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ORIGINAL ARTICLE

Comparing sustainable development measurement based on different priorities: sustainable development goals, economics, and human well-being—Southeast Europe case

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Abstract
Sustainability analysis practice has so far proved that measurement of the level of sustainable development (SD) is associated with a large number of methodological difficulties and limitations, related mainly to the selection of indicators, data processing and interpretation of the results. This study is based on an assumption that SD should be measured in ways that depend on the level of development of the country, i.e., it is highly recommended to develop separate sets of indicators to be used for highly developed, medium-developed and poor countries. To that end, we carried out the study on a sample of 13 Southeast European (SEE) countries, and Germany and the Russian Federation for comparison—which are at different levels of development and overall political and socio-economic ambients. The research includes analysis by three different approaches to SD, each based on different sets of indicators: a "GDP approach" which is traditional, and in which economic and GDP-based indicators hold the dominant role; a "Beyond-GDP approach" that reduces the use of economic indicators while increasing the share of social indicators and those based on natural resources; and an "SDG-based approach" that is mainly using indicators of quality of life as defined by the United Nations (UN) SDG. The analysis was performed using the method of composite indicators. Groups of 20 indicators were selected according to their suitability to each of the 3 above-described approaches. The study objective leads to examining ways for measuring development, to suggest new ones, recommend approaches to sustainability planning for the considered SEE countries and beyond, to contribute to the analysis methodology (by assessing usability and reliability of certain indicators and of linkages between them), as well as to rank the countries' levels of SD under these approaches. Some of the main conclusions are: (a) the indicators having the highest potential impact on the level of SD were foreign direct investments, public debt, energy imports, total natural resources rents, terrestrial and marine protected areas, vulnerable employment, and the Corruption Index; (b) use of the Inclusive Wealth Index is encouraged, so it is important to advance proper methodologies for its measurement; (c) Slovenia and Hungary were the highest-ranked SEE countries under all three approaches, just under Germany; and (d) the ranking order under the SDG-based approach could be used to identify the prioritization of development effort and funding that countries should apply and receive for meeting the SDG. Recommendations for further sustainability measurement were made based on the study's findings.

Keywords Sustainable development goals · Sustainable development quantification · Human well-being · Beyond GDP · Southeast Europe

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Introduction

The main objective of this study is to provide quantitative information about the effects of applying a sustainability evaluation and analysis approach based the relatively new sustainable development goal (SDG) indicators (named here the SDG-based approach), to sustainable development (SD) of Southeast European (SEE) countries, all of which are in transition and described by their specific attributes and needs, and compare its results with the most common approach that emphasizes gross domestic product (GDP)-related indicators (the GDP-based approach), and with an approach developed by the authors that emphasizes human welfare and natural wealth (named here "Beyond-GDP"). The SDG are defined as "a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity" (SDG, United Nations 2015, United Nations Leadership Council 2015) and it is of great interest to examine their SD results for these other two approaches. In this study, the three approaches are quantitatively defined by the arguably smallest number of indicators that best characterize them, described and quantified in "The analysis algorithms" and "The input data" below. The analysed sample, consisting of 13 SEE countries, and Germany and the Russian Federation for comparison, is also an excellent example for other transition countries. The analysis and its results can be used to guide how the ways of using the SDG indicators in policy may affect the SD of such countries. It is noteworthy that studies of the degree of sustainability in SEE are very rare and incomplete, so this research provides perhaps the first clear insight about this topic. An additional contribution of this study is also the inclusion of the Russian Federation, for which published research of this kind is practically absent.

There are also other approaches for measuring sustainability, and we list the four most known, alongside with general comments on measurement methods and challenges for the future in this field:

The inclusive wealth approach aims to measure the natural, human and manufactured capital of nations (Duraiappah et al. 2013); The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) represents conceptual and analytical tool for sustainability measurement, whose priority is to identify and prioritize key scientific information and data needed for policy making addressed through catalysing efforts to generate new knowledge and networking (Diaz et al. 2015); The Approach of New Commons represents the combination of land, water and climate, and their underlying processes that regulate ecosystem structure and functions to maintain a sustainable supply of common pool resources for human well-being (Duraiappah et al. 2014), and the Governance-oriented Approach based on development of economic, social, and governance systems capable of ending poverty and achieving sustainable levels of population and consumption while securing the life-support systems underpinning current and future human well-being (Guerry et al. 2015).

A common base for all approaches is that focus is given to natural resources, economic development and human well-being. The most appropriate way to measure sustainability level and progress remains a challenge. A recent review, which included 55 systems [12 composite indicators and 43 SD indicator (SDI) sets], showed that SDI sets are more commonly used than composite indicators (Shoenaker et al. 2016). The choice of best methodologies for measuring sustainability remains an open question for the future (Miller et al. 2014; Lang et al. 2012; Arrow et al. 2013).

Numerous difficulties exist in advancing sustainability analysis and planning, with the main reasons including unclear and non-uniform definition of sustainability, the difficulties in applying of sustainable approaches in real life, and inadequate education in this entire field (Dasgupta 2007; Wiek et al. 2011). The question as to how knowledge generated by sustainability science will contribute to transitions toward sustainability is critical for research in the coming decade. A clear conclusion and recommendation is thus that sustainability science should, over the next decade, strengthen its empirical, theoretical and practical fundamentals, focused on the role of values in the science and decision-making of sustainability.

A further challenge is the methodology for measuring the current degree of SD, as well as of the prediction of future SD, which is the subject of numerous studies that are producing different and often contradictory results (Akimoto et al. 2012). The development of any methodology is a complex scientific endeavour that demands deep knowledge of the issues to be addressed, and requires a multidisciplinary approach and familiarity with the needs of the user (Lior 2015). It is clear that it is impossible to define the methodology to be comprehensive, accurate and acceptable to all stakeholders, but there is an indisputable need to develop a methodology (or methodologies) that will lead to the conciliation of different views, and that will be increasingly reliable than existing ones. Basic economic theory must be included in a multi-criteria model, so that the final results would have a clear sustainability context (Boggia and Cortina 2010).

Many diverse indicators that adequately characterize the three sustainability pillars of environment, economy and society, which are typically interrelated, and time-dependent, are needed (Ciegis et al. 2009; Lior 2015). Their monitoring and aggregation, and appreciation of uncertainty are hence essential prerequisites (Desborders and Koop 2016). There

is no standard yet for the choice of indicators, and increased efforts in that directions are most needed.

A basic problem in national development is the influence of economic development on natural resources (Jorgenson and Dietz 2015), but the highest priority has been given to the relationship between energy consumption and climate change (Capellán-Pérez et al. 2015; Filipović et al. 2015a, b). The introduction of the social economy with the imperative of inclusive development is certainly a step forward towards greater level of adoption of the human well-being of citizens than of the wealth measured only through economic indicators (Lloyd 2007; Kubiszewski et al. 2013). The group of new approaches of measuring development investments include measurement of human happiness and well-being (Delhey and Kroll 2013), and life satisfaction in general, wherein research studies show that the level of life satisfaction is often not directly correlated to income level (Deaton 2008). For example, a study of satisfaction in the Russian Federation showed that changes in real household incomes explained only 10% of the total change in reported life satisfaction (Frijters et al. 2006).

Another problem in the identification of sustainability measurement is in the consideration of countries' natural resources/wealth as part this measurement and planning, and in determination of both positive and negative effects that exploitation of natural resources could have on the overall development (Radovanović and Filipović 2015). National and international efforts to develop natural capital accounts are increasing, but the results are so far insufficiently conclusive and thus still not generally accepted for global application (Terama et al. 2016).

It is often necessary that the analysis methodology, as well as its indicators and their weights, comply with the global SD strategy such as the Millennium Development Goals, succeeded later in the United Nations-defined set of 17 SDG (SDG, Sachs 2012; Griggs et al. 2013; United Nations Leadership Council 2015). The SDG approach is based on a set of objectives which should help improve the situation of the poor and developing countries.

Monitoring progress and implementing measures to promote SD of countries requires the definition, measurement and monitoring of the achieved and planned level of SD, adjusted individually to each country or region. A special challenge is measuring the degree of SD in countries that have passed, or are undergoing, intensive transition of economic development and geopolitical positioning, such as in SEE and the Russian Federation. These countries have passed through a long period of communism (ranging from the more dogmatic one of the former Soviet Union to the milder one of former Yugoslavia) and then, at the beginning of the 1990s, opted for a more market-based concept of economy. A big problem, inherited from the past, is the economy based on the exploitation of resources, which continues to exist to date, and it is reflected in environmental problems that arise as a result of efforts to prioritize the improvement of economic development well above the preservation of the natural resources and the quality of the environment (Radovanović and Lior 2017).

There is little published research about the quantitative level of SD in the SEE region, and the Russian Federation. Of the 13 SEE countries that are the subject of this study, 6 are members of the European Union (EU). The majority of these SEE countries expressed interest in joining the EU, while the Russian Federation expressed commitment to its full independence in every respect (Deacon et al. 2007). The results of the very few published studies indicate that the SEE countries are at different level of SD, and that their level of SD is far lower than that in Germany which is used as comparator (Golušin et al. 2011; Radovanović and Lior 2017). Also, the process of transition and implementation of sustainable policies is assessed as slow and uneven (Adomßent et al. 2014). One study shows that the SEE region has a characteristic that government spending on capital formation, development assistance, private investment, and trade-openness has positive and significant effects on economic growth, but that population growth, in contrast, is statistically insignificant (Alexiou 2009), and that the European model of public administration, which was introduced into the countries of the region, proved to be extremely inefficient (Drechsler 2014)—all which has to be kept in mind when selecting indicators.

Despite certain original social structure similarities (excepting Germany), the countries in this study have developed differently after the 1990s. Furthermore, the published information about their development, dominated by Western European and US writers and research settings, is not adequately suitable for characterizing and quantifying the situation and governance in SEE (Stubbs 2005). It was shown, e.g., that by 2005 the average GDP rose by about 25% above its early 1990s level, life satisfaction was typically back to its earlier level, but still below pre-transition values (Easterlin 2009). Considering SEE countries in the period after 2008, it was found that institutional progress (EU integration, transition reforms) in these countries had a negative relationship to their economic growth (Bartlett and Prica 2012; Filipović and Miljković 2014), while SEE countries with higher progress in transition reforms had a greater external indebtedness (Filipović et al. 2015a, b).

As to the Russian Federation, whose economy is traditionally based on the exploitation of natural resources, it is clear that there is a discrepancy between the expected level of development and the country's great wealth of natural resources (especially energy, Didenko and Skripnuk 2014). The "Resource curse" is a paradox which characterizes the many countries that, despite their wealth of natural resources, or perhaps because of it, have not achieved

corresponding economic growth and development. Van Der Ploeg and Poelhekke (2009) indicate that the essence of this paradox lies in volatility of initial income, investment and human capital; i.e., the direct positive effect that natural resources have on economic growth is much lower than the indirect negative effect of the instability. The problem is also the levels of trade openness, natural resource dependence, and population growth. Countries that do not have access to the sea and that are faced with ethnic tensions have higher volatility and lower economic growth. SD in the Russian Federation also suffers from the fact that its educational system may inadequately address it, thus diminishing the possibility for preparing adequate cadres of future professionals who could adequately deal with these problems in their country and promote SD (Kasimov and Mazurov 2008).

