



Task Force 2  
**Climate Change, Sustainable Energy  
& Environment**

**Policy brief**

# **NATURE-BASED SOLUTIONS FOR CLIMATE CHANGE, CLEAN ENERGY & HEALTH**

SEPTEMBER 2021

**Thomas Crowther** ETH Zurich

**Thomas Elliott** ETH Zurich

**James Hospedales** EarthMedic and EarthNurse Foundation

**John Kirton** G20 Research Group

**Rachel Kupka** Global Alliance on Health and Air Pollution

**Marina Larionova** Center for International Institutions Research

**Rajani Ranjan Rashmi** The Energy Research Institute

**Laura Schaepli** Global Alliance on Health and Air Pollution

**Andrey Shelepov** Center for International Institutions Research

**Brittaney Warren** G20 Research Group

T20 NATIONAL COORDINATOR AND CHAIR



T20 CO-CHAIR



T20 SUMMIT CO-CHAIR



Università  
Bocconi  
MILANO





# ABSTRACT

The G20 should control climate change by mobilizing nature-based solutions to:

1. **Foster forests** ecosystems by supporting the Restor platform to help re-grow one trillion trees by 2025;
2. **Preserve peatlands** and wetlands as natural protected areas;
3. **Clean cities** by cutting air and lead pollution by 25% by 2025 and reducing heat sinks;
4. **Green coasts**, including on small island developing states, through “SDR for NBS” swaps.
5. **Raise renewables’** share of energy to 25% by 2030, and by doubling nature-intensive geothermal, tidal and wave power’s share by 2025 to cut coal;
6. **Lower Land-Use Stress**, by shifting **from** animal to plant-based agriculture, and minimizing methane emissions.



# CHALLENGE

Controlling the relentless rise in the global average temperature from atmospheric concentrations of greenhouse gas (GHG) emissions is a central challenge. These emissions are now approaching critical, potentially irreversible thresholds and are significantly harming the global economy, environment and human health. The situation requires urgent, ambitious action on GHG sinks as well as sources, centred on nature-based solutions (NbS) amidst accelerating biodiversity loss. NbS are defined as “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience” (EU n.d.).

Controlling climate change and meeting the widely agreed goal of net-zero emission by 2050 requires decisive action on sources of emissions, but also on the sinks that remove the emissions. As the only proven carbon sinks, nature-based solutions are critical to solving the dual climate and biodiversity crises. The land and oceans’ combined sinks store 50% of such emissions (WEF 2020; Project Drawdown n.d.).

The Agriculture, Forestry and Other Land Use (AFOLU) sector accounts for 18.4% of global emissions and, in conjunction with food pre- and post-production processes, generates up to 37% of emissions (Our World In Data 2020; IPCC 2019). Globally, agriculture accounts for 73% of deforestation, 70% of water use and more emissions than cars, trucks, ships and planes (IPCC 2019; Agrawal, Wollenberg and Persha 2014). It produces 44% of global methane emissions and 81% of global nitrous oxide emissions (IPCC 2019). Hydrocarbon energy sources used for electricity, heat and transportation combined account for 73.2% of global emissions (Our World In Data 2020).<sup>1</sup>

Urban areas account for over 70% of global emissions, and since 90% of urban areas are situated on coastlines, they are highly susceptible to climate-fuelled disasters (C40 Cities n.d.).

These emissions pollute the air, water, soil and coasts. They harm human health, especially for the poor and marginalized.

These nature-based forestry, agriculture and land sources have also served as powerful, low-cost carbon sinks for untold millennia. Yet they have declined at a proliferating rate in the last few decades. It is time to stop this decline and bring them back in bigger and better ways.

G20 leaders at their summits have recognized the relevance of NbS, but have only done so recently, rarely and in an irregular and restricted way (see Appendix A).

The G20’s Rome Summit should unleash the full power of NbS to help stop the climate crisis now.



# PROPOSAL

The science clearly shows that the most cost-effective NbS are at hand and bring many co-benefits in terms of climate, health and the economy. The top 20 climate change solutions listed by Project Drawdown, an ongoing research project of the most impactful solutions for “drawing down” emissions, includes 12 nature-based solutions (Hawken 2017). Six of these relate to forests make and five to food and agriculture, with nature-intensive geothermal energy also making the top 20 (see Table 1 below).

**TABLE 1**

<b>Solution</b>	<b>Ranking</b>
Plant-based diet	4
Tropical forests	5
Silvopasture	9
Regenerative agriculture	11
Temperate forests	12
Peatlands	13
Tropical staple trees	14
Afforestation	15
Conservation agriculture	16
Tree intercropping	17
Geothermal	18
Managed grazing	19

Six of these nature-based solutions stand out for the G20's Rome Summit to adopt

## ***FOSTER FORESTS***

Forest ecosystems are critical for life. They determine the climate, regulate air and water and enhance human and animal health. Yet they have long been shrinking and suffering increasingly severe stress. Science shows the global potential to restore 900 million hectares of land, led by the G20 members Russia (151 million), the United States (103 million), Canada (78 million), Australia (58 million) and Brazil (50 million). Through the Trillion Tree Initiative (1T.org) and support from industry and governments, more budgets back these essential ecosystems.



