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For more information, please contact:

Susan Tonassi (stonassi@burness.com; +1 202 716 9665) in Washington, DC
Florence Wood (fwood@burness.com; +44 7491 147 576) in GMT+1

As national climate plans fall short, new study lays out country-by-country potential and feasibility for slashing land-based GHG emissions from forests, farming and consumer behavior

Assessment of 20 land management activities across more than 200 countries fills critical data gaps to aid countries with updating and increasing ambition on their national climate plans

(Washington, DC) 12 October 2021—At a time when only one country in the world is on track to reduce greenhouse gas emissions in line with limiting global warming to 1.5°C, a [new study](#) published in *Global Change Biology* provides a comprehensive reference guide on the potential and feasibility of land-based climate solutions for over 200 countries.

The study analyzes 20 land-based measures that reduce GHG emissions or remove GHGs from the atmosphere. They include the protection, management and restoration of forests and other ecosystems. Other measures consider changes in agricultural practices; soil carbon sequestration in croplands and grasslands; use of bioenergy; and demand-side measures within food systems such as reducing food waste and shifting to more sustainable and less livestock-dependent diets. If implemented in a way that delivers biodiversity and social benefits, land-based mitigation measures are considered nature-based solutions.

“Our analysis shows which and how much nature-based solutions could be prioritized country-by-country,” said Stephanie Roe, an environmental scientist at Climate Focus and the lead author of the study. “Many land-based mitigation activities are unique in that they can be rapidly implemented, provide additional environmental and socio-economic co-benefits, work in tandem with the decarbonization of other sectors – like energy, and are relatively low cost. For many countries, they also provide the largest share of the low-cost mitigation needed to reach net zero emissions by mid-century and deliver on the Paris Agreement targets.”

The study was developed in response to country requests to the Intergovernmental Panel on Climate Change to identify options on a regional- and individual country-basis for curtailing greenhouse gas (GHG) emissions. It provides the most in-depth and rigorous assessment to date of how each country can lower their emissions through specific land-use activities, outlining cost-effective mitigation potentials, associated land footprints and feasibility.

Main findings include:

- Land-based measures could cumulatively reduce CO₂ emissions (or their equivalents) by 8-13.8 billion tons every year between 2020 and 2050, or approximately

20-30 percent of the total mitigation needed to achieve the 1.5°C temperature target.

- Roughly half of cost-effective mitigation potential comes from the protection, restoration and improved management of forests and other ecosystems; 35 percent comes from changes in agriculture; and 15 percent comes from demand-side measures (an amount that triples when considering the impact of reduced food waste and diet shifts on avoided land conversion).
- Forest protection that avoids deforestation and conversion of wetlands provides the highest level of mitigation potential (28 percent of total cost-effective potential); more than ecosystem restoration (13 percent) or forest management (7 percent).
- About a third of countries have cost-effective nature-based solutions that are more than 50 percent of their total national emissions, whereas about 15 percent of countries have potential that exceeds all their emissions.
- About 60 percent of the cost-effective mitigation potential is found in top 15 countries, mainly because of their large size: Brazil, China, Indonesia, United States, India, Russian Federation, Canada, the Democratic Republic of the Congo (DRC), Colombia, Mexico, Argentina, Australia, Bolivia, Peru, and Myanmar.
- But when considering *mitigation density* (mitigation potential per unit area), the top 15 countries shift toward smaller, mostly forested countries and island states: Maldives, Brunei, Bangladesh, Indonesia, Vietnam, Trinidad and Tobago, Malaysia, Malta, Rwanda, South Korea, Netherlands, Cambodia, Mauritius, Philippines and El Salvador.
- Investment, governance and other conditions affect the feasibility of delivering land-based mitigation. To assess barriers and opportunities for implementation, the researchers developed a new feasibility index based on 19 indicators (categorized as either economic, institutional, geophysical, technological, socio-cultural, or environmental). Feasibility scores identify challenges and opportunities for land-based mitigation in each country. About 80 percent of potential is in developing and Least Developed Countries, where implementation feasibility is of greatest concern.

“Assisting countries to overcome barriers—particularly through enhanced financing and investments—will be critical to realizing a significant amount of near-term reductions in GHG emissions,” Roe said.

“Since our study shows that about 80 percent of potential for land-based mitigation is in developing and Least Developed Countries, it is imperative that the \$100 billion per year promised in 2010 by wealthy countries to developing countries finally gets delivered at COP26 in Glasgow in a few weeks’ time,” said Pete Smith, Professor at the University of Aberdeen and co-author of the study.

Forests and wetland ecosystems foremost

The study found that the protection of forests and other ecosystems (peatlands and coastal wetlands) and demand-side measures (reduced food waste and shifts to healthy diets) present particularly high mitigation efficiency, high provision of co-benefits, and relatively lower costs.

The prevention of deforestation and protection ecosystems also offer the highest mitigation density.

