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FAOSTAT ANALYTICAL BRIEF 63

# Temperature change statistics 1961–2022

Global, regional and country trends

## HIGHLIGHTS

- The 2022 global mean annual temperature change on land was 1.4 °C. More than two-thirds of the observed warming happened since 1990.
- The last eight years, 2015–2022, were the eight warmest years on record since 1961, and in fact since the beginning of observations in 1880.
- Europe recorded the largest temperature increase (2.2 °C) among regions, with 2022 being the sixth year of the past decade with warming above 2 °C in this continent. Warming in Asia (1.8 °C) was likewise higher than the observed world average.
- The Americas and Africa were 1.0 °C warmer than normal in 2022, with warming in Oceania more moderate, but still significant, at 0.8 °C.
- In 2022, the mean annual temperatures were warmer than normal in more than 170 countries and territories. Of these, 125 experienced exceptional warming compared to the reference climatology.

## FAOSTAT TEMPERATURE CHANGE

### INTRODUCTION

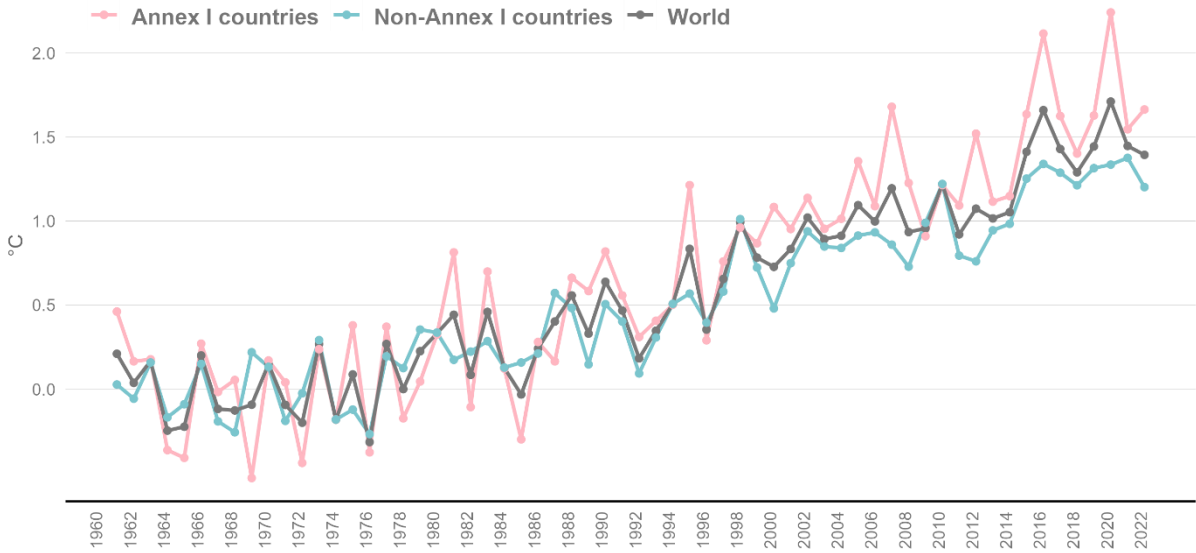
Anthropogenic greenhouse gas emissions lead to planetary warming. Their abatement is at the core of the existing international policy commitments to combat global warming, with the aim to reduce its projected and increasingly observed impacts on livelihoods throughout the world – and in particular to safeguard food production (IPCC, 2022). The Paris Agreement seeks to maintain global surface temperature increase to no more than 2 °C warming, and possibly to below 1.5 °C, above pre-industrial levels. The [FAOSTAT Temperature change on land](#) statistics allow to monitor the observed warming trends on land at the country, regional and global level, to help gauge expected risks to the agriculture, forestry and fisheries sectors. They are disseminated for the period 1961–2022 for 188 countries and 38 territories, and are produced in collaboration with the [NASA Goddard Institute for Space Studies](#) (NASA–GISS). Temperature changes are computed with respect to a reference climatology corresponding to the period 1951–1980 (see Explanatory Notes).