However, thousands of global ecological restoration projects have survival rates of only 30%, due in part to missing ecological data and monitoring tools. To bring connectivity and transparency to the thousands of actors working to restore degraded land and diverse ecosystems, the G20 can start by joining the UN Environment Program (UNEP) and Christiana Figueres in supporting evidence-based efforts and networks, including through Restor, an innovative online ecosystem network.

Restor is analogous to Google Maps for ecosystems. It transparently connects many stakeholders, including governments, practitioners, investors, international organizations, farmers, citizens and others, with the ecological and practical data they need for local decision-making. This encourages responsible ecosystem restoration, promotes local biodiversity, avoids invasive species, reveals where native trees will exist under current and future climate conditions, and best deploys sustainable finance. It is the most advanced initiative aimed at creating a much-needed single, comprehensive and increasingly detailed data repository.

Building and mobilizing this network will help G20 members implement their own commitments, their commitments under the Bonn Challenge co-launched by G20 member Germany, and their own national initiatives. The initiative helps overcome socioeconomic, trust and financial accessibility barriers by connecting projects to a network of organizations and markets that can help refine and develop incentives for restoration. The G20 leaders can specifically endorse Restor as a highly promising solution to this critical need, offer to provide their relevant government data to it and work with it to mobilize a full range of stakeholders in the desired way.

G20 summits have dedicated less than 1% of their public communiqués to forest ecosystems (see Appendix A).<sup>2</sup> They have not included monitoring in their environmental or climate change commitments. However, at Riyadh, leaders committed to reducing degraded land by 50% by 2040 “on a voluntary basis.” At Rome G20 leaders should:

**Foster forest ecosystems by supporting the Restor platform and committing to re-growing at least one trillion trees by 2025 in a fully ecosystem supportive way.**

## ***PRESERVE PEATLANDS***

Peat extraction accounts for roughly 25% of global methane emissions (Rojas Urrego 2019). Peat is found in bogs, a type of wetland. Other wetlands are salt marshes, mangroves, sea-grass beds and coral reefs. Peatlands cover only 3% of the world’s surface, but store almost 33% of land-based carbon — twice as much as forests (Rojas Urrego 2019). Intact coastal wetlands protect against coastal erosion from sea level rise, hurricanes, tsunamis and storms, and the related deaths and economic costs (Narayan and Beck 2018). Yet during the past 45 years humans have destroyed over one-third of the world’s wetlands. They are disappearing three times as fast as forests.



Preserving peat saves 21.57 gigatons of CO<sub>2</sub> and protects a further 1,230.38 gigatons (Hawken 2017, p. 123). Peatland restoration and reforestation offer potential carbon offset credits of 2.9 GtCO<sub>2</sub> per year (Lex 2021).

G20 members possess much of the world's peatlands. Russia's Asian territory has 1,176,280km<sup>2</sup> and its European territory 199,410 (Wetlands International 2009). Canada has 1,133,926km<sup>2</sup>, followed by Indonesia with 265,500km<sup>2</sup>, Alaska with 131,990km<sup>2</sup> and the US's lower 48 states with 91,819km<sup>2</sup>.

The Ramsar Convention on Wetlands, signed by all G20 members except for Saudi Arabia, has 916 officially designated Wetlands of International Importance within G20 countries, covering 91,453,367 hectares (Ramsar 2014) (see Appendix B). Italy ranks fifth with 56 wetlands. The UK, its co-host of the 2021 UN 26th Conference of the Parties (COP 26) climate conference, ranks first with 175 sites. G20 summits have never recognized the relevance of peatlands and wetlands. At their Rome Summit, leaders should thus promise to:

**Preserve peatlands and promote their quality, by immediately designating them as natural protected areas through national action and under the UN Biodiversity and Ramsar Convention, and map all global peatlands at ground level. They should do so for wetlands by 2025, pursuant and complementary to the Convention's Kunming COP 15 outcomes in October.**

## ***CLEAN CITIES***

Clean cities protect people and the planet, while helping ensure prosperity.

Concentrated in cities, where most people now live, pollution kills nine million people and costs up to 2% of gross domestic product (GDP) and 7% of healthcare costs annually (Lan-drigan and Acosta 2017). Six G20 countries are among the top ten in annual premature deaths due to pollution (GAHP 2019). Ninety-one percent of the world's population breathes unhealthy air (WHO 2021). One in three children is lead poisoned (UNICEF 2020). The burning of fossil fuels, including via transportation, is a major source of emissions in cities that simultaneously contribute to air pollution and climate change (GAHP 2020).

In cities, air pollutants interact with high temperatures, exacerbating poor health and increasing the death rate in urban populations. Cities are well-known "heat islands": average temperatures in cities are up to 3°C hotter than in non-urban areas, with even greater disparities at night, due to heat-retaining concrete, tall buildings that block cooling air flow, much human activity and, importantly, a lack of greenery (Tan and Siri 2016). These heat effects are likely to increase with climate change due to increased average temperatures, increased frequency of heat waves and potentially decreased precipitation (Filho et al. 2018). Air pollution and high heat have synergistic negative effects on human health, and significantly reduce quality of life (Scortichini et al. 2018).



Solutions to urban pollution include reducing the burning of fossil fuels for heating, electricity generation and transport by upgrading public transportation, reducing the sulphur content of motor fuels, promoting use of low- and zero-emission vehicles powered by clean energy, ensuring proper recycling of lead acid batteries from vehicles and solar installations, encouraging walking and cycling, restricting cars and trucks from city centres, preserving and planting trees, and implementing other urban nature-based solutions, such as green walls. Such measures simultaneously improve air quality, enhance the quality of urban life, protect the climate, build climate resiliency and reduce childhood asthma, cardiovascular disease, stroke and adult diabetes (Schmidt 2011; Landrigan and Acosta 2017).