“On a per unit area, ecosystem protection beats restoration on climate mitigation any day,” Roe said. “It prevents CO₂ emissions that occur when natural ecosystems like forests are destroyed, and it also allows for ongoing carbon sequestration. When we lose forests, peatlands and coastal wetlands, most of the carbon lost is irrecoverable by 2050, a time when we need to reach net zero carbon emissions. Restoration processes just take too long to re-accumulate that lost carbon.”

Furthermore, forest protection contributes to climate resilience, as a buffer against extreme heat and diminished rainfall. Ecosystem protection is also vital for conserving biodiversity and delivering on nature positive targets.

“We see that northern Hemispheric forests are already suffering under climate change and increased disturbances leading to a reduced sink. We can curb this trend with improved forest management which also enhances biodiversity conservation and the provision of wood products. The improvement of this whole chain is crucial to achieve success,” said Gert-Jan Nabuurs, Professor of European forest resources at Wageningen University and co-author of the study.

On a regional basis, the highest cost-effective potentials are in Asia and developing Pacific, followed by Latin America and Caribbean, then Africa and Middle East, Developed Countries, and Eastern Europe and West-Central Asia. In both the Asian and Latin American regions, as well as the Africa region, the highest cost-effective mitigation potential is the protection of forests.

Livestock and consumer measures critical for reducing methane emissions

As the recent [IPCC report](#) emphasized, [methane](#) is responsible for about 30-50 percent of the ~1°C warming that we see today, about a third of which comes from land. Because methane only stays in the atmosphere for 10-20 years and is about 80 times more potent than carbon dioxide, mitigating methane emissions is a highly effective strategy for reducing warming in the near-term. The livestock management measures laid out in the new study, such as reducing enteric fermentation and manure management, and consumer measures that reduce food waste and shift to plant-rich diets, are crucial for curbing methane. Developed countries, including the U.S. and EU countries, can do the most to slash methane emissions through livestock and demand-side measures, and they have a [pledge to cut 30 percent by 2030](#). Emerging economies with large beef industries—such as Brazil and Argentina—also have a major role to play.

“The agricultural sector is the single largest source of both global methane and nitrous oxide and can make an important and relatively low-cost contribution to meeting emissions reduction targets. However, there is substantial variability in mitigation potential and costs across countries depending on current emissions, climate and soil characteristics, production practices, market conditions, and other factors. Our study captures important differences in the relative potential of individual measures available within the agricultural sector as well as comparison to other land-based measures at the country level, which can help inform the development of cost-effective national mitigation plans,” said Robert Beach, Senior Economist and Fellow at RTI International and co-author of the study.

"Preventing food waste and shifting to healthier, more sustainable--and still delicious--diets turns out to be crucial for achieving the 1.5C climate targets, ensuring future food security, and preventing continued degradation of ecosystems. Decisions we all make everyday about what and how much we eat can send ripples across the food system reducing emissions and helping to achieve the SDGs," said Chad Frischmann, Senior Director at Project Drawdown and co-author of the study.

Study methodology

The study was developed through collaboration among 31 co-authors from 24 institutions who incorporated two different analytical approaches. One approach drew on 25 different databases that looked at individual mitigation measures. The other collated the result of six different climate models and 131 scenarios. A comparison of both approaches provides a robust boundary of land-based mitigation potentials.

Building on and refining previous studies that examined the mitigation potential of land-based measures, this is the first to assess both land and demand management potentials as well as implementation feasibility in every country in the world, estimating not only technical potential (what is possible with available technology, regardless of cost), but more importantly the cost-effective potential of each of the 20 measures. Cost-effective potential provides more practical options for policymaking than technical potential, as it is grounded in public willingness to pay for climate mitigation. A measure was considered cost-effective if it cost no more than \$100/tCO₂eq.

Implications

Global greenhouse gas emissions, measured in 'carbon dioxide-equivalents' (CO₂e), collectively amount to around 50 gigatons tons of CO₂e each year--more than [40 percent higher than in 1990](#). To meet the global target of preventing temperatures from rising more than 1.5°C above pre-industrial levels, global emissions would need to fall by about 50% each decade, until net zero emissions are reached mid-century. Yet today, global carbon dioxide emissions are set for their [second-biggest increase in history](#).

A recent assessment of countries' nationally determined contributions (NDCs) under the Paris Agreement found that very few include ambitious, quantified targets for forest- and land-use based mitigation. "Our study offers countries the insight they need to identify strategies that boost their climate ambitions, align with Sustainable Development Goals, and update national mitigation plans in advance of November's global climate summit and beyond," said Roe.

"The study helps to bridge a knowledge gap between global studies and national policy planning. By providing country-specific information on mitigation activities and potentials, it allows governments to prioritize policy interventions and donors to target particular activities - such as avoided deforestation or regenerative agriculture- in the support they offer developing countries. The study also shows the importance of demand-side shifts. What we eat – or waste- has a direct impact on emissions in other countries," said Charlotte Streck, Managing Director at Climate Focus and co-author of the study.

