

[Open Peer Review on Qeios](#)

The State of the ‘Planet’ Pillar by 2022 — A Partial Ordering-Based Analysis of the Sustainable Development Goals 6, 12, 13, 14, and 15

Lars Carlsen

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.

Abstract

The 2022 Sustainable Development Report provides the data for the so-called Planet pillar, i.e., the Sustainable Development Goals (SDGs) 6, 12, 13, 14, and 15 that are studied to elucidate the state of simultaneous compliance with these five goals as well as the trends in development for the 193 countries included in the report. To the extent that data for all five SDGs were available partial ordering methodology was applied as the analytical tool to rank the countries according to their compliance as well as their trend toward compliance based on the 2022 data. The analytical approach allows simultaneously taking data for all five SDGs into account to get an overall picture of the “planet” midway through the 15 years of the 17 UN SDGs. From the analyses, it became clear that high-income countries, despite their economic capacity are lagging both about the actual state and especially about the trend of development toward eventual compliance with the goals. The analyses further pinpointed that SDG 6 – clean water and sanitation – appeared as the most important indicator for the ranking of countries or regions. Building on the author’s previous research on the topic, this study points to the necessity for high-income countries to focus on the eventual compliance with the goal, both for themselves as well as for supporting countries with less economic capacities.

Lars Carlsen

Awareness Center

Linkøpingvej 35, Trekroner, DK-4000 Roskilde, Denmark

Email: LC@Awarenesscenter.dk

Keywords: Sustainable development goals, Planet, State, Trends, Partial ordering methodology.

1. Introduction

Under Danish chairmanship, the United Nations General Assembly in September 2015 unanimously adopted the 17

Sustainable Development Goals (SDGs). The SDGs – or the so-called global goals – went into force by January 1st, 2016. By the end of 2022, a mid-point in the estimated 15 years lifespan of the goals is approached. Thus, an obvious question arises: how are we doing? Or, in other words, what is the status of the goals, and what is the trend in reaching the goals by 2030?

The seventeen goals constitute the ‘compass directions’ for countries, regions, districts, companies, organizations, and single persons. With their 169 sub-goals and 231 unique indicators, they are virtually focusing on every aspect of the global society and constitute and point directions to secure the progress, prosperity, and eventually the survival of the planet. It is, however, important to stress that it is goals for development. Thus, compliance with the goals does not assure a sustainable world but only indicates that it is not getting worse. This is reflected in the Earth Overshoot Day, the day when the yearly consumption of resources has passed the limit where the planet may regenerate them (EOD, 2023). The day has for the last 10-15 years leveled out around August 1st.

The SDGs focus on three dimensions, i.e., the social, the economic, and the environmental (Future Learn, 2021). The interplay between these three pillars has been discussed by Clune and Zehnder (2018). Alternatively, the seventeen goals may be grouped into five so-called pillars (SEG, 2021; Whatcanyou do, 2021) (Table 1) each focusing on key areas of our society (Table 1). These pillars are intricately linked to the mentioned three dimensions. It should be noted that the last two goals - peace and partnership, respectively - constitute separate groups as they are of utmost importance for all other goals. However, it should be emphasized that there is a close interplay between the SDGs across the single pillars constituting a complex system (Tremblay et al. 2020). As an example, the unambiguous interplay between climate change and the economy is obvious and has in detail been discussed by Postu et al (2023) and Hysa et al. (2020).

Table 1. The 5 P's of the SDGs (SEG, 2021; Whatcanyou do, 2021)

Pillar	Description	SDGs
People	End poverty in all forms and ensure dignity and equality	1, 2, 3, 4, 5
Planet	Protect our planet's natural resources and climate for future generations	6, 12, 13, 14, 15
Prosperity	Ensure prosperous and fulfilling lives in harmony with nature	7, 8, 9, 10, 11
Peace	Foster a peaceful, just, and inclusive society	16
Partnership	Implement the agenda through a solid global partnership	17

For the general population, the SDGs constituting pillar Planet constitute the more important goals where especially goal no. 13, climate action, received significant attention. The present study has its focuses on the five goals that constitute the pillar planet, i.e., SDG 6 (Clean water and sanitation) SDG 12 (Responsible consumption and production), SDG 13 (Climate action), SDG 14 (Life below water), and SDG 15 (Life on land). SDG 12 has previously as a single goal been studied (Carlsen, 2021). Based on the data for 193 countries (cf. Supplementary Table A) available through the 2022 version of the “Sustainable Development Report” (Sachs et al., 2022) the present study elucidates the actual state of the five SDGs of the pillar planet as well as the development trends for the individual countries as well as for the 12 groups of

countries (cf. Table 2) (Sachs et al., 2022).

The development towards compliance with the single SDGs has annually been reported and thoroughly discussed by Sachs et al (2022). However, these annual reports have dealt with the development of the single SDGs, whereas a closer look at the development within the single countries based on the groups of SDGs in the above-mentioned five pillars has not previously been reported, which is remedied by the present study.

The pillars ‘people’ and ‘prosperity’ have been analyzed and discussed in two parallel papers (Carlsen, 2023a,b). The relative importance of the three pillars, people, prosperity, and planet, has recently been reported by Carlsen (2024).

Table 2. Grouping of countries		
East and South Asia	E_S_Asia	focus-economics.com/ESA_Sample_Report
Eastern Europe and Central Asia	E_Euro_Asia	ilo.org/moscow/countries/lang--en/index.htm
Latin America and the Caribbean	LAC	worldometers.info/geography/how-many-countries-in-latin-america/
Middle East and North Africa	MENA	en.wikipedia.org/wiki/MENA
Oceania	Oceania	worldometers.info/geography/how-many-countries-in-oceania/
OECD members	OECD	oecd.org/about/
Small Island Developing States	SIDS	un.org/ohrlls/content/list-sids
Sub-Saharan Africa	Africa	
Low-income Countries	LIC	g2lm-lic.iza.org/call-phase-iv/list-of-lic/
Lower-middle-income Countries	LMIC	worldpopulationreview.com/country-rankings/middle-income-countries
Upper-middle-income Countries	UMIC	worldpopulationreview.com/country-rankings/middle-income-countries
High-income Countries	HIC	worlddeconomics.com/Regions/High-Income-Countries/

The basic ranking of the countries and groups of countries has been performed by applying partial ordering methodology, a methodology that allows simultaneously taking into account several indicators (here the five SDGs in pillar planet) without any pretreatment like, e.g., aggregation, thus, avoiding possible compensation effects, i.e., that a high value for one indicator will be compensated to a low value in another indicator and consequently blur the results. The paper can be seen as an update to our conference contrition from 2021 (Carlsen and Bruggeman, 2022).

2. Method

2.1. Data

The data material from the Sustainable Development Report (Sachs et al., 2022) is color coded as green, yellow, orange, red, and grey which signalizes ‘Goal Achievement’, ‘Challenges remain’, ‘Significant challenges’, ‘Major challenges’, and ‘Insufficient data’, respectively. The trends are visualized by arrows. Thus ↑, ↗, →, and ↓ that refers to ‘On track or

maintaining achievement', 'Moderately Increasing', 'Stagnating', and 'Decreasing', respectively.

As input for the partial order analyses the color/arrow coding for both states as well as for trends was transferred into numbers: green = 3, yellow = 2, orange = 1, red = 0, and grey = -1, respectively. Likewise, the arrow codes were transferred into $\uparrow = 3$, $\nearrow = 2$, $\rightarrow = 1$, and $\downarrow = 0$, respectively.

In the case of states two sets of calculations were performed, i.e., 1: excluding countries/groups where data were not available and 2: including all countries/groups associating the lack of data by the value -1. In the case of trends, countries/groups with no data available were excluded from the study. The latest available data, i.e., 2022 were used for the study (Sachs et al. 2022).