The study methodology and data

The countries' study sample

The study sample includes 15 countries:

- SEE EU members: Bulgaria, Croatia, Greece, Hungary, Romania and Slovenia;
- SEE non-EU members: Albania, Belarus, Bosnia and Herzegovina, FYR Macedonia, Moldova, Montenegro and Serbia;
- The Russian Federation, for comparison and
- Germany—a developed EU country for comparison.

All but Germany are countries undergoing strong socio-economic transition.

Three approaches for sustainability evaluation and comparison

The study is planned according to its main objective: to quantify the level of development in 15 countries using 3 different approaches, as described below in more detail.

The GDP-based approach is a long-standing one that is based on measuring the progress of specific countries by major use of traditional economic indicators, led by the GDP. It is broadly used because many countries' governments, both developed and developing, have an innate preference for economic growth, typically measured by the simple and readily available GDP indicator.

The Beyond-GDP approach is a newly developed approach based on the fact that the GDP by itself is excessively used as a major metric of national sustainability, while it is obvious that there are additional and more important metrics beyond the GDP that are needed to measure and attain the ultimate goal of human well-being and of preservation and fostering of natural resources. One of the basic problems of the future beyond-GDP development, which is related to the UN's SDG—the elimination of deep poverty and reductions in global wealth inequality—usually remains independent of average national income, and increase of the GDP by itself has the negative effect of raising the demand for ecological service. Countering these problems requires improvement of the distribution uniformity of income and national wealth with full consideration of the needs and available resources of future generations. There is a consequent increasing critique of using the GDP as major sustainability and success criterion (Dipetro and Anoruo 2006; Lloyd 2007; Costanza et al. 2009; Marc 2009; Delhey and Kroll 2013; Kubiszewski et al. 2013; Masood 2016; Mankiw 2016), as well as significant advances in defining the social worth of an economy's entire set of capital assets—not just as GDP (Dasgupta 2013; Dasgupta and Ramanathan 2014, 2017; Dasgupta et al. 2015; Dasgupta and Managi 2017). In fact, a de-growth approach is considered supporting an extension of human relations instead of market relations and demand to replace the addiction to growth that creates a spiralling increase in demand.

Consequently, the "Beyond-GDP" approach was constructed and used here by introducing new sustainability measuring indicators that are more suitable to the countries in the SEE region. It still uses GDP-purchasing power parity (PPP) per capita, but additional indicators have been selected to better reflect their economic and social history, taking into account especially those indicators relating to the social status of citizens and natural wealth—as indicators which undoubtedly reflect the quality of life of the population. It is noteworthy that the values of the indicators public expenditure on education or health, and Happiness Index and Social Progress Index in SEE are scarcely different from those in Germany. Noteworthy also is the indicator remittances received, personal (% of GDP), which is particularly high in certain countries of SEE. Income of this kind became part of the GDP of the country from which the migrants come from, but it is not entirely clear whether or not it contribute to a successful transition (Horvat 2004). It was taken into account in this study because a large number of people from SEE live and work in wealthier countries such as those of Western Europe and financially supports their families in their countries of origin.

The SDG-based approach is based here on the 17 UN-defined SDG and their 169 targets, as an agenda for SD for all nations that embraces economic growth, social inclusion, and environmental protection. The agenda is now moving to implementing and achieving these goals (Stafford-Smith et al. 2017). Recent examples of SDG indicator-based assessments enabling more in-depth exploration of interlinkages and dynamics among the SDG include Allen et al. (2016) and Shahadu (2016), which are mostly dedicated to

improving the situation in poorer countries and regions of the world. It is noteworthy that low quality of life in some countries exists despite the fact that they may have large quantities of valuable natural resources, but without adequate benefit for the general population (Kronenberg and Hubacek 2016), leading to increasing inequality (OECD 2011). Raising the population's degree of well-being requires stronger focus on health status, household financial satisfaction and emancipative values; prosperity, political stability (Ngamaba 2016), and happiness should also be policy goals (Oishi 2014).

The sustainability analysis indicators

The definition of appropriate indicators for any sustainability analysis, or even just selection among existing ones, is rather challenging because of, above all, different approaches to the very essence of sustainability, different priorities in different countries and regions, which can change over time, and globalization and complexity of geopolitical changes (Dasgupta 2007; Akimoto et al. 2012; Lior 2015). The development of any methodology is a complex scientific endeavour that demands deep knowledge of the issues to be addressed, and requires a multidisciplinary approach and familiarity with the needs of the user. It is thus impossible to define the methodology to be comprehensive, accurate and acceptable to all stakeholders, but there is an indisputable need to develop methodologies that will lead to the conciliation of different views, and that will be increasingly reliable than existing ones.

Many diverse indicators that adequately characterize the three sustainability pillars of environment, economy and society, which are typically interrelated, and time-dependent, are needed (Ciegis et al. 2009; Lior 2015). Their monitoring and aggregation, and appreciation of uncertainty are hence essential prerequisites (Desborders and Koop 2016).

Some (or most) indicators are typically inter-linked, and some of their mutual impacts are mentioned and discussed in the "Results" section below, but a complete analysis of the interrelations would require evaluation of thousands of indicator permutations. Here, we therefore mostly focused on the independent effects of the indicators. At the same time, rather detailed cause-and-effect discussion about the indicators to explain their effects is presented in "The analysis algorithms".

Our choice of the characteristics of suitable and perhaps most efficient indicators of sustainability are: (a) relevance in relation to the study objective—they show important characteristics of a monitored subsystem; (b) comprehensibility—they are comprehensible to the stake-holding public, not only to the experts of the monitored fields; (c) reliability—the pieces of information incorporated in the indicator are accurate enough and (d) availability of the needed data—the data are adjusted to the national statistical system for processing the data and information, as explained in Golušin et al. (2014) and further discussed in more detail in "The input data" and "Discussion prefacing comments" below.

We chose 20 different representative indicators for each of the 3 approaches for the countries in the sample. They are defined in Table 1, and their values for the GDP-based, the Beyond-GDP-based, and the SDG-based approaches are given in "The input data" below. Generally, traditional economic indicators plus indicators of natural resources and basic pollution were used for the GDP-based approach, social well-being and quality of life for were included in the Beyond-GDP-based approach, and indicators derived from the defined 17 sustainable goals for the SDG-based approach.

The values of most of the indicators are obtained from the UN Human Development Reports (2014), World Bank Indicators (2014) and United Nations Development Programme online report (2014). Data for the Inclusive Wealth Index are from UNU-IHDP and UNEP (2015) a newer version is not yet available, for the Happiness Index from Sustainable Development Solution Network (2015), for the Social Progress Index from SPI, Social Progress Imperative (Porter et al. 2016), and for the Corruption Perception Index from Transparency International (2015).

The sustainability analysis method and data

The analysis algorithms

The data analysis was performed using the method of composite indicators, based on the weight coefficients technique (ISPRA 2008; Singh et al. 2012; Lior 2015, 2017; Lior and Kim 2018). It allows subjective accounting of the importance of an indicator at a given time and country (Blanc et al. 2008), and is applicable to data that may be expressed in different units of measurement (as in this and similar cases). The method here has two stages:

1. Scaling techniques aimed at transforming (normalizing) variables to make them comparable based on a common unit.

In this study, the normalization is for each indicator type j (e.g., GDP-PPP, energy consumption, CO_2 emissions, and such), with $j = 1$ to J, and is relative to all the countries in the chosen set of N countries $i = 1$ to N. In this study, there were 15 countries, so $N = 15$, with the normalized indicators $z_{i,j}$ (indexed by country i and indicator type j) calculated by the min–max method from the values of the "raw" (pre-normalized) indicators $x_{i,j}$ for country i and indicator type

Table 1 The indicators used for calculating the relative level of sustainable development in SEE, Russian Federation and Germany (2014)—with designated impact direction on sustainability [positive (+) or negative (−)]

GDP-based approach	Beyond-GDP-based approach	SDG-based approach
Name of indicator (x)		
Gross domestic product per capita (current international $; +)	Gross domestic product per capita (current international $; +)	Public expenditure on education (% of GDP; +)
Total unemployment rate (% of labour force; −)	Consumer price index (−)	Public health expenditure (% of GDP; +)
Inflation rate, consumer prices (%; −)	GINI (−)	Total unemployment rate (%; −)
Industrial growth (annual %; +)	Public expenditure on education (% of GDP; +)	Physicians density (physicians per 1000 people; +)
GDP growth (annual %; +)	Public health expenditure (% of GDP; +)	Population below poverty line (%; −)
Foreign direct investment, net inflows (% of GDP; +)	Export of goods and services (% of GDP; +)	Inequality-adjusted HDI (+)
Private capital flows (% of GDP; +)	Remittances received, personal (% of GDP; +)	Corruption perception index (+)
Public debt (% of GDP; −)	Inequality-adjusted HDI (+)	Total natural resources rents (% of GDP; +)
Bank capital to asset ratio (%; −)	Gender inequality index (−)	Improved water source (% of population with access; +)
Gross savings (% pf GDP; +)	Population below poverty line (%; −)	Energy imports, net (% of energy use; −)
Export of goods and services (% of GDP; +)	Infant mortality rate (in 1000; −)	Arable land (% of total land; +)
Remittances received, personal (% of GDP; +)	Total unemployment rate (%; −)	Internet users (% of population; +)
Population below poverty line (%; −)	Crime index (−)	Carbon dioxide emissions per capita (tonnes; −)
Public health expenditure (% of GDP; +)	Internet users (% of population; +)	Water dependency (% of water from neighbouring countries; −)
Primary energy supply, fossil fuels (% of total; −)	Carbon dioxide emissions per capita (tonnes; −)	Adjusted savings: energy depletion [% of gross national income (GNI); −]
Energy imports, net (% of energy use; −)	Primary energy supply, fossil fuels (% of total; −)	Terrestrial and marine protected areas (% of total territorial area; +)
Carbon dioxide emissions per capita (tonnes; −)	Forest area (% of total; +)	Urban population (%; −)
Arable land (% of total land; +)	Water dependency (% of water from neighbouring countries; −)	Old age pension recipients (% of statutory pension age population; +)
Water dependency (% of water from neighbouring countries; −)	Happiness index (+)	Vulnerable employment (% of employed engaged as unpaid family workers and own-account workers; −)
Forest area (% of total area; +)	Social progress index (+)	Inclusive Wealth Index (IWI) per capita (+)

j, which are found in appropriate databases. The method allows comparison of heterogeneous data (Zhou et al. 2007) and only of the level of SD relative to the other countries in the studied set (Lindholm et al. 2007; Streimikiene et al. 2012). Thus,

$$z_{i,j} = \frac{x_{i,j} - x\min_j}{x\max_j - x\min_j} 100 \quad (1)$$

where for country i and indicator type j:

$z_{i,j}$: value of the normalized indicator (%, dimensionless and positive by definition), $x_{i,j}$: value of the pre-normalized ("raw") indicator, $x_{\max,j}$: highest value of the pre-normalized ("raw") indicator among the set of N considered countries, $x_{\min,j}$: minimal value of the pre-normalized ("raw") indicator among the set of N considered countries,

with all x values having the dimensions by which these "raw" indicators are measured (e.g., $, tons, %, etc.), and can be positive or negative.

