UCL Policy Commission on Communicating Climate Science

Phase-II

Annual Report
August 2019 to Oct 2020

The UCL Policy Commission on Communicating Climate Science (CCSPC) is an interdisciplinary body comprising experts from academia, policy, environment, business, media and the arts. The membership is listed in Annex I. It is chaired by Professor Chris Rapley (UCL Earth Sciences). It is supported by the UCL Public Policy Unit and the UCL Grand Challenge for Sustainable Cites, both of which operate from within the UCL Office of the Vice Provost for Research. Since late 2019 it has been supported in part by a grant from the Thirty Percy charitable foundation, by a small budget allocated to Chris Rapley from UCL internal funds, and by project-specific funds from the OVPR for the 'Pathways to Net Zero' and 'Net Zero Innovation' programmes (see later).

Mission

The Commission is an incubator of projects aiming to:

- *Identify gaps in climate change communication and policy and create targeted interventions with significant impacts*

- *Help break down communication barriers within and between professional communities and the wider public*

- *Identify and work with 'communities of practice' to allow scaling of successful encounters*

Vision

The Commission's Vision is to:

- *Facilitate the creation of agency (the ability to make change) to increase the effectiveness, scale, and pace of actions addressing the climate crisis*

The Commission draws on selected insights from the social, behavioural and mind sciences, from the varied and extensive experience of its membership, from the ideas and insights of invited experts, and from 'learning by doing'.

Figure 1 shows a schematic of the climate science-society domain, which the Commission uses as a map to guide its interventions.

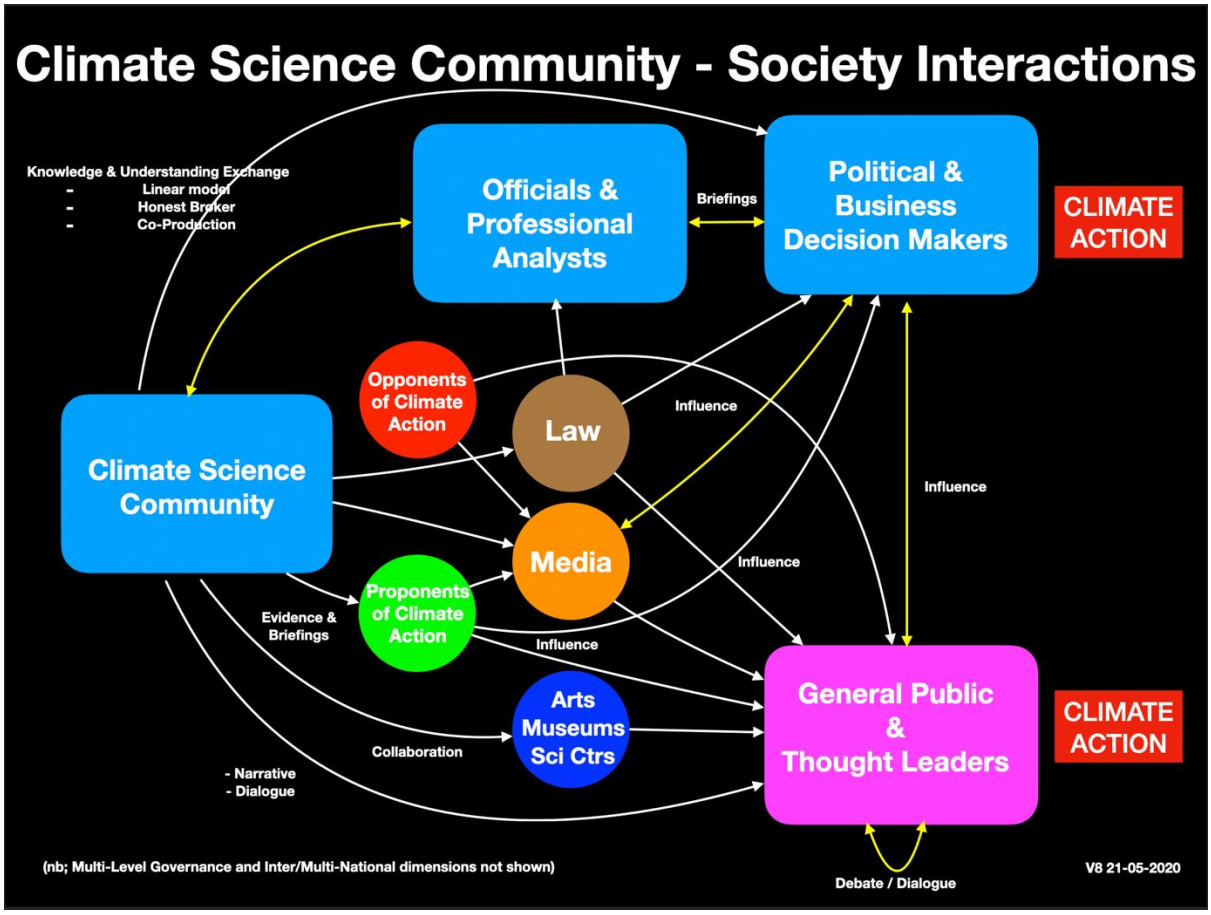


Figure 1: The Climate Science – Society domain. Yellow arrows indicate two-way encounters or co-production. White arrows indicate one-way information delivery. Both can harbour barriers to effective communication and are the subject of the Commission's interventions.