G20 leaders recognized the general relevance of air pollution in 2017, 2019 and 2020. This year, G20 leaders should commit to:

**Cleaning cities and the air by cutting air and lead pollution and urban heat sinks by 25% by 2025, reducing fine particulate matter (PM2.5) concentrations to World Health Organization (WHO) air quality standards by 2030; investing \$100 million per year in tree planting and maintenance; ensuring clean, safe lead-acid and other battery manufacturing and recycling practices; remediating highly toxic urban sites; and improving watershed management practices.**

They should also conduct inter-ministerial exchanges, mainstream and fund air pollution prevention and mitigation, integrate air pollution and health planning into country and city processes, including their Nationally Determined Contributions; immediately end fossil fuel subsidies, and rapidly phase out incentives for polluting industries, with aggressive targets and timetables and effective law enforcement.

## **GREEN COASTS**

Greening coasts improves carbon capture, health, food security, water quality, storm surge protection, biodiversity, coastal economies, fisheries and sustainable tourism.

Yet climate change is increasingly destroying and damaging the coasts of G20 members and small island developing states (SIDS) in the Caribbean and elsewhere, and the many coastal cities around the world. All G20 countries are land and military bases, transportation corridors and coastal states (which are increasingly vulnerable to storm damage, sea level rise and sinking cities). Most have many small islands within their borders, notably Indonesia, which will host the G20 in 2022. Many G20 members have islands adjacent to their mainland, and some have overseas island territories around the world.

SIDS have climate adaptation, disaster response and recovery plans in place, but only limited capacity for resilience and mitigation. They lack access to financing based on vulnerability, they lack information and monitoring on marine resource status, and they lack effective regional governance structures for prioritizing, planning and integrating work, and advocating for financial, technical and policy support, to help themselves and the world.



G20 summits have long recognized the vulnerability of SIDS and singled out the Caribbean with the catastrophic risk insurance facility they endorsed. But more is urgently needed now. At Rome G20 leaders should commit to:

**Greening coasts as living shorelines, especially in SIDS, by expanding mangroves, sea-grass, coral reefs and “ridge-to-reef” programmes aimed at reducing land-based pollution, including marine litter; and enhancing marine protected areas, climate-friendly coastal infrastructure for walking and biking, plant-based agriculture and the necessary international governance and finance.**

G20 leaders should mandate G20 institutions to coordinate work with SIDS and their institutions, e.g. the Caribbean Community (CARICOM), the Caribbean Institute for Meteorology and Hydrology (CIMH), the Caribbean Public Health Agency (CARPHA) and their equivalent bodies in other regions, the US National Oceanic and Atmospheric Administration Marine Debris Program and the German Agency for International Cooperation (GIZ), to strengthen data for monitoring coastal areas, and establish sustained, appropriate, region-wide information and education on the value of the environment, sea and coasts, and the responsibilities of citizens

G20 leaders should improve access to finance based on the multi-dimensional vulnerability index that the Alliance of Small Island States (AOSIS) has repeatedly endorsed, and through new “SDR for NbS swaps”, where G20 members donate unneeded special drawing rights (SDR) at the International Monetary Fund (IMF) to SIDS, to use mainly for climate action through NbS.

## **REINFORCE RENEWABLES**

Wind and solar power are well known, widely used, rapidly expanding, nature-intensive renewable energy sources. However, they face a critical barrier in replacing climate-polluting, non-renewable hydrocarbon sources at the required speed and scale. That barrier — their unpredictable intermittency when the sun does not shine and the wind does not blow — can be partially overcome by reinforcing geothermal, tidal and wave power, which are reliable nature-intensive renewables, to help provide base-load and surge-capacity. As all G20 countries have oceanic coasts and land for household heat exchanges, all can contribute and benefit. Their collective effort can help cut costs and secure the necessary site availability.

Geothermal energy can save at least 16.6 gigatons of CO<sub>2</sub> at a cost of US\$ 155.5 billion, for net savings of US\$ 1.03 trillion (Hawken 2017). It emits 99% less CO<sub>2</sub> than similarly sized fossil fuel power plants (EIA 2020). It is always available and accessible to households through heat exchangers installed in the yards of homes (at a cost of only US\$ 10,000.00 per house); deep geothermal, which replaces oil and gas wells by extracting renewable heat rather than hydrocarbons; and freely available, fully natural sources in naturally endowed countries such as Japan, Indonesia, the United States and Iceland. By 2050, geothermal could expand eightfold in Europe and 26-fold in the US, to provide 8.5% of American electricity as well as direct heat (Robbins 2020).





Italy, the G20 2021 host, is a leader in geothermal energy (Istituto Affari Internazionali 2020). The US is the world's largest geothermal producer. China leads in developing geothermal district heating systems, Canada in deep closed loop systems and Sweden in ground source heat pump technology (Robbins 2020). At Hamburg in 2017, G20 leaders recognized that “the energy transition needs to ... includ[e] enhanced renewables deployment in heating and cooling” and that “this includes...geothermal” (G20 2017).