Since some of the indicator values represent sustainable attributes, such as GDP-PPP or the Happiness Index, yet others represent unsustainable attributes such as total unemployment rate (TER) or infant mortality rate, the values of $x_{\max,j}$ and $x_{\min,j}$ in the normalization of each indicator [by Eq. (1)] were chosen accordingly. For example, for indicators that represent sustainable attributes, such as GDP-PPP, $x_{\max,j}$ was assigned the highest GDP-PPP value, and the $x_{\min,j}$ was assigned the lowest GDP value, among the country set, resulting hence in higher rankings of countries with higher GDP-PPP. For indicators that represent unsustainable attributes, such as TER, $x_{\max,j}$ was assigned the lowest TER value, and the $x_{\min,j}$ was assigned the highest TER value, among the

country set, resulting hence in higher rankings of countries with lower TER.

It is important to note that this method as applied here ranks the countries' sustainability level based on the relative magnitude of their "raw" indicators $x_{i,j}$, with $z_{i,j}$ scaled from 0 to 100, where $z_{i,j}=0$ for the countries that have the very lowest value of the "raw" indicator, $x_{\min,j}$, and $z_{i,j}=100$ for the countries that have the very highest value of the "raw" indicator, $x_{\max,j}$.

2. Weighting and aggregation are the final steps in the process of constructing a composite index. There are several methods for quantifying and analysing the degree of SD of nations, and we have chosen the indicators aggregation method, which depends directly on the choice of sustainability indicators and of their weights. Aggregation is a process of addition (or multiplication) together of the system chosen indicators, usually multiplied by their weights, into one single metric that is easily comparable across countries and in time (OECD 2008; Lior 2015).

According to determined values and weight coefficients, the value of a Total Composite Sustainability Index (TCSI) is calculated here by using a technique defined by the equation:

$$\mathrm{TCSI}_i^t = \sum_{j=1}^{J} w_{i,j}^t \cdot z_{i,j}^t, \tag{2}$$

assuming (as usual) that the number of indicators is equal to the number of corresponding weights J, indexed as $j=1$, 2,.., J, where:

$TCSI_i^t$: The Composite Sustainability Index of country i at time t, dimensionless. $z_{i,j}^t$: The value of the normalized indicator z indexed by weight type j, for country i at time t, and J: The number of indicators types = the number corresponding weights, used; here, 20 indicators were chosen, so $J=20$. $w_{i,j}^t$: The weight associated to individual indicator $z_{i,j}^t$, at time t (%, or just dimensionless).

The weight of an indicator is the quantitative expression of its importance relative to the rest of the indicators used in the analysis. Composite indicators always require weighting of indicators, which means establishing a ranking among them, and while their choice is very important, it is usually somewhat subjective. There are several methods for their choice, including weighting based on statistical methods (principal component analysis, factor analysis, data envelopment analysis and regression analysis), weighting based on expert/public opinion polls (budget allocation process analytic hierarchy process and conjoint analysis), and equal weighting where all the weights are assumed to be equal or when the analysis is focused only on the values of the indicators and not of their weights (e.g., Ispra 2008).

Compared with indicators, which are environmental, economic and social quantitative facts for each country, the weights are individual choices for the countries, which can be changed arbitrarily (e.g., for assessment or planning). In this study, the focus is therefore only on the effects of the indicators, thus excluding the effects of the weights (this is equivalent to assigning an equal weight to each indicator). The effects of weights can be easily added to this analysis if wished. That, and ignoring time dependency and without any loss of accuracy calculating the indicator-averaged *CSI*, reduces Eq. (2) to

$$\mathrm{CSI}_i = \frac{1}{J}\sum_{j=1}^{J} z_{i,j}, \tag{3}$$

where the CSI_i (in %) is used for the sustainability relative ranking of country i; i.e., in this method, the larger the value of *CSI* of a country, the higher is its level of sustainability.

The input data

The "raw" (before normalization) indicators used to measure the degree of SD using the GDP-based approach have been traditionally in use for decades, and their values are in Table 2.

The raw indicators selected for the "Beyond GDP" approach are more oriented to SEE conditions and aspirations for quality of life, natural resources and quality of the environment, and their values are in Table 3.

The raw indicators selected for the SDG-based approach, representing the basic features of the 17 SDG, are in Table 4.

The results from the analysis

Results

The calculated results from the application of the GDP-based, Beyond-GDP-based and SDG–based approaches for sustainability measurement are presented in Tables 5, 6 and 7, respectively.

Figure 1 allows an easy comparison of the average values of the rankings of SD expressed by the CSI (Eq. (3)] under the three approaches.

A summary of the changes in countries' rankings incurred by application of the three approaches is given in Table 8.

The computed results of the analysis presented in Tables 2, 3, 4, 5, 6, 7 and 8 and Fig. 1 provide a large wealth of information useful for sustainable planning and analytical methodology. A complete analysis of the cause-and-effect

Table 2 The indicators' input data for the GDP-based approach (the indicators' definitions and data sources are described in the paper text and the "Appendix")

Indicator (*x*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
GDP-PPP pc (current international $)	11,305.00	17,660.00	10,510.00	17,512.00	21,881.00	47,268	26,680.00	25,582.00
Total unemployment rate (% of labour force)	13.40	6.10	19.60	12.90	17.30	5.30	27.30	10.20
Inflation rate, consumer prices (%)	1.63	18.00	– 0.90	–1.00	0.00	0.91	– 1.31	– 0.22
Industrial growth	2.30	– 6.50	3.20	2.70	1.90	1.00	– 2.60	5.80
GDP growth (annual %)	2.17	1.59	1.08	1.55	– 0.36	1.60	0.65	3.67
Foreign direct investment, net inflows (% of GDP)	8.70	2.45	2.68	3.48	6.89	0.22	0.71	8.96
Private capital flows (% of GDP)	– 8.30	– 2.70	– 11.00	–2.00	– 5.70	6.70	1.70	– 2.40
Public debt (% of GDP)	69.30	34.10	44.80	27.00	86.50	74.60	180.50	76.20
Bank capital-to-asset ratio (%)	9.00	13.32	14.47	11.57	14.04	5.61	8.06	9.11
Gross savings (% pf GDP)	11.82	26.54	10.93	22.26	18.91	26.94	10.78	24.31
Export of goods and services (% of GDP)	28.25	57.20	33.90	65.11	46.28	45.73	32.69	89.25
Remittances received, personal (% of GDP)	8.64	1.62	11.26	2.97	3.76	0.46	0.31	3.37
Population below poverty line (%)	14.30	6.30	17.20	21.80	19.50	15.50	36.00	14.90
Public health expenditure (% of GDP)	2.94	3.74	6.81	4.61	6.39	8.70	4.99	4.88
Primary energy supply, fossil fuels (% of total)	60.50	90.40	60.20	75.00	81.60	82.00	90.60	71.10
Energy imports, net (% of energy use)	12.28	85.39	28.46	37.16	53.02	60.89	62.62	55.06
Carbon dioxide emissions per capita (tonnes)	1.60	6.70	4.10	6.70	4.80	8.90	7.60	4.90
Arable land (% of total land)	22.52	27.47	19.73	32.05	15.66	34.07	19.76	48.64
Water dependency	10.93	41.28	5.33	1.41	64.27	30.52	15.20	94.23
Forest area (% of total area)	28.19	42.45	42.68	35.06	34.34	32.76	31.22	22.80
Indicator, x	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
GDP-PPP pc (current international $)	13,908.00	5,039.00	15,486.00	21,403.00	24,451.00	13, 842.00	31,122.00	
Total unemployment rate (% of labour force)	29.00	5.60	19.60	7.30	5.50	22.10	10.10	
Inflation rate, consumer prices (%)	– 0.28	9.68	– 0.78	1.07	7.81	2.08	0.20	
Industrial growth	7.80	1.00	4.50	3.30	– 3.60	4.70	3.30	
GDP growth (annual %)	3.77	4.60	1.78	2.78	0.64	– 1.81	3.05	
Direct foreign investment, net inflows (% of GDP)	0.54	4.39	10.83	1.94	3.48	4.56	2.08	

Table 2 (continued)

Indicator (*x*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Private capital flows (% of GDP)	– 1.60	– 2.70	– 11.00	– 6.00	1.30	– 9.20	– 9.60	
Public debt (% of GDP)	46.00	39.40	57.90	39.80	9.50	70.40	81.00	
Bank capital-to-asset ratio (%)	10.82	12.73	14.16	7.38	8.54	20.67	8.20	
Gross savings (% pf GDP)	29.29	19.35	5.01	22.28	23.44	10.67	26.78	
Export of goods and services (% of GDP)	47.86	41.64	40.14	41.13	30.02	44.34	76.53	
Remittances received, personal (% of GDP)	3.24	26.17	9.40	1.70	0.42	8.43	1.53	
Population below poverty line (%)	30.40	20.80	8.60	22.40	11.20	9.20	13.50	
Public health expenditure (% of GDP)	4.10	5.30	3.67	4.47	3.69	6.42	6.62	
Primary energy supply, fossil fuels (% of total)	82.10	94.90	60.20	77.70	91.00	89.10	66.6	
Energy imports, net (% of energy use)	48.39	90.05	25.57	18.56	– 83.37	23.69	43.99	
Carbon dioxide emissions per capita (tonnes)	4.40	1.40	4.10	4.20	12.60	6.80	7.50	
Arable land (% of total land)	16.38	55.23	0.58	38.02	7.46	37.72	8.64	
Water dependency	50.04	86.80	92.10	80.01	4.71	8.22	41.42	
Forest area (% of total area)	39.57	12.30	61.49	29.53	49.76	31.08	61.96	

principles would be prohibitively extensive for this paper, so the main underlying causes of the ranking results, and some more interesting or unexpected findings, are briefly summarized as follows:

- Using the GDP-based approach, Germany, Hungary and Slovenia had the highest rankings, in that order. For Germany, this is primarily a consequence of highest level of GDP and all GDP-related indicators, as well as of all other indicators used. For Hungary, it is due to exceptional industrial growth (5.8%) and GDP growth (3.67%—second highest in the group), foreign direct investment (8.96%—second highest in the group), export of goods and services (89.25%—highest in the group); It seems that Hungary had a very successful economic and financial policy and activity. Slovenia, the third ranked country showed high GDP growth (3.05%—third highest in the group), gross savings (26.78%—second highest in the group), public health expenditure (6.62%—second highest in the group), export of goods and services (76.53%—second highest in the group), and forest area (61.96%—highest in the group).

The countries with the lowest rankings were Greece, Serbia and Moldova, principally because of their relatively low GDP and all GDP-related indicators. In addition, Greece had the second highest unemployment rate in the group (27.3%), and Serbia the third highest (22.1%). Greece also had a very low level of foreign direct investment (0.71%), highest public debt (180.5%) and population below the poverty line (36%). Serbia had the lowest GDP growth (–1.81%). Moldova had the smallest GDP-PPP value in the group (USD 5039 vs. USD 47,268 for Germany), second highest inflation rate (9.68%), and third largest population below the poverty line (20.8%).