The Commission meets monthly throughout the year (with a break in the Summer), to hear and discuss expert presentations, to develop, select and guide its programme of activities, and to review progress. A list of the invited presentations during this reporting period is given in Annex II.

At the start of the reporting period the Commission was offered volunteer administrative and organisational support by Freya Roberts, a Research Administrator in the UCL Clinical trials Unit. Freya has a background in climate change and previously worked for Carbon Brief. The offer was gratefully accepted.

During the year a Business Plan was developed for a 5-person 'UCL Climate Action Unit' (CAU). At a proposed cost of £2m over 3 years, the CAU aims to achieve transformative action on aspects of climate change and its communication. Its mission is to bring about a step change in how scientists, policymakers, the public and civil society organisations engage with one another to accelerate the reduction of human carbon emissions, and to increase societal resilience to climate change. The proposal has been developed in collaboration with Jake Hayman, a 'broker' acting as a bridge to the world of philanthropy , and with UCL OVP (Advancement).

From March 2020 the Commission's activities were disrupted by the COVID-19 crisis. The monthly meetings continued remotely using ZOOM, and the team adapted its training and workshops to remote implementation. Projects that could not be adapted were placed on hold, and progress with

obtaining philanthropic funding slowed. Discussions with potential funders are continuing, but as yet none has come forward with an offer of support.

In spite of this, as the plans have become more concrete, the CAU has been 'spun out' from the CCSPC as an entity with a separate website and identity. Projects initiated under the aegis of the CCSPC have gradually been migrated to the CAU, along with new projects developed solely under its aegis. The list of activities below covers both work streams. Funds from the Thirty Percy award have been used to guarantee projects at the commitments stage, some of which during development have attracted support from other sources, releasing the Thirty Percy funds for other uses.

Activities

Chris Rapley Briefings and Presentations (CCSPC)

Chris Rapley continued his programme of briefings and presentations to professional bodies and the public. A list is given in Appendix III.

AGU Session U24A (CCSPC with support from CGR budget)

Chris Rapley with US and Canadian collaborators convened a Union Session at the 2019 Fall meeting of the American Geophysical Union (AGU) in San Francisco entitled *"Is Environmental Science Serving / Failing Society? Strategies for Rapid Progress on Climate Solutions".* The Keynote speaker was Prof Jane Lubchenco, who spoke of *"A moment of truth: The Social Contract Realized?"*, revisiting her seminal 1998 paper *"Entering the Century of the Environment: A New Social Contract for Science"*. Additional papers were delivered on the role of science in a warming world, and ways of helping society to develop the agency to act. The session was attended by ~100 predominantly Early Career Scientists. The Keynote talk was reported in the widely read AGU journal EOS (https://eos.org/articles/former-noaa-head-calls-for-renewed-social-contract-for-science). There followed a lively discussion about the role of scientists and the need to rebalance the emphasis from the discovery of new facts and insights to the co-production of action to address the climate and biodiversity loss crises. The Journal Environmental Research Letters (ERL) invited the session presenters to write up their work for an ERL Special Issue. The AGU session organisers agreed to act as issue Editors and took steps at the AGU to invite papers from a wider group than those who presented in the Union session. A dozen papers have been submitted and are in the process of peer review. The Keynote paper by Lubchenco and Rapley has been published, and a paper by De Meyer, Coren, McCaffrey and Slean has been accepted for publication. Both are attached in Annex IV.

BBC Follow-ons (CCSPC)

Chris Rapley has continued working with Serena Davies, the Series Producer of "Climate Change – The Facts,' narrated by Sir David Attenborough, which aired in March 2019. An 'access documentary' was proposed to a major oil company to follow their internal deliberations on how to navigate to net zero, but after negotiations at the highest levels, the company decided not to proceed. Other possibilities, including a comedy series are under discussion. In the meantime, Chris has been appointed as Science Advisor to a four-part BBC-1 series on Greta Thunberg being produced by Rob Liddle. Production has been delayed by the COVID crisis.

Theatre and Museums (CCSPC)

Chris Rapley is providing advice on climate change to the playwright Chris Thorpe, commissioned by the Royal Court theatre to write a new play on climate change in the run-up to COP26. In addition,

Chris has advised the theatre Director Katie Mitchell and the playwright Chris Bush on a production "In Real Life", and Katie and the playwright Dawn King on a production "The Trees", based on Chekhov's "Cherry Orchard"

Communication and engagement training for environmental scientists and policymakers (CCSPC)

Kris De Meyer continued to deliver the NERC science communication training which grew out of the CCSPC 2014 report "Time for Change: Climate Science Reconsidered". It was delivered in person to doctoral training programmes at the National Oceanography Centre in Southampton; the British Antarctic Survey in Cambridge; the Natural History Museum (for London universities); the University of Edinburgh; and Bristol University. Following COVID restrictions, it was adapted for online delivery and delivered to the University of East Anglia and the University of Southampton.

As part of the DEFRA-funded "Citizen Engagement on the Environment", a three-day engagement training was delivered for environmental scientists, policymakers and conservation specialists at the Marine Biological Association in Plymouth in August 2019 (following earlier deliveries in May 2019 in Bristol and Liverpool). An online version of this training was delivered in June 2020 to marine science, economy and policy experts of Wageningen Marine Research in the Netherlands.

