Methodology

Well-being

Country risk indexes usually take into account only specific macroeconomic dimensions and traditional indicators of performance. In this section, we elaborated some composite indicators that assess specific dimensions of well-being that often are not considered when assessing country risks. Notwithstanding methodologies vary, the measurement of well-being represents a priority for various national and international statistical institutions. The OECD was one of the first institutions to put efforts on the best way to determine how to deem a society better off or worse off over time with its Better Life Index - released for the first time in 2011. Since 2013 the Italian National Institute of Statistics (ISTAT) and the National Council for Economics and Labour (CNEL) are publishing an annual extensive report on equitable and sustainable well-being, known as BES.

Following BES approach, we considered well-being as a multi-dimensional concept and some indicators related to five essential well-being domains were aggregated: demography, equality, health, education and labour. In order to elaborate these new composite indicators for most of the countries in the world, we followed a data-driven and diversified approach, processing data through a Min-Max normalization technique[1], assigning 100 to the highest country in the ranking and 0 to the lowest one. As second step, an experts' committee attributed specific weights to each selected indicators included in the domain, establishing the polarity and then we elaborate the following five composite indicators.

Demography

Demographic factors can have a strong impact on future well-being of countries. A country with many pensioners and not enough young people can struggle much more than a country with many young people and few older ones. In order to include these elements, we put forward a demographic composite including the age dependency ratio and the fertility rate. The age dependency ratio represents the ratio of people younger than 15 or older than 64 with respect to the working-age population (those ages 15-64). We decided to split the indicator considering the people younger than 15 (age dependency ratio, young) as a positive contribution to the composite. On the contrary, we considered the people older than 64 (age dependency ratio, old) with a reverse polarity on our demography composite. Each of the measure weighs 30%. Finally, we considered the total fertility rate – that represents the number of children that would be born to a woman if she were to live to the end of her childbearing years – with a weight of 40%. Elaborations were made on World Bank database.

Demography	*Weight*	*Polarity*
Fertility rate	40%	+
Age dependency ratio, old	30%	-
Age dependency ratio, young	30%	+

Source: World Bank

Equality

The increase of inequalities represents one of the most dangerous threats that has worsened after the COVID-19 pandemic and, for this reason, reducing inequalities is now a major economic, social and political challenge worldwide. In order to evaluate the level of overall equality in each country we selected five indicators of inequality used worldwide calculating their reverse polarity. The most well-known indicator of income inequality is the Gini Index that measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. It is included in our composite with a weight of 25%. The poverty gap at $1.90 a day weighs 25% in our equality composite and it reflects the depth

[1] According to the formula: (X-Min)/(Max - Min)*100

of poverty as well as its incidence in each country. We also included the percentage share of income held by the highest decile (10%) of population: this indicator weighs 20% in our composite. Another important indicator that weighs 15% in the composite is the proportion of the urban population living in slums[2]. All these four indicators were elaborated starting from data available on World Bank database. Finally, we also included with a weight of 15% a measure of gender inequality i.e. the gender inequality index elaborated by the UNDP.

Equality	*Weight*	*Polarity*
Gini Index	25%	-
Poverty gap at $1.90 a day	25%	-
Income held by highest 10%	20%	-
Population living in slums	15%	-
Gender inequality index	15%	-

Source: World Bank, UNDP

Health

Health is undoubtedly among the top priorities for the mankind and the recent Covid-19 pandemic has seriously exacerbated the condition of millions of people worldwide. The most important indicator of health is the life expectancy at birth, which measures how long a newborn can expect to live, on average, if current death rates will be the same as in the year of birth; it is the most important component of the composite and for this reason, we assigned a weight of 35%. The mortality rate under the age of 5 can also be a good proxy of the health status of a population: it weighs 30%; nevertheless, with respect to the former one, it has a reverse polarity i.e. if it increases, the health composite will decrease. Another important measure that weighs 20% in our composite is the physician availability per inhabitant. The current health expenditure in percentage of GDP completes the composite indicator of health and weighs 15%. Apart from the data on 'physician availability' that have been compiled by the WHO, all data on the other Health indicators are available on WB database.