Tidal and wave power can save at least 9.2 gigatons of CO<sub>2</sub> at a net cost of US\$ 411.8 billion, for net savings of about US\$ 1 trillion (Hawken 2017, 12-13). Tidal power is invisible, totally predictable, and requires no storage, but is the most expensive renewable. Although it accounts for only 0.0004% of global electricity at present, this figure could rise to 0.28% by 2050, including 25% of electricity in the US, 30% in Australia and 70% in Scotland, with Korea geographically favoured too.

This shift to reliable, nature-intensive renewables for base-load power should rapidly reduce coal use. Coal supplied over 37% of global energy in 2019. The share was over 70% in countries where energy needs are still rising. Transition away from coal is therefore crucial for a sustainable climate. With the variable cost of solar falling in most economies, coal's share of energy could be reduced if technological innovations make it possible for energy to be stored at commercially viable costs. At the same time, hydrogen-based heat applications are critical for an effective industrial transition. If G20 countries implement their stated policies to retrofit, repurpose or retire their existing coal-fired power plants, they can halve coal-fired emissions by 2030 and reduce coal's share of energy to 28% by 2030. In a more ambitious scenario, where energy storage and green hydrogen is promoted, the global share could fall to 15%. This is possible if the major industrialised countries, led by the US, Australia, Germany and Japan, take measures to bring down their share faster than the rest.

G20 summits, whose members have 80% of global energy consumption and installed renewable generation, have made 43 commitments on renewables and clean energy, averaging compliance of 88%. But they have so far neglected the reliable renewables and coal transition. Thus, at Rome, G20 leaders should commit to:

**Raising renewables' share of their total energy mix to at least 50% by 2030; doubling the share of geothermal, tidal and wave power by 2025; all substituting from energy storage or other reliable renewables; cutting coal to 15% (or less) of global energy generation by 2030; cutting coal-fired emissions, coal financing and new production and consumption by 50% by 2030, while mitigating the many risks and assuring affordable, accessible, reliable energy for all by 2030.**



## LOWER LAND-USE STRESS

Agriculture, Food or Land Use (AFOLU) accounts for up to 37% of all global emissions, including pre- and post-production activities in the food sector (IPCC 2019). Globally, agriculture causes 73% of deforestation, 70% of water use and more emissions than cars, trucks, ships and planes (IPCC 2019; Agrawal, Wollenberg and Persha 2014). AFOLU emissions pollute air, water, soil and coasts, causing many diseases that disproportionately harm poor and marginalized people, including non-communicable diseases, antimicrobial resistance and public health crises, such as the current Covid-19 pandemic.

The AFOLU sector creates 44% of methane emissions, which warm 28-34 times more than CO<sub>2</sub> (IPCC 2019, UNECE n.d.; Candell 2020; Tian, Rongting, Josep et al. 2020). Other major emitters of methane into the atmosphere include the oil and gas industry (24%), landfills (11%) and coal mining (9%) (UN FAO 2021; GMI 2015). In some G20 countries, agriculture produces more than 40% of methane emissions (UN FAO 2021a). Methane accounts for 20% of global GHG and one-third of their warming and will rapidly increase by 2030 (GMI n.d.).

Shifting from industrial animal agriculture to growing and eating plant-based foods can eliminate at least 66.11 gigatons of CO<sub>2</sub> emissions and benefit the environment and human health in many other ways (Hawken 2017, pp. 39-40; Clark, Springmann, Hill et al. 2019). Some G20 governments are increasingly promoting predominantly plant-based diets (Sorrel 2017; Tello 2018; Flanagan 2019; IPCC 2019).

G20 leaders have long addressed agriculture and food. Saudi Arabia's initial public priorities for 2020 included "sustainable agriculture and changing dietary habits" to address the impacts of climate change on food systems (G20 Saudi Arabia 2019). However, this was completely crowded out by Covid-19 at the Riyadh Summit. The Italian presidency should robustly revive it, especially as the home of the core UN food and agriculture organizations, a contributor to the UN food summit in September and co-chair, with the UK, of the UN climate summit in Glasgow in November. Moreover, Italy is home to the European Food Safety Agency, and the largely plant-based Mediterranean diet has been recognized as an intangible heritage asset by UNESCO.

Minimizing methane requires breeding fewer ruminants for beef, pork and lamb, and lowering the methane the remaining ones emit. Moreover, the global oil and gas industry can reduce methane emissions by 75% using existing technologies, with up to two thirds coming at zero net cost, by following the Methane Guiding Principles (IEA 2017; Li 2021).

Most G20 members are acting domestically and as partners of the Global Methane Initiative and the Climate and Clean Air Coalition (CCAC) (GMI 2015; CCAC n.d.), but G20 summits have never addressed methane. The G20's Rome Summit should therefore:

**Lower land-use stress, by immediately shifting from industrial animal agriculture to growing and eating diversified plant-based foods; reducing food waste; minimizing**



**methane emissions by applying the Methane Guiding Principles and aiming to achieve, by 2025, a 25% shift from animal to plant-based food, and a commensurate cut in methane emissions from the agriculture and oil and gas sectors.**

The Rome Summit should also foster carbon farming practices following the Koronivia Joint Work on Agriculture under the UN Framework Convention on Climate Change (UNFCCC), the UN Food and Agriculture Organization's Thematic Working Group on Agriculture, and the CCAC's agriculture initiative, and support the EU initiative to create an international methane emissions observatory (European Commission 2020).