Kris De Meyer's involvement with the DEFRA-funded project also led to 2 workshops and meetings at the Environment Agency to discuss how to embed the training in the continuing professional development of agency staff. Kris also presented at a Natural England conference on environmental communication and behaviour change.

Communicate – Masterclass on 'Reframing Behaviour Change' (CCSPC)

Kris De Meyer and Lucy Hubble-Rose ran a workshop at the Communicate conference in Bristol in November 2019 on reframing behaviour change for climate action as the development of agency. This session formed the basis for several of the agency-developing projects that followed.

Training – Delivering Climate Action in the Community (CCSPC – CCSPC funded)

In February 2020, Kris De Meyer and Lucy Hubble-Rose ran a three-day community training in Cornwall on how to develop agency for climate action. The purpose of the workshop was to help organisation and community leaders to deliver meaningful action on climate change.

InSpire (CCSPC – CAU – part CCSPC and client funded)

The InSpire project is in collaboration with the Church of England. The aim is to engage congregations initially in the Oxford Diocese, subsequently across the country and even internationally and inter-faith, in collective actions to tackle climate change. The project started with a meeting at the Oxford Diocese in October 2020. Kris De Meyer and Lucy Hubble-Rose's involvement is to deliver a 'climate action' training (as delivered in Cornwall) for leadership teams of local churches. Delivery was postponed – due to COVID – from April 2020 to January 2021.

Pathways to Net Zero (CCSPC – CAU – OVPR funded)

In collaboration with UCL Public Policy and the Local Government Association, Kris De Meyer and Lucy Hubble-Rose developed and facilitated a training to foster partnership working between local councils and university 'net zero' experts to accelerate the delivery of climate action plans. This training was originally envisaged as a one-day workshop but adapted to a 4-session online delivery in

April 2020. The training was perceived as extremely helpful by participants as well as the Local Government Association and subsequently developed into the Net Zero Innovation Programme.

Net Zero Innovation Programme (CCSPC – CAU – OVPR funded)

Following the Pathways to Net Zero project, UCL Public Policy and the LGA committed to a larger-scale programme that would not only deliver training for partnership working but would allow university and council partnership teams to deliver actual projects to deliver their climate action plans. The programme is currently running, with delivery of 12 projects around England scheduled for the first half of 2021. In October 2020, Kris De Meyer and Lucy Hubble-Rose delivered an updated version of the partnership development workshop, and they continue to advise the UCL Public Policy and LGA teams on the co-production aspects of the project.

UK-China Collaboration on Climate Change Risk Assessments (CCSPC – CAU)

Kris De Meyer and Lucy Hubble-Rose are supporting a UK Foreign, Commonwealth and Development Office, Chatham House & Chinese government project on strengthening the use of climate risk information in policy making. They ran a co-production workshop in Beijing in January 2020 and a co-production workshop at Chatham House in February 2020 to facilitate cross-workstream collaborations. They also delivered 4 international co-production sessions in September, bringing together experts in energy transition policy and finance ('model users') and energy system modellers ('model producers'). The aim was to test and improve the communication of ground-breaking energy modelling work from project partners at Oxford University. Their work shows the economic benefits of accelerating investment in the deployment of renewable energy technologies like solar, batteries and electrolysers, and could become highly influential in changing the 'policy mood music' which currently assumes that the energy transition to net zero will be expensive.

North Star Transition (CCSPC – CAU)

In January 2020, Jyoti Banerjee presented to the Commission on his system's change initiative "North Star Transition". Following that, the team has started to collaborate with North Star in the facilitating cross-sector meetings in the "Wales Transition Lab". They are delivering a series of online workshops bringing together representatives from the farming, food, health, and finance communities in Wales to reconnect food, health, and nature, with the aim to accelerate the transition towards sustainable and regenerative agriculture which supports the wellbeing of farmers, citizens, and nature. This work started in October 2020 and will continue into 2021.

Facilitator Training (CAU)

The Climate Action Unit developed its own training programme for organisational development consultants and leadership coaches. The aim of this training was to build their capacity to bring climate change decision making into the project work they do with clients in business and government organisations. We have seen great breakthroughs and had amazing feedback to this programme. Most of the participants admitted to 'being stuck' before joining but have now started to incorporate climate change into the work with their clients. A second phase of this training is in development, with some of the participants of our first cohort taking part of the responsibility in delivering the training. This project, in all its aspects, is a great demonstration of the accelerating and multiplying effect that our interventions have when done with stakeholders whose new-found 'agency' ('knowing how to act') have downstream influence on others.

Parliamentarian Programme (CAU)

Following the success of the facilitator programme, it was established to set up a similar programme for UK Parliamentarians. An initial poll of contacts in the House of Commons and House of Lords was met with much enthusiasm. The CAU team has since started to develop the programme, which will be delivered in the first half of 2021.

Summary

In each of these projects, our aims are to build bridges, break silos, and help people develop agency for action on climate change that is suitable to their professional context. We take a 'systems thinking' approach to getting people to work together more effectively, with the aim to accelerate the systems transition we all need to be part of.

