Methodological Appendix

1. Model BRI Countries in GCAM

The Global Change Assessment Model (GCAM 5.4, jgcri.github.io/gcam-doc/) is a global integrated assessment model. It represents energy and economy in the 32 geopolitical regions and represents land use and agriculture in 384 land regions nested within 235 water basins.

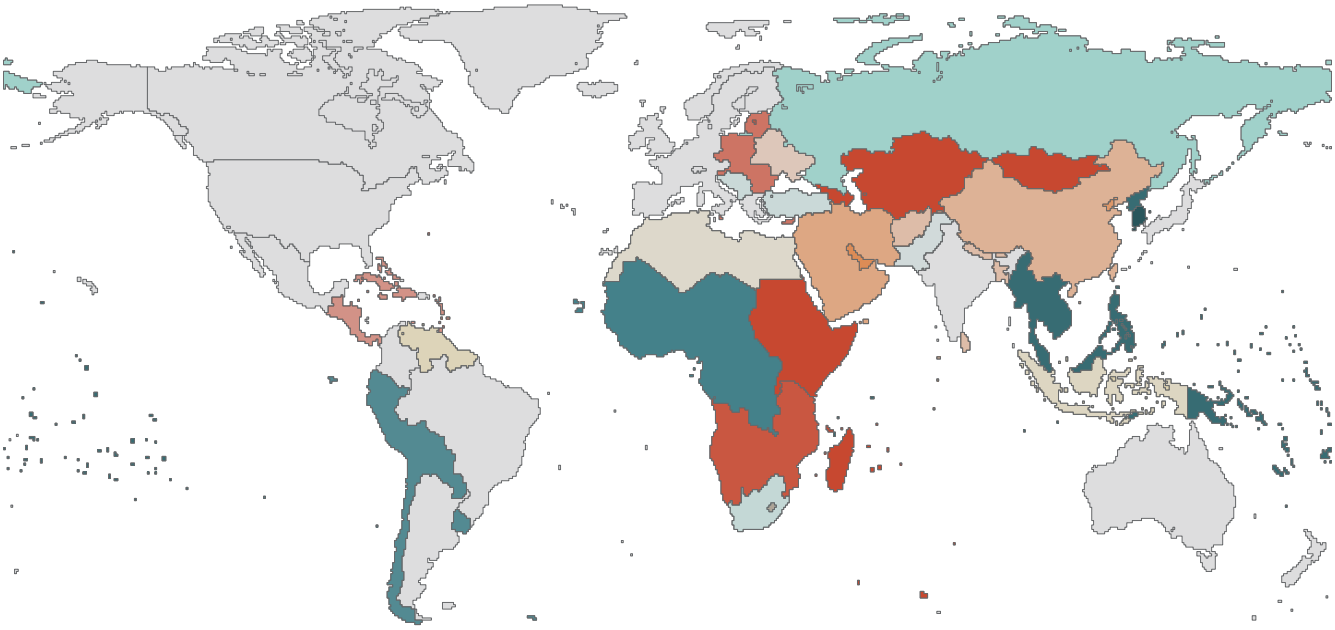
The energy system consists of detailed representations of depletable primary resources such as coal, gas, oil and uranium, in addition to renewable resources such as bioenergy, hydro, solar, wind and geothermal. Additionally, GCAM includes representations of the processes that transform these resources into final energy carriers. The energy carriers are then used to deliver services to end uses in the buildings, transportation and industrial sectors. Energy demand is determined by model inputs such as GDP, population, cost, commodity prices, water withdrawals and production.

The water system provides information about water withdrawals and water consumption at the basin level for six major sectors: agriculture, electricity, industrial manufacturing, primary energy production, livestock, and municipal uses. The agriculture and land systems represent land use, land cover, carbon stocks and net emissions, the production of bioenergy, food, fiber and forest products. Food demand is modeled based on the price of commodities, income, and food input. The price of commodities will be affected based on competition with other land use activities. Commodities are aggregated into staple foods (i.e., maize, rice, wheat, other grains and roots and tubers), non-staple foods (fruits, vegetables, oils, meat, etc.) and materials.