# APPENDIX A

## G20 SUMMIT CONCLUSIONS OF KEY NATURE-BASED SOLUTIONS

Year	Total	Average	For ests	Air pollu tion	Urba n air pollu tion	Green cities	Coasts	Tidal	Geother mal	Coal
2008W	0									
2009L	0									
2009P	0									
2010T	0									
2010S	379	0.011	165 (1.05 %)							
2011C	180	0.013								180 (1.28% )
2012LC	358	0.009	94 (0.7 4%)							133 (1.04 %)
2013SP	184	0.006								184 (0.64 %)
2014B	0									
2015A	0									
2016Hz	66	0.002	31 (0.2 0%)							35 (0.22 %)
2017Hb	645	0.002	173 (0.5 0%)	48 (0.14%)	48 (0.14 %)		88 (0.25%)	49 (0.14% )	49 (0.14%)	
2018Ba	257	0.016					137 (1.61%)			
2019O	726	0.027		179 (2.70%)						
2020R	440	0.023	113 (1.20 %)	68 (1.19%)			259 (4.55%)			
<b>Total</b>	2033	n/a	576	295	48	1202	484	49	49	532
<b>Average #</b>	216	n/a	115	98	48	240	161	49	49	133
<b>Average %</b>	n/a	0.010	0.07	0.013	0.001	0.025	0.021	0.001	0.001	0.008



Notes: blank cells = no data. n/a = not applicable. Peat/wetlands, in-stream hydro, methane and plant-based diets had no references. Numbers = number of words on the subject. Percentages in brackets = percent of total words on the subject.

Conclusions: Data measured by the G20 Research Group by coding the total number of words in the G20 leaders' public communiqués on a given subject and dividing by the total number of words in the communiqué across all subjects, to determine the level of public attention given to said subject relative to others.

Inclusion terms: Forests = forests, deforestation, afforestation, trees, land degradation, desertification, REDD+, Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGFT), agroforestry. Peat = peatlands. Air pollution = air pollution, clean cookstoves, clean air. Urban air pollution = outdoor urban air pollution, urban environmental quality (excludes indoor air pollution, clean cookstoves).

Coasts = coast/al, SIDS, mangroves seagrass, coral reefs, coastal infrastructure (excludes marine litter, marine pollution, marine environment, plastics, oceans). Run of river hydro (pumped hydro from renewable sources) = run of river hydro (excludes hydro). Tidal = tidal, wave, ocean energy. Geothermal = geothermal. Coal = coal (excludes carbon, fossil fuels). Methane = methane. Plant-based diet/agriculture = plant-based diet, vegetarian, vegan, flexitarian (excludes food security, diversified diet, nutrition, hunger, small-holder agriculture).



# APPENDIX B

## THE G20 AND WETLANDS PROTECTION

<b>G20 member</b>	<b>Joined Convention</b>	<b>Number of Designated Wetlands of International Importance</b>	<b>Surface Area in Hectares</b>
<b>United Kingdom</b>	May 5, 1976	175	1,283,040
<b>Mexico</b>	Nov. 4, 1986	142	8,657,057
<b>Australia</b>	Dec. 21, 1975	66	8,307,694
<b>China</b>	July 31, 1992	64	7,326,952
<b>Italy</b>	April 14, 1977	56	73,308
<b>Japan</b>	Oct. 17, 1980	52	154,696
<b>France</b>	Dec. 1, 1986	50	3,748,200
<b>India</b>	Feb. 1, 1982	42	1,081,438
<b>United States</b>	Dec. 18, 1986	41	1,884,551
<b>Canada</b>	May 15, 1981	37	13,086,767
<b>Germany</b>	June 26, 1976	35	869,256
<b>Russia</b>	Feb. 11, 1977	35	10,323,767
<b>Brazil</b>	Sept. 24, 1993	27	26,794,455
<b>South Africa</b>	Dec. 21, 1975	27	571,089
<b>Argentina</b>	Sept. 4, 1992	23	5,714,016
<b>Korea</b>	July 28, 1997	23	19,618
<b>Turkey</b>	Nov. 13, 1994	14	184,487
<b>Indonesia</b>	Aug. 8, 1992	7	1,372,976
<b>Total</b>		916	91,453,367

**Source:** <https://www.ramsar.org/country-profiles>.



## NOTES

<sup>1</sup>Emissions estimations are derived from different sources. As such, the totals may not add up to 100%, but illustrate the trends. Moreover, the “up to 37%” of emissions in the AFOLU sector includes the pre- and post-production food supply chain, which may include energy usage and therefore create overlap between the emissions estimates for the AFOLU and energy sectors.

<sup>2</sup> Data measured by the G20 Research Group by coding the total number of words in the G20 leaders’ public communiqués on a given subject, in this cases forests, and dividing by the total number of words in the communiqué across all subjects, to determine the level of public attention given to said subject relative to others.