Annex I

Membership

Chair

Chris Rapley – UCL Earth Sciences

Professor Chris Rapley CBE is Professor of Climate Science at University College London (UCL). He is a Fellow of UCL and of St Edmund's College Cambridge, a member of the Academia Europaea, Chair of the European Science Foundation's European Space Sciences Committee, Member of the Advisory Board of the UK government's Clean Growth Fund, Patron of the Surrey Climate Commission, a member of the UK Science Museum Group's Science Advisory Board, a member of the Science Advisory Board of Scientists' Warning, and a member of the UK Parliamentary and Scientific Committee. His previous posts include Director of the Science Museum, Director of the British Antarctic Survey, Chairman of the London Climate Change Partnership, President of the Scientific Committee on Antarctic Research, Executive Director of the International Geosphere-Biosphere Programme, and Distinguished Visiting Scientist at NASA's Jet Propulsion Laboratory. He spent the first 25y of his career as a space scientist at UCL's Mullard Space Science Laboratory. He was founder and Head of UCL MSSL's Earth Remote Sensing Group. He was Chair of the International Planning Group for the International Polar Year 2007-2008 and Chair of the European Space Agency Director General's High-Level Science Policy Advisory Committee. In 2014 Prof Rapley and the playwright Duncan Macmillan wrote the acclaimed play '2071' which Prof Rapley performed at the Royal Court theatre and in Hamburg and Brussels. Prof Rapley was the Science Consultant on BBC1's 'Climate Change – The Facts' presented by Sir David Attenborough. In 2003 Prof Rapley was appointed CBE by Her Majesty the Queen. In 2008 he was awarded the Edinburgh Science Medal for having made 'a significant contribution to the understanding and wellbeing of humanity'.

Email: chris.g.rapley@ucl.ac.uk

Core Members

Kris De Meyer – King's College London – Neuroimaging & Geography

Dr Kris De Meyer is a neuroscientist and science communicator at King's College London. He specialises in the neuroscience of how people become entrenched in their beliefs, how this leads to polarisation in society, and how to overcome this. Kris works with climate scientists and policymakers to support them in communicating constructively about climate change. He produced documentary Right Between Your Ears (exploring the neuroscience and psychology of entrenched views) and co-created The Justice Syndicate - half theatre play, half psychology experiment - which looks at how we make decisions - individually and in groups. Kris speaks regularly on radio and television about the "brain facts" behind post-truth and why fake news can be so believable, and recently did a TEDx talk on the rise of polarisation in society.

Email: kris.de_meyer@kcl.ac.uk

Andrew Jackson – ProReal

Andrew studied climatology before becoming a management consultant. In 2008, he co-founded IBM's Climate Change Centre of Expertise (CCCoE) where he worked with corporate clients to explore responses to business and supply chain risk, presenting at COP14. In 2012, Andrew founded ProReal Ltd which designed a 3D avatar technology for communications skills and reflective practice. He is an active member of UCL's Policy Commission on the Communication of Climate Science and a co-founder of the CAU. In this role, he has designed and facilitated events with early career scientists, Executive coaches and organisational change facilitators.

Email: andrew.jackson@proreal.world

Peter Gingold – Time and Tide Bell

Peter has worked on climate change since the early 2000s. He established the organisation TippingPoint: a facilitator of dialogue between the climate science and arts worlds. From its core programme at the University of Oxford, TippingPoint expanded to working in five continents with over two thousand artists, leading to numerous pieces of work and arts-science collaborations. In addition the organisation commissioned 15 pieces of performative work and a dozen written pieces. Peter also runs the Time and Tide Bell project, which will install 16 large specially designed bronze bells, at locations round the coast of the UK, ringing through the action of the waves at high tide. The bells provide an insistent, poetic, reminder of rising sea levels.

Email: peter@gingold.com

Hannah Knox – UCL Anthropology

Hannah is an Associate Professor of Anthropology at UCL and since 2011 she has been researching the everyday work of urban planning and governance in the face of climate change. Her work straddles environmental anthropology and the ethnographic study of technology and infrastructure - an apposite combination for understanding the infrastructural and socio-technical nature of the challenges that climate change poses. She has published widely in anthropology and social science journals and her new book Thinking like a Climate: Governing a City in Times of Environmental Change was published in 2020 with Duke University Press.

Email: h.knox@ucl.ac.uk

Lucy Hubble Rose – Facilitator

Lucy Hubble-Rose obtained a PhD in cultural geography and climate change engagement from Exeter University. She is an expert facilitator who is involved in the design and delivery of many of the co-production projects run by the CCSPC/CAU. She ran Creative Data Projects, a creative design agency, before working as a facilitator and project manager in the rail industry. Since the start of 2020, Lucy is focussing on co-production facilitation for the CAU.

Email: lucy.hubblerose@gmail.com

Freya Roberts – UCL Public Policy

Freya works in research support at UCL and provides administrative assistance to the CCSPCII and its projects. Freya is particularly passionate about climate science and finding impactful solutions to address the climate crisis. Prior to joining UCL, Freya worked as a climate science researcher & writer for the website Carbon Brief. She is a graduate of the University of Southampton where she studied global climate change as the focus of a degree in Environmental Sciences. Freya is also a STEM ambassador and works as a freelance researcher for environmental websites/blogs. She is highly commended by UCL for her outstanding commitment to sustainability.

Email: freya.roberts@ucl.ac.uk

Members

Luke Bevan – Doctoral Researcher, STEaPP, UCL

Luke Bevan is a doctoral researcher in UCL Department of Science, Technology, Engineering and Public Policy (STEaPP). Luke's doctoral research concerns the conceptualisation of uncertainty in climate and energy systems modelling. His research is underpinned by an interest in the interface between science and its application to real-world problems. His undergraduate degree is in Physics, from Balliol College, Oxford University, and he holds and MSc in Sustainable Energy Futures from Imperial College London. Prior to coming to STEaPP Luke was working as Research Manager in the Centre for Climate Finance and Investment (CCFI) at Imperial College Business School. He has also worked at the Grantham Institute, Imperial College London and as an Energy Industry Analyst.

