



CLIMATE CHANGE MODELLING INFORMATION

Quarterly report – Q2 2023 report





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A report submitted by [ICF S.A.](#)

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- **High-level executive summary**

This report under the “**Climate change modelling information**” series presents recent developments reported by key international climate modelling institutions. This issue sets particular emphasis on Land Use, Land Use Change and Forestry (including agriculture) in addition to the regular sections on Nationally Determined Contributions and Mid-century strategies.

The first section of the report highlights various modelling studies related to **Land Use, Land Use Change and Forestry**. Researchers from Indian Institute of Technology Kharagpur, **India**, published a comprehensive review on Land Use Land Cover (LULC) modelling techniques to better understand the linkages between land use, land cover and urban growth. The review emphasises the need to better incorporate policy frameworks into LULC modelling. Another study from researchers in the **USA** emphasises the importance of protecting high biomass forests for achieving global carbon mitigation goals. Researchers from the Joint Research Centre, in **Europe**, assess greenhouse gas emissions and removals of the European Agriculture, Forestry, and Other Land Use (AFOLU) sector integrating different sectoral modelling tools. This research can help in the ex-ante evaluation of climate neutrality in the AFOLU sectors.

The second section focuses on research developments linked to the implementation of the **Nationally Determined Contributions (NDCs)**. Researchers from the **European Scientific Advisory Board on Climate Change** provide advice on the EU greenhouse gas emissions budget for 2030-2050, recommending a 90-95% GHG emissions reduction target by 2040 relative to 1990 and emphasising the benefits of demand-side actions. In **Greece**, researchers analyse the ambitious NDCs targets in Morocco, and suggest strengthening policies to cover sectors beyond electricity, such as transport, industry, buildings sectors. In **Spain**, a research group highlighting that near-term pledges alone lead to warming above 2°C, while long-term pledges are compatible with a future well below 2 °C. However, the authors raise concerns regarding the feasibility of implementing these pledges.

The third section features research linked to **mid-century strategies**. A study conducted in **Switzerland** assesses the benefits of a joint Carbon Border Adjustments Mechanism (CBAM) between EU, USA and China; showing the potential of CBAM as collective instruments to improve mitigation efforts and trade competitiveness. A group of researchers in **Italy** explores the decarbonisation options of the Central Asian and Caspian regions, emphasising the need for rigorous energy planning to align with the Paris Agreement targets, and reduce dependence on energy policies of importing countries. Another report by ClimateWorks Global Intelligence in the **USA** explores the availability and emissions reduction impact of climate solutions across the energy and land use sectors that can help achieve the climate ambitions of the Paris Agreement. Lastly, researchers from **China** showing that achieving carbon neutrality by 2050 can reduce heat-related mortality risk by almost a quarter.

● Introduction

This report is the second quarterly report of 2023 under the series “Climate change modelling information” financed by the European Commission. The objective of this series is to inform the European Commission and the wider climate change and energy modelling community about recent and relevant modelling developments. The data presented in this report were collected through desk research as the open survey sent to more than 200 modelling teams worldwide that usually inform this report did not receive any responses.

The survey asked modellers to report relevant developments with a focus on Land Use, Land Use Change and Forestry (including agriculture, water systems, etc.) the implementation of Nationally Determined Contributions (NDCs), and mid-century strategies.

Although the objective of this report is to present a list of the most recent developments, it cannot be considered exhaustive. The modelling developments discussed in this report are summarised below and further described in the coming chapters.

Modelling developments linked to the Land Use, Land Use Change and Forestry

- [A Comprehensive Review on Land Use/Land Cover \(LULC\) Change Modelling for Urban Development: Current Status and Future Prospects \(India\)](#)
- [The effectiveness of global protected areas for climate change mitigation \(USA\)](#)
- [A multi-sectoral integrated modelling framework for assessing greenhouse gas emissions and removals in the European Agriculture, Forestry and Land Use Sectors \(EU\)](#)

Modelling developments linked to Nationally Determined Contributions (NDCs)

- [Scientific advice for the determination of an EU-wide 2040 climate target and a greenhouse gas budget for 2030–2050 \(EU\)](#)
- [Assessing the energy system impacts of Morocco's nationally determined contribution and low-emission pathways \(Greece\)](#)
- [A multimodel analysis of post-Glasgow climate targets and feasibility challenges \(Spain\)](#)

Modelling developments linked to mid-century strategies

- [Carbon border adjustment mechanism in the transition to net-zero emissions: collective implementation and distributional impacts \(Switzerland\)](#)
- [Reinforcing the Paris Agreement: Ambitious scenarios for the decarbonisation of the Central Asian and Caspian region \(Italy\)](#)
- [Achieving global climate goals by 2050: Pathways to a 1.5° C future \(USA\)](#)
- [Avoidable heat risk under scenarios of carbon neutrality by mid-century \(China\)](#)

- Modelling developments linked to land use, land use change and forestry

- Researchers from the [Indian Institute of Technology Kharagpur](#) published a comprehensive [review](#) of Land Use Land Cover (LULC) modelling techniques and new approaches to better understand how these tools can support improved urban development in the future. The review describes and compares different modelling approaches, assessing strengths and weaknesses of each technique. Researchers also assess the use of the hybridisation of different techniques, such as machine learning model combined with statistical models, to LULC modelling to complement their strengths.