Health	*Weight*	*Polarity*
Life expectancy at birth	35%	+
Mortality rate under-5	30%	-
Physician availability per inhabitant	20%	+
Current health expenditure	15%	+

Source: World Bank, WHO

Education

Education is key to a better future and countries with higher education attainment and, in general, with better schools are those more equipped to future challenges. A few education data are available at global level and the best proxy of education achievement among them is the Learning Adjusted Years of School (LAYS), because it combines quantity and quality of schooling into one metric. Indeed, LAYS compares years of schooling across countries, while adjusting those years by the amount of learning that takes place during them. These data are available on the World Bank database, the elaborated indicator represents alone 65% of our education composite as it can give an idea of the education level in each country. Another data complementing our composite is the ratio of total enrollment at tertiary level education as percentage of the population in the age of advanced studies. This data is available on the World Bank database and weighs 25% in our education composite. Finally, the last indicator included in our composite is the general government expenditure on education expressed as a percentage of GDP. Data are available on World Bank database and it weighs 10% in our education composite.

[2] A slum household can be defined as a group of individuals living under the same roof lacking one or more of the following conditions: access to improved water, access to improved sanitation, sufficient living area, and durability of housing.

Education	Weight	Polarity
Learning Adjusted Years of School	65%	+
School enrollment, tertiary	25%	+
Government expenses on education	10%	+

Source: World Bank

Labor

The last composite indicator we calculated is a labor composite. The first measure we considered (with a weight of 30%) is the labor force participation rate aged 15+ which corresponds to the proportion of the population older than 15 that is economically active in the country: all people who supply labor for the production of goods and services. Then we considered with the same importance (weight of 30%) the employment rate that represents the proportion of a country's population that is employed (persons of working age engaged in any activity to produce goods or provide services for pay or profit). The third indicator included in our labor force composite with a weight of 25% and a reverse polarity is a measure of the people (as percentage of total employment) working for less than $3.20 (PPP) a day, the so-called working poor. Finally, we included with a weight of 15% and a reverse polarity the personal remittances received by the country (in % GDP), which consist of all current transfers received by resident households from non-resident households. The working poor indicator is based on ILOSTAT data, all the other indicators are calculated on World Bank data.

Labor	Weight	Polarity
Labor force participation rate	30%	+
Employment rate	30%	+
Working poor at 3.20$ a day	25%	-
Personal remittances	15%	-

Source: World Bank, ILOSTAT

ENERGY TRANSITION

In this section, we elaborated some composite indicators that assess specific dimensions of energy transition, aimed at evaluating the current status and the perspective positioning of selected countries, reconsidering the future fluxes of fossil resources, the vulnerabilities brought about by slowing down these transformation processes as well as the opportunities emerging by decisive efforts towards energy transition, including the related geopolitical effects.

To assess risks raising by following short on the energy transition race and the opportunities laying ahead of a decisive move toward the transition, we considered energy transition as a multi-dimensional concept and some indicators related to five essential energy domains were aggregated. **Fossil fuels** in the mix and **emission** in order to establish a base line of stranded or potentially stranded assets and flow/stock pollution on one side, and energy **efficiency** and **electrification** - on the demand side - and **renewable** sources – on the supply side – as essential elements to ensure a successful energy transition over time.

We selected the indicators to take into consideration on the basis of the consistency, availability and quality of secondary data. Raw country data have been further processed through the Min-Max normalization technique. As second step, a committee of experts assigned specific weights to each selected indicators included in the domain, establishing the polarity and then elaborating the five composites.