### GLOBAL

In 2022, the global mean annual land temperature anomaly was 1.4 °C, confirming the observed warming trend of recent decades. In fact, the eight years since 2015 were the eight warmest on record since 1961, in terms of data available in FAOSTAT and more generally they were the eight warmest years ever recorded since 1880, the beginning of the global temperature measurements. Each decade since 1993 brought an additional temperature increase of 0.3–0.4 °C. Figure 1 illustrates trends in temperature change globally as well as for the Annex I and Non-Annex I groups of parties reporting to the United Nations Framework Convention on Climate Change (UNFCCC) due to the relevance of this indicator of climate change. The two groups differ in their commitments for reporting and action under

the Convention, with Annex I countries usually having more affluent economies and stricter requirements for reporting. Consistently with the physical understanding of climate change, Annex I countries, which are often located at higher latitudes, recorded relatively more warming compared to Non-Annex I countries, which are more frequently located in tropical and subtropical regions.<sup>1</sup>

**Figure 1: Mean annual land temperature anomalies measured over land**

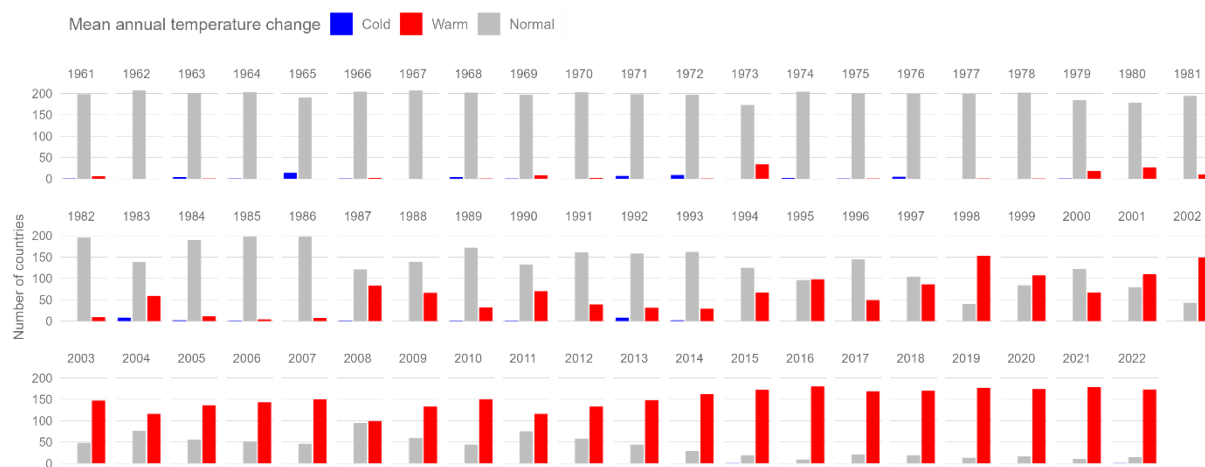


**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>

Temperature change data in each country and territory were analysed as normal, warm or cold anomalies in comparison to the 1951–1980 climatology. In 2022, mean annual temperatures were warmer than normal in 173 countries and territories (Figure 2), and much warmer than normal in 125 of them. Only two countries recorded cold temperature anomalies in 2022: Botswana (which was much colder than normal) and Zimbabwe (colder). Conversely, back in 1961, nearly 200 countries and territories had global mean land temperatures within the climatic normal.

<sup>1</sup> The list of the type of parties to the UNFCCC is reported in the Annex and is drawn from <https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states>. For corresponding FAOSTAT area codes, please also see the tab 'Country Group' in FAOSTAT Definitions and Standards <http://www.fao.org/faostat/en/#definitions>.