2.2. Partial ordering methodology

Partial ordering is a relation among the objects to be ordered. In mathematical terms, the only relation is " \leq " (Bruggemann and Patil, 2011; Carlsen, 2088; Carlsen and Bruggemann, 2018; Bruggemann and Carlsen, 2006). The " \leq " relation is the basis for a comparison of objects and constitutes a graph, the so-called Hasse diagram (see below).

Two objects x and y , both being characterized by a series of indicators $r_j(x)$, $j = 1, \dots, m$ and $r_j(y)$, $j = 1, \dots, m$ are connected if and only if the relation " $x \leq y$ " holds.

$$r_l(x) \leq r_l(y) \text{ for all } l = 1, \dots, m$$

Objects that fulfill eq. 1 are denoted as comparable, in contrast to those pairs of objects that do not fulfill the equation. These are denoted incomparable. It should be remembered that eq. 1 sets a strict requirement for comparisons as at least one indicator value of object x must be lower (the remaining lower or at least equal) to those of object y .

The partially ordered set may be visualized by a Hasse diagram. Comparable elements (vide supra) are connected by lines in so-called chains, whereas elements that do not fulfill eqn. 1 are denoted incomparable and constitute so-called antichains.

The module mHDCI7_1 of the PyHasse software (vide infra) was used for the basic partial ordering calculations and the associated construction of the Hasse diagrams.

So-called peculiar objects, i.e., objects with surprisingly high or low indicator values for one or more indicators are calculated as described in detail by Bruggemann and Carlsen (2014).

The peculiar elements were calculated by applying the incomposet9_3 (Bruggemann and Carlsen, 2014) of the PyHasse software (vide infra).

2.2.1. Sensitivity—indicator importance

The relative importance of the single indicators in play can be determined through a sensitivity analysis (Bruggemann, Halfon, and Welzl, et al., 2001). These analyses focus on the disclosure of which indicator has the biggest effect on the

Hasse diagram, i.e., the ordering. The influence of the single indicators is disclosed by calculating the distance between the original Hasse diagram and the Hasse diagrams derived from datasets where the single indicators one by one have been eliminated. The indicator whose elimination leads to the highest distance has the largest influence on the ranking.

The sensitivity values were calculated by the sensitivity24_5 module (Bruggemann and Patil, 2011) of the PyHasse software (vide infra).

2.2.2. Average ranking

In the Hasse diagram, the level structure provides a first approximation to order. However, as all elements at the same level will be assigned equal rank the ranking is rather 'crude.' Due to the presence of incomparabilities, partial ordering does not lead to a strict linear ordering as a priori a multitude of linear orders can be derived from the partially ordered dataset. However, partial order methodology provides methods to calculate an average order of the single objects, which is based on the probabilities for the single elements to have a specific order, e.g., described by Bruggemann and Carlsen (2011) and Bruggemann and Annoni (2014).

The average rankings were calculated by applying the LPOMext9_1 (Bruggemann and Carlsen, 2011) of the PyHasse software (vide infra).

2.2.3. Software

All partial order analyses were conducted using the PyHasse software (Bruggemann et al., 2014). PyHasse is programmed using the interpreter language Python (version 2.6), and the software package contains around 140 more or less specialized modules. Selected modules are available from the author.

3. Results and Discussion

Scrutinizing the color coding for the single countries and regions displaying the actual state of the five SDGs (cf. Sachs et al., 2022) it is immediately clear that a substantial number of non-green colors dominate the scheme. Hence, the orange, red, and grey-colored countries constitute approx. 72 % of the total 965 entries (5 x 193) and the green- and yellow-colored countries constitute only approximately 13 and 15 %, respectively. The actual distribution for the five SDGs is shown in Table 3 giving an overall picture of to what extent the 193 countries included in the data material (Sachs et al., 2022) comply with the five SDGs of the pillar people.

Table 3. Compliance with the SDGs 6, 12, 13, 14, and 15 for the 193 countries (cf. Supplementary Table C)

	"green"	"yellow"	"orange"	"red"	"grey"
SDG 6 - Clean water and sanitation	2	27	80	83	1
SDG 12 - Responsible consumption and production	54	44	38	37	20
SDG 13 - Climate action	64	52	20	49	8
SDG 14 - Life below water	0	9	35	107	42
SDG 15 - Life on land	4	12	47	123	7

The partial ordering of the single countries has been conducted by 1: excluding all countries for which data are missing for one or more of the five SDGs, which leaves 130 countries, and 2: for all 193 countries. Hence, the analyses apply multi-indicator systems (MIS) with values only 0, 1, 2, and 3 and -1, 0, 1, 2, and 3, respectively.

3.1. Ranking of individual countries

The MIS where countries with missing data for one or more of the five SDGs are excluded leaves 130 countries with a complete set of data (Supplementary Table B). The Hasse diagram based on this MIS is shown in Fig. 1. It should be noted that the diagram displays only representatives for the single countries as several countries have identical indicator profiles and thus will appear in identical locations in the diagram. This leaves a simplified diagram. In Table 4 the equivalent, i.e., having identical indicator profiles countries are listed.

It should be noted that a broad Hasse diagram is obtained because the diagram has 1561 incomparisons and only 650 comparisons. The diagram has nine levels 9 levels.

Table 4. Equivalent countries due to identical indicator profiles. The first country in each group is the one displayed in the diagram (Fig. 1)



AGO, CMR, MOZ,
ALB, SLV,
ARE, ISR, KWT, SGP,
ARG, GUY,
AUS, USA,
BEL, CYP, SVN,
BEN, GIN, GMB, PNG,
BGD, ERI, GTM, HTI, IND, KEN, KHM, MDG, PAK, SEN, SLE, SOM, TZA, VUT, YEM,
BHR, BHS, BRN, SAU,
CAN, ESP,
CHN, EGY, IDN, IRQ, JAM, PER, TUN, UKR, VEN, VNM,
CIV, GHA, NGA,
CUB, FJI,
DJI, MMR,
ECU, JOR,
GAB, NIC,
GRC, NLD,
HND, MAR, PRK,
ISL, NOR,
JPN, SWE,
KOR, RUS,
LBN, ZAF,
LBY, OMN,
LKA, MRT, SDN,
LTU, LVA,
MNE, MUS, URY,
MYS, PAN, THA,
NZL, TUR,
STP, TGO,