Emissions

The composite indicator related to Emissions is calculated considering the *levels of CO_2 emissions per capita* (with a weight of 40%), the *CO_2 intensity of the energy sector* (with a weight of 30%) and the level of *air pollution in urban contexts*, expressed in terms of mean annual exposure to PM2.5 (with a weight of 30%). This composite offers a comprehensive understanding of the national capacity to limit or reduce GHG emissions at different levels, including the general economy, the energy sector, and the urban environment.

Emissions composite	*Weight*	*Polarity*
CO_2 emissions per capita	40%	-
Carbon intensity of energy mix	30%	-
Urban air quality	30%	-

Source: World Bank, IEA, WHO

Fossil Fuels

The Fossil Fuels composite is calculated taking into account the *share of fossil fuels in final energy consumption* (with a weight of 60%), the *reserves of oil and coal* (with a weight of 15%) *and the reserves of gas* (with a weight of 10%) at the national level - the availability of which could encourage the massive usage of fossils internally. The level of *subsidies to fossil fuels* as a share of GDP (with a weight of 15%), which make a fossil phase-out more costly at the societal level, is also included in the indicator. This composite is helpful in catching the country's overall difficulties in moving away from the usage of fossil fuels, and in pushing for their replacement with decarbonized energy sources such as renewables.

Fossil fuels composite	*Weight*	*Polarity*
Gas reserves	10%	-
Oil + coal reserves	15%	-
Post-tax Subsidies as a % of GDP	15%	-
Fossils on final energy consumption	60%	-

Source: US EIA, IMF

Renewables

Renewable energy sources are a key factor for energy transition, as they decarbonize not only the electricity sector, but also transports, buildings and industrial activities. The Renewables composite is calculated taking into account the *share of renewable energy sources in the national electricity mix* (weighted 55%) and the contribution of RES in the country's final energy consumption (weighted 45%). This indicator is fundamental to assess the level of penetration of non-carbon technology and to evaluate the degree of decarbonization achieved by each country, looking both at the overall economic activities and specifically at the electricity sector.

Renewables composite	*Weight*	*Polarity*
Renewables on electricity generation mix	55%	+
Renewables on final energy consumption	45%	+

Source: World Bank, IRENA

Efficiency

The Efficiency composite - which is calculated taking into account the value of *transmission and distribution losses* of the electricity grid (with a weight of 30%), the level *energy intensity of the economy*, (weighted 40%) and the *availability of clean cooking services* (weighted 30%) - provides an assessment on the national efforts to reduce the overall energy consumption and to limit/eliminate inefficient practices in specific energy domains, such as the electricity and the residential sectors.

Efficiency composite	*Weight*	*Polarity*
Electric transmission & distribution losses	30%	-
Energy use per GDP output	40%	-
Access to clean cooking	30%	+

Source: World Bank, IEA

Electrification

The Electrification composite is calculated considering the share of *electricity in final energy consumption* (with a weight of 40%), the share of population with *access to electricity modern electricity services (with a weight of 30%)*, and the *quality of electricity supplies* in terms of readiness, costs, reliability, transparency (weighted 30%). The indicator provides an assessment of the trends towards greater usage of electricity at the country level, an essential precondition to decarbonize not only the generation sector, but more in general the economic and social activities at the national level.

Electrification composite	*Weight*	*Polarity*
Electrification of energy consumption	40%	+
Quality of electricity supply	30%	+
Access to electricity services	30%	+

Source: World Bank, IEA

Risk index for climate change

The climate risk index has been defined following the standard methodology based on hazard / vulnerability / exposure. Each component has expressed in terms of proxies like:

- Macroeconomic variables (exposure)
- Demographic variables (vulnerabilities)
- Climate variables (hazard) for which a future projection is available.

Exposure and vulnerability

According to some of the most common definitions [3] , exposure is associated with the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructures or economic assets, in places and contexts that could be affected by adverse events.

Vulnerability, in general, is associated with the propensity or predisposition to suffer negative effects from such phenomena; involving a variety of concepts and elements, including sensitivity or susceptibility to damage and lack of ability to cope with the event and adaptation. A rigorous application of these principles assumes a detailed and localized deep knowledge of the underlying socio-economic systems, incompatible with a global and homogeneous vision.