**Figure 2: Mean annual land temperature change expressed as anomalies by country**



**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>

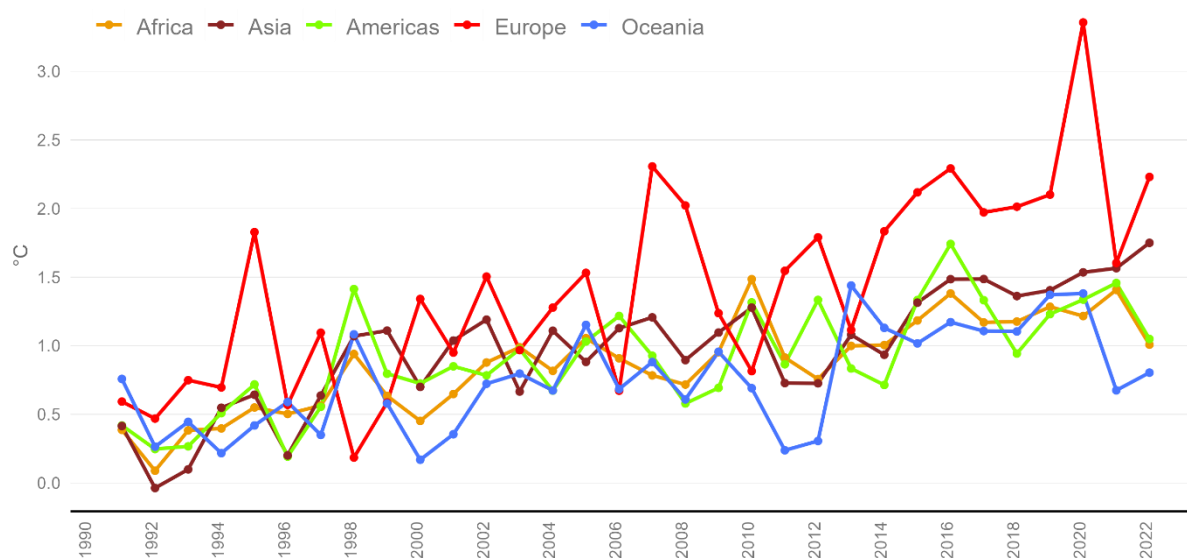
Annual bars in Figure 2 represent the number of FAOSTAT countries and territories with normal (grey bars), colder (blue) and warmer (red) temperatures. The graph visually represents the concept of the “loaded dice”, first put forward by NASA climatologist Jim Hansen in the 1990s (Hansen, 2012). The visible effects of climate change can in fact be seen as producing a continuous shift towards the red in the probability of future years being warmer than past climatology.

## REGIONAL

Europe<sup>2</sup> recorded the largest temperature increase (2.2 °C) among regions, with 2022 being the sixth year during the past decade with warming above 2 °C. Warming in Asia (1.8 °C) was likewise larger than the observed world average. The Americas and Africa were 1.0 °C warmer than normal in 2022, with warming in Oceania more moderate though still statistically significant, at 0.8 °C. The observed temperature anomalies were all statistically significant (95 percent confidence interval) in all regions.

<sup>2</sup> The Europe regional aggregate of FAOSTAT includes the Russian Federation.