## REFERENCES

Agrawal A., E. Wollenberg, and L. Persha, (2014), "Governing Agriculture-Forest Landscapes to Achieve Climate Change Mitigation", *Global Environmental Change*, vol. 28, p. 270-80

C40 Cities, "Cities Have the Power to Change the World", C40 Cities, n.d. [https://www.c40.org/why\\_cities](https://www.c40.org/why_cities)

Candell P., (2020), "Nitrous Oxide Emissions 300 Times More Powerful than Carbon Dioxide are Jeopardizing Earth's Future", *PhysOrg*, 6 October [https://phys.org/news/2020-10-nitrous-oxide-emissions-powerful-carbon.html#:~:text=As%20a%20greenhouse%20gas%2C%20N,in%20the%20atmosphere\)%20and%20methane](https://phys.org/news/2020-10-nitrous-oxide-emissions-powerful-carbon.html#:~:text=As%20a%20greenhouse%20gas%2C%20N,in%20the%20atmosphere)%20and%20methane)

Climate and Clean Air Coalition (CCAC), "The CCAC Oil and Gas Methane Partnership", n.d. <https://www.ccacoalition.org/en/activity/ccac-oil-gas-methane-partnership>

Chioando M., (2021), "Number of Vegans in Britain Skyrocketed by 40% in 2020, Claims Survey", *Plant Based News*, 8 January <https://plantbasednews.org/culture/ethics/vegans-in-britain-skyrocketed/>

Clark M. et al., (2019), "Multiple Health and Environmental Impacts of Foods", *Proceedings of the National Academy of Sciences of the United States of America*, vol. 116, no. 46, p. 23357-23362 <https://doi.org/10.1073/pnas.1906908116>

Energy Information Administration (EIA), (2020), "Geothermal Explained: Geothermal Energy and the Environment", U.S. Energy Information Administration, last updated 19 November 2020 <https://www.eia.gov/energyexplained/geothermal/geothermal-energy-and-the-environment.php#:~:text=Geothermal%20power%20plants%20have%20low,sulfur%20dioxide%20and%20carbon%20dioxide.&text=Geothermal%20power%20plants%20use%20scrubbers,naturally%20found%20in%20geothermal%20reservoirs>

European Union, "The EU and Nature-based Solutions", European Commission, n.d. [https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions\\_en](https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en)

European Commission, (2020), "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on an EU Strategy to Reduce Methane Emissions", Brussels, 14 October (COM2020 663 final) [https://ec.europa.eu/energy/sites/ener/files/eu\\_methane\\_strategy.pdf](https://ec.europa.eu/energy/sites/ener/files/eu_methane_strategy.pdf)

Filho W. et al., (2018), "Coping with the Impacts of Urban Heat Islands. A Literature Based Study on Understanding Urban Vulnerability and the Need for Resilience in Cities in a Global Climate Change Context", *Journal of Cleaner Production*, vol. 171, no. 10, p. 1140-49 <https://doi.org/10.1016/j.jclepro.2017.10.086>





Flanagan R., (2019), “Canada’s Food Guide Recommends We Eat More Plants, Less Meat”, CTV News, 22 January <https://www.ctvnews.ca/canada/canada-s-food-guide-recommends-we-eat-more-plants-less-meat-1.4263478>

G20, (2017), “G20 Hamburg Climate and Energy Action Plan for Growth,” G20 Information Centre, 8 July <http://www.g20.utoronto.ca/2017/2017-g20-climate-and-energy.html>

G20 Saudi Arabia, (2019), “Overview of Saudi Arabia’s 2020 G20 Presidency”, G20 Information Centre, 1 December [http://www.g20.utoronto.ca/2020/2020-Presidency\\_Agenda-V5.pdf](http://www.g20.utoronto.ca/2020/2020-Presidency_Agenda-V5.pdf)

Global Alliance on Health and Pollution (GAHP), (2019), “Pollution and Health Metrics: Global, Regional, and Country Analysis” [https://gahp.net/wp-content/uploads/2019/12/PollutionandHealthMetrics-final-12\\_18\\_2019.pdf](https://gahp.net/wp-content/uploads/2019/12/PollutionandHealthMetrics-final-12_18_2019.pdf)

Global Alliance on Health and Pollution (GAHP), (2020), “Air Pollution Interventions: Climate and Health Impacts” <https://gahp.net/report-air-pollution-interventions-seeking-the-intersection-between-climate-health/>

Global Methane Initiative (GMI), “Global Methane Emissions and Mitigation Opportunities”, n.d. <https://www.globalmethane.org/documents/gmi-mitigation-factsheet.pdf>

Global Methane Initiative (GMI),(2015), “Why is Methane So Important?”, December <https://www.globalmethane.org/methane/index.aspx>

Hawken P., (2017), Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming, New York, Penguin Books

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019 <http://ipbes-global-assessment-report-summary-for-policymakers>.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), The Global Assessment Report on Biodiversity and Ecosystem Services

International Energy Agency (IEA), (2017), “The Environmental Case for Natural Gas”, 23 October <https://www.iea.org/commentaries/the-environmental-case-for-natural-gas>

International Energy Agency (IEA), (2020), World Energy Outlook

Istituto Affari Internazionali (IAI), (2020), Geopolitics and Italian Foreign Policy in the Age of Renewable Energies, June [https://www.iai.it/sites/default/files/iaip2013\\_statistical\\_factsheet.pdf](https://www.iai.it/sites/default/files/iaip2013_statistical_factsheet.pdf)

Intergovernmental Panel on Climate Change (IPCC), (2019), “Climate Change and Land: Summary for Policymakers”, 7 August <https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/>

Landrigan P.J., R. Fuller, and N.J.R. Acosta, (2017), “Lancet Commission on Pollution and Health”, The Lancet, vol. 391, no. 10119, pp. 462-512



Lex, (2021), "Tree Planting: Everything but the Carbon Sink", Financial Times, 22 March, p. 18

McDonald R., (2016), "Planting Healthy Air: A Natural Solution to Address Pollution and Heat in Cities", World Bank, 31 October <https://blogs.worldbank.org/sustainablecities/planting-healthy-air-natural-solution-address-pollution-and-heat-cities>.