For an approximated determination of exposure and vulnerability indicators, has been used some proxies selected from variables identified globally by international institutions [4]. Together with these variables, all the historical data available on past disasters, collected in an available open database has been also taken in account [5]. Disaster events are stored in this database based on their classification by type of event, extent of economic damage and human losses.

With regard to exposure, value-added indices of different economic sectors, expressed in terms of percentage of gross domestic product were used together with the sum of the economic damage due to historical disasters. For vulnerability population indicators, calculated as a percentage of the global population, were used together with national and rural population density.

In addition, the "Drought, floods and extreme temperatures" index developed by the World Bank has been considered. To these data has been added the value of human losses encountered in historical disasters. In the composition of the index, less weight was given to the historical component compared to the macroeconomic and demographic one, to avoid an overestimation linked to past events and an underestimation of the other risk factors.

Climate Indicators

Basic variables such as temperature, precipitation and wind speed were used, coming from different simulations included in the IPCC CMPI5[6] experiment by selecting the elaborations carried out on the historical period (1960 - 2005) and future projections (2006 - 2100). With regards to future projection, the intermediate scenario "Representative Concentration Pathway 4.5" (RCP4.5) was chosen which corresponds to a projection of an increase in average temperatures of 1.4 ° C (0.9 - 2.0) in the period 2046-2065 and a increase in average temperatures of 1.8 ° C (1.1 - 2.6) in the period 2081 - 2100 (5). The models provide the processing of variables on a daily basis, corresponding to a grid with a mesh that measure 200 x 400 km.

Starting from the basic variables, a series of climatic indicators (see below) significant for certain types of hazards have been calculated. The distribution of these indicators over each period examined (1960-2005, 2006-2050, 2051-2100) was determined by calculating the probability (in terms of frequencies) that the indicator exceeds the value of the 75th percentile in each period. These last values has been grouped, through

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[3] IPCC, 2014: Climate Change 2014: Impacts, Adaptation, and Vulnerability
[4] World Bank, data.worldbank.org
[5] "The International Disaster Database", www.emdat.be
[6] www.wcrp-climate.org/wgcm-cmip/wgcm-cmip5

weights, in appropriate sets significant for each hazard and represent the risk index for that particular hazard. The list of hazards considered is the following:

- Temperatures (heat waves, droughts, fires)
- Hydrogeological (floods, landslides)
- Wind (hurricanes, cyclones)

The three components were then grouped in the calculation of the climate risk index for each type of hazard and for each country.

Methodology

The methodology developed consists in the following steps:

- Segmentation of disaster events in terms of type, time period and geographical area
- Characterization of the individual disaster event selected in terms of climatic indicators, temporally and spatially close to the event themself
- Association of losses suffered due to disaster events with demographic and macroeconomic indexes and definition of the vulnerability / exposures associated with each hazard
- Definition of the climate risk in the reference period based on the selected climate indicators, vulnerability and exposure estimates
- future projection of the indices on the climate scenarios involved and therefore calculation of the forecast climate risk

Each index is calculated on a territorial grid base, the exposure and vulnerability indexes are distributed on the basis of the distribution of population density[7]. Each node of this grid is associated with the closest point of the grid that contains the probability of hazard.