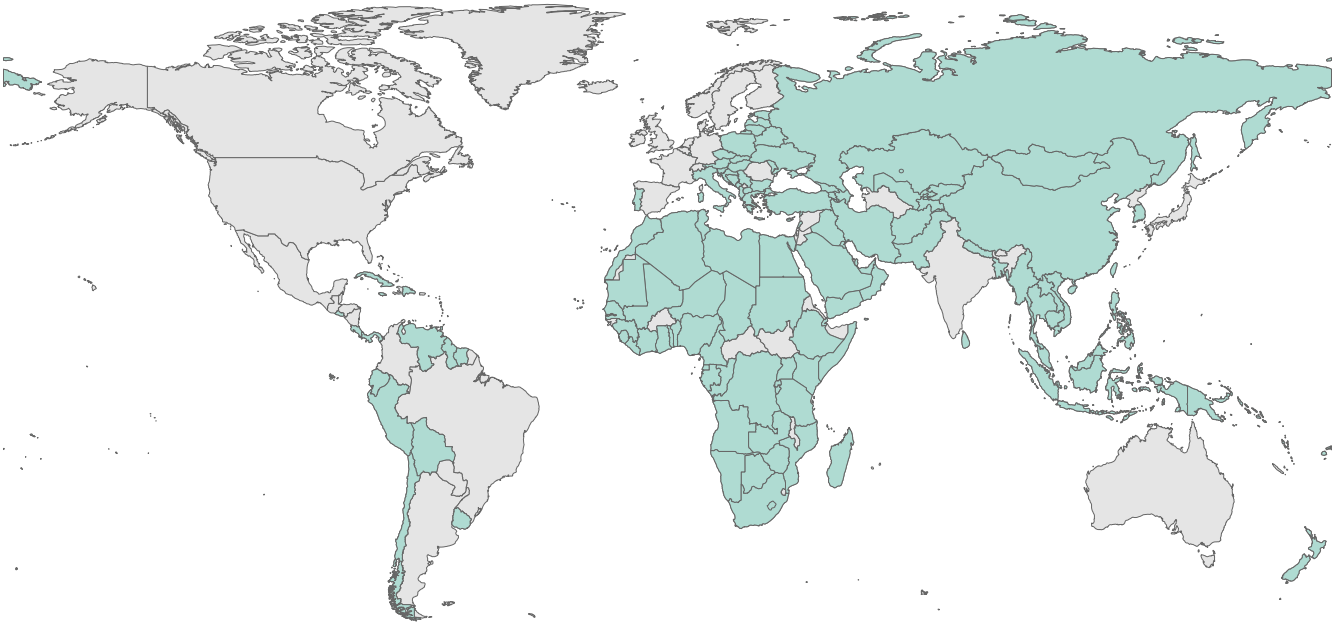
To obtain BRI region-specific results, we mapped the BRI countries to GCAM's 32 regions. While some countries were straightforward to map (i.e., China is its own region in GCAM), others were more difficult. As an example, Australia and New Zealand are grouped as one region in GCAM (Australia_NZ), but New Zealand is a BRI country while Australia is not. As a result of this type of mismatch between BRI countries and GCAM regions, not every BRI country was accounted for, and a few non-BRI countries were included in our calculations (please check the Fig. S1.). Overally, our mapping strategy ensures that we fairly represent the BRI region based on the total GDP and population data.

Fig. S1. Map of BRI regions and countries. (A) BRI and non-BRI regions in GCAM. (B) BRI countries and non-BRI countries.

A



B



2. Alternative 1.5°C scenarios

To evaluate the uncertainty of decarbonization pathways, we run a total of eight different scenarios towards the global 1.5°C goal and we list total four scenarios that are relevant to the policy brief series (Table S1). These alternative pathways vary across different policy designs and technology assumptions, including land-based mitigation, availability of bioenergy, regional coordination, and sectoral carbon prices. For comparison, we also run a reference scenario, in which climate ambition continues as reflected in current policies without enhanced ambition.