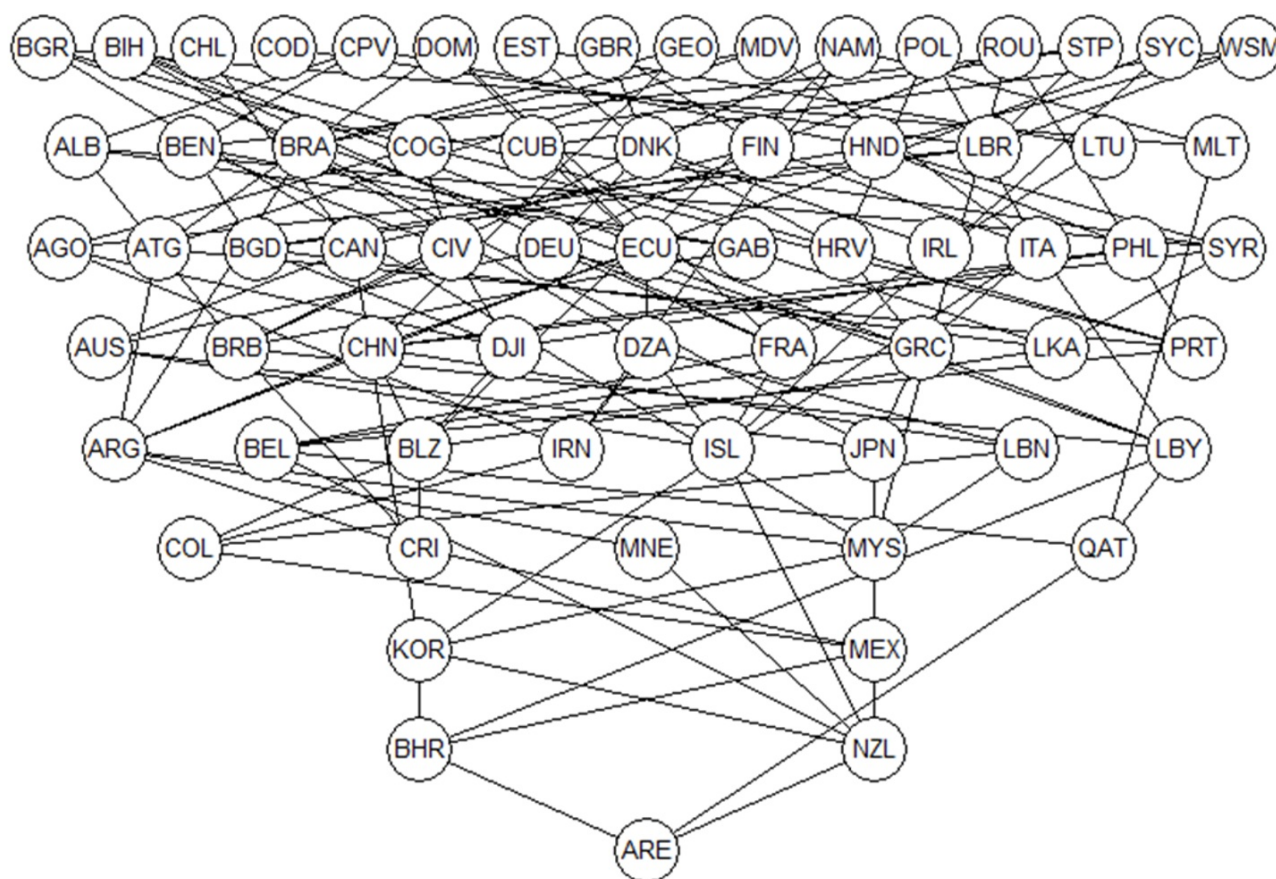


Figure 1. Hasse diagram displaying the partial ordering of the 130 countries where data for all countries for all 5 SDGs are available

A first simple ranking of the 130 countries is obtained simply by the level structure of the (Fig. 1). The diagram discloses that the top level, i.e., those 17 countries (note STP represents also TGO) that on an overall level best comply with the pillar planet SDGs, whereas the bottom level contains the countries ARE, ISR, KWT, and SGP represented by the United Arab Emirates (ARE). These four countries are characterized by being in “red figures” on all parameters (cf. Supplementary Table B).

Due to the high number of equivalences (cf. table 4), the Hasse diagram (Fig. 1) still gives only a rough picture of the mutual ranking of the 130 countries. A more informative picture was obtained through the calculation of the average ranks. In Table 5 the average ranking of the top twenty countries is given. The bottom rank is occupied by the four countries mentioned above the joint ranking was estimated to be 128.5 (127-130).

Table 5. The average rank of the top twenty countries

Country	Country code	Average ranking	Rank
Cabo Verde	CPV	65,312	1
Samoa	WSM	65,032	2
Dominican Republic	DOM	64,280	3
Sao Tome and Principe	STP	63,907	4.5
Togo	TGO	63,907	4.5
United Kingdom	GBR	63,879	6
Romania	ROU	63,541	7
Maldives	MDV	63,340	8
Estonia	EST	62,600	9
Bosnia and Herzegovina	BIH	61,884	10
Georgia	GEO	61,155	11
Albania	ALB	60,925	12.5
El Salvador	SLV	60,925	12.5
Congo, Dem. Rep.	COD	60,471	14
Cuba	CUB	59,885	15.5
Fiji	FJI	59,885	15.5
Poland	POL	59,596	17
Namibia	NAM	59,127	18
Bulgaria	BGR	58,775	19
Chile	CHL	56,980	20

It is noted that Seychelles (SYC), although located at the top level is not found among the top twenty countries (Table 5). SYC occupies an average rank of 25. The location in the top level is an artifact due to the construction rules of Hasse diagrams saying that objects (here countries) are always placed as high as possible and since SYC is a maximal element, i.e., not being covered by any other country, it will consequently be placed in the top level. The remaining 16 maximal countries located in the top level are all found among the top twenty countries together with four countries (two sets of equivalent countries: ALB/SLV, CUB/FJI) from the second highest level (level 8).

An obvious question is which of the five SDGs is dominant in the average ranking? The most important indicator turns out to be SDG 6 (Clean water and sanitation) with a relative importance of 39.6% followed by SDG 15 (Life on land) by 21.1 %. The SDGs 12, 13, and 14 have relative weights of 15.6, 13.5 and 10.2 %, respectively.

The importance of SDG 6 must be seen because by 2020 only 74 % of the world population had access to safely managed drinking water meaning that more than two billion people are living without access to clean water, 71% had access to handwashing facilities with water and soap and only 54% had safely managed sanitation (Sachs et al., 2022; UN, 2022). Further, the water stress, although below 20% on a global scale, is high > 75% in Southern and Central Asia and even over 100% in Northern Africa (Sachs et al., 2022; UN, 2022).

Considering all 193 countries do not make any significant changes in the top twenty countries. Only a few countries are changing positions and the equivalent HND and MAR enter at rank 19 and 20 at the expense of BGR and CHL.

Apart from the state of the single countries also data are available for the twelve regions (Table 2). In Table 6 the data for the regions are shown. From Table 6 it is clear that MENA and UMIC as well as Africa and LMIC appear as equivalent pairs. Referring to the above discussion about SDG 6, it is from Table 6 clear that Oceania, SIDS, Africa, LIC, and LMIC are all in “red” color for goal 6. Missing data are noted for Oceania (SDG 12) and E_Euro_Asia (SDG 14). However, none of the regions are all in “red”. The resulting Hasse diagram is shown in Fig. 2.

Table 6. MIS for the twelve regions excluding (green = 3, yellow = 2, orange = 1, red = 0, grey = -1)

ID	SDG6	SDG12	SDG13	SDG14	SDG15
E_S_Asia	1	3	2	0	0
E_Euro_Asia	1	2	1	-1	0
LAC	1	2	2	0	0
MENA	1	2	1	0	0
Oceania	0	-1	3	0	1
OECD	2	1	0	0	0
SIDS	0	2	2	0	0
Africa	0	3	2	0	0
LIC	0	3	3	0	0
LMIC	0	3	2	0	0
UMIC	1	2	1	0	0
HIC	1	1	0	0	0

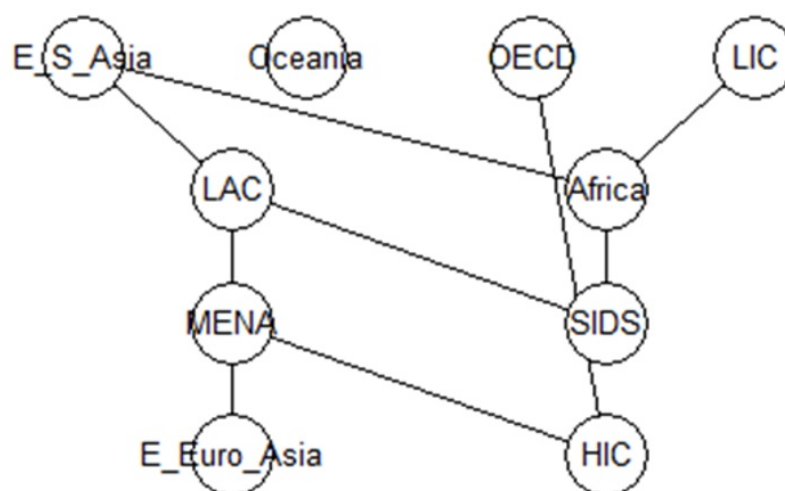


Figure 2. Hasse diagram displaying the partial ordering of the twelve regions (note: for equivalences see text)

The average ranking of the twelve regions is in the following order: E_S_Asia > LIC > LAC > OECD > MENA = UMIC > Oceania > Africa = LMIC > E_Euro_Asia > HIC > SIDS. The diagram shows that the high-income countries (HIC) are exceptionally low on the ranking, which unfortunately is not a major surprise despite these countries' potential economic capacities.