Email: l.bevan.17@ucl.ac.uk

Nick Comer-Calder – The Climate Media Net

Nick Comer-Calder worked in the BBC's Continuing Education Department then joined the fledgling Discovery Channel where he became Head of Programming and then Senior Vice President of Discovery Networks Europe. After leaving Discovery Nick became an Associate Fellow of the Institute for Public Policy Research where he initiated the IPPR's Media Leaders and Climate Change Initiative which convened a series of senior level round table meeting to discuss media responses to climate change. Nick set up The Climate Media Net to actively encourage the development of popular media content which touched on climate change.

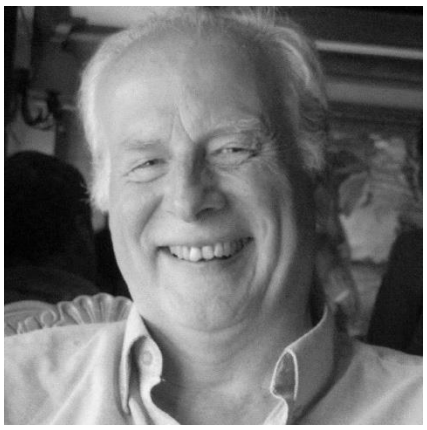
Email: nickcc@theclimatemedia.net

Kathryn Janda - UCL Energy Institute

Katy Janda is a Principal Research Fellow in the Energy Institute at UCL's Bartlett School of Environment, Energy and Resources. She investigates energy demand from a socio-technical perspective, focusing on technological innovation, organisational decision-making, and energy policy. She leads research on story-telling, change from the middle-out, and the role of professions in the built environment. She has held academic positions at the Environmental Change Institute at the University of Oxford; Lawrence Berkeley National Laboratory (California); the U.S. Environmental Protection Agency (Washington D.C.); and Oberlin College (Ohio). She received university degrees in electrical engineering and English literature from Brown University, and her MSc and PhD are in energy and resources from the University of California at Berkeley.

Email: k.janda@ucl.ac.uk

Dan Osborn – UCL Earth Sciences



Dan Osborn is Professor of Human Ecology at UCL, Earth Sciences. He was co-lead of the chapter on people and the built environment for the evidence report for the 2nd UK Climate Change Risk Assessment and is making a limited contribution to the third such exercise. He has worked on many types of environmental risk assessment involving the way human activity impinges on the environment. This includes work on UK and European regulatory regimes and research in many different parts of the environment.

Email: dan.osborn1@ucl.ac.uk

James Parr – Trillium Technologies

James is Founder and CEO of Trillium Technologies - a specialist technology consultancy in the application of emerging technologies to grand challenges such as climate change, deforestation mitigation, climate resilience and planetary defence from asteroids. James is also Founder of Frontier Development Lab (FDL) Europe - an applied artifical intelligence research lab with the European Space Agency and Oxford University.

Email: james@trillium.tech

James Paskins – UCL Grand Challenges

Dr James Paskins is the Deputy Director for the UCL Grand Challenges Programme, a programme which encourages cross-disciplinary engagement with complex societal issues. He studied Psychology at Westminster University and holds a PhD from University College London. He is a member of the British Psychological Society and a Fellow of the Royal Society of Arts.

Email: j.paskins@ucl.ac.uk

Josh Powell - Doctoral Researcher, ZSL & UCL Geography

Joshua Powell CF is a doctoral researcher in the Institute of Zoology (IoZ) at the Zoological Society of London (ZSL) and the Department of Geography at University College London (UCL), on the London NERC DTP. Josh is interested in the impact of climate change on wildlife populations and global biodiversity. He holds a Master of Environmental Studies (MES) from the University of Pennsylvania, where he was a Thouron Scholar from the UK. Josh was formerly a policy advisor for the Department for Environment, Food & Rural Affairs (Defra) and he currently serves as an advisor for the Queen's Commonwealth Trust (QCT) on environment and society. He is a National Geographic Explorer and a presenter for WWF's #WWFVoices campaign on global biodiversity, reporting on the impacts of climate change from the world's polar regions.

Email: joshua.powell.19@ucl.ac.uk

Tim Reeder

Tim Reeder is a thought-leader and practitioner in strengthening decision making for uncertain climate futures. He pioneered the Adaptation Pathways approach to sea level rise as Project Scientist for the Thames Estuary 2100 Project. He now advises on use of the Adaptation Pathways approach in Europe, USA, Australia, Central Asia and Africa. Tim also led the development of a proactive low head hydropower policy for the Thames and oversaw the installation of a hydropower scheme which now powers Windsor Castle. He is a contributing author to the IPCC 4th assessment report, the UKCP09 projections report and the second UK Climate Change Risk Assessment report. He is also Advisor to the London Climate Change Partnership, which he helped set up. Tim has

written several papers on climate change uncertainty and decision making and continues to contribute to climate change practice and policy world-wide.