**Figure 3: Regional trends in mean annual temperature changes measured over land**



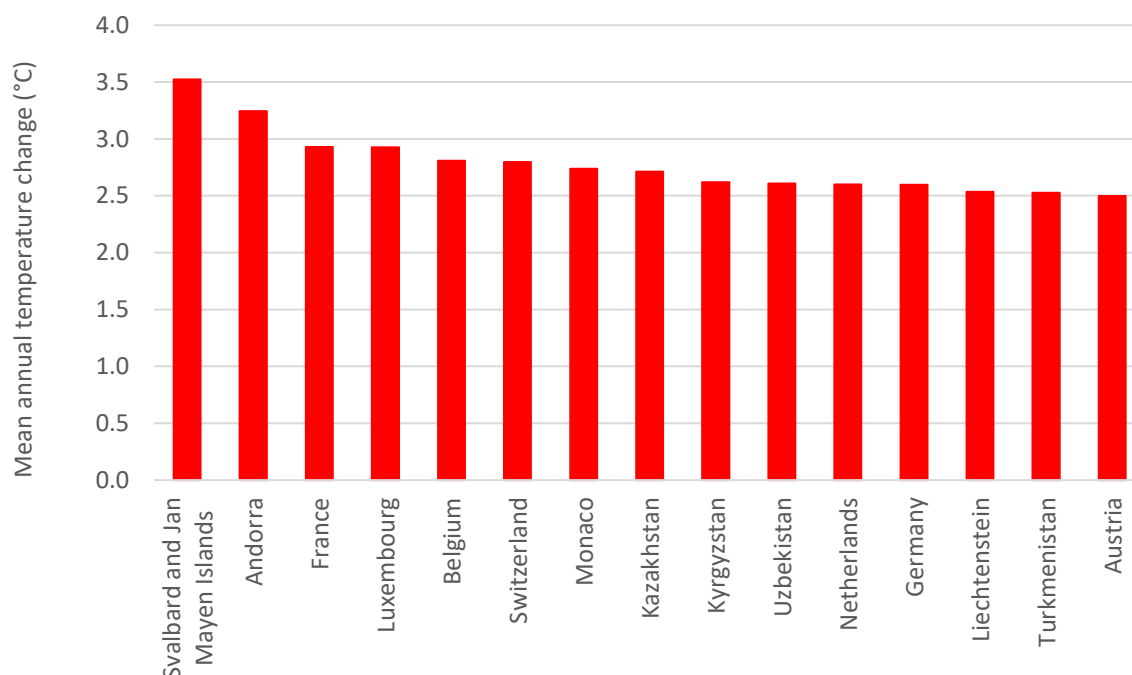
**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>

## COUNTRY

In 2022, 170 countries and territories – nearly 85 percent of the total – experienced at the national scale annual mean warming greater than 1.0 °C. Warming in half of these was greater than 1.5 °C, and in 15 of them it was greater than 2.5 °C.

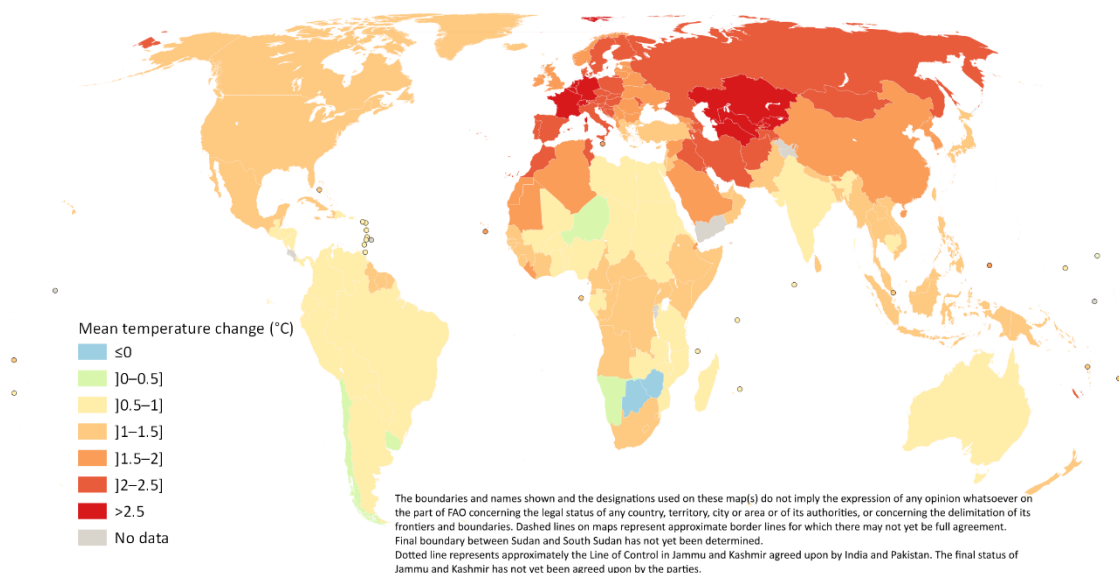
In 2022, the countries and territories with the most pronounced observed warming (Figure 4) were recorded at northern latitudes in Western and Northern Europe (Svalbard Islands, France, Luxembourg, Belgium, Switzerland, Monaco, the Netherlands, Liechtenstein, Germany and Austria) and in Central Asia (Kazakhstan, Kyrgyzstan, Uzbekistan and Turkmenistan). The largest observed temperature anomaly at the country/territory level was 3.5 °C, recorded in the Svalbard Islands (Norway). Conversely, Zimbabwe (colder than normal) and Botswana (much colder) were the only two countries with recorded negative temperature anomalies (see Figure 5).