McKinsey and Company, "Pathways to a Low-Carbon Economy for Brazil", n.d. [https://www.mckinsey.com/~media/mckinsey/dotcom/client\\_service/infrastructure/pdfs/pathways\\_low\\_carbon\\_economy\\_brazil.ashx](https://www.mckinsey.com/~media/mckinsey/dotcom/client_service/infrastructure/pdfs/pathways_low_carbon_economy_brazil.ashx).

Narayan, S., (2018), "Protecting Wetlands Helps Communities Reduce Damage from Hurricanes and Storms", The Conversation, 11 October <https://theconversation.com/protecting-wetlands-helps-communities-reduce-damage-from-hurricanes-and-storms-104670>.

Our World in Data, (2020), "Sector by Sector: Where do Global Greenhouse Gas Emissions Come From?", Our World in Data <https://ourworldindata.org/ghg-emissions-by-sector>

Project Drawdown, "Land Sinks", n.d. <https://drawdown.org/sectors/land-sinks>.

Ramsar, (2014), "Country Profiles", Ramsar Convention on Wetlands <https://www.ramsar.org/country-profiles>

Robbins J., (2020), "Can Geothermal Power Play a Key Role in the Energy Transition?", Yale Environment 360, 22 December [https://e360.yale.edu/features/can-geo-](https://e360.yale.edu/features/can-geo-thermal-power-play-a-key-role-in-the-energy-transition#:~:text=Geothermal%20is%20destined%20to%20play,%2Dthe%2Dabove%20strategy.%E2%80%9D)

[thermal-power-play-a-key-role-in-the-energy-transition#:~:text=Geothermal%20is%20destined%20to%20play,%2Dthe%2Dabove%20strategy.%E2%80%9D](https://e360.yale.edu/features/can-geo-thermal-power-play-a-key-role-in-the-energy-transition#:~:text=Geothermal%20is%20destined%20to%20play,%2Dthe%2Dabove%20strategy.%E2%80%9D)

Rojas Urrego M., (2019), "Wetlands and Climate Change," Ramsar Convention on Wetlands, 30 January <https://www.ramsar.org/news/wetlands-and-climate-change>

Seddon N. et al., (2020), "Understanding The Value And Limits Of Nature-Based Solutions To Climate Change And Other Global Challenges", Philosophical Transactions Of The Royal Society B: Biological Sciences, vol. 375, no. 1794

Scortichini M. et al., (2018), "Short-Term Effects of Heat on Mortality and Effect Modification by Air Pollution in 25 Italian Cities", International Journal of Environmental Research and Public Health, vol. 15, no. 8, p. 1771 <https://doi.org/10.3390/ijerph15081771>

Schmidt C.W., (2011), "Black carbon: the dark horse of climate change drivers", Environmental Health Perspectives, vol. 119, no. 4, p. A172-5

Sorrel C., (2017), "The German Environment Ministry Makes the Government Go Vegetarian", Fast Company, 2 March <https://www.fastcompany.com/3068567/the-german-environment-ministry-makes-the-government-go-vegetarian>

Tello M., (2018), "Eat More Plants, Fewer Animals", Harvard Medical School, 29 November <https://www.health.harvard.edu/blog/eat-more-plants-fewer-animals-2018112915198>.



Tian, H., R. Xu, J.G. Canadell et al., (2020), “A Comprehensive Quantification of Global Nitrous Oxide Sources and Sinks”, *Nature*, vol 586, pp. 248-56

United Nations Economic Commission for Europe (UNECE), “The Challenge”, n.d. <https://unece.org/challenge#:~:text=Methane%20is%20a%20powerful%20greenhouses,are%20due%20to%20human%20activities>

UN Food and Agriculture Organization of the United Nations (UN FAO), (2021), “Food Systems Account for More Than One Third of Global Greenhouse Gas Emissions”, 9 March <http://www.fao.org/news/story/en/item/1379373/icode/>

UN Food and Agriculture Organization of the United Nations (UN FAO), “Argentina”, last updated 2021(a) <http://www.fao.org/in-action/enteric-methane/participating-countries/south-america/argentina/es/>

UNICEF, (2020), “The Toxic Truth: Children Exposure to Lead Pollution Undermines a Generation Future Potential”, July

Watts N. et al., (2019), “The 2019 Report of the Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today is not Defined by a Changing Climate”, *The Lancet*, vol. 394, no. 10211, pp. 1836-78

World Economic Forum (WEF), (2020), “The Oceans are Absorbing More Carbon than Previously Thought” <https://www.weforum.org/agenda/2020/10/oceans-absorb-carbon-seas-climate-change-environment-water-co2/>.

Wetlands International, (2009), “The Global Peatland CO<sub>2</sub> Picture: Peatland Status and Emissions in all Countries of the World”, United Nations Framework Convention on Climate Change, September/October <https://unfccc.int/sites/default/files/draftpeatlandco2report.pdf>.