The review finds that although the great progress made in LULC modelling, there is a need to increase the incorporation of the policy framework into LULC modelling for better urban planning and management. It provides six recommendations that may fill the research gap, including the development of an open-access simple modelling framework and datasets that are globally applicable as well as the incorporation of policies and relevant stakeholders in the LULC modelling frameworks.

Policy implications: the review will help the research community and policymakers to achieve better land management practices related to future urban expansion and ultimately support in achieving Sustainable Development Goal-15 (life on land).

- A research group led by the [University of Maryland](#), conducted a [study](#) published on *Nature Communications*, assessing the role of protected areas (PA), as an approach to forest conservation, in the mitigation of climate change. Researchers used NASA's Global Ecosystem Dynamics Investigation (GEDI) data¹ to quantify the effectiveness of protected areas at preserving forest structure and aboveground carbon (AGC). They then used statistical matching to quantify the differences between areas with forest conservation through PA designation to areas that are not PA, but with similarity in terms of their ecology, environment, and human pressure using data from 2000.

Results show that most forested PAs had significantly higher AGC in 2020 than the correspondent unprotected areas. These higher C stocks are primarily from avoided emissions from deforestation and degradation in PAs compared to unprotected forests.

Policy implications: Protected areas are effective for preventing carbon emissions related to deforestation and degradation, these areas are particularly critical in regions of the world experiencing high rates of deforestation.

- The [Joint Research Centre](#) has recently published a [technical report](#), with the aim to test the integration of several sectoral modelling tools for assessing GHG emissions and removals of the European AFOLU sectors. Researchers linked JRC modelling tools, such as CAPRI, POTEnCIA, CBM, and LUISA-BEES, in a consistent way to identify specific data flows and strengthen their simulation architecture. This allows researchers to show the challenges of integrating different modelling tools to account for complex land use changes. Researchers also explored the uncertainties underlying model assumptions and how different policies and technological options can impact the European markets and the environment.

Results shows that, despite the encountered challenges in the integration of different modelling approaches, the framework offers a useful tool for supplementing the impact assessment of bioenergy consumption in the energy sector. Particularly, the framework

¹ GEDI is a lidar mission aboard the International Space Station (ISS) that has been collecting high-resolution (25 m) samples of 3D vegetation structure since 2019.

contributes to capture potential impacts of alternative to fossil fuels on Agriculture, Forestry, and Other Land Use (AFOLU) sectors.

Policy implications: this report can inform decision making about the overall emission mitigation potential that these sectors can provide in the future, both by enhancing CO2 removals and reducing GHG emissions. Overall, it helps in the ex-ante evaluation of climate neutrality in the AFOLU sectors.

- **Modelling developments linked to Nationally Determined Contributions (NDCs)**

- The [European Scientific Advisory Board on Climate Change](#) has published its [recommendations](#) for setting the 2040 climate target for the EU. In doing so, it has consulted more than 20 research institutions and modelling groups to receive inputs on GHG scenario data. The recommendations report presents the different scenarios to achieve climate neutrality by 2050 in EU, addressing implications in terms of feasibility and challenges, as well as exploring in detail the implications of the scenarios, in terms of sectoral transformations, and synergies and trade-offs with the sustainable development goals.

The report shows that to achieve climate neutrality, the EU should set a target of 90-95% of emission reduction, relative to 1990. This target refers to net domestic greenhouse gas emissions, including emissions from intra-EU aviation and maritime transport. It also finds that focussing on demand-side actions that promote modest use of natural resources offers more synergies and fewer trade-offs across multiple SDGs.

Policy implications: the analysis aims to support the achievement of the European Climate Law's objective by providing EU institutions with its own estimate of an EU greenhouse gas emissions budget for 2030-2050 and a 2040 target, consistent with the Paris Agreement and the EU's 2050 climate neutrality target.

- The [study](#) from [E3Modelling](#) in Greece, published on *Energy Strategy Review* explores Morocco's Nationally Determined Contribution (NDC) targets, which are considered one of the most ambitious globally. The research focuses on the energy system, emissions, and cost impacts of meeting Morocco's (conditional and unconditional) targets for 2030 and assesses long-term strategies aligned with the Paris Agreement. They use a country-level energy system model, the MENA-EDS integrated energy system model, incorporating detailed representations of energy demand and supply options to analyse scenarios with different climate policies.