**Figure 4: Countries and territories with largest mean annual temperature change over land for the year 2022**



**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>

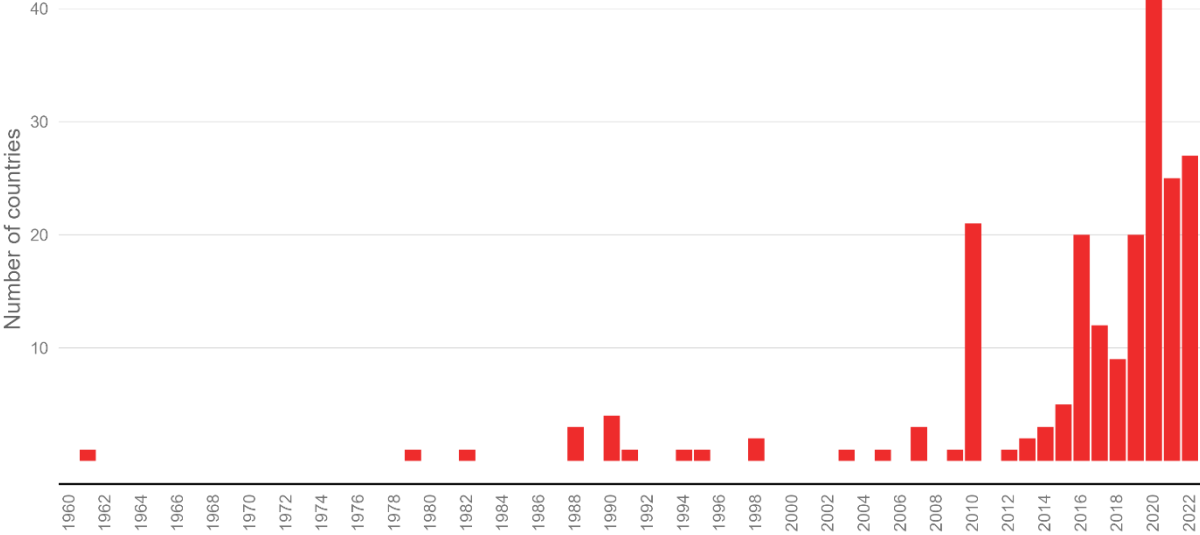
**Figure 5: Global map of observed temperature changes, 2022**



**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET> based on UN Geospatial. 2020. Map geodata [shapefiles]. New York, USA, UN.

Finally in 2022, 27 countries or territories broke national warming records. This was the second highest number since 1961, with 41 countries recorded in 2020 (Figure 6).