Using the Beyond-GDP approach, the highest ranked countries, Germany, Slovenia and Hungary (in that order), show nearly the same rankings as for using the above-described GDP-based approach, with Slovenia replacing Hungary as second, but significant changes exist in the rankings of the mid-ranked countries of the group. Germany, Slovenia and Hungary are at the top primarily because the set of indicators in this approach includes six GDP-related ones. At the same time, these

Table 3 The indicators' input data for the Beyond-GDP-based approach (the indicators' definitions and data sources are described in the paper text and the "Appendix")

Indicator (*x*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
GDP-PPP pc (current international $)	11,305.00	17,660.00	10,510.00	17,512.00	21,881.00	47,268.00	26,680.00	25,582.00
Consumer price index	107.60	288.60	105.70	108.3	108.10	105.70	103.90	111.80
GINI	29.00	26.50	33.00	34.4	33.60	30.60	34.70	28.90
Public education expenditure on education (% of GDP)	3.50	4.99	2.98	3.59	4.16	4.95	3.97	4.65
Public health expenditure (% of GDP)	2.94	3.74	6.81	4.61	6.39	8.70	4.99	4.88
Export of goods and services (% of GDP)	28.25	57.20	33.90	65.11	46.28	45.73	32.69	89.25
Remittances received, personal (% of GDP)	8.64	1.62	11.26	2.97	3.76	0.46	0.31	3.37
Inequality-adjusted HDI	0.63	0.74	0.63	0.699	0.74	0.85	0.75	0.76
Gender inequality index	0.21	0.15	0.20	0.212	0.14	0.04	0.14	0.20
Population below poverty line (%)	14.30	6.30	17.20	21.8	19.50	15.50	36.00	14.90
Infant mortality rate (in 1000)	13.30	3.70	5.70	10.1	3.80	3.20	3.70	5.20
Total unemployment rate (%)	13.40	6.10	19.60	12.9	17.30	5.30	27.30	10.20
Crime index	51.31	32.89	44.98	40.02	28.90	27.14	43.05	37.52
Internet users (% of population)	60.10	59.02	60.80	55.49	68.57	86.19	63.21	76.13
Carbon dioxide emissions per capita (tunes)	1.60	6.70	4.10	6.70	4.80	8.90	7.60	4.90
Primary energy supply, fossil fuels (% of total)	60.50	90.40	60.20	75.00	81.60	82.00	90.60	71.10
Forest area (% of total)	28.19	42.45	42.68	35.06	34.34	32.76	31.22	22.80
Water dependency (% of water from neighbouring countries)	10.93	41.28	5.33	1.41	64.27	30.52	15.20	94.23
Happiness index	4.95	5.81	4.94	4.218	5.75	6.75	4.85	4.90
Social progress index	68.19	64.98	66.15	70.19	73.3	84.04	74.03	74.80
Indicator (*x*)	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
GDP-PPP pc (current international $)	13,908.00	5,039.00	15,486.00	21,403.00	24,451.00	13, 842.00	31,122.00	
Consumer price index	110.30	117.80	109.10	113.70	121.60	128.50	106.30	
GINI	44.20	30.60	30.60	27.30	39.70	29.70	24.90	
Public education expenditure on education (% of GDP)	3.30	7.50	3.20	2.99	4.15	4.43	5.66	
Public health expenditure (% of GDP)	4.10	5.30	3.67	4.47	3.69	6.42	6.62	
Export of goods and services (% of GDP)	47.86	41.64	40.14	41.13	30.02	44.34	76.53	
Remittances received, personal (% of GDP)	3.24	26.17	9.40	1.70	0.42	8.43	1.53	
Inequality-adjusted HDI	0.62	0.61	0.72	0.71	0.71	0.69	0.82	
Gender inequality index	0.16	0.24	0.17	0.33	0.27	0.17	0.01	

Table 3 (continued)

Indicator (*x*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Population below poverty line (%)	30.40	20.80	8.60	22.40	11.20	9.20	13.50	
Infant mortality rate (in 1000)	5.80	13.30	4.90	10.50	8.60	5.80	2.30	
Total unemployment rate (%)	29.00	5.60	19.60	7.30	5.50	22.10	10.10	
Crime index	41.67	46.32	30.10	28.73	52.67	39.28	33.21	
Internet users (% of population)	68.06	46.60	61.00	54.08	70.52	53.50	71.59	
Carbon dioxide emissions per capita (tunes)	4.40	1.40	4.10	4.20	12.60	6.80	7.50	
Primary energy supply, fossil fuels (% of total)	82.10	94.90	60.20	77.70	91.00	89.10	66.6	
Forest area (% of total)	39.57	12.30	61.49	29.53	49.76	31.08	61.96	
Water dependency (% of water from neighbouring countries)	50.04	86.80	92.10	80.01	4.71	8.22	41.42	
Happiness index	5.01	5.88	5.19	5.12	5.71	5.12	5.84	
Social progress index	67.79	63.68	69.01	68.37	63.64	69.79	81.62	

three countries are ranked only in the middle of the group for most other indicators. It is noteworthy that lowest and highest level of public health expenditure are in Albania (2.94) and in Germany (8.70).

The countries with the lowest rankings when using the Beyond-GDP approach were Macedonia, Moldova and Albania, whereas when using the GDP-based approach, they were Greece, Serbia and Moldova. Interestingly, Bosnia and Herzegovina and Serbia had high values of public health expenditure, 6.81 (second place) and 6.42 (fourth place), respectively, and Moldova had the very highest level of public education expenditure (7.5, vs. 4.95 for Germany). Interestingly, the inequality-adjusted HDI for Greece was the fourth (0.75) just below that of the three top-ranked countries despite its 10th overall ranking, and the GINI index of the 5th overall-ranked Belarus is second (26.5, v. 24.9 for the 1st ranked Slovenia) indicate that these inequality-related indices do not necessarily follow the overall country ranking nor the level of economic development. Further similar conclusions are about the population below the poverty line, where the lowest (6.30) was of 5th overall-ranked Belarus, the second lowest (8.60) was for 6th overall-ranked Montenegro, and the third lowest (9.20) for 7th overall-ranked Serbia. An explanation for these patterns could be the cultural/social tradition of these countries for preserving and maintaining acceptable quality of life standards for their most vulnerable groups.

The Happiness index is highest for Germany (6.75), followed by (unexpectedly, considering overall economic characteristics) Moldova (5.88), the 3rd highest for Slovenia (5.84), and the fourth for the Russian Federation (5.71). It does not vary much among the countries in the investigated group, and is not strongly related to the level of economic development, while the values of the Social Progress index are in line with level of economic development.

- Using the SDG-based approach, the countries' rankings were much closer to those using the Beyond-GDP-based approach, thus confirming that the SDG-based approach, is also highly oriented to human well-being and respect for the value of natural resources, in fact, by definition. The highest ranked countries remained Germany, Slovenia and Hungary, in the same order. It is noteworthy that inclusion of the Happiness Index and the Social Progress Index did not create a significant change in rankings.

The countries with the lowest rankings were Albania (13th), Montenegro (14th) and Macedonia (15th), whereas when using the Beyond-GDP-based approach, they were Albania (13th), Moldova (14th) and Macedonia (15th). Macedonia had the highest total unemployment rate (29%), second highest population below

Table 4 The indicators' input data for the SDGs-based approach (the indicators' definitions and data sources are described in the paper text and the "Appendix")

Indicator (x)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Public education expenditure on education (% of GDP)	3.50	4.99	2.98	3.59	4.16	4.95	3.97	4.65
Public health expenditure (% of GDP)	2.94	3.74	6.81	4.61	6.39	8.70	4.99	4.88
Total unemployment rate (%)	13.40	6.10	19.60	12.90	17.30	5.30	27.30	10.20
Physicians density (physicians per 1000 people)	1.15	3.93	1.93	3.87	2.84	3.89	2.70	3.10
Population below poverty line (%)	14.30	6.30	17.20	21.8	19.50	15.50	36.00	14.90
Inequality-adjusted HDI	0.63	0.74	0.63	0.69	0.74	0.85	0.75	0.76
Corruption perception index	33.00	31.00	39.00	43.00	48.00	79.00	43.00	54.00
Total natural resources rents (% of GDP)	5.40	1.94	1.49	1.87	1.68	0.13	0.18	0.47
Improved water source (% of population with access)	95.00	100.00	100.00	99.00	100.00	100.00	100.00	100.00
Energy imports, net (% of energy use)	12.28	85.39	28.46	37.16	53.02	60.89	62.62	55.06
Arable land	22.52	27.47	19.73	32.05	15.66	34.07	19.76	48.64
Internet users	60.10	59.02	60.80	55.49	68.57	86.19	63.21	76.13
Carbon dioxide emissions per capita (tonnes)	1.60	6.70	4.10	6.70	4.80	8.90	7.60	4.90
Water dependency	10.93	41.28	5.33	1.41	64.27	30.52	15.20	94.23
Adjusted savings: energy depletion (% of GNI)	3.48	0.75	0.00	0.02	0.50	0.04	0.01	0.26
Terrestrial and marine protected areas (% of total territorial area)	2.34	8.57	1.28	40.52	37.73	37.40	34.86	22.55
Urban population (%)	56.41	76.28	39.62	73.63	58.66	75.09	77.68	70.77
Old age pension recipients (% of statutory pension age population)	77.00	93.60	29.60	96.90	57.60	100	77.40	91.40
Vulnerable employment	58.10	2.10	25.30	8.20	13.70	6.50	30.30	6.00
Inclusive Wealth Index (IWI) per capita	40,462.00	49,132.00	51,876.00	51,614.00	165,767.00	435,655.00	216,142.00	142,741.00
Indicator, x	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
Public education expenditure on education (% of GDP)	3.30	7.50	3.20	2.99	4.15	4.43	5.66	
Public health expenditure (% of GDP)	4.10	5.30	3.67	4.47	3.69	6.42	6.62	
Total unemployment rate (%)	29.00	5.60	19.60	7.30	5.50	22.10	10.10	

Table 4 (continued)

Indicator (*x*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Physicians density (physicians per 1000 people)	2.62	2.98	2.11	2.45	4.31	2.11	2.54	
Population below poverty line (%)	30.40	20.80	8.6	22.40	11.20	9.20	13.50	
Inequality-adjusted HDI	0.62	0.61	0.72	0.71	0.71	0.69	0.82	
Corruption perception index	45.00	35.00	42.00	43.00	28.00	41.00	58.00	
Total natural resources rents (% of GDP)	3.06	0.42	0.71	1.69	16.25	3.03	0.50	
Improved water source (% of population with access)	99.00	88.00	100.00	100.00	97.00	99.00	100.00	
Energy imports, net (% of energy use)	48.39	90.05	25.57	18.56	–83.37	23.69	43.99	
Arable land	16.38	55.23	0.58	38.02	7.46	37.72	8.64	
Internet users	68.06	46.60	61.00	54.08	70.52	53.50	71.59	
Carbon dioxide emissions per capita (tonnes)	4.40	1.40	4.10	4.20	12.60	6.80	7.50	
Water dependency	50.04	86.80	92.10	80.01	4.71	8.22	41.42	
Adjusted savings: energy depletion (% of GNI)	0.00	0.00	0.04	0.99	8.82	1.30	0.00	
Terrestrial and marine protected areas (% of total territorial area)	9.70	3.82	4.14	23.80	11.36	6.76	53.56	
Urban population (%)	57.03	44.93	63.83	54.39	73.92	55.37	49.70	
Old age pension recipients (% of statutory pension age population)	52.20	72.80	52.30	98.00	100.00	46.10	95.10	
Vulnerable employment (% of unpaid family workers and own-account workers)	23.40	30.50	26.00	30.90	5.70	28.60	13.60	
Inclusive Wealth Index (IWI) per capita	52,066.00	15,012.00	61,114.00	62,522.00	136,156.00	57,905.00	243,936.00	

the poverty line (30.4%) and 3d lowest Old Age Pension Recipients (30.4% vs. 100% for Germany).