Here the picture displaying the importance of SDG 6 becomes even more clear (vide supra). Thus, the relative importance of the five SDGs is SDG 6 (61.5%), SDG 12 (17.3%), SDG 13 (13.5 %), SDG 14 (5.8%), and SDG 15 (1.9 %).

Looking for peculiar regions four specific regions appear with peculiar indicator patterns. Hence, Oceania was found to be unexpectedly low in SDGs 6 and 12, whereas SIDS, Africa, and LIC are all unexpectedly low in SDGs 6 and 15, respectively. These figures are obviously substantiated by the data given in Table 6. The issues about SDG 6 have been discussed above and about SDG15 the problem with land use and degradation appears as a major issue as close to 75 % of the poor are directly affected by the degradation (UN, 2016; World Bank, 2017; UNDP, 2020).

3.2. Trend analyses

Obviously, not only the state of the current compliance with the SDGs is of interest. Also, the trends, i.e., are the single countries or regions on the right track to living up to the goal by 2030? In analyzing the development trends in the planet pillar SDGs, countries with missing data are for obvious reasons excluded as trends simply could not be established. Hence, excluding countries with missing data for one or more of the remaining four SDGs leaves 127 countries and eleven regions (LIC is missing) for the trend analyses (Supplementary Table D).

The partial ordering of the 133 countries is illustrated by the Hasse diagram in Fig. 3. As above it should, by inspecting the diagram, be remembered that only representatives for equivalent countries are shown. The equivalences are shown in Table 7.

Table 7. Equivalent countries due to identical trend profiles. The first country in each group is the one displayed in the diagram (Fig. 3)

AGO, CIV, GIN, GMB, MDG, NIC, SLV,
VUT,
ALB, MAR,
ARE, ISR, KWT,
BEL, CYP, SYC,
BEN, HTI, KEN, LBR, PNG, SLE, TZA,
BGD, BLZ, GHA, NGA, WSM,
CHN, IDN, IRQ, VNM,
CMR, SOM, STP,
COL, FJI, GTM, HND, IND, MMR, MOZ,
CPV, CUB, KHM,
DEU, ITA,
ECU, JOR, PHL,
EGY, TUN,
FRA, NOR,
GAB, PRK,
LKA, PAK, PER, SEN, VEN,
MNE, ROU,
NAM, SDN,
OMN, ZAF,
SVN, SWE,
TGO, YEM,

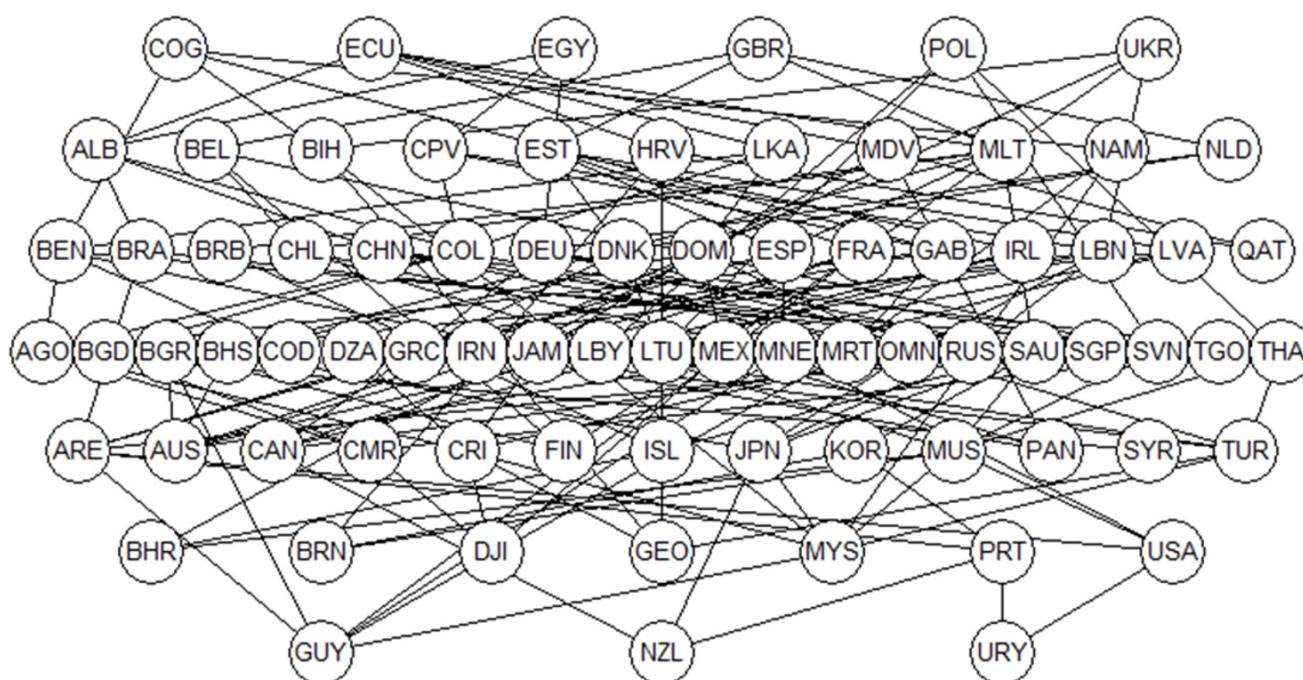


Figure 3. Hasse diagram displaying the partial ordering of the 127 countries where trend data for all countries for SDGs 6, 12, 13, 14, and 15 are available.

As above (Fig. 1) we here see a broad diagram with 2314 incomparisons and only 612 comparisons. The calculations of the average ranks disclosed the thirteen top countries are ECU = JOR = PHL > EGY = TUN > GBR > UKR > COG > (LKA, PAK, PER, SEN, VEN), whereas the bottom ranks are occupied by URY > NZL > GUY. URY and NZL are both HIC whereas Guyana (GUY) is one of the poorest countries in South America (Domonoske and Kellman, 2021) (belonging to LAC). It is noteworthy that among the thirteen top countries, only the United Kingdom (GBR) is recognized as a high-income country (HIC) whereas all thirteen are OECD members, which not necessarily is a designation of economic status. The interesting message here is that countries, i.e., the HICs, in principle should be the top candidates for improving sustainability through compliance with the SDGs are not willing to offer the necessary resources to be the front runners.

This is further clear from the ranking of the trends for the twelve regions, where we find OECD and HIC at the bottom of the list together with, not surprisingly LIC. The full ranking of the regions was found to be LMIC > E_S_Asia = MENA = UMIC > Africa > SIDS > LAC > OECD > HIC > LIC.

Both in the case of the individual countries as well as for the regions again we find SDG 6 (Clean water and sanitation) as the most important indicator for the rankings. In the case of the regions, however, of equal importance as SDG 13 (Climate action).

4. Future Outlook and Conclusions

The 17 United Nations Sustainable Development Goals were adopted in 1915 and are supposed, at least initially, to have a 'lifespan' of 15 years. Thus, by 2022 roughly the midway of this period has been reached and the present paper offers a closer look at how the single 193 countries and 12 regions are doing both with the respect to the actual state of as well as the trend toward eventual compliance with the goals. Hence, only 2, 54, 64, 0, and 4 countries comply with the SDGs 6, 12, 13, 14, and 15, respectively today, whereas 83, 37, 49, 107 and 123 countries are still in "red" figures, i.e., are facing a major challenge, for the same 5 SDGs, respectively.