**Figure 6: Number of countries and territories with record warming**



**Source:** FAO. 2023. FAOSTAT: Temperature change on land. In: FAO. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>

**EXPLANATORY NOTES**

The FAOSTAT [Temperature change on land](#) domain disseminates statistics of temperature change measured over land by country, with annual updates. The current database covers the period 1961–2022. Statistics are available for 188 countries and 38 territories in 2022. They are available for monthly, annual and seasonal (winter, spring, summer and autumn) temperature anomalies, i.e. temperature change with respect to a reference climatology corresponding to the period 1951–1980. Data are also available for regional aggregates and special groups, such as the Annex I and Non-Annex I Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (see the Annex with the list of countries in each group).

For each country or territory, and for each temperature variable considered, the mean and standard deviation  $\sigma$  of the 1951–1980 climatology was computed and disseminated in the dataset – except in cases with less than 20 available records in the time series. The standard deviation of the climatological mean annual, seasonal and monthly temperatures can be taken to represent the natural interannual variability of that variable, by country. Warmer (or colder) temperature changes were defined as deviations exceeding  $2 \sigma$ , hence outside the 95.45 percent confidence interval (CI). Similarly, much warmer (or much colder) temperature anomalies were those exceeding  $3 \sigma$ , or outside the 99.7 percent CI. Conversely, temperature deviations within  $2 \sigma$  from the climatological mean were considered natural interannual variability, specifically  $\pm 0.4 \text{ }^\circ\text{C}$  for the world;  $\pm 0.5 \text{ }^\circ\text{C}$  for Africa, Asia and the Americas; and  $\pm 0.9 \text{ }^\circ\text{C}$  for Europe (95% CI).

The FAOSTAT data are based on the publicly available [GISTEMP data](#), the Global Surface Temperature Change data distributed by the National Aeronautics and Space Administration Goddard Institute for Space Studies (NASA–GISS), with information from 1880 onwards. The original GISTEMP analysis generates a set of gridded values from the Global Historical Climatology Network (GHCN v4), composed of continuously updated temperature data from over 26 000 meteorological stations around the globe. A finer grid was prepared for the purpose of the FAOSTAT dataset, excluding ocean data, and subsequently aggregated at the country level using the FAO Global Administrative Unit Layer (GAUL). The FAOSTAT methodology includes reconstructing the time series to take into account the administrative changes that occurred since 1961 (e.g. the split of the Soviet Union in 1991 or the separation of the Sudan, former in 2011). Finally, country statistics were area-weighted to compute regional aggregates, using country area data from the FAOSTAT [Land Use](#) dataset as weights.

According to NASA, compared to statistics of absolute temperature value, a dataset based on temperature anomalies is more stable and coherent in the face of variations in coverage in space and time of the meteorological stations that underlie the information. The uncertainties of the gridded data, and thus the uncertainty of the FAOSTAT country statistics, which are also disseminated in the dataset, depend on the spatial and temporal coverage of the GHCN stations. Measurement uncertainty is around 5–10 percent for global and regional aggregates (typically 0.1–0.2 °C), while it can be significantly higher for country values, depending on the density of the underlying network of meteorological stations. For instance, countries in regions with denser station networks, such as Northern America, Europe and Australia have smaller measurement uncertainties whereas data from countries with less dense and reliable networks, such as parts of South America, Africa and the Near East, have greater uncertainty.

A [methodological note](#) of the Temperature change on land domain is available in FAOSTAT.