It is noteworthy that under the GDP-based approach, Greece and Serbia were the lowest ranked, but that changed significantly under the SDG-based approach: Greece rose to the 10th place and Serbia to the 7th. For Serbia, the significant rise in rank can be explained by the relatively high level of the socially related indicators, public education expenditure, public health expenditure and population below the poverty line. Serbia also had low energy import (28.78% vs. 60.89% for Germany). Water dependence in both Serbia (8.22) and Greece (15.2) was much lower than in Germany (30.52). This high level of socially related indicators and natural resources wealth countered the negative impact of its relatively low strongly GDP-oriented indicators.

The Inclusive Wealth Index (IWI), developed as an integrated score of natural, human and produced capital, included in the measurement by this approach,

Table 5 Normalized values of the sustainable development levels obtained by use of the GDP-based approach, in Southeast Europe, Germany and the Russian Federation (2014)

Normalized indicator (*z*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
GDP-PPP pc (current international $)	14.84	29.89	12.96	29.54	39.88	100.00	51.25	48.65
Total unemployment rate (% of labour force)	65.82	96.62	39.66	67.93	49.37	100.00	7.17	79.32
Inflation rate, consumer prices (%; %)	84.77	0.00	97.88	98.39	93.22	88.50	100.00	94.36
Industrial growth	61.54	0.00	67.83	64.34	58.74	52.45	27.27	86.01
GDP growth (annual %)	71.33	60.93	51.79	60.22	25.99	61.11	44.09	98.21
Direct foreign investment, net inflows (% of GDP)	79.92	21.02	23.19	30.73	62.87	0.00	4.62	82.38
Private capital flows	15.25	46.89	0.00	50.85	29.94	100.00	71.75	48.59
Public debt	65.03	85.61	79.36	89.77	54.97	61.93	0.00	60.99
Bank capital to asset ratio (%)	77.49	48.80	41.17	60.42	44.02	100.00	83.73	76.76
Gross savings (% pf GDP)	31.05	98.18	26.99	78.66	63.38	100.00	26.31	88.01
Export of goods and services (% of GDP)	0.00	47.46	9.26	60.43	29.56	28.66	7.28	100.00
Remittances received, personal (% of GDP)	68.18	95.49	57.99	90.24	87.16	100.00	100.58	88.68
Population below poverty line (%)	73.06	100.00	63.30	47.81	55.56	69.02	0.00	71.04
Public health expenditure (% of GDP)	0.00	20.67	100.00	43.15	89.15	148.84	52.97	50.13
Primary energy supply, fossil fuels (% of total)	99.14	12.97	100.00	57.35	38.33	37.18	12.39	68.59
Energy imports, net (% of energy use)	44.84	2.69	35.51	30.50	21.35	16.81	15.82	20.18
Carbon dioxide emissions per capita (tonnes)	98.21	52.68	75.89	52.68	69.64	33.04	44.64	68.75
Arable land (% of total land)	40.15	49.20	35.04	57.58	27.59	61.28	35.10	87.94
Water dependency	89.74	57.05	95.78	100.00	32.28	68.64	85.14	0.00
Forest area (% of total area)	32.37	60.93	61.39	46.12	44.68	41.52	38.43	21.57
TCSI	1112.75	987.08	1074.99	1216.70	1017.68	1368.97	808.55	1340.15
CSI	55.64	49.35	53.75	60.84	50.88	68.45	40.43	67.01
Normalized Indicator, (*z*)	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
GDP-PPP pc (current international $)	21.00	0.00	24.74	38.75	45.97	19.99	61.77	
Total unemployment rate (% of labour force)	0.00	98.73	39.66	91.56	99.16	29.11	79.75	
Inflation rate, consumer prices (%; %)	94.67	43.09	97.26	87.67	52.77	82.44	92.18	
Industrial growth	100.00	52.45	76.92	68.53	20.28	78.32	68.53	
GDP growth (annual %)	100.00	114.87	64.34	82.26	43.91	0.00	87.10	
Direct foreign investment, net inflows (% of GDP)	3.02	39.30	100.00	16.21	30.73	40.90	17.53	
Private capital flows	53.11	46.89	0.00	28.25	69.49	10.17	7.91	
Public debt	78.65	82.51	71.70	82.28	100.00	64.39	58.19	
Bank capital to asset ratio (%)	65.41	52.72	43.23	88.25	80.54	0.00	82.80	
Gross savings (% pf GDP)	110.72	65.39	0.00	78.75	84.04	25.81	99.27	
Export of goods and services (% of GDP)	32.15	21.95	19.49	21.11	2.90	26.38	79.15	

Table 5 (continued)

Normalized indicator (*z*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Remittances received, personal (% of GDP)	89.19	0.00	65.23	95.18	100.16	69.00	95.84	
Population below poverty line (%)	18.86	51.18	92.26	45.79	83.50	90.24	75.76	
Public health expenditure (% of GDP)	29.97	60.98	18.86	39.53	19.38	89.92	95.09	
Primary energy supply, fossil fuels (% of total)	36.89	0.00	100.00	49.57	11.24	16.71	81.56	
Energy imports, net (% of energy use)	24.02	0.00	37.18	41.22	100.00	38.27	26.56	
Carbon dioxide emissions per capita (tonnes)	73.21	100.00	75.89	75.00	0.00	51.79	45.54	
Arable land (% of total land)	28.91	100.00	0.00	68.51	12.59	67.96	14.75	
Water dependency	47.61	8.00	2.29	15.32	96.44	92.66	56.90	
Forest area (% of total area)	55.16	0.54	99.06	35.05	75.57	38.15	100.00	
TCSI	1062.53	938.62	1028.11	1148.80	1128.66	932.22	1326.15	
CSI	53.13	46.93	51.41	57.44	56.43	46.61	66.31	

showed the highest values for Germany (435.655), Slovenia (243.936), Greece (216.142), Croatia (165.767), Hungary (142.747) and the Russian Federation (135.156). The values of the IWI In the other countries in the sample are between 62.522 (Romania) and 15.012 (Moldova—the lowest in the sample). Keeping in mind the difficulties related to measurement and normalization of these three types of capital (especially natural and human), the IWI values must be used very cautiously. For example, Greece had the third largest value of IWI even though it was faced by numerous serious economic problems during the last decade. Also, the Russian Federation had the lowest IWI value when compared with Slovenia, Greece, Croatia and Hungary, despite its vast natural resources, whose value was apparently not determined. The other countries, with few exceptions, had IWI values in the range of approximately 50,000 to 60,000, with the similarity to be expected due to their similar historical, economical and nature characteristics. Consequently, further development of IWI must be oriented to definition of a more precise methodology for its measurement and validation, especially when it comes to measurement of the value of natural resources.

It is noteworthy that the Corruption Perception Index of countries was found to relate to the their degree of economic development and overall ranking. Countries with highest Corruption Perception were those having the highest value of development as measured by all three approaches: Germany (79), Slovenia (58) and Hungary (54), while most of the lowest-ranked countries also had lowest Corruption Perception Indices. This leads to the poignant conclusion that corruption is a deep-seated (to our opinion perhaps insurmountable) obstacle to SD.

- The Russian Federation was ranked 6th under the GDP-based and Beyond-GDP-based approaches, and 12th under the SDG-based approach. This lower ranking under the SDG-based approach is at least partially a result of especially low indicator values of carbon dioxide emission and arable land, which are important in that approach.

Discussion of the results from each approach

Discussion prefacing comments

Tables 5, 6, 7 and 8 and Fig. 1 are used to compare the effects of each of the three approaches on the country rankings determined by the calculated CSI, and to discuss the comparison outcomes. Considering 15 countries and 3 approaches, each using a set of 20 different indicators, the cause-and-effect relationships depend on thousands of possible permutations, beyond the page limits and scope of this paper. The discussion consequently addresses only very major aspects, but the input and output data and the analytical methodology are given and can be used to examine other approaches and conditions. For example, a sensitivity analysis to the effects of different indicators, and to different indicators' weights [if used, Eq. (2)], can be performed.

Examination of the indicators and of their use has shown that the indicators having the highest potential impact on the level of SD (whether positive or negative)

Table 6 Normalized values of the sustainable development levels, as obtained by use of the SEE Beyond-GDP-based approach, in Southeast Europe, the Russian Federation and Germany (2014)

Normalized indicator (*z*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
GDP-PPP pc (current international $)	14.84	29.89	12.96	29.54	39.88	100.00	51.25	48.65
Consumer price index	98.00	0.00	99.03	97.62	97.73	99.03	100.00	95.72
GINI	78.76	91.71	58.03	50.78	54.92	70.47	49.22	79.27
Public education expenditure on education (% of GDP)	19.40	75.00	0.00	22.76	44.03	73.51	36.94	62.31
Public health expenditure (% of GDP)	0.00	20.67	100.00	43.15	89.15	148.84	52.97	50.13
Export of goods and services (% of GDP)	0.00	47.46	9.26	60.43	29.56	28.66	7.28	100.00
Remittances received, personal (% of GDP)	68.18	95.49	57.99	90.24	87.16	100.00	100.58	88.68
Inequality-adjusted HDI	6.81	52.34	7.23	34.47	53.19	100.00	59.57	64.26
Gender inequality index	36.59	57.41	41.64	38.17	58.04	92.11	58.99	39.12
Population below poverty line (%)	73.06	100.00	63.30	47.81	55.56	69.02	0.00	71.04
Infant mortality rate	0.00	87.27	69.09	29.09	86.36	91.82	87.27	73.64
Total unemployment rate (%)	65.82	96.62	39.66	67.93	49.37	100.00	7.17	79.32
Crime index	5.33	77.48	30.12	49.55	93.11	100.00	37.68	59.34
Internet users (% of population)	34.10	31.37	35.87	22.46	55.49	100.00	41.96	74.59
Carbon dioxide emissions per capita (tonnes)	98.21	52.68	75.89	52.68	69.64	33.04	44.64	68.75
Primary energy supply, fossil fuels (% of total)	99.14	12.97	100.00	57.35	38.33	37.18	12.39	68.59
Forest area (% of total)	32.37	60.93	61.39	46.12	44.68	41.52	38.43	21.57
Water dependency	89.74	57.05	95.78	100.00	32.28	68.64	85.14	0.00
Happiness index	29.27	62.99	28.87	0.00	60.86	100.00	25.24	26.97
Social progress index	22.30	6.57	12.30	32.11	47.35	100.00	50.93	54.71
TCSI	871.92	1115.90	998.41	972.25	1186.70	1653.82	947.67	1226.67
CSI	43.60	55.79	49.92	48.61	59.33	82.69	47.38	61.33
Normalized indicator (*z*)	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
GDP-PPP pc (current international $)	21.00	0.00	24.74	38.75	45.97	19.99	61.77	
Consumer price index	96.53	92.47	97.18	94.69	90.42	86.68	98.70	
GINI	0.00	70.47	70.47	87.56	23.32	75.13	100.00	
Public education expenditure on education (% of GDP)	11.94	168.66	8.21	0.37	43.66	54.10	100.00	
Public health expenditure (% of GDP)	29.97	60.98	18.86	39.53	19.38	89.92	95.09	
Export of goods and services (% of GDP)	32.15	21.95	19.49	21.11	2.90	26.38	79.15	
Remittances received, personal (% of GDP)	89.19	0.00	65.23	95.18	100.16	69.00	95.84	
Inequality-adjusted HDI	1.70	0.00	46.81	39.57	40.85	31.91	89.79	
Gender inequality index	53.31	26.81	51.10	0.00	17.98	49.53	100.00	
Population below poverty line (%)	18.86	51.18	92.26	45.79	83.50	90.24	75.76	
Infant mortality rate	68.18	0.00	76.36	25.45	42.73	68.18	100.00	
Total unemployment rate (%)	0.00	98.73	39.66	91.56	99.16	29.11	79.75	
Crime index	43.09	24.87	88.41	93.77	0.00	52.45	76.22	