World Health Organization (WHO), “Air Pollution”, last updated 2021 [https://www.who.int/health-topics/air-pollution#tab=tab\\_1](https://www.who.int/health-topics/air-pollution#tab=tab_1)

World Bank Group. “Agricultural Pollution Field Burning”, World Bank Group, n.d. <http://documents1.worldbank.org/curated/en/989351521207797690/pdf/124342-repl-WB-Knowledge-Burning.pdf>

You L. and K. Schoenmakers, (2020), “Why China’s Methane-Spewing Farms Are a Hidden Climate Risk”, *Sixth Tone*, 27 November 27 <https://www.sixthtone.com/news/1006501/why-chinas-methane-spewing-farms-are-a-hidden-climate-risk>

You L. (2021), “Emissions of Methane, a Powerful Greenhouse Gas”, *Sixth Tone*, 22 March <https://www.sixthtone.com/news/1006954/china-to-reduce-emissions-of-methane%2C-a-powerful-greenhouse-gas>



## ABOUT THE AUTHORS



**Thomas Crowther** ETH Zurich (Switzerland)

Welsh scientist studying ecology and biodiversity, he is a Professor in the Department of Global Ecosystem Ecology at ETH Zurich, where he founded Crowther Lab, an interdisciplinary group of scientists studying global ecosystems and generating knowledge to protect biodiversity and address climate change. He serves as co-chair of the advisory board of the UN Decade on Ecosystem Restoration, along with Lucy Mulenkei.



**Thomas Elliott** ETH Zurich (Switzerland)

**James Hospedales** EarthMedic and EarthNurse Foundation



A lover of nature, an accomplished public health physician, a person of faith, a father, grandfather, and woodworker, Dr Hospedales founded EarthMedic and EarthNurse to mobilise health professionals and others to address the climate and health crisis. He chairs the Defeat-NCD partnership executive committee, addressing NCDs in low-resource countries. He was inaugural Executive Director of the Caribbean Public Health Agency (CARPHA), and coordinator chronic disease prevention and control in PAHO/WHO. A graduate of UWI and the London School of Hygiene and Tropical Medicine, Fellow of the UK Faculty of Public Health, Dr H has published more than 100 papers and reports.



**John J. Kirton** G20 Research Group

Director of the G20 Research Group and the G7 Research Group, Co-Director of the BRICS Research Group, and Co-Director of the Global Health Diplomacy Program, all based at the Munk School of Global Affairs and Public Policy at Trinity College in the University of Toronto, where he is a professor of political science and Canadian foreign policy. He is the author of *China's G20 Governance* (2016) and *G20 Governance for a Globalized World* (2013), co-author of *Global Governance on Climate Change: G7, G20 and UN Leadership* (2015), and co-editor of *Accountability for Effectiveness in Global Governance* (2018). He is also co-editor of the recently published *G20 Japan: The 2019 Osaka Summit and Health: A Political Choice*.



**Rachael Kupka** Global Alliance on Health and Pollution, Geneva (Switzerland)

Acting Executive Director at the Global Alliance on Health and Pollution. She has over 15 years experience in nonprofit, program management, development and fundraising. Rachael holds a MA in International Political Economy and Development from Fordham University, and a Certificate in Conservation Biology from Columbia.



**Marina Larionova** Center for International Institutions Research (CIIR), Moscow (Russia)

Head of the Center for International Institutions Research (CIIR) of the Russian Presidential Academy of National Economy and Public Administration (RANEPA). She is author, co-author and editor of several books on the global governance, G7/G8 and G20 system, BRICS and other international institutions. Dr Larionova is Professor at the Faculty of World Economy and International Affairs, HSE University, and the Editor-in-Chief of the International Organisations Research Journal (IORJ). She holds a doctorate in political science awarded by the Russian Peoples' Friendship University and a doctorate in philology awarded by Moscow State Pedagogical Institute.



**Rajani Ranjan Rashmi** The Energy & Resources Institute (TERI), New Delhi (India)

Distinguished Fellow and Programme Director in The Energy & Resources Institute (TERI), a leading think tank of India in the field of environmental research and advocacy. He advises and works on the areas relating to climate change policy, low carbon development, carbon markets, and other environmental issues. Dr Rashmi was India's principal negotiator of the Government of India for climate change for several years and has over 35 years of experience of working with the Government. He held the position of Special Secretary to the Ministry of Environment, Forests & Climate Change where he played a key role in framing India's approach to climate policies before and after the Paris Agreement.



**Laura Schaepli** Global Alliance on Health and Air Pollution, Geneva (Switzerland)

Program Manager at the Global Alliance on Health and Pollution. She has over 7 years of experience in project management in non-profit environments. Laura holds a PhD in Geography from Queen's University in Kingston, Ontario, Canada.



**Andrey Shelepov** Center for International Institutions Research (CIIR), Moscow (Russia)

Researcher in the Center for International Institutions Research (CIIR) of the Russian Presidential Academy of National Economy and Public Administration (RANEPA). He is an author and co-author of several books and papers on the G8/7, G20 and BRICS, and their engagement with other international institutions, as well as on multilateral development banks. He holds a PhD in economics.



**Brittany Warren** G20 Research Group

Lead Researcher on Climate Change for the G20 Research Group, the G7 Research Group and the BRICS Research Group at the Munk School of Global Affairs and Public Policy at Trinity College in the University of Toronto. She has published on accountability measures in summit commitments, the G20 and G7's compliance and governance of climate change, and the G20's governance of digitalisation. She holds a master's degree in environmental studies from York University.