Email: tim.reeder@ntlworld.com

Simon Sharpe – Cabinet Office COP26 Unit

Simon Sharpe is Deputy Director for Policy Campaigns at the Cabinet Office COP26 Unit. He has previously worked as head of private office to the energy minister, as policy lead on clean growth in the UK industrial strategy, and as head of climate change strategy at the Foreign and Commonwealth Office in the run-up to the Paris Agreement. He spent ten years in diplomacy, with postings in China and India. He recently co-authored the report 'Accelerating the low carbon transition: the case for stronger, more targeted and coordinated international action', and previously produced the report 'Climate change: a risk assessment'.

Email: simon.sharpe@cabinetoffice.gov.uk

Katherine Welch – UCL Public Policy

Katherine is Head of External Engagement and Partnerships at the Office of the Vice Provost Research (OVPR), supporting UCL researchers and academics to connect their work with strategic partners across academia, policy, third sector and professional organisations. With a passion for addressing the climate crisis, Katherine is working with the commission to shape activities and outputs to inform the knowledge and evidence base of a wide range of policy professionals.

Email: k.welch@ucl.ac.uk

Matt Winning – UCL Institute for Sustainable Resources

Dr Matthew Winning is a Research Associate at the UCL Institute for Sustainable Resources. He provides economic analysis, macroeconomic modelling and energy system modelling on the subjects of climate policy, green growth, the circular economy, and low-carbon transitions. He undertook his PhD in the Fraser of Allander Institute at the University of Strathclyde. Matthew is also involved in Public Engagement activities on communicating climate change including being a member of the UCL Policy Commission on Communicating Climate Science. He has performed three different comedy shows at the Edinburgh Festival Fringe about climate change. He has appeared on BBC Scotland, BBC Three, Sky News, Dave, BBC Radio Scotland, The Now Show on BBC Radio 4, BBC London, and written pieces for Guardian, Metro, Scotsman, and Sunday Post.

Email: m.winning@ucl.ac.uk

Annex II

Expert Presentations

Sep 2019: **Rebecca Willis** (Professor in Practice at Lancaster Environment Centre, and an Expert Lead for Climate Assembly UK) – Rebecca presented her research and experiences when seconded to the House of Commons on the attitudes and scope for action of MPs to Climate Change

Oct 2019: **Josh Powell** (UCL Geography Dept PhD Student) – Josh presented on "How to Engage Policy makers on climate issues" based on his experience seconded to DEFRA

Luke Bevan (UCL Department of Science, Technology, Engineering and Public Policy (STEaPP) Post-Doctoral researcher) – Luke presented on Framing techniques in climate narratives based on a recent course

Nov 2019: **Luke Jackson** (Nuffield College, Oxford) - Luke presented on "Lessons learned communicating climate science to the public" based on his experience having set up several educational initiatives including the NERC-funded "Operation Earth" for 5-9 year olds and their families

Katy Janda (UCL Bartlett School) – Katy presented on "Story telling in climate communications" based on her work developing narratives for the presentation of climate change to industry

Dec 2019: **Derek Bates** (Agenda for the Future) – provided an overview of his latest book and the thinking of the 'Agenda for the Future' group

Jan 2020: **Ian Dodgeon** (OKRE - Opening Knowledge across Research and Entertainment) – Ian described OKRE which is a product of his earlier work with the film. TV and games industries and is rooted in the idea that the content people choose to watch influences their understanding of the world.

Feb 2020: **Jyoti Banerjee** (North Star Collective) – Jyoti provided an overview of the North Star Collective initiative to accelerate systemic change addressing the climate crisis working via transformative tipping points

Robin Webster (Climate Outreach) – Robin presented on "Having good climate conversation" based on the 'Talking Climate' handbook recently published by Climate Outreach

March 2020: **Henry Dieudonne-Demaria** (Head of Emissions Trading Strategy - BEIS) – Henry presented his reflections on Climate Change policy making from a Departmental perspective, including the need for an integrated approach across government

April 2020: **Robin Matthews** (Senior Science Officer, IPCC WGI Technical Support Unit, and Adaptation Research U East London) – Robin presented on communicating climate science from an IPCC perspective, including an interactive atlas of climate change impacts, clearer figures in IPCC reports and cross-chapter feature boxes

May 2020: **Abi Bunker** (Director of Conservation and External Affairs, Woodland Trust) – Abi presented on climate change and nature, the dual goals of the Woodland Trust, and discussed the role of trees in the enhanced drawdown of atmospheric carbon dioxide

June 2020: **Ben Littlefield & Dom Galliano** (UCL Culture Engagement team) – Ben and Dom described the work of the UCL Culture Team, which aims to engage the public in UCL's research output. Also mentioned was the UCL Centre for Co-production in Health research which is planning a major launch in Autumn 2020

July 2020: **Liz Bentley** (Chief Executive, Royal Met Soc) – Liz presented on communicating climate science from the perspective of the R. Met. Soc., including a wide range of publications, events, educational activities, media engagement and policy advice.