Table 6 (continued)

Normalized indicator (z)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Internet users (% of population)	54.21	0.00	36.37	18.89	60.42	17.43	63.12	
Carbon dioxide emissions per capita (tunes)	73.21	100.00	75.89	75.00	0.00	51.79	45.54	
Primary energy supply, fossil fuels (% of total)	36.89	0.00	100.00	49.57	11.24	16.71	81.56	
Forest area (% of total)	55.16	0.54	99.06	35.05	75.57	38.15	100.00	
Water dependency	47.61	8.00	2.29	15.32	96.44	92.66	56.90	
Happiness index	31.16	66.00	38.47	35.78	59.16	35.74	64.38	
Social progress index	20.34	0.20	26.32	23.19	0.00	30.15	88.14	
TCSI	784.50	790.87	1077.19	926.16	912.84	1025.26	1651.68	
CSI	39.23	39.54	53.86	46.31	45.64	51.26	82.58	

for the countries studied in this paper were foreign direct investments (% of GDP), public debt (% of GDP), energy imports (as % of energy use), the corruption index, total natural resources rents (% of GDP), terrestrial and marine protected areas (% of total territorial area) and vulnerable employment (percentage of employed people engaged as unpaid family workers and own-account workers). The indicators GDP growth (%), CO_2 emission (tonnes/per capita), GINI, arable land (% of total land), water dependency (% of water from neighbouring countries), improved water source (% of population with access), forest area (% of total area), public expenditure on education and health (% of GDP), physician density (physicians per 1000 people) and infant mortality rate (in 1000 people) had weak effects. The list of all indicators is in Table 1 while their explanations and definitions are in the "Appendix".

The smallest differences in values of input data and therefore indicators with smallest potential to make problems in the future are: industrial growth, GDP growth, public health expenditure, public education expenditure, GINI, physician density, infant mortality, improved water source (% of population with access) and carbon dioxide emission that is far above the other countries in the group.

For the GDP-based approach to sustainability measurement

Under this conventional approach, calculated *CSI* of most of the countries, except for Germany, Hungary, Slovenia and Greece, have similar rankings, where Germany, Hungary and Slovenia have the significantly highest and Greece the lowest value of CSI. An interesting observation is that these highest-ranked three countries have rather similar rankings despite the fact that Germany is in many ways considered to be significantly more developed than Hungary and Slovenia. Furthermore, the ranking of these three top countries is only about 25% higher than the average ranking of the rest (with Greece excluded as an outlier), indicating that the SEE countries and the Russian Federation, all of which are in a developing stage, are improving significantly from their dire situation in the early 1990s. A quantitative examination of the countries' progress with time would be of interest, but there are very few published studies on sustainability measurement for the region of SEE region and Russia, and the available ones, mostly led by one of the co-authors of this paper (MR; Golušin et al. 2009, 2011, 2013), addressed only a part of the countries in the current sample and used different indicators. Furthermore, data definition and collection methods change with time, making proper comparison difficult, if not impossible. This strengthens our recommendation for standardization of both sustainability data and analysis.

Even though the GDP-based approach is most commonly used in contemporary sustainability analysis, the results showed that further research should be done to evaluate its suitability in general, and for countries like these SEE countries and Russian Federation in particular.

For the SEE Beyond-GDP-based approach for sustainability measurement

In this approach, the results have a much higher scatter, with values from 39.54 to 82.69 (vs. 40.43 to 68.45 under the GDP-based approach). Germany (CSI = 82.69) and Slovenia (82.58) are by far the highest ranked and nearly the same, with Hungary now the third, but significantly lower (61.33). FYR Macedonia and Moldova have the lowest values (~40) and the other countries are between values of 46 and 59.

Compared with the GDP-based approach, significant drops in rankings were recorded for Albania, Bulgaria, FYR Macedonia and Russian Federation, while significant rises in rankings were for Belarus, Croatia, Greece, Moldova,

Table 7 Normalized values of the sustainable development levels, as obtained by use of the SDG-based approach, in Southeastern Europe, the Russian Federation, and Germany (2014)

Normalized indicator (z)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Public education expenditure on education (% of GDP)	19.40	75.00	0.00	22.76	44.03	73.51	36.94	62.31
Public health expenditure (% of GDP)	0.00	20.67	100.00	43.15	89.15	148.84	52.97	50.13
Total unemployment rate (%)	65.82	96.62	39.66	67.93	49.37	100.00	7.17	79.32
Physicians density (physicians per 1000 people)	0.00	87.97	24.68	86.08	53.48	86.71	49.05	61.71
Population below poverty line (%)	73.06	100.00	63.30	47.81	55.56	69.02	0.00	71.04
Inequality-adjusted HDI	6.81	52.34	7.23	34.47	53.19	100.00	59.57	64.26
Corruption perception index	9.80	5.88	21.57	29.41	39.22	100.00	29.41	50.98
Total natural resources rents (% of GDP)	32.69	11.23	8.44	10.79	9.62	0.00	0.31	2.11
Improved water source (% of population with access)	58.33	100.00	100.00	91.67	100.00	100.00	100.00	100.00
Energy imports, net (% of energy use)	44.84	2.69	35.51	30.50	21.35	16.81	15.82	20.18
Arable land (% of total land)	40.15	49.20	35.04	57.58	27.59	61.28	35.10	87.94
Internet users (% of population)	34.10	31.37	35.87	22.46	55.49	100.00	41.96	74.59
Carbon dioxide emissions per capita (tonnes)	98.21	52.68	75.89	52.68	69.64	33.04	44.64	68.75
Water dependency	89.74	57.05	95.78	100.00	32.28	68.64	85.14	0.00
Adjusted savings: energy depletion (% of GNI)	60.54	91.50	100.00	99.77	94.33	99.55	99.89	97.05
Terrestrial and marine protected areas (% of total territorial area)	2.70	18.58	0.00	100.00	92.89	92.05	85.58	54.20
Urban population (%)	55.89	3.68	100.00	10.64	49.97	6.81	0.00	18.16
Old age pension recipients (% of statutory pension age population)	67.33	90.91	0.00	95.60	39.77	100.00	67.90	87.78
Vulnerable employment	0.00	100.00	58.57	89.11	79.29	92.14	49.64	93.04
Inclusive Wealth Index (IWI) per capita	6.05	8.11	8.76	8.70	35.84	100.00	47.81	30.37
TCSI	765.49	1055.48	910.31	1101.11	1092.06	1548.39	908.90	1173.92
CSI	38.27	52.77	45.52	55.06	54.60	77.42	45.45	58.70
Normalized Indicator (z	Macedonia	Moldova	Montenegro	Romania	Russian Federation	Serbia	Slovenia	
Public education expenditure on education (% of GDP)	11.94	168.66	8.21	0.37	43.66	54.10	100.00	
Public health expenditure (% of GDP)	29.97	60.98	18.86	39.53	19.38	89.92	95.09	
Total unemployment rate (%)	0.00	98.73	39.66	91.56	99.16	29.11	79.75	
Physicians density (physicians per 1000 people)	46.52	57.91	30.38	41.14	100.00	30.38	43.99	
Population below poverty line (%)	18.86	51.18	92.26	45.79	83.50	90.24	75.76	
Inequality-adjusted HDI	1.70	0.00	46.81	39.57	40.85	31.91	89.79	
Corruption perception index	33.33	13.73	27.45	29.41	0.00	25.49	58.82	
Total natural resources rents (% of GDP)	18.18	1.80	3.60	9.68	100.00	17.99	2.30	
Improved water source (% of population with access)	91.67	0.00	100.00	100.00	75.00	91.67	100.00	

Table 7 (continued)

Normalized indicator (*z*)	Albania	Belarus	Bosnia and Herzegovina	Bulgaria	Croatia	Germany	Greece	Hungary
Energy imports, net (% of energy use)	24.02	0.00	37.18	41.22	100.00	38.27	26.56	
Arable land (% of total land)	28.91	100.00	0.00	68.51	12.59	67.96	14.75	
Internet users (% of population)	54.21	0.00	36.37	18.89	60.42	17.43	63.12	
Carbon dioxide emissions per capita (tonnes)	73.21	100.00	75.89	75.00	0.00	51.79	45.54	
Water dependency	47.61	8.00	2.29	15.32	96.44	92.66	56.90	
Adjusted savings: energy depletion (% of GNI)	100.00	100.00	99.55	88.78	0.00	85.26	100.00	
Terrestrial and marine protected areas (% of total territorial area)	21.46	6.47	7.29	57.39	25.69	13.97	133.23	
Urban population (%)	54.26	86.05	36.39	61.19	9.88	58.62	73.52	
Old age pension recipients (% of statutory pension age population)	32.10	61.36	32.24	97.16	100.00	23.44	93.04	
Vulnerable employment	61.96	49.29	57.32	48.57	93.57	52.68	79.46	
Inclusive Wealth Index (IWI) per capita	8.81	0.00	10.96	11.29	28.80	10.20	54.42	
TCSI	758.72	964.16	762.72	980.39	1088.94	973.08	1386.02	
CSI	37.94	48.21	38.14	49.02	54.45	48.65	69.30	

