS Etropole	-0.1431
20	DGS Kostenetz	-0.2809
21	DGS Dobrinishte	-0.3678
22	DGS Eleshnitza	-0.3893
23	DGS Kresna	-0.4364
24	DGS Strumyani	-0.4503
25	DGS Purvomai	-0.4615
26	DGS Sandanski	-0.4689
27	DGS Breznik	-0.4700
28	DGS Slivnitza	-0.4884
29	DLS Aramlietz	-0.4962
30	DGS Petrich	-0.5611
31	DGS Belitza	-0.6050
32	DGS Zemen	-0.6341
33	DLS Iskar	-0.7406
34	DGS Rilsky manastir	-0.7539
35	DGS Teteven	-0.8232

5 Conclusions

On the grounds of the assessment of the process towards sustainable forest management in territorial departments of SWSE the following conclusions can be done:

- The indicators (value of the timber sold on temporary storage; value of the sold standing timber (on root); forest and other wooded land; growing stock in forest and on other wooded land; net annual increment; index of non-realized contracts for sales of timber from temporary storage; index of non-realized contracts for sales of standing timber; number of employees; costs for wages; costs for social and health securities), which characterize the process towards sustainable forest management are objective and clear for understanding by all stakeholders. They are monitored, reported and processed by territorial departments of SWSE at low costs and reflect casual links with many of the quantative Pan-European indicators. It should be underlined that when a complex indicator (like sustainable forest management) with multifaceted dimensions is quantified it is not possible to put terms for including all indicators as some parts of the studied phenomenon are not possible to be revealed.
- The index of sustainable forest management permits complexity in assessment, and analysis in static and dynamics of the results and set goals. Furthermore the index of national forestry competitiveness computed by means of factor analysis is more sensitive to changes in the values of involved indicators, than the method of linear ordering in multidimensional space applied in [17].
- On the basis of factor analysis is established that the indicators with the highest contribution to the value of the index of sustainable forest management are 'Growing stock in forest and other wooded land' and 'Net Annual Increment', which communalities respectively amount to 0.951 and 0.950.

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