Table S1. Alternative 1.5°C scenarios.

Scenario name	Bioenergy availability	LUC carbon price	Energy sector carbon price	Regional emission pathways
1p5-10pLUC-limbio (core scenario)	Default: Linear to 100 EJ in 2050	Default: 10% of energy CO_2 price	Default: Same price across sectors	Default: Separate constraints for net-zero countries and one constraint for ROW
1p5-UCT-limbio	Default	Same as energy CO_2 price	Default	Default
1p5-FFICT-fullbio	No limit	None	Default	Default
1p5-sct-limbio	Default	Default	3 times carbon price in building and transport	Default

3. Metrics

We used a total of 17 metrics to quantify the changes across a number of areas between today and alternative 1.5°C futures (Table S2). Specifically, we examined changes in air quality and health, employment, consumer well-being, energy and agriculture trade, stranded assets, energy investment, and land and water impacts. Therefore, our main policy brief covers 17 metrics, while individual policy briefs have a deep-dive analysis of specific metrics.

For air quality and health, we processed GCAM results through rfasst, an open-access R package that uses the calculations of the Fast Scenario Screening Tool (TM5-FASST) air quality model to estimate air pollutant concentrations and adverse health effects attributable to air pollution. To evaluate changes in employment, we used several employment factors and other assumptions from existing literature to estimate changes in employment in the power, electric vehicle, energy efficiency and resource production sectors. Our analysis also evaluated employment across job types, technologies and regions. We focused on three dimensions of consumer well-being: food security, energy consumption and electricity consumption. We compared today and future per capita total calorie intake, non-staple calorie share, transportation and building service per capita, and per capita electricity consumption. For energy and agriculture trade, we compared staple crops

and energy sources production to imports and exports and evaluated the value of imports as a percentage of GDP. To assess stranded assets risks, we used plant-level data to determine capacity allocation for each vintage group across regions. Energy investment includes electricity, transmission and energy efficiency investment, and was calculated using projected capacity from the GCAM model, overnight capital costs by technology, and investment assumptions from existing literature. Land and water metrics are outputs directly from GCAM.

Table S2. Summary of metrics and methodology.

	Outcome	Metrics	Methodology
Environmental	Climate change	• GHG emissions	GCAM outputs
	Land-use & water	• Natural forest cover • Water withdrawals per capita	GCAM outputs
	Air quality & health	• PM2.5 concentration • O3 concentration • Premature mortality (deaths per 100,000 persons)	rfasst outputs
Social	Consumer well-being	• Calorie consumption per capita • Nultrition: non-staple calorie share [0, 100%] • Energy service per capita • Electricity access: electricity consumption per capita	GCAM outputs
	Employment	• Green employment: RE, EV, storage, energy efficiency • Fossil employment: power sector and resource production	GCAM outputs post processing (employment coefficients)
Economic	Investment & stranded assets	• Energy investments: power sector and EE • Stranded assets of fossil plants due to early retirement	GCAM outputs post processing
	Trade	• Energy self-sufficiency ratio [0, 100%] • Staple crops self-sufficiency ratio [0, 100%] • Cost of energy & agriculture imports as % of GDP [0, 100%]	GCAM outputs post processing

Note: To evaluate the impact of the low-carbon transition on air pollutant concentrations and premature mortality in BRI regions, we processed GCAM results across a range of scenarios in rfasst, an open-access R package that replicates the calculations of the Fast Scenario Screening Tool (TM5-FASST) air quality model[1] to estimate air pollutant concentrations and adverse health effects attributable to air pollution[2].

1 R. Van Dingenen *et al.*, *Atmos. Chem. Phys.* 18, 16173–16211 (2018).

2 J. Sampedro *et al.*, *Journal of Open Source Software* (in review), doi:10.21105/joss.03820.