A general picture for both the states as well as for the trends has developed, i.e., the high-income countries are found very low in the ranking, which becomes very clear from the ranking of the state of the regions, where E_S_Asia > LIC > LAC > OECD > MENA = UMIC > Oceania > Africa = LMIC > E_Euro_Asia > HIC > SIDS as well as the ranking of the trends for the regions, where LMIC > E_S_Asia = MENA = UMIC > Africa > SIDS > LAC > OECD > HIC > LIC. This puts high pressure on the HICs not only to focus on their situation but also to support, e.g., the LIC, as was clearly expressed at the recent COP 26.

An overall conclusion and outlook are that although several countries are on track most countries still have considerable challenges to eventually comply with the pillar planet, i.e., SDGs 6, 12, 13, 14, and 15 by the end of 2030. The study specifically points to the fact that a special focus should address SDG 6 – clean water and sanitation.

Unambiguously the present study has its limitations that are to be sought for in the data material. The data provided are

given for the single countries and as such being averages despite major differences across regions may prevail. This can be remedied only by significantly more fine-meshed data material.

As mentioned in the introduction the SDGs, as the name indicates, focus on development. As such it is obvious that the SDGs are only an – important – stepping-stone towards a sustainable planet and, roughly speaking ‘dragging out the pain’ as complying with the SDGs will not as such save the planet. Hence, when reaching 2030 it can be hoped that the development, in the broad sense, has reached a point where it will be sustainable. The next step will be to set up goals towards a sustainable planet.

It is worthwhile to finalize with a couple of quotes from a recent update of the Sustainable Development Report (Sachs et al., 2023) stating that **“At the midpoint of the 2030 Agenda, all of the SDGs are seriously off track”** and **“only limited progress is being made on the environmental and biodiversity goals, including SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land), even in countries that are largely to blame for the climate and biodiversity crises”**.

Supplementary Material

Supplementary Table A. ISO3 country code for the included countries			
Country Code ISO3	Country	Country Code ISO3	Country
AFG	Afghanistan	LBR	Liberia
AGO	Angola	LBY	Libya
ALB	Albania	LCA	St. Lucia
AND	Andorra	LIE	Liechtenstein
ARE	United Arab Emirates	LKA	Sri Lanka
ARG	Argentina	LSO	Lesotho
ARM	Armenia	LTU	Lithuania
ATG	Antigua and Barbuda	LUX	Luxembourg
AUS	Australia	LVA	Latvia
AUT	Austria	MAR	Morocco
AZE	Azerbaijan	MCO	Monaco
BDI	Burundi	MDA	Moldova
BEL	Belgium	MDG	Madagascar
BEN	Benin	MDV	Maldives
BFA	Burkina Faso	MEX	Mexico
BGD	Bangladesh	MHL	Marshall Islands
BGR	Bulgaria	MKD	North Macedonia
BHR	Bahrain	MLI	Mali
BHS	Bahamas, The	MLT	Malta
BOS	Bosnia and Herzegovina	MMR	Myanmar

BIH	Herzegovina	MMR	Myanmar
BLR	Belarus	MNE	Montenegro
BLZ	Belize	MNG	Mongolia
BOL	Bolivia	MOZ	Mozambique
BRA	Brazil	MRT	Mauritania
BRB	Barbados	MUS	Mauritius
BRN	Brunei Darussalam	MWI	Malawi
BTN	Bhutan	MYS	Malaysia
BWA	Botswana	NAM	Namibia
CAF	Central African Republic	NER	Niger
CAN	Canada	NGA	Nigeria
CHE	Switzerland	NIC	Nicaragua
CHL	Chile	NLD	Netherlands
CHN	China	NOR	Norway
CIV	Cote d'Ivoire	NPL	Nepal
CMR	Cameroon	NRU	Nauru
COD	Congo, Dem. Rep.	NZL	New Zealand
COG	Congo, Rep.	OMN	Oman
COL	Colombia	PAK	Pakistan
COM	Comoros	PAN	Panama
CPV	Cabo Verde	PER	Peru
CRI	Costa Rica	PHL	Philippines
CUB	Cuba	PLW	Palau
CYP	Cyprus	PNG	Papua New Guinea
CZE	Czech Republic	POL	Poland
DEU	Germany	PRK	Korea, Dem. Rep.
DJI	Djibouti	PRT	Portugal
DMA	Dominica	PRY	Paraguay
DNK	Denmark	QAT	Qatar
DOM	Dominican Republic	ROU	Romania
DZA	Algeria	RUS	Russian Federation
ECU	Ecuador	RWA	Rwanda
EGY	Egypt, Arab Rep.	SAU	Saudi Arabia
ERI	Eritrea	SDN	Sudan
ESP	Spain	SEN	Senegal
EST	Estonia	SGP	Singapore
ETH	Ethiopia	SLB	Solomon Islands
FIN	Finland	SLE	Sierra Leone
FJI	Fiji	SLV	El Salvador
FRA	France	SMR	San Marino
FSM	Micronesia, Fed. Sts.	SOM	Somalia

GAB	Gabon	SRB	Serbia
GBR	United Kingdom	SSD	South Sudan
GEO	Georgia	STP	Sao Tome and Principe
GHA	Ghana	SUR	Suriname
GIN	Guinea	SVK	Slovak Republic
GMB	Gambia, The	SVN	Slovenia
GNB	Guinea-Bissau	SWE	Sweden
GNQ	Equatorial Guinea	SWZ	Eswatini
GRC	Greece	SYC	Seychelles
GRD	Grenada	SYR	Syrian Arab Republic
GTM	Guatemala	TCD	Chad
GUY	Guyana	TGO	Togo
HND	Honduras	THA	Thailand
HRV	Croatia	TJK	Tajikistan
HTI	Haiti	TKM	Turkmenistan
HUN	Hungary	TLS	Timor-Leste
IDN	Indonesia	TON	Tonga
IND	India	TTO	Trinidad and Tobago
IRL	Ireland	TUN	Tunisia
IRN	Iran, Islamic Rep.	TUR	Turkey
IRQ	Iraq	TUV	Tuvalu
ISL	Iceland	TZA	Tanzania
ISR	Israel	UGA	Uganda
ITA	Italy	UKR	Ukraine
JAM	Jamaica	URY	Uruguay
JOR	Jordan	USA	United States
JPN	Japan	UZB	Uzbekistan
KAZ	Kazakhstan	VCT	St. Vincent and the Grenadines
KEN	Kenya	VEN	Venezuela, RB
KGZ	Kyrgyz Republic	VNM	Vietnam
KHM	Cambodia	VUT	Vanuatu
KIR	Kiribati	WSM	Samoa
KNA	St. Kitts and Nevis	YEM	Yemen, Rep.
KOR	Korea, Rep.	ZAF	South Africa
KWT	Kuwait	ZMB	Zambia
LAO	Lao PDR	ZWE	Zimbabwe
LBN	Lebanon		

Supplementary Table B. MIS for countries
excluding countries with missing data (green =
3, yellow = 2, orange = 1, red = 0)