Sep 2020: **Ben Gammon** (Museum audience research & interpretation consultant)
– Ben presented on "How to achieve effective dialogue – lessons from the Science Museum's Dana Centre experience"

Oct 2020: **Bill Bordass** (Usable Buildings Trust) – Bill presented lessons he has learned over multiple decades on climate action from the building and architecture sectors

Annex III

Chris Rapley - Invited Lectures, Panels, Broadcasts, Interviews, Briefings, Articles

1. "Grappling the Horizon" Evidence presented to the All Party Parliamentary Group Inquiry on Long-termism in Policymaking – Focus on Climate Change, ZOOM (29th Oct 2020)

2. "Climate Change and the Financial Services industry" – Webinar Interview with Andrew Parry of Newton Investment Management – ZOOM – (20th Oct 2020)

3. "Coronavirus: The Whole Story – "Could COVID-19 Save the Environment?" Podcast - interviewed by Vivienne Parry, with Jacqueline McGlade and Rachel Freeman – broadcast on 19th Oct – via Zencastr (13th Oct 2020)

4. "US West coast wildfires and other current examples of climate change" – interview with Leslie Hook, Financial Times (10th Oct 2020)

5. "Together We Can", Great Portland Estates Webinar, 2nd Oct 2020)

6. "The Climate Emergency: Changing Behaviours Through Insurance", Chair - Resilience First Webinar (22nd Sep 2020)

7. "Hotting Updated", Webinar for Welsh Business Membership organisations, (9th Sep 2020)

8. "Climate Change actions" – video interview with Simone Bye, Commercial (10th June 2020)

9. "The importance of investment in early-stage clean growth companies", Video upload for launch of the UK Clean Growth Investment Fund (15th May 2020)

10. "Melting of Sea Ice", Video upload for Card 18 of "The Climate Collage", Faces of Climate Collage (10th May 2020)

11. "Scientifically Illiterate vs Politically Clueless? Wisdom Shall Prevail", Blog for UCL Public Policy Website (6th May 2020)

12. "COVID-19 and Climate Change – What can we learn?", interview for London City University Blog by Nicole Huggins, by phone (21st Apr 2020)

13. "Together We Can" – Institute of Environmental Sciences Webinar (11th Mar 2020)

14. "Together We Can" – Climate Change lecture, London School of Economics MSc students Cumberland Lodge retreat, Cumberland Lodge (29th Feb 2020)

15. Climate Change and Policy briefing for Baroness Sheehan, House of Lords (26th Feb 2020)

16. "Climate Change in context" – video session for Sophie Marple commissioned video (24th Feb 2020 UCL)

17. 'Antarctic heat wave" Talk Radio interview – via landline (13th Feb 2020)

18. "Whether you like it or not", Invited presentation, "A Woman's Place is in the Fight Against Climate Breakdown!", Burgh House, Hampstead, (21st Jan 2020)

19. "Our Common Home", Invited Keynote, Climate Change Among the Religions", St George's House, Windsor (17th Jan 2020)

20. Jane Lubchenco Interview: "Our Moment of Truth – The Social Contract for Science Revisited" In Union session U24A "Is Environmental Science Serving or Failing Society? Strategies for Rapid Climate Solutions" – American Geophysical Union 2019 Fall meeting, San Francisco (10th Dec 2019)

21. "Reflections", Surrey Climate Commission meeting, WWF Building, Woking (4th Dec 2019)

22. "Hotting Up", Institute of Environmental Management Invited lecture, The Sekforde, London (3rd Dec 2019)

23. "Hotting Up", Video presentation to senior members of Welsh Business Community, via Webex, (27th Nov 2019)

24. "What do you know about climate change?", St Mary's Junior School, Cambridge (22nd Nov 2019)

25. "Use Your Voice", Assembly talk, St Mary's School, Cambridge (22nd Nov 2019)

26. "Hotting Up", Earth Sciences First Year Undergraduate course "The Earth", UCL, London (21st Nov 2019)

27. "Communicating Climate Science", UCL Natural Sciences student Podcast, London, (20th Nov 2019)

28. "Hotting Up", Invited Keynote, "Delivering Net Zero", Global CCS Institute event, Butchers' Hall, London (19th Nov 2019)

29. "Climate Emergency" Video Blog interview; Guildford Dragon News, Guildford (18th Nov 2019)

30. "Hotting Up", Invited Keynote, BSRIA 2019 Briefing "A Climate of Change", The Brewery, London (15th Nov 2019)

31. "Hotting Up", The Landscape Institute's 2019 Jellicoe lecture, Leicester Town hall, Leicester (7th Nov 2019)

32. "Climate Change – Solutions to the Global Threat", Invited Keynote speaker, The D Group, Senior business lunch, Mayfair, London (7th Nov 2019)

33. "Whether You Like It or Not", Masters lecture, Surrey University, Guildford, (6th Nov 2019)

34. Panellist – Harris Debate "Climate Change – Your Impact, Your responsibilities", Royal Institution of Chartered Surveyors, Parliament Square, London, (30th Oct 2019)

35. "Whether You Like It or Not", "Chew On It Lecture", Natural History Museum, London, (30th Oct 2019)

36. "Whether You Like It or Not", Guildford Environmental Forum, Council Chamber, Guildford Borough council, Guildford, (28th Oct 2019)

37. "Whether You Like It or Not", UCL Science and Technology Studies Lecture, UCL (17th Oct 2019)

38. "Whether You Like It or Not", Keynote presentation, Carbon Trust Corporate Sustainability Summit 2019, Science Museum London (16th Oct 2019)

39. "Resilient Nation", Climate Change – Is There a Plan B? - Parliamentary and Science Committee, Grimmond Room, Portcullis House, London (14th Oct 2019)

40. "Hotting Up", UCL Climate Action Society lecture and workshop, UCL (10th Oct 2019)