Calculation of the climatic risk index (for each hazard)

Clima risk index = Esposition Index * Vulnerability Index * Hazard Probability

The final index is normalized according to the following procedure:

1. The distribution of the climate risk index of all countries is determined for each scenario and for each type of hazard.
2. The final index is the percentile of the previously calculated distribution

***Esposition index* (for each hazard)**	**Weight**
• Esposition base index	60%
• Economic damage index	40%

***Vulnerability* index (for each hazard)**	**Weight**
• Vulnerability base index	60%
• Historical mortality index	40%

Esposition base index	**Weight**
• **Temperature**	
○ Agriculture value added	30%
○ Industry value added	12%
○ Manufacturing value added	12%
○ Services value added	6%

[7] Center for International Earth Science Information Network - CIESIN - Columbia University. 2018

- **Hidrogeological**
  - Industry value added 20%
  - Manufacturing value added 20%
  - Services value added 20%
- **Wind**
  - Industry value added 20%
  - Manufacturing value added 20%
  - Services value added 20%

Vulnerability base index **Weight**

- **Temperature**
  - "Droughts floods extreme temp" 30%
  - Population density 5%
  - Total Population 5%
  - Rural Population 20%
- **Hidrogeological**
  - "Droughts floods extreme temp" 30%
  - Population density 5%
  - Total Population 5%
  - Rural Population 20%
- **Wind**
  - "Droughts floods extreme temp" 30%
  - Population density 5%
  - Total Population 5%
  - Rural Population 20%

Historical Mortality Index = ∑ (human losses per year / population anno) / Years numbes
Economic damage index = ∑ (economic losses per year / GDP year) / Years numeber

The index is normalized in the closed interval [0 - 1] the extremes correspond respectively to the minimum and maximum value of the set.

Hazard probability

Lista of hazard:

- Temperature
  - Droughts
  - Heat waves
  - Wildfires
- Hidrogeological
  - Floods
  - Landslide
- Wind
  - Cyclons
  - Huricanes

Climatic scenarious:

- Historical (1960 – 2015)
- RCP 4.5 (2016 – 2050)
- RCP 4.5 (2051 – 2100)

Using the basic variables (produced by the simulations of climate models on a grid of 200 x 400 km) has been calculated the climatic indicators listed in the table where the names and standard abbreviations are reported[8].

[8] www.climdex.org/learn/indices

Code	Name	Description
csd	Maximum consecutive summer days	Maximum number of consecutive summer days (TX > 25 Celsius)
d50mm	Heavy precipitation days	Number of days with precipitation above 50mm
dr1mm	Wet days 1mm	Total number of wet days >= 1 mm
fgcalm	Calm days	Number of calm days (FG <=2 m/s)
fgmax	Mean of daily max wind strength	Mean of daily max Wind speed
gsl	Growing season length	Annual count of days between the first span of at least 6 days with TG > 5 Celsius and first span after 1 July of 6 days with TG < 5 Celsius
ldp	Longest dry period	Maximum length of consecutive dry days (RR<1)
ntg	Minimum TG	Minimum of daily mean air temperature
ntx	Minimum TX	Minimum of daily maximum air temperature
pci	Precipitation Concentration Index	Index to evaluate precipitation heterogeneity at a monthly scale. Values <10 (uniform monthly rainfall distribution); values 11-15 (moderate concentration of precipitation); values 16-20 (irregular distribution); and >20 ((high precipitation concentration)
r20mm	Days precipitation >= R20mm	Days with daily precipitation amount >= 20mm
rtwd	Total precipitation wet days	Precipitation amount on days with RR >= 1 mm
sdii	Simple precipitation intensity index	sum of precipitation in wet days (days with >1mm of precipitation), and dividing that by the number of wet days in the period.
spi12	Standardized precipitation index calculated at 12-month time scale	Standardized precipitation index calculated at 12-month time scale
xtg	Maximum TG	Maximum of daily mean temperature
xtn	Maximum TN	Maximum of daily minimum temperature
xtx	Maximum TX	Maximum of daily maximum

These indicators were considered as proxies for determining the probability of the extreme climatological events under consideration, combining them according to the following associations:

- Temperature
  - Csd
  - Gsl
  - Ldp
  - Ntg
  - Ntx
  - spi12
  - xtg
  - xtn
  - xtx
- Hidrogeological
  - d50mm
  - dr1mm
  - r20mm
  - rtwd
  - sdii
- Wind
  - fgcalm
  - fgmax
  - pci