ID	SDG6	SDG12	SDG13	SDG14	SDG15
AGO	0	3	2	1	0
ALB	1	2	3	0	1
ARE	0	0	0	0	0
ARG	1	1	2	0	0
ATG	1	1	2	0	1
AUS	2	0	0	1	0
BEL	1	0	0	0	1
BEN	0	3	3	0	1
BGD	0	3	3	0	0
BGR	1	1	1	0	2
BHR	0	1	0	0	0
BHS	0	1	0	0	0
BIH	1	2	1	2	1
BLZ	0	2	2	0	0
BRA	2	1	2	0	0
BRB	0	1	2	0	1
BRN	0	1	0	0	0
CAN	2	1	0	1	0
CHL	2	1	0	2	0
CHN	1	2	2	0	0
CIV	0	3	2	0	1
CMR	0	3	2	1	0
COD	0	3	3	2	0
COG	0	3	2	1	1
COL	0	2	1	0	0
CPV	1	3	3	0	1
CRI	0	1	2	0	0
CUB	1	2	3	1	0
CYP	1	0	0	0	1
DEU	2	0	0	1	1
DJI	0	3	2	0	0
DNK	2	0	0	1	2
DOM	1	2	2	1	1
DZA	1	2	1	1	0
ECU	1	2	2	1	0
EGY	1	2	2	0	0
ERI	0	3	3	0	0

Country	Q1	Q2	Q3	Q4	Q5
ESP	2	1	0	1	0
EST	2	0	0	1	3
FIN	2	1	0	1	1
FJI	1	2	3	1	0
FRA	1	0	0	1	1
GAB	0	2	3	0	1
GBR	2	1	0	1	2
GEO	2	2	2	0	0
GHA	0	3	2	0	1
GIN	0	3	3	0	1
GMB	0	3	3	0	1
GRC	2	0	0	0	1
GTM	0	3	3	0	0
GUY	1	1	2	0	0
HND	1	3	3	0	0
HRV	2	0	0	0	2
HTI	0	3	3	0	0
IDN	1	2	2	0	0
IND	0	3	3	0	0
IRL	1	0	0	1	2
IRN	0	2	1	1	0
IRQ	1	2	2	0	0
ISL	1	0	0	1	0
ISR	0	0	0	0	0
ITA	2	1	0	0	1
JAM	1	2	2	0	0
JOR	1	2	2	1	0
JPN	2	0	0	0	0
KEN	0	3	3	0	0
KHM	0	3	3	0	0
KOR	1	1	0	0	0
KWT	0	0	0	0	0
LBN	1	2	1	0	0
LBR	0	3	3	1	0
LBY	0	1	0	0	1
LKA	0	2	3	0	0
LTU	1	0	0	1	3
LVA	1	0	0	1	3
MAR	1	3	3	0	0
MDG	0	3	3	0	0
MDV	2	1	2	0	1

Country	1	2	3	4	5
MEX	0	1	1	0	0
MLT	0	0	1	0	2
MMR	0	3	2	0	0
MNE	1	0	2	0	0
MOZ	0	3	2	1	0
MRT	0	2	3	0	0
MUS	1	0	2	0	0
MYS	1	1	1	0	0
NAM	0	2	2	2	2
NGA	0	3	2	0	1
NIC	0	2	3	0	1
NLD	2	0	0	0	1
NOR	1	0	0	1	0
NZL	1	0	0	0	0
OMN	0	1	0	0	1
PAK	0	3	3	0	0
PAN	1	1	1	0	0
PER	1	2	2	0	0
PHL	1	3	2	0	0
PNG	0	3	3	0	1
POL	2	1	0	0	3
PRK	1	3	3	0	0
PRT	1	0	1	0	1
QAT	0	0	0	0	1
ROU	2	1	1	1	1
RUS	1	1	0	0	0
SAU	0	1	0	0	0
SDN	0	2	3	0	0
SEN	0	3	3	0	0
SGP	0	0	0	0	0
SLE	0	3	3	0	0
SLV	1	2	3	0	1
SOM	0	3	3	0	0
STP	0	3	3	1	1
SVN	1	0	0	0	1
SWE	2	0	0	0	0
SYC	1	1	2	2	0
SYR	1	2	3	0	0
TGO	0	3	3	1	1
THA	1	1	1	0	0
TUN	1	2	2	0	0

TUR	1	0	0	0	0
TZA	0	3	3	0	0
UKR	1	2	2	0	0
URY	1	0	2	0	0
USA	2	0	0	1	0
VEN	1	2	2	0	0
VNM	1	2	2	0	0
VUT	0	3	3	0	0
WSM	1	3	3	1	0
YEM	0	3	3	0	0
ZAF	1	2	1	0	0

Supplementary Table C. MIS for all countries

including countries with missing data (green = 3, yellow = 2, orange = 1, red = 0, grey = -1)

ID	SDG6	SDG12	SDG13	SDG14	SDG15
AFG	0	3	3	-1	0
AGO	0	3	2	1	0
ALB	1	2	3	0	1
AND	3	0	2	-1	1
ARE	0	0	0	0	0
ARG	1	1	2	0	0
ARM	1	2	2	-1	0
ATG	1	1	2	0	1
AUS	2	0	0	1	0
AUT	2	0	0	-1	1
AZE	1	2	1	-1	0
BDI	0	3	3	-1	1
BEL	1	0	0	0	1
BEN	0	3	3	0	1
BFA	0	3	3	-1	1
BGD	0	3	3	0	0
BGR	1	1	1	0	2
BHR	0	1	0	0	0
BHS	0	1	0	0	0
BIH	1	2	1	2	1
BLR	1	1	0	-1	0
BLZ	0	2	2	0	0
BOL	0	2	2	-1	0
BRA	2	1	2	0	0

BRB	0	1	2	0	1
BRN	0	1	0	0	0
BTN	1	3	2	-1	0
BWA	1	2	1	-1	0
CAF	0	2	3	-1	2
CAN	2	1	0	1	0
CHE	1	0	1	-1	0
CHL	2	1	0	2	0
CHN	1	2	2	0	0
CIV	0	3	2	0	1
CMR	0	3	2	1	0
COD	0	3	3	2	0
COG	0	3	2	1	1
COL	0	2	1	0	0
COM	0	-1	3	0	0
CPV	1	3	3	0	1
CRI	0	1	2	0	0
CUB	1	2	3	1	0
CYP	1	0	0	0	1
CZE	2	0	0	-1	2
DEU	2	0	0	1	1
DJI	0	3	2	0	0
DMA	1	-1	3	0	0
DNK	2	0	0	1	2
DOM	1	2	2	1	1
DZA	1	2	1	1	0
ECU	1	2	2	1	0
EGY	1	2	2	0	0
ERI	0	3	3	0	0
ESP	2	1	0	1	0
EST	2	0	0	1	3
ETH	0	3	3	-1	0
FIN	2	1	0	1	1
FJI	1	2	3	1	0
FRA	1	0	0	1	1
FSM	1	-1	3	0	0
GAB	0	2	3	0	1
GBR	2	1	0	1	2
GEO	2	2	2	0	0
GHA	0	3	2	0	1
GIN	0	3	3	0	1

GMB	0	3	3	0	1
GNB	0	-1	3	0	0
GNQ	0	-1	1	1	1
GRC	2	0	0	0	1
GRD	1	-1	2	0	0
GTM	0	3	3	0	0
GUY	1	1	2	0	0
HND	1	3	3	0	0
HRV	2	0	0	0	2
HTI	0	3	3	0	0
HUN	2	1	0	-1	2
IDN	1	2	2	0	0
IND	0	3	3	0	0
IRL	1	0	0	1	2
IRN	0	2	1	1	0
IRQ	1	2	2	0	0
ISL	1	0	0	1	0
ISR	0	0	0	0	0
ITA	2	1	0	0	1
JAM	1	2	2	0	0
JOR	1	2	2	1	0
JPN	2	0	0	0	0
KAZ	1	1	0	-1	0
KEN	0	3	3	0	0
KGZ	1	3	2	-1	0
KHM	0	3	3	0	0
KIR	0	-1	3	1	-1
KNA	1	-1	2	0	0
KOR	1	1	0	0	0
KWT	0	0	0	0	0
LAO	1	3	2	-1	0
LBN	1	2	1	0	0
LBR	0	3	3	1	0
LBY	0	1	0	0	1
LCA	1	-1	2	0	1
LIE	-1	-1	-1	-1	2
LKA	0	2	3	0	0
LSO	0	3	3	-1	1
LTU	1	0	0	1	3
LUX	1	0	0	-1	0
LVA	1	0	0	1	3