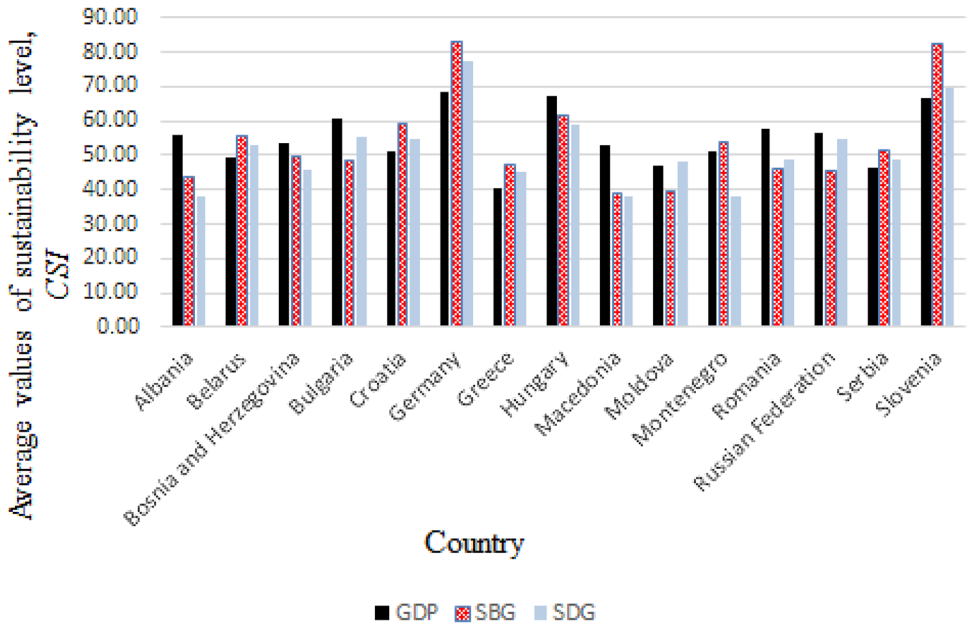

Fig. 1 Average values of the degree of sustainable development (CSI) obtained by application of the GDP-based (GDP), the Beyond-GDP (SBG) and the SDG-based (SDG) approaches in SEE, the Russian Federation and Germany (2014)

Montenegro and Serbia, and nearly negligible changes were for Bosnia and Herzegovina, Germany, Hungary, Montenegro and Slovenia. Excluding Germany and Russia, in this approach, the ranking of 10 SEE countries rose or remained the same, and only the rankings of 3 dropped.

For the SDG-based approach for sustainability measurement

Germany (77.42), Slovenia (69.30) and Hungary (59.70) remain the top-ranked countries in the sample, followed by Bulgaria, Croatia, Russian Federation and Belarus, closely clustered (values between 55.92 and 61.28). They are

Table 8 Comparison of the country rankings by their level of sustainable development for the three approaches for Southeast Europe, the Russian Federation and Germany (2014). The lowest and highest ranking numbers in each of the approaches are bolded

Country/approach	GDP-based approach ranking	Beyond-GDP-based approach ranking	SDG-based approach ranking
Albania	7	13	13
Belarus	12	5	7
Bosnia and Herzegovina	8	8	11
Bulgaria	4	9	4
Croatia	11	4	5
Germany	**1**	**1**	**1**
Greece	**15**	10	12
Hungary	**2**	3	3
Macedonia	9	**15**	**15**
Moldova	13	14	10
Montenegro	10	6	14
Romania	5	11	8
Russian Federation	6	12	6
Serbia	14	7	9
Slovenia	3	2	2

followed by Romania, Serbia, Moldova, Bosnia and Herzegovina and Greece (between 45 and 50). The lowest values are recorded for Albania (38.27), Montenegro (38.14) and FYR Macedonia (37.94).

Compared with the GDP-based approach, significant drops in rankings were recorded only for Albania and Montenegro, significant rises were for Belarus and Serbia, and relatively small changes were for the remaining countries. The rankings of the SEE countries relative to the Beyond-GDP-based approach remains nearly the same, excepting Montenegro.

One of the useful conclusions from the analysis under the SDG-based approach could be that the CSI inverse ranking order could also be used to identify the recommended ranking of the level of development effort and funding that countries should apply and receive for meeting the SDG.

The SEE countries can advance their sustainability by retaining the positive social attributes from their past, such as low extent of poverty, low unemployment and relatively low inequality, and reduce the negative effects, such as corruption, pollution and unsustainable exploitation of natural resources.

The results of this research showed that proper and effective development of the SDG, its indicators and of SD in general have to take into consideration national and regional differences, cultures and histories, as well as the time, because a single and time-independent methodology and approach are unsuitable and could promote wrong sustainability planning, especially for the poorer developing countries and countries in developmental transition. The SEE countries studied in this paper are a good example for that, and these conclusions are highly recommended for further research.

Comparison of the results between the approaches

Relative to the other two approaches, the "Beyond-GDP" approach resulted in the biggest spread among the countries' rankings (43.46, vs. 28.02 for the GDP-based and 38.48 for the SDG-based), showing that its indicator choices make the largest differences from these other approaches, even from the new SDG-based one.

As shown in Table 8, the smallest differences in ranking as a function of the applied approach were found in the top ranked three countries Germany (1:1:1), Slovenia (3:2:2) and Hungary (2:3:3), as well as for Bosnia and Herzegovina (8:8:11) and Moldova (13:14:10). All the other countries show difference of five or more ranking levels, while the largest difference in ranking position is recorded for Montenegro (10:6:14). The ranking of the Russian Federation is in the middle of the set. Besides the three best-performing countries, the CSI values and the rankings for all the others countries differ more significantly based on this approach.

In this study that addresses a large amount of data and results based on many criteria and approaches, it is difficult to produce generalized advice on which approach is the best for the countries in the analysed sample, but some related conclusions are obvious:

- All three approaches generate similar top rankings top for Germany, Slovenia, and Hungary,
- Relative to the other approaches, the Beyond-GDP approach results in the lowest ranking of the Russian Federation,
- All three approaches rank Greece and Moldova lowest,

- Relative to the other approaches, the GDP based approach ranks the relatively new EU members Bulgaria and Romania highest, because their emphasis is currently on economic development,
- The Beyond-GDP based approach is generally best for the rest of the countries,
- The SDG-based approach is more appropriate for measurement of sustainability in the more developed countries. These are countries that already have satisfactory level of economic development and therefore they aim and plan for new priorities, focused on further improvement of indicators of quality of life,
- Although human well-being is at least as important for underdeveloped countries as well, at the time of this study, at which all transition countries show unstable economic results, it is a fact, despite of is negative aspects, that they assess their sustainability level by using the traditional GDP-approach i.e., by economic growth. For the sake of global and own national sustainability, they should switch to a Beyond-GDP and SDG-based approach as soon as they achieve a certain degree of development and move from the turbulent transition process to a more stable period.

Conclusions and some recommendations

The conclusions and recommendations can be categorized as those about SD, those about the methodology of such analyses and those about choices of indicators and their relative effects.

In the first category, detailed results and discussion of the SD ranking of countries under the three approaches/indicator sets are presented in "The results from the analysis". The most obvious related conclusions are that the highest-ranked countries under all three approaches were Germany (used as a reference), Slovenia and Hungary. The lowest-ranked countries in general were Albania, Greece, Macedonia (FYR) and Moldova. Due to some inevitable subjectivities of probably any sustainability analysis, the calculated country rankings can most constructively be used primarily for identifying problems and looking for ways of improvement.

The smallest differences in country rankings as a function of the applied approach were found for the top-ranked three countries and Moldova (13:14:10). All the other countries show a difference of five or more ranking levels, with the largest difference in ranking position for Montenegro. The ranking of the Russian Federation is in the middle of the set. It can thus be concluded that, besides for the three best performing countries, the *CSI* values and rankings for all the others differ more significantly based on the used approach.

The Beyond GDP-based approach resulted in the biggest differences among the countries' rankings, indicating that the results of this approach also have the largest differences from other approaches'.

One of the conclusions from the analysis under the SDG-based approach is that the CSI inverse ranking order could also be used to identify the recommended ranking of the level of development effort and funding that countries should apply and receive for meeting the SDG.

The country indicators that have the largest range of values, more than by 50% (for many indicators there are order-of-magnitude differences), which thus have the highest impact on the CSI rankings, are GDP-PPP, foreign direct investment, remmittances received, energy imports, CO_2 emissions per capita, exports, corruption perception index, total natural resources rents, old age pension recipients, and inclusive wealth index. It is noteworthy that indicators that differ less among the countries are mostly those of quality of life. This includes, surprisingly, for example, the Happiness index and public expenditure on health and education. While this may be a consequence of some inadequacy of such indicators, it could also be a result of adaptation.

In the methodology category, some of the main conclusions and recommendations are that the definition of the analysis goals and of the choice of the indicators is obviously of critical importance and requires much higher uniformity and standardization. Conceptual and value errors may obviously be misleading, and this is especially grave for development planning of countries in transition (and in all underdeveloped countries) as it is more strongly reflected in wrong assessment of their strengths and weaknesses and may have longer-term negative consequences.

It can be advised to avoid simultaneous use of indicators that have strong linkages and interdependences. For example, for the Russian Federation CO_2 emissions per capita are the highest, but their influence on the ranking is offset by the very low energy imports.

Proper and effective measurement of SD in general must take into consideration national and regional differences, cultures and histories, and transience, because, obviously, methodology and approaches based on outdated information and concepts are unsuitable and could promote wrong planning (preparing for fighting the past war…), especially for the poorer countries and those in developmental transition, and because of the transience of understanding and application of the relatively new science of sustainability. Adequate measurement of SD can also serve well as an early indicator (and warning) of whether the country is evolving in the desired direction, which allows timely correction of plans, policies and initiatives.

As to the choices of indicators and their relative effects, indicators of natural wealth should be subject of further consideration. For example, the relatively very low level of arable land in the Russian Federation (7.46%) is considered to be a sustainability detriment because of it relation

to food supply, which it is practically not a problem there. The same can be said for forest area, because its magnitude does not show how this natural wealth is used. Of planning significance is the fact that while the arable land is small, its forest area is very high, leading to a question of choices for planning for a sustainable future. Introduction of indicators showing sustainable and effective use of natural resources is highly advisable.

The IWI and Social Progress indices are rather suitable, but the methods for their measurement and use must be developed further, especially as related to measuring of natural resources. The same can be said for inequality-adjusted HDI, Happiness index and Gender inequality index. Their use has its purpose, but they cannot be seen as valuable input indicators for aggregation methods. First, because they are result of aggregation itself and second, their values in observed countries are similar and they have no potential to point on important issues.

Results of the study showed that foreign direct investments (used as indicator only in the GDP-based approach) is a very important indicator of sustainability. It should, however, be noted that their inflow is strongly related to macroeconomics and political conditions. Even though they are traditionally promoted as accelerators of development, their positive effects can take place only if the domestic country has developed a proper related regulatory framework. It was also observed that the level of that inflow is in many cases related to the level of corruption.

The study has shown that countries with the lowest level of corruption (i.e., the highest Corruption Perception index) had the highest value of development as measured by all three approaches, while most of the lowest ranked countries also had the lowest Corruption Perception indices. This leads to a conclusion that corruption is a deep-seated obstacle for SD.

Finally, the SEE countries can also advance their sustainability by retaining any relevant positive social attributes from their past, such as low extent of poverty, low unemployment and relatively low inequality, and reducing the negative effects, such as corruption, pollution and unsustainable exploitation of natural resources.

The SEE countries studied in this paper are a good example for that, and these conclusions are highly recommended for further research. To reduce subjectivity and error in measuring the level of SD, and to thereby advance broader acceptance at all levels, the related scientific community and beneficiaries of sustainable planning should accelerate and improve their effort for developing commonly accepted and relevant definitions, and for standardization. Also, increased use of such methods is advised since it serves importantly in advancement of their learning curve. Education about scientific sustainability, especially of researchers and implementers, as well as leaders and stake holders, is of paramount importance for SD.