Results show that current policies for NDC implementation in Morocco are mainly based on the transformation of the electricity sector with rapid up-scaling of renewable technologies (especially solar PV and wind) combined with elimination of coal-fired power plants by 2030. The study suggests these policies should be strengthened to meet the NDCs targets for 2030, and focus more on both energy supply and energy demand, including implementing strategies in the transport, industry, buildings sectors as an example.

Policy implications: the study highlights the challenges and opportunities to achieve deep decarbonisation in Morocco, without compromising its energy security, especially through reconfiguration of the energy sector, moving away from fossil fuel imports and accelerating clean investments.

- Researchers led by the [Basque Centre for Climate Change](#) (BC3), in Spain published an [article](#) on *Nature Climate Change*, that assesses the CO2 emission trajectories in the near- and long-term based on national policies and pledges. Researchers used four different integrated assessment models (IAMs), combined with a non-CO2 infilling model and a simple climate model to assess the temperature implications. They also explore the feasibility of pathways of countries' pledges to identify where and when the largest bottlenecks to achieving climate targets can be found. In particular, the study evaluates their 1) socioeconomic feasibility, related to the cost burden of mitigation

policies; (2) technology scale-up feasibility, related to the speed at which clean technologies replace incumbent technologies; and (3) physical feasibility constraints related to the physical potentials for bioenergy production and carbon storage.

The study finds that if all near-term (2030) and long-term (2050) pledges are achieved, global temperature will stay below 2° C with a ~75% certainty. However, several feasibility concerns emerge across all modelled pathways, with regards to the cost of mitigation and the rates and scales of deployed technologies and measures.

Policy implications: when developing near and long-term pledges and targets, it is important to take into account the mitigation strategies and policies to overcome feasibility concerns related to the implementation of pledges and targets.

- **Modelling developments linked to mid-century strategies**

- A [study](#) conducted by the [École Polytechnique Fédérale de Lausanne](#) (EPFL) and available on the journal *Society for Environmental Economics and Policy Studies - SEEPS*, assesses the distributional impact of a joint Carbon Border Adjustments Mechanism (CBAM) between the world's most significant emissions contributors, the EU, the USA, and China. Researchers use the General Equilibrium Model of International-National Interactions between Economy, Energy and the Environment (GEMINI-E3), a general equilibrium model incorporating multi-country and multi-sector factors. The version of the model used is built on a specific database (GTAP 10), with 2014 as reference year.

The study shows that a joint CBAM reduces leakage, improves production on energy-intensive industries, and increases the joint CBAM member's welfare relative to a non-CBAM and a unilateral implementation.

Policy implications: the study shows the potential of CBAM as collective instruments to improve mitigation efforts and trade competitiveness. As an instrument to minimise carbon leakage, the effects and feasibility of CBAM will depend on multiple design options.

- Researchers from [E4SMA](#) in Italy, published a [paper](#) available on the *Renewable and Sustainable Energy Transition* journal to explore the decarbonisation options of the Central Asian and Caspian regions. In this paper, researchers performed an energy scenario analysis of four countries in the region, namely Azerbaijan, Kazakhstan, Uzbekistan and Turkmenistan, to explore how ambitious their regional decarbonisation targets for 2050 are and to propose a net-zero emission pathway to reinforce the regional climate ambition in the long term. They used the TIMES-CAC energy system model and co-designed the scenario analysis engaging with regional stakeholders from December 2020 to May 2021.

The study shows that the current regional energy policies are insufficient to achieve ambitious climate targets in the long term suggesting that the lack of a sound long-term strategy to decrease the dependence on fossil fuels export increases the influence of importing countries' energy policies on regional strategies. The study also finds that in a decarbonised scenario, while the dependence on the European Union decreases, the role of China remains substantial.

Policy implications: the region should start implementing a rigorous energy planning process today to fill the ambition gap and be in line with the Paris Agreement targets.

- The [ClimateWorks Global Intelligence](#) published the second edition of its [report](#) on achieving global climate goals by 2050, illustrating pathways towards achieving the emissions reductions needed to achieve a 1.5 compatible pathway. Scenarios are built using the Global Change Analysis Model (GCAM), which is an integrated assessment model (IAM), developed by the Joint Global Change Research Institute (JGCRI), which has an extensive sectoral, technological and geographical representation. The analysis aims to provide actionable insights on climate change mitigation pathways for philanthropic investments.

The study shows that near-term action is necessary to achieve ambitious climate targets (net-zero by 2050). Various types of interventions are identified, covering energy (e.g. electricity, fuel supply, transport, etc.) and land use sectors (e.g. forests,

agriculture, etc.). While interventions are delivered at sectoral level, cross-sectoral linkages should also be considered.