MAR	1	3	3	0	0
MCO	3	-1	-1	2	-1
MDA	1	1	2	-1	0
MDG	0	3	3	0	0
MDV	2	1	2	0	1
MEX	0	1	1	0	0
MHL	1	-1	-1	0	-1
MKD	1	1	2	-1	1
MLI	0	2	3	-1	0
MLT	0	0	1	0	2
MMR	0	3	2	0	0
MNE	1	0	2	0	0
MNG	0	0	0	-1	0
MOZ	0	3	2	1	0
MRT	0	2	3	0	0
MUS	1	0	2	0	0
MWI	0	3	3	-1	1
MYS	1	1	1	0	0
NAM	0	2	2	2	2
NER	0	3	3	-1	0
NGA	0	3	2	0	1
NIC	0	2	3	0	1
NLD	2	0	0	0	1
NOR	1	0	0	1	0
NPL	1	3	3	-1	0
NRU	0	-1	2	0	-1
NZL	1	0	0	0	0
OMN	0	1	0	0	1
PAK	0	3	3	0	0
PAN	1	1	1	0	0
PER	1	2	2	0	0
PHL	1	3	2	0	0
PLW	2	-1	-1	1	0
PNG	0	3	3	0	1
POL	2	1	0	0	3
PRK	1	3	3	0	0
PRT	1	0	1	0	1
PRY	1	1	3	-1	0
QAT	0	0	0	0	1
ROU	2	1	1	1	1
RUS	1	1	0	0	0

RWA	0	2	3	-1	0
SAU	0	1	0	0	0
SDN	0	2	3	0	0
SEN	0	3	3	0	0
SGP	0	0	0	0	0
SLB	0	-1	3	0	0
SLE	0	3	3	0	0
SLV	1	2	3	0	1
SMR	2	-1	-1	2	-1
SOM	0	3	3	0	0
SRB	1	1	1	-1	0
SSD	0	2	3	-1	0
STP	0	3	3	1	1
SUR	1	2	-1	2	0
SVK	2	1	0	-1	2
SVN	1	0	0	0	1
SWE	2	0	0	0	0
SWZ	0	2	2	-1	1
SYC	1	1	2	2	0
SYR	1	2	3	0	0
TCD	0	2	3	-1	1
TGO	0	3	3	1	1
THA	1	1	1	0	0
TJK	1	3	3	-1	0
TKM	0	2	1	-1	0
TLS	0	-1	-1	1	1
TON	1	-1	3	0	-1
TTO	1	1	-1	0	0
TUN	1	2	2	0	0
TUR	1	0	0	0	0
TUV	1	-1	3	2	-1
TZA	0	3	3	0	0
UGA	0	3	3	-1	0
UKR	1	2	2	0	0
URY	1	0	2	0	0
USA	2	0	0	1	0
UZB	0	3	2	-1	0
VCT	1	-1	3	0	0
VEN	1	2	2	0	0
VNM	1	2	2	0	0
VUT	0	3	3	0	0

WSM	1	3	3	1	0
YEM	0	3	3	0	0
ZAF	1	2	1	0	0
ZMB	0	3	3	-1	0
ZWE	0	3	2	-1	1

Supplementary Table D. Trend data (↑ = 3, ↗ = 2, → = 1, and ↓ = 0)

ID	SDG6	SDG12	SDG13	SDG14	SDG15
AGO	1	3	3	1	1
ALB	3	3	3	1	1
ARE	3	1	2	1	1
AUS	2	0	1	2	1
BEL	3	2	1	2	2
BEN	1	3	3	2	1
BGD	2	3	3	1	0
BGR	2	1	1	2	3
BHR	3	2	1	1	0
BHS	2	2	2	2	1
BIH	1	3	1	2	2
BLZ	2	3	3	1	0
BRA	3	1	3	1	1
BRB	3	2	2	2	0
BRN	3	2	0	0	1
CAN	2	0	2	1	2
CHL	3	2	1	2	1
CHN	3	3	2	1	1
CIV	1	3	3	1	1
CMR	1	3	3	1	0
COD	0	3	3	2	1
COG	1	3	3	2	2
COL	2	3	3	1	1
CPV	2	3	3	1	2
CRI	1	3	2	1	1
CUB	2	3	3	1	2
CYP	3	2	1	2	2
DEU	3	2	2	1	2
DJI	1	3	2	1	0
DNK	3	1	2	1	3
DOM	2	3	2	2	1

DZA	1	3	2	1	2
ECU	3	3	3	2	1
EGY	3	3	3	1	2
ESP	3	1	2	2	1
EST	3	1	2	2	3
FIN	2	1	0	2	2
FJI	2	3	3	1	1
FRA	2	1	2	2	2
GAB	1	3	3	1	2
GBR	3	2	2	2	3
GEO	1	3	0	1	1
GHA	2	3	3	1	0
GIN	1	3	3	1	1
GMB	1	3	3	1	1
GRC	3	1	2	1	2
GTM	2	3	3	1	1
GUY	1	1	1	1	1
HND	2	3	3	1	1
HRV	3	3	0	2	1
HTI	1	3	3	2	1
IDN	3	3	2	1	1
IND	2	3	3	1	1
IRL	2	0	2	2	3
IRN	2	3	1	2	1
IRQ	3	3	2	1	1
ISL	3	2	2	1	0
ISR	3	1	2	1	1
ITA	3	2	2	1	2
JAM	1	3	2	2	1
JOR	3	3	3	2	1
JPN	2	2	2	1	1
KEN	1	3	3	2	1
KHM	2	3	3	1	2
KOR	3	2	2	0	1
KWT	3	1	2	1	1
LBN	2	3	2	1	2
LBR	1	3	3	2	1
LBY	2	3	1	1	2
LKA	2	3	3	2	1
LTU	3	1	0	1	3
LVA	3	1	1	2	3

MAR	3	3	3	1	1
MDG	1	3	3	1	1
MDV	3	3	1	2	0
MEX	2	3	2	2	0
MLT	3	2	2	2	1
MMR	2	3	3	1	1
MNE	3	1	1	2	1
MOZ	2	3	3	1	1
MRT	1	1	3	1	2
MUS	3	2	1	1	1
MYS	1	2	1	1	1
NAM	1	2	3	2	2
NGA	2	3	3	1	0
NIC	1	3	3	1	1
NLD	3	2	2	1	3
NOR	2	1	2	2	2
NZL	2	0	2	0	1
OMN	2	3	2	1	1
PAK	2	3	3	2	1
PAN	2	3	1	2	0
PER	2	3	3	2	1
PHL	3	3	3	2	1
PNG	1	3	3	2	1
POL	3	3	1	1	3
PRK	1	3	3	1	2
PRT	3	1	2	0	1
QAT	3	3	0	2	0
ROU	3	1	1	2	1
RUS	2	2	2	1	2
SAU	3	2	2	1	1
SDN	1	2	3	2	2
SEN	2	3	3	2	1
SGP	3	1	3	1	0
SLE	1	3	3	2	1
SLV	1	3	3	1	1
SOM	1	3	3	1	0
STP	1	3	3	1	0
SVN	3	2	1	1	2
SWE	3	2	1	1	2
SYC	3	2	1	2	2
SYR	1	3	3	0	1

TGO	1	3	3	2	0
THA	3	3	1	1	1
TUN	3	3	3	1	2
TUR	2	3	1	1	1
TZA	1	3	3	2	1
UKR	2	3	2	2	2
URY	3	0	1	0	1
USA	3	0	1	1	1
VEN	2	3	3	2	1
VNM	3	3	2	1	1
VUT	1	3	3	1	1
WSM	2	3	3	1	0
YEM	1	3	3	2	0
ZAF	2	3	2	1	1

