

Impact case study (REF3)

Institution: Imperial College London		
Unit of Assessment: 14 – Geography and Environmental Studies		
Title of case study: C14-2 International climate change policy research leads to effective mitigation negotiations and national climate policy action		
Period when the underpinning research was undertaken: 2018-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Dr Joeri Rogelj	Role(s) (e.g. job title): Lecturer in Climate Change and the Environment and Director of Research – Grantham Institute Climate Change and the Environment	Period(s) employed by submitting HEI: May 2018 – to present
Period when the claimed impact occurred: 2018-2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>Impact: Dr Joeri Rogelj set out new societal transformation pathways for limiting global warming to 1.5°C above pre-industrial levels and developed the world's first comprehensive framework for estimating and tracking the remaining global carbon budget. His work underpins landmark science-policy assessments, informing and driving ambitious new climate policies at the international and national levels, while broadening societal awareness of the importance of urgent climate change mitigation.</p> <p>Beneficiaries: International and national policymakers, human and natural systems threatened by climate change.</p> <p>Significance and Reach: Rogelj's findings, which have already resulted in new climate legislation in the UK, France and elsewhere, have reached a worldwide audience and will support implementation of the Paris Agreement, benefiting billions of people across the planet.</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Research led by Dr Joeri Rogelj of Imperial College London has addressed key knowledge gaps at the climate science-policy interface. Climate change mitigation research over the past decade has looked at strategies for limiting global warming to levels considered safe by society, a question often explored with models that integrate knowledge across the engineering, economic, agricultural and physical sciences.</p> <p>Rogelj pioneered the exploration of detailed societal transformation pathways towards limiting warming to 1.5°C. This work provided the only study of its kind in time to inform the negotiations on the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC). He led an international consortium of six integrated assessment modelling teams to show how society's ability to limit warming to 1.5°C critically depends on specific socioeconomic drivers (in the literature described as "Shared Socioeconomic Pathways"). This climate change research has continued with several publications that contribute important, novel perspectives on how the Paris Agreement can be implemented.</p> <p>Rogelj's Imperial work, published in 2018, showed how increased energy services can be provided to poor and vulnerable populations while reducing overall global energy demand and achieving sustainable development goals through a transformation to a highly efficient society [1]. An additional influential 2019 study highlighted the inherent biases of dominant approaches used to design climate change scenarios. Rogelj's work identified those strategies that result in high</p>		

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climate risk and engrained intergenerational unfairness. He then presented solutions by focussing on net-zero targets instead [2].

More recent work by Rogelj and colleagues on societal transformation scenarios culminated in the design, development, and open-source publication of a vetted climate scenario database [3]. This now serves as a key community resource, enabling re-use and further investigation of societal transformation pathways by academics and government analysts. This research provides, inter alia, the evidence underpinning key characteristics of 1.5°C-consistent pathways, including the need to reach net zero CO₂ emissions by mid-century.

This research on societal transformations for ambitious climate goals is complemented by research on methods to analyse the implications of the current gap between countries' pledges and pathways that limit global warming to the levels agreed upon in the UN Paris Agreement [4]. For example, Rogelj's research highlighted the woeful inadequacy of progress towards climate protection over the past 10 years and demonstrated that more ambitious climate pledges, combined with early and aggressive action, are now imperative to ensure a safe future climate.

Finally, Rogelj and colleagues established a comprehensive framework for estimating and tracking the remaining carbon budget, that is, the total amount of CO₂ that can ever be emitted while keeping global warming below specific temperature limits [5]. This framework resolved key misunderstandings and provided clarity to policy makers about how some of their policy choices influence the amount of CO₂ that can still be emitted while keeping warming to levels consistent with the UN Paris Agreement.

3. References to the research (indicative maximum of six references)

[1] Grubler, A. et al. A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies. *Nature Energy* **3**, 515–527 (2018). <https://doi.org/10.1038/s41560-018-0172-6>

[2] Rogelj, J. et al. A new scenario logic for the Paris Agreement long-term temperature goal. *Nature* **573**, 357–363 (2019). <https://doi.org/10.1038/s41586-019-1541-4>

[3] Huppmann, D., Rogelj, J., Kriegler, E., Krey, V. & Riahi, K. A new scenario resource for integrated 1.5 °C research. *Nature Climate Change* **8**, 1027–1030 (2018); with accompanying database available at: doi:10.22022/SR15/08-2018.15429. <https://data.ene.iiasa.ac.at/iamc-1.5c-explorer/>

[4] Höhne, N., den Elzen, M., Rogelj, J., et al. Emissions: world has four times the work or one-third of the time. *Nature* **579**, 25–28 (2020). <https://doi.org/10.1038/d41586-020-00571-x>