Policy implications: the study aims to inform philanthropic strategic priorities and investments based on the latest science and data. The findings can also help the wider climate solutions community to consider the impact of available emissions reductions measures that support higher climate ambitions.

- Researchers led by the [Fudan University of Shanghai](#), published an [article](#) on the journal *Science of The Total Environment*, exploring the risks related to population exposure to heat under two global carbon neutrality scenarios. Researchers quantified the avoided heat risk during 2040 – 2049 under two scenarios, carbon neutrality by 2060 and carbon neutrality by 2050, relative to the baseline scenario (FOSSIL). Researchers based the scenarios on a multi-model large ensemble climate projections from a new climate model intercomparison project (CovidMIP).

The study shows that global population exposure to extreme heat stress increases by approximately four times during 2040 – 2049 in the baseline scenario, whereas the heat exposure could be reduced by 12 % and 23 % under the carbon neutrality scenarios by 2050 and 2060, respectively. In addition, global mean heat-related mortality risk is mitigated by 14 % (and 24 %) under the carbon neutrality scenarios during 2040 – 2049 relative to baseline. Overall, heat risk could be reduced by around a tenth if globally we were to achieve carbon neutrality 10 years earlier (2050 versus 2060).

Policy implications: climate change mitigation policies that aim at achieving carbon neutrality can bring multiple benefits, such as reducing global population exposure to heat and lowering heat-related mortality risks.

● Events

Event	Date and location	Objectives	Topics covered / relevance to climate change modelling	Deadlines
2023 EMCC-VII Econometric Models of Climate Change	24-25 Aug 2023 Amsterdam, Netherlands	The conference aims to bring together researchers from econometrics and climate sciences and aims at creating an engaging and collaborative atmosphere where experts from both fields can exchange ideas and knowledge.	The conference will cover topics, such as econometric analysis and statistics in relation to climate data and/or on climate impacts assessment.	Abstract submissions are closed.
EMS Annual Meeting 2023	3 -8 September 2023 Bratislava, Slovakia and online	The European Meteorological Society convenes annually The Annual Meetings of the EMS aim at fostering cross-fertilisation of ideas, feedback between science and applications, and the involvement of all the diverse actors in the fields of weather, climate, water and the environment.	A particular focus of the EMS Annual Meeting 2023 will be on “Europe and droughts: Hydrometeorological processes, forecasting and preparedness”.	Abstract submissions are closed.
2nd World Conference on Climate Change & Sustainability	16 – 18 October 2023 Rome, Italy	The 2nd World Conference on Climate Change & Sustainability (Climate Week 2023) is the annual gathering of climate leaders from the academic, business, public and non-profit sectors, focusing on international educational for climate, environmental, and atmospheric science professionals hosted by The People Events.	The 2nd World Conference on Climate Change & Sustainability (Climate Week 2023) runs with this year’s theme: “Advancing Nature and Positive Solutions for Net Zero and Sustainable Future.”	Abstract submissions are open.
World Climate Research Programme Open Science Conference	23-27 October 2023 Kigali, Rwanda and online	The World Climate Research Programme (WCRP) organises the WCRP Open Science Conference, focusing on “Advancing climate science for a sustainable future”, with the major goal of bridging science and society. The WCRP OSC will accommodate workshops, meetings, learning labs, townhalls and other events during the conference.	The conference will focus on “Advancing climate science for a sustainable future”.	Abstract submissions are closed.
16th IAMC Annual Meeting 2023	14-16 Nov 2023 Venice, Italy	The purpose of the Integrated Assessment Modelling Consortium (IAMC) Annual Meetings is to: <ul style="list-style-type: none"> • Present and discuss the state of the art in integrated assessment modelling; • Review the status of ongoing community activities including both multi-model studies and the activities of the IAMC Scientific Working Groups; 	The conference focuses on latest developments related to integrated assessment modelling.	Abstract submissions are closed.

		<ul style="list-style-type: none"> Facilitate interaction with collaborating communities; Evaluate and revisit the priorities of the integrated assessment community. 		
AGU Fall Meeting 2023	11-15 December 2023 San Francisco, USA and online	AGU's Fall Meeting convenes >25,000 attendees from 100+ countries to share research and connect with friends and colleagues. Scientists, educators, policymakers, journalists and communicators attend #AGU23 to better understand our planet and environment, opening pathways to discovery, opening greater awareness to address climate change, opening greater collaborations to lead to solutions and opening the fields and professions of science to a whole new age of justice equity, diversity, inclusion and belonging.	The theme of the conference is "Wide. Open. Science". The conference aim is: - Making Earth and space data and scientific advancement more accessible, interoperable, and impactful. Expanding scientific collaborations across disciplines and geographic barriers in the Earth and space sciences and beyond.	Abstract submissions close on 2 August.