Acknowledgments

In memoriam Rainer Bruggemann (28. Oct. 1943 – 4. Dec. 2022)

Declarations

The author declares that

- the paper has not previously been published
- there are no conflicts of interest and
- the work has not received any external funding

References

- Apostu, S. A., Gigauri, I., Panait, M., Martín-Cervantes, P. A. (2023). Is Europe on the Way to Sustainable Development? Compatibility of Green Environment, Economic Growth, and Circular Economy Issues. *International Journal of Environmental Research and Public Health*, 20(2), 1078; DOI: 10.4236/jep.2018.93015
- Bruggemann R, Carlsen L. 2006. Introduction to partial order theory exemplified by the evaluation of sampling sites, In Bruggemann R and Carlsen L (Eds.), *Partial Order in Environmental Sciences and Chemistry*, Springer, Berlin, 61–110. Available from: <https://www.springer.com/gp/book/9783540339687> (Accessed Jan. 2023)
- Brüggemann, R, Carlsen L. 2011. An Improved Estimation of Averaged Ranks of Partial Orders. *Match Commun.Math.Comput.Chem.* 65:383-414; https://match.pmf.kg.ac.rs/electronic_versions/Match65/n2/match65n2_383-414.pdf (Accessed Jan. 2023)

- Bruggemann R, Carlsen L. 2014. Incomparable-What now? MATCH Commun.Math.Comput.Chem. 71:699-714; https://match.pmf.kg.ac.rs/electronic_versions/Match71/n3/match71n3_699-716.pdf (accessed jan. 2023)
- Bruggemann R, Carlsen L, Voigt K, Wieland R. 2014. PyHasse Software for Partial Order Analysis: Scientific Background and Description of Selected Modules, In: Bruggemann R, Carlsen L, and Wittmann J (Eds), *Multi-indicator Systems and Modelling in Partial Order*, Springer, New York, 389–423; DOI: 10.1007/978-1-4614-8223-9_19 (accessed Jan. 2023)
- Bruggemann R, Halfon E, Welzl G, Voigt K, Steinberg CEW. 2001. Applying the Concept of Partially Ordered Sets on the Ranking of Near-Shore Sediments by a Battery of Tests. *J Chem Inf Comp Sci* 41: 918–925; DOI: <https://doi.org/10.1021/ci000055k>
- Bruggemann R, Münzer B. 1993. A Graph-Theoretical Tool for Priority Setting of Chemicals. *Chemosphere* 27: 1729–1736; DOI: 10.1016/0045-6535(93)90153-V
- Bruggemann R, Patil GP. 2011. *Ranking and Prioritization for Multi-indicator Systems—Introduction to Partial Order Applications*, Springer, New York; <https://link.springer.com/book/10.1007/978-1-4419-8477-7> (Accessed Jan. 2023)
- Carlsen L. 2018. Happiness as a sustainability factor. The World Happiness Index. A Posetic Based Data Analysis. *Sustain Sci* 13: 549–571; DOI: 10.1007/s11625-017-0482-9
- Carlsen L. 2021. Responsible consumption and production in the European Union. A partial order analysis of Eurostat SDG 12 data, *Green Finance*, 4, 28-45; DOI: 10.3934/GF.2021003
- Carlsen, L. (2023a) The state of the “Prosperity” pillar by 2022. A partial ordering-based analysis of the sustainable development goals 7 – 11, *Green Finance* 5 (2023) 89-101
- Carlsen, L. (2023b) The state of the “People” pillar by 2022. A partial ordering-based analysis of the sustainable development goals 1-5 *World Development Sustainability* 2 (2023) 100071
- Carlsen, L. (2024) The Relative Importance of the SDG Pillars, Qeios, <https://doi.org/10.32388/EPDRDF>
- Carlsen L, Bruggemann R (2013) Partial order methodology a valuable tool in chemometrics. *J Chemometrics* 28: 226–234; DOI: 10.1002/cem.2569
- Carlsen L, Bruggemann R. 2018. Environmental perception in 33 European countries an analysis based on partial order. *Environ Dev Sustain* 22: 1873–1896; DOI: 10.1007/s10668-018-0267-z
- Carlsen L, Bruggemann R. 2022. The state of the sustainable development around the globe. A partial ordering-based analysis of the ‘Planet’ pillar, *Simulation in den Umwelt- und Geowissenschaft*, J. Wittmann and R. Wieland, eds., ASIM-Mitteilung AM 176, Shaker Verlag, 2022, pp 137-160; <https://www.asim-gi.org/publikationen/asim-fg-workshops/detail/sug-workshop-2021> (Accessed Jan. 2023)
- Clune, W. H., Zehnder, A. J. (2018). The three pillars of sustainability framework: approaches for laws and governance. *Journal of Environmental Protection*, 9(3), 211-240; DOI: 10.4236/jep.2018.9301
- Domonoske C, Kellman R. 2021. Guyana is a poor country that was a green champion. Then Exxon discovered oil, <https://www.houstonpublicmedia.org/npr/2021/11/07/1051892092/guyana-is-a-poor-country-that-was-a-green-champion-then-exxon-discovered-oil/> (accessed Jan. 2023)
- EOD (2023) Earth Overshoot Day, <https://www.overshootday.org/> (accessed Aug. 2023)
- Future Learn. 2021 The three pillars of sustainability, <https://www.futurelearn.com/info/courses/sustainabilitysociety-and-you/0/steps/4618> (accessed Jan. 2023)

- Hysa, E., Kruja, A., Rehman, N. U., & Laurenti, R. (2020). Circular economy innovation and environmental sustainability impact on economic growth: An integrated model for sustainable development. *Sustainability*, 12(12), 4831; DOI: 10.3390/su1212483
- Sachs JD, Lafortune G, Kroll C, Fuller G, Woelm F. (2022). From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and Beyond. *Sustainable Development Report 2022*. Cambridge: Cambridge University Press.; DOI: 10.1017/9781009210058SEG. 2021. 5 pillars of Sustainable Development Goals (SDGs), *Social Enterprise Guide*, <http://socialenterpriseguide.com/5-pillars-of-sustainable-development-goals-sdgs/> (accessed Jan. 2023).
- Sachs, J.D., Lafortune, G., Fuller, G., Drumm, E. (2023). Implementing the SDG Stimulus. *Sustainable Development Report 2023*. Paris: SDSN, Dublin: Dublin University Press, 2023. DOI: 10.25546/102924
- Tremblay, D., Fortier, F., Boucher, J. F., Riffon, O., Villeneuve, C. (2020). Sustainable development goal interactions: An analysis based on the five pillars of the 2030 agenda. *Sustainable Development*, 28, 1584-1596; DOI: 10.1002/sd.2107
- UN. 2016. Life on land. Why it matters; https://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/15_Why-it-Matters_Goal15_Life-on-Land_3p.pdf (accessed Jan. 2023)
- UN. 2022. Goal 6: Ensure access to water and sanitation for all, <https://www.un.org/sustainabledevelopment/water-and-sanitation/> (accessed Jan. 2023)
- UNDP. 2020. Life on Land. Fighting land degradation in Ghana through ecological farming; <https://undp.shorthandstories.com/gef-sgp-life-on-land/> (accessed Jan. 2023)
- Whatcanyoudo. 2021. What can you do? The 5p's, <https://whatcanyoudo.earth/selecting-the-sdg-for-youraction/the-5-ps/> (accessed Jan. 2023).
- World Bank. 2017. Life on Land; <https://datatopics.worldbank.org/sdgatlas/archive/2017/SDG-15-life-on-land.html> (accessed Jan. 2023)