[5] Rogelj, J., Forster, P. M., Kriegler, E., Smith, C. J. & Séférian, R. Estimating and tracking the remaining carbon budget for stringent climate targets. *Nature* **571**, 335–342 (2019). <https://doi.org/10.1038/s41586-019-1368-z>

4. Details of the impact (indicative maximum 750 words)

Global warming, driven by anthropogenic emissions of greenhouse gases, poses severe risks for natural and human systems. Average global temperatures have already risen to approximately 1.0°C above pre-industrial levels as a result of human activities [A] and a science-policy consensus has emerged, enshrined in the Paris Agreement, which seeks to limit warming to well below 2.0°C, and ideally to 1.5°C.

Before Rogelj's research, policy-makers faced two significant obstacles:

- It was unclear whether and how the 1.5°C limit might be achieved. While numerous groups publish scenarios, none offered a clear way forward to keep warming below the 1.5°C limit. Moreover, the scenarios were risky, permitting the 1.5°C limit to be exceeded (as long as

temperatures returned to 1.5°C by 2100) and unfair, placing the greatest burdens on later generations.

- There was also disagreement and misunderstanding about the size of the world's remaining carbon budget, the total amount of CO₂ that can still be emitted while keeping global warming below the 1.5°C limit. A robust and up-to-date carbon budget estimate was critical to informing climate policies, and tracking performance, but a wide range of conflicting estimates hindered progress.

Rogelj successfully addressed both challenges, by detailing new societal transformation pathways that could limit warming to 1.5°C without exceeding the target or requiring intergenerational unfairness [1, 2, 3], and by establishing a comprehensive, transparent framework for estimating and tracking the carbon budget [5]. He also developed methods [4] to assess the gap between the global warming outcomes likely to result from national climate pledges and the temperature limits established in the Paris Agreement.

As a result, Rogelj's ground-breaking work has:

- Transformed science-policy assessments at the international level**
- Driven ambitious policy decisions at the national level**
- Broadened wider societal awareness and engagement in climate change**

International impacts

Rogelj's research provided a critical evidence base for the Special Report on Global Warming of 1.5°C (SR1.5), a landmark report published in October 2018 by the Intergovernmental Panel on Climate Change (IPCC) [A]. More than 15 of Rogelj's papers were referenced in the SR1.5. Importantly, all four of the central illustrative pathways used by the report to communicate strategic mitigation choices to policymakers are from studies led or co-authored by Rogelj. Indeed, Chapter 2 of the SR1.5 directly referenced Rogelj's work [1] when describing these pathways (page 110), as well as applying Rogelj's framework for estimating remaining carbon budget [5] for the first time (pages 104-8). The SR1.5 concludes, again directly based on Rogelj's research, [3] that pathways consistent with limiting warming to 1.5°C halve global CO₂ emissions by 2030 compared to 2010 and reach net zero CO₂ around mid-century – insights that have had a fundamental impact on national policy.

Rogelj's research [1, 3, 4] also directly underpins the Emissions Gap Report (EGR) [B], published annually by the UN Environment Programme (UNEP). The EGR estimates how much warming could be expected should countries' pledges on greenhouse gas emissions-cutting be implemented, and how temperatures would diverge from the limits set out in the Paris Agreement. The Head of Thematic Scientific Assessments at UNEP, confirms that *"the novel methods Joeri Rogelj published to assess the gap between countries' climate pledges and their global warming outcome have become the [EGR's] scientific and analytical backbone."* [C]. The EGR and - by extension, Rogelj's work - is of critical importance in international climate policy circles. Referencing the opening session of Conference of the Parties (COP 25), the 2019 UN Climate Change Conference held in Madrid, they note that *"3 out of 5 speakers ... made direct use of EGR messages in their speech. The same was the case for the UN Secretary General in his separate address..."* [C]. The EGR findings were referred to in Decisions 1/CMA.2 and 1/CP.25 of COP25, adopted by all 197 countries of the UNFCCC.

National impacts

Rogelj's research, and the authoritative science-policy assessments it informs, has also directly influenced significant national policy change. The publication of the IPCC SR1.5 [A] prompted the UK, Scottish and Welsh Governments to ask the UK Committee on Climate Change (CCC) to assess its implications for the UK's long-term climate target and net zero greenhouse gas date [D]. The resulting Net Zero Report [E], published by CCC in May 2019, cites Rogelj's research database [3] as evidencing four of the six diagrams in Chapter 2, and for all quantitative tables in both Chapter 2 and 3. Insights from Rogelj's research activities for the UNEP EGR [B] are also cited in the Net Zero Report's context setting and analysis. The UK CCC corroborates Rogelj's contribution: *"Research outputs of Dr Rogelj played a critical role in shaping the evidence base for*

the SR1.5 and subsequently informing the CCC advice to Government” [F]. The CCC Net Zero Report directly led to the UK’s adoption in June 2019 of an ambitious net zero greenhouse gas emissions target as a legally binding national long-term climate goal. The new law [G] explicitly references both the conclusions of the IPCC SR1.5 [A] and the advice provided by the CCC [E].