## REFERENCES

- FAO.** 2023. FAOSTAT: Temperature change on land. In: *FAO*. Rome. Cited March 2023. <http://www.fao.org/faostat/en/#data/ET>
- Hansen, J., Johnson, D., Lacis, A., Lebedeff, S., Lee, P., Rind, D. & Russell, G.** 1981. Climate impact of increasing atmospheric carbon dioxide. *Science* 213, 957–966.
- Hansen, J., Sato, M., Ruedy, R., Lo, K., Lea, D.W. & Medina-Elizade, M.** 2006. Global temperature change. *Proceedings of the National Academy of Sciences* 103, 14288–14293.
- Hansen, J., Ruedy, R., Sato, M. & Lo, K.** 2010. Global surface temperature change. *Reviews of Geophysics* 48.
- Hansen, J., Sato, M. and Ruedy, R.** 2012. Public perception of climate change and the new climate dice. arXiv preprint arXiv:1204.1286.
- Lenzen, N.J., Schmidt, G.A., Hansen, J.E., Menne, M.J., Persin, A., Ruedy, R. & Zyss, D.** 2019. Improvements in the GISTEMP uncertainty model. *Journal of Geophysical Research: Atmospheres* 124, 6307–6326.
- Menne, M.J., Williams, C.N., Gleason, B.E., Rennie, J.J. & Lawrimore, J.H.** 2018. The global historical climatology network monthly temperature dataset, version 4. *Journal of Climate* 31, 9835–9854.
- NASA–GISS.** 2023. GISTEMP Team, GISS Surface Temperature Analysis (GISTEMP), version 4. In: *NASA Goddard Institute for Space Studies*. New York. Cited March 2023. <https://data.giss.nasa.gov/gistemp/>.
- UN Geospatial.** 2020. *United Nations Clear Map* [online]. Cited June 2021. <https://geoservices.un.org/Html5Viewer/index.html?viewer=clearmap>

## ANNEX

### ANNEX I COUNTRIES

Australia; Austria; Belarus; Belgium; Bulgaria; Canada; Croatia; Cyprus; Czechia; Denmark; Estonia; European Union; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Japan; Latvia; Liechtenstein; Lithuania; Luxembourg; Malta; Monaco; Netherlands (Kingdom of the); New Zealand; Norway; Poland; Portugal; Romania; Russian Federation; Slovakia; Slovenia; Spain; Sweden; Switzerland; Türkiye; Ukraine; United Kingdom of Great Britain and Northern Ireland; United States of America.

### NON-ANNEX I COUNTRIES

Afghanistan; Albania; Algeria; Andorra; Angola; Antigua and Barbuda; Argentina; Armenia; Azerbaijan; Bahamas; Bahrain; Bangladesh; Barbados; Belize; Benin; Bhutan; Bolivia (Plurinational State of); Bosnia and Herzegovina; Botswana; Brazil; Brunei Darussalam; Burkina Faso; Burundi; Cabo Verde; Cambodia; Cameroon; Central African Republic; Chad; Chile; China; Colombia; Comoros; Congo; Cook Islands; Costa Rica; Côte d'Ivoire; Cuba; Democratic People's Republic of Korea; Democratic Republic of the Congo; Djibouti; Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea;

Eritrea; Eswatini; Ethiopia; Fiji; Gabon; Gambia; Georgia; Ghana; Grenada; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran (Islamic Republic of); Iraq; Israel; Jamaica; Jordan; Kazakhstan; Kenya; Kiribati; Kuwait; Kyrgyzstan; Lao People's Democratic Republic; Lebanon; Lesotho; Liberia; Libya; Madagascar; Malawi; Malaysia; Maldives; Mali; Marshall Islands; Mauritania; Mauritius; Mexico; Micronesia (Federated States of); Mongolia; Montenegro; Morocco; Mozambique; Myanmar; Namibia; Nauru; Nepal; Nicaragua; Niger; Nigeria; Niue; North Macedonia; Oman; Pakistan; Palau; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Qatar; Republic of Korea; Republic of Moldova; Rwanda; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; San Marino; Sao Tome and Principe; Saudi Arabia; Senegal; Serbia; Seychelles; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; South Sudan; Sri Lanka; State of Palestine; Sudan; Suriname; Syrian Arab Republic; Tajikistan; Thailand; Timor-Leste; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkmenistan; Tuvalu; Uganda; United Arab Emirates; United Republic of Tanzania; Uruguay; Uzbekistan; Vanuatu; Venezuela (Bolivarian Republic of); Viet Nam; Yemen; Zambia; Zimbabwe.

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