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Appendix: definitions of the lesser-known indicators used in this study

Adjusted savings: energy depletion (% of GNI, World Bank, The Changing Wealth of Nations 2011) http://siteresources.worldbank.org/ENVIRONMENT/Resources/ChangingWealthNations.pdf.

Energy depletion is the ratio of the value of the stock of energy resources-to-the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil and natural gas.

Arable land [% of total land, Food and Agriculture Organization (FAO) 2014].

https://www.indexmundi.com/facts/indicators/AG.LND.ARBL.ZS.

Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.

Bank capital-to-assets ratio (%, International Monetary Fund 2014).

https://www.indexmundi.com/facts/indicators/FB.BNK.CAPA.ZS.

Bank capital-to-assets ratio is the ratio of bank capital and reserves-to-total assets. Capital and reserves include funds contributed by owners, retained earnings, general and special reserves, provisions, and valuation adjustments. Capital includes tier 1 capital (paid-up shares and common stock), which is a common feature in all countries' banking systems, and total regulatory capital, which includes several specified types of subordinated debt instruments that need not be repaid if the funds are required to maintain minimum capital levels (these comprise tier 2 and tier 3 capital). Total assets include all nonfinancial and financial assets.

Carbon dioxide emissions per capita (tonnes, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/27706.

Human-originated carbon dioxide emissions stemming from the burning of fossil fuels, gas flaring and the production of cement, divided by mid-year population. Includes carbon dioxide emitted by forest biomass through depletion of forest areas.

Consumer price index (World Bank, Development Research Group, 2015).

https://www.indexmundi.com/facts/indicators/FP.CPI.TOTL/compare?country=zm.

Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. Data are period averages.

Corruption perception index (Transparency International 2014).

https://www.transparency.org/cpi2014.

It measures the perceived levels of public sector corruption in countries.

Crime index (Federal Bureau of Investigation, USA, 2014).

https://www.numbeo.com/crime/rankings_by_country.jsp?title=2014.

The Crime Index is an annual study of crime rates and occurrences; it is an estimation of overall level of crime in a given city or a country.

Energy imports, net (% of energy use, International Energy Agency, 2014).

https://www.indexmundi.com/facts/indicators/EG.IMP.CONS.ZS.

Net energy imports are estimated as energy use less production, both measured in oil equivalents. A negative value indicates that the country is a net exporter. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

Export of goods and services (% of GDP, International Monetary Fund, 2014).

https://www.indexmundi.com/facts/indicators/NE.EXP.GNFS.ZS.

The sum of exports and imports of goods and services, expressed as a percentage of gross domestic product (GDP). It is a basic indicator of openness to foreign trade and economic integration and indicates the dependence of domestic producers on foreign demand (exports) and of domestic consumers and producers on foreign supply (imports), relative to the country's economic size (GDP).

Foreign direct investment, net inflows (% of GDP, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/53506.

Sum of equity capital, reinvestment of earnings, other long-term capital and short-term capital, expressed as a percentage of GDP.

Forest area (% of total area, United Nations Development Program 2014).

https://www.indexmundi.com/facts/indicators/AG.LND.FRST.ZS.

Land spanning more than 0.5 hectare with trees taller than 5 m and a canopy cover of more than 10% or trees able to reach these thresholds in situ. Excludes land predominantly under agricultural or urban land use, tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10% and a tree height of 5 m are included, as are temporarily unstacked areas resulting from human intervention or natural causes that are expected to regenerate.

GDP growth (annual%, World Bank, 2015).

https://www.indexmundi.com/facts/indicators/NY.GDP.MKTP.KD.ZG.

The GDP growth rate measures how fast the economy is growing. It does this by comparing one quarter of the country's GDP to the previous quarter.

Gender inequality index (United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/68606.

A composite measure reflecting inequality in achievement between women and men in three dimensions: reproductive health, empowerment and the labour market.

GNI gross national income [GNI $ pc—(United Nations Development Program 2014)].

http://hdr.undp.org/en/indicators/141706.

Aggregate income of an economy generated by its production and its ownership of factors of production, less the incomes paid for the use of factors of production owned by the rest of the world, converted to international dollars using PPP rates, divided by midyear population.

GINI Index (World Bank, Development Research Group 2015).

https://www.indexmundi.com/facts/indicators/SI.POV.GINI.

GINI index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The GINI index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a GINI index of 0 represents perfect equality, while an index of 100 implies perfect inequality.

Gross domestic product per capita (United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/136706

Sum of gross value added by all resident producers in the economy plus any product taxes, minus any subsidies not included in the value of the products, expressed in

international dollars using purchasing power parity rates and divided by total population of the same period.

Gross savings (% pf GDP, World Bank 2014).

https://www.indexmundi.com/facts/indicators/NY.GNS.ICTR.ZS.

Gross savings are calculated as gross national income less total consumption, plus net transfers.

Happiness Index (World Happiness Report, 2015).

http://worldhappiness.report/wp-content/uploads/sites/2/2015/04/WHR15.pdf.

The six factors composing this index are GDP per capita, healthy years of life expectancy, social support (as measured by having someone to count on in times of trouble), trust (as measured by a perceived absence of corruption in government and business), perceived freedom to make life decisions, and generosity (as measured by recent donations, adjusted for differences in income).

Inclusive Wealth Index (UNU-IHDP and UNEP, Inclusive Wealth Report 2014, Measuring progress toward sustainability 2015).

http://mgiep.unesco.org/wp-content/uploads/2014/12/IWR2014.pdf.

It measures the wealth of nations by carrying out a comprehensive analysis of a country's productive base: it measures all of the assets from which human well-being is derived, including manufactured, human and natural capital. In this, it measures a nation's capacity to create and maintain human well-being over time.

Improved water source [% of population with access, WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation, 2014].

https://data.worldbank.org/indicator/SH.H2O.SAFE.ZS.

Access to improved sanitation facilities refers to the percentage of the population using improved sanitation facilities. Improved sanitation facilities are likely to ensure hygienic separation of human excreta from human contact. They include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

Inequality-adjusted Human Development Index (IHDI, United Nations Development Programme 2014).

http://hdr.undp.org/en/indicators/138806.

The IHDI combines a country's average achievements in health, education and income with how those achievements are distributed among country's population by "discounting" each dimension's average value according to its level of inequality. Thus, the IHDI is distribution-sensitive average level of human development. Dimensions of human development:

1. Long and healthy life (life expectancy at birth, life expectancy and inequality-adjusted life expectancy index)
2. Knowledge (mean years of schooling/educated years of schooling, years of schooling and inequality-adjusted education index)
3. A decent standard of living [GNI, PPP ($), income/consumption and inequality-adjusted income index]

Infant mortality rate (in 1000, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/57206.

Probability of dying between birth and exactly age 1, expressed per 1000 live births.

Inflation rate (%, International Monetary Fund, 2015).

https://www.indexmundi.com/facts/indicators/FP.CPI.TOTL.ZG.

Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly.

Industrial growth (annual %, World Bank, 2015).

https://data.worldbank.org/indicator/NV.IND.TOTL.KD.ZG.

The Industrial growth rate measures how fast the industry is growing. It does this by comparing one quarter of the country's industrial performance to the previous quarter.

Internet users (% of population, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/43606.

People with access to the worldwide network.

Old age pension recipients (% of statutory pension age population, European system of integrated social protection statistics, 2014).

http://hdr.undp.org/en/indicators/123806.

Periodic payments intended to: (1) maintain the income of the beneficiary after retirement from paid employment at the legal or standard age; or (2) support the income of elderly persons (excluding where payments are made for a limited period only).

Primary energy supply, fossil fuels (% of total, International Energy Agency, 2014).

https://www.iea.org/countries/.

Total primary energy supply (TPES) is a term used to indicate the sum of production and imports subtracting exports and storage changes of fossil fuels.

Private capital flows (% of GDP, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/53506.

Net foreign direct investment and portfolio investment, expressed as a percentage of GDP.

Public debt (% pf GDP, International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates, 2014).

https://data.worldbank.org/indicator/GC.DOD.TOTL.GD.ZS?view=chart.

The total of all bonds and other debt owed by a government. Most of the time, the national debt comes from bonds. The public debt is defined as how much a country owes to lenders outside of itself. These can include individuals, businesses and even other governments.

Public expenditure on education (% of GDP, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/149206.

Current, capital and transfer spending on education, expressed as a percentage of GDP.

Public health expenditure (% of GDP, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/53906

Current and capital spending on health from government (central and local) budgets, external borrowing and grants (including donations from international agencies and non-governmental organizations) and social (or compulsory) health insurance funds, expressed as a percentage of GDP.

Remittances, inflows (% of GDP, United Nations Development Programme 2014).

http://hdr.undp.org/en/indicators/52606.

Earnings and material resources transferred by international migrants or refugees to recipients in their country of origin or countries in which the migrant formerly resided.

Social Progress Index (SPI, Social Progress Imperative (Porter et al. 2016).

http://13i8vn49fibl3go3i12f59gh.wpengine.netdna-cdn.com/wp-content/uploads/2016/06/SPI-2016-Main-Report.pdf.

The SPI measures the well-being of a society by observing social and environmental outcomes directly rather than the economic factors:

- Basic human needs: nutrition and basic human care, water and sanitation, shelter and personal safety
- Foundations of well-being: access to basic knowledge, health and wellness and environmental quality.
- Opportunity: personal rights, personal freedom and choice, tolerance and inclusion and access to advanced education.

Fifty-four indicators in the areas of basic human needs, foundations of well-being and opportunity to progress show the relative performance of nations.

Total natural resources rents (% of GDP, The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium, World Bank 2011).

https://www.indexmundi.com/facts/indicators/NY.GDP.TOTL.RT.ZS.

Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents and forest rents.

Total unemployment (% of labour force—United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/140606.

Percentage of the labour force population ages 15 and older that is not in paid employment or self-employed but is available for work and has taken steps to seek paid employment or self-employment.

Terrestrial and marine protected areas (% of total territorial area, United Nations Environmental Program and the World Conservation Monitoring Centre, 2013) https://www.indexmundi.com/facts/indicators/ER.PTD.TOTL.ZS.

Terrestrial protected areas are totally or partially protected areas of at least 1000 hectares that are designated by national authorities as scientific reserves with limited public access, national parks, natural monuments, nature reserves or wildlife sanctuaries, protected landscapes, and areas managed mainly for sustainable use. Marine protected areas are areas of intertidal or subtidal terrain—and overlying water and associated flora and fauna and historical and cultural features—that have been reserved by law or other effective means to protect part or all of the enclosed environment. Sites protected under local or provincial law are excluded.

Vulnerable employment (% of employed people engaged as unpaid family workers and own-account workers, United Nations Development Program 2014).

http://hdr.undp.org/en/indicators/43006.

Percentage of employed people engaged as unpaid family workers and own-account workers.

Water dependency (%, UN Food and Agricultural Organization, 2014).

http://chartsbin.com/view/1471.

Dependency ratio expresses the part of the total renewable water resources originating outside the country. This indicator may theoretically vary between 0% (the country does not receive water from neighbouring countries) and 100% (country receives all its water from outside without producing any).

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