Similarly, Rogelj’s research on 1.5°C-consistent pathways, included in the IPCC SR1.5, is cited in the First Annual Report of the High Council on Climate of France [H], leading in June 2019 to France setting a national carbon neutrality target in legislation, and referenced as key scientific evidence in the EU’s draft proposal for a European Climate Law [I].

5. Sources to corroborate the impact (indicative maximum of 10 references)

[A] Intergovernmental Panel on Climate Change (IPCC). Summary for Policymakers in *Global Warming of 1.5 °C: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (eds. Masson-Delmotte, V. et al.) 32 (IPCC/World Meteorological Organization, 2018). <https://www.ipcc.ch/sr15/> (Archived [here](#))

and particularly its second chapter:

Rogelj, J. et al. Mitigation pathways compatible with 1.5°C in the context of sustainable development. in *Global Warming of 1.5 °C: an IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (eds. Flato, G., Fuglestedt, J., Mrabet, R. & Schaeffer, R.) 93–174 (IPCC/WMO, 2018). (Archived [here](#))

[B] United Nations Environment Program (UNEP). The Emissions Gap Report 2019. 108 (UNEP, 2019). <https://www.unenvironment.org/interactive/emissions-gap-report/2019/> (Archived [here](#))

see also earlier annual publications of these reports like

<https://www.unenvironment.org/resources/emissions-gap-report-2018> or

<https://www.unenvironment.org/resources/emissions-gap-report-2017>

[C] Testimonial Letter from Head of Thematic Scientific Assessments, UNEP, 25 August 2020, corroborating the impact of Dr Rogelj’s research and highlighting the role and importance of UNEP Emissions Gap Reports in the UNFCCC negotiations

[D] Letter of the UK, Scottish, and Welsh Governments to Lord Deben, Chairman of the UK Committee on Climate Change (2018)

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/748489/CCC_commission_for_Paris_Advice_-_Scot_UK.pdf (Archived [here](#))

[E] UK Committee on Climate Change. Net Zero – The UK’s contribution to stopping global warming. 277 (Committee on Climate Change, 2019)

<https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/> (Archived [here](#))

[F] Testimonial Letter from Senior Analyst, UK Committee on Climate Change corroborating the impact of Dr Rogelj’s research on their work for the UK Net Zero Report.

[G] Explanatory Memorandum to the Climate Change Act 2008 (2050 Target Amendment) Order 2019 No. 1056 (UK Government, 2019)

https://www.legislation.gov.uk/uksi/2019/1056/pdfs/uksem_20191056_en.pdf (Archived [here](#))

[H] Haut Conseil pour le Climat. Acting in line with ambitions – first annual report of the High Council on Climate of France. 66 (High Council on Climate of France, 2019)

<https://www.hautconseilclimat.fr/publications/rapport-2019-english-version/> (Archived [here](#))

Citing: “According to the global scenarios presented by the Intergovernmental Panel on Climate Change (IPCC), being in line with the Paris Agreement implies that global net CO₂ emissions are reduced to zero. CO₂ emissions must reach net zero around 2050 to limit warming to 1.5°C, and around 2070 to limit global warming to 2°C.”

[I] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the framework for achieving climate neutrality and amending Regulation (EU) 2018/1999 (European Climate Law) Brussels, 4.3.2020 COM(2020) 80 final 2020/0036 (COD) (European Commission, 2020)

https://ec.europa.eu/info/sites/info/files/commission-proposal-regulation-european-climate-law-march-2020_en.pdf (Archived [here](#))

Citing: “Tackling climate change is an urgent challenge. [...] The Intergovernmental Panel on Climate Change (IPCC) Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways [...] estimates that in order to be on a pathway to limit temperature increase to 1.5 °C, net-zero CO₂ emissions at global level needs to be achieved around 2050 and neutrality for all other greenhouse gases somewhat later in the century. This urgent challenge calls for the EU to step up its action to show global leadership by becoming climate-neutral by 2050, covering all sectors of the economy and compensating, by 2050, not only any remaining CO₂ but also any other remaining greenhouse gas emissions, as set out in the Communication ‘A Clean Planet for all- A European strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy’ and as confirmed by the ‘European Green Deal’ Communication.”