41. "Hotting Up", Invited speaker, Intelligence Forum, Shoosmiths Law, The City, London (9th Oct 2019)

42. Contributor, Guildford Environmental Forum public discussion of the Climate Emergency, Guildford Institute, Guildford (3rd Oct 2019)

43. "Hotting Up", UCL Earth Sciences Doctoral Training Programme lecture, UCL Earth Sciences (2nd Oct 2019)

44. "Hotting Up", Lecture / briefing to Scottish Government mid-ranking civil servants, Edinburgh (9th Sept 2019)

45. "Hotting Up", Lecture / briefing to Scottish Government senior civil servants, Edinburgh (9th Sept 2019)

Annex IV

Publications

AGU Session U24A - Is Environmental Science serving or failing society? Strategies for rapid progress on Climate Solutions. 10th Dec 2019 – San Francisco

Environ. Res. Lett. **15** (2020) 110201

Our Moment of Truth: The Social Contract Realized?

Jane Lubchenco, Oregon State University, Corvallis, USA
Chris Rapley, University College London, UK

Abstract
Much has changed in the two decades since I (JL) proposed that scientists should re-examine their obligations to society in order to serve society better. Today, more environmental scientists are actively sharing their science broadly, conducting use-inspired science (*sensu* Stokes) in addition to basic science, engaging with society, and crafting solutions to problems not just diagnosing them – all very welcome and exciting developments. For the most part, however, environmental scientists have taken on these extra duties because they believed it was the right thing to do and despite the considerable impediments that exist within academia. But make no mistake, the culture of academia continues to impede progress. As a result, although the above actions have had demonstrable effect, their collective impact falls far short of what is needed if society is to tackle effectively the disruption underway due to climate change, ocean acidification, biodiversity loss, pandemics, and more. Actions by *individuals* can take us only so far. To truly help society meet its grand challenges, environmental scientists must now make a quantum leap in engagement with society. It is time for *strategic, collective action* to change the culture of academia and create the enabling conditions for science to serve society better.

Keynote
Welcome to our AGU Union Session and thank you for joining us. I (JL) am here today to challenge us to look in the mirror, ponder this Moment of Truth, and take stock of our responsibilities to society, each other, and future generations. I pose four questions:

- What is the social contract for science?
- Why is it important?
- How are we doing?
- What do we need to do?

Let's start with the first two. Twenty-two years ago, I focused my AAAS Presidential Address on "Entering the Century of the Environment: A New Social Contract for Science" [1]. My remarks highlighted a plethora of serious environmental problems that were insufficiently addressed by the scientific community. We needed scientific answers that we did not have, and we needed to do a much more effective job of using existing knowledge. I noted that the culture of academia rewarded publishing scientific results in scientific journals, not connecting that knowledge to policy makers, managers, decision-makers, industry, or citizens. Far too much scientific knowledge was languishing in scientific journals and not accessible to or used by society. Confronting this conundrum, I asked, "What are our obligations as scientists?" I suggested that, in exchange for public funding, scientists

have an obligation to be more helpful to society. Specifically, we needed to do more than conduct great science that is driven solely by curiosity and do more than simply publish it in journals read only by other scientists. We *also* needed to focus on the scientific issues underpinning major challenges confronting society and share our results widely.

I concluded that we were not delivering on our social contract. The scientific enterprise was creating vast amounts of knowledge, but it was not collectively adding up to the kind of information that society could use to be informed about or solve big problems. I suggested that our social contract should include 1) a focus on wicked, urgent problems, 2) a commitment to share our knowledge widely, and 3) a pledge do so with humility, transparency, and honesty. The overarching goal I had in mind was helping society move towards a more sustainable biosphere, one that is ecologically sustainable, politically feasible, socially just, and economically viable.

I closed my AAAS Presidential Address with a Calvin and Hobbes cartoon by the incomparable Bill Watterson: Calvin, in his little red wagon being pushed through a forest by Hobbes, says, "*It's true Hobbes, ignorance IS bliss. Once you know things you start seeing problems everywhere. And once you see problems you feel like you ought to try to fix them. And fixing problems always seems to require personal change. And change means doing things that aren't fun. I say phooey to that.* They start down a steep slope, with Calvin looking backward saying, *But if you are wilfully stupid, you don't know any better, so you can keep doing whatever you like*". As their wagon picks up speed, Calvin muses, "*The secret to happiness is short term stupid self-interest*". Hobbes, looking ahead shouts, "*We're heading for that cliff*". Calvin, covering his eyes shouts back, "*I don't want to know about it*". They fly over the cliff – "*Waaaaugh!"* Crash! Splayed on the ground with broken wagon bits all around, Hobbes mumbles, *"I'm not sure I can stand so much bliss*". And Calvin replies, "*Careful! We don't want to learn anything from this*".

I loved and used that cartoon because it encapsulated the inertia in society and academia alike and the worldview of many that staying the course was the best option, when in fact, greater awareness and action to change course were sorely needed. Change is hard, but it was needed. With this call to re-examine our social contract, I intended to prompt a discussion of our individual and collective responsibilities and trigger action.

What has transpired in the intervening twenty-two years? Are we fulfilling our social contract now? If not, why not, and what is needed?

My answers are personal reflections, based on my perspectives as a research scientist, university educator, science communicator, and government official. My four years in Washington DC as the Under Secretary of Commerce for Oceans and Atmosphere and a member of President Obama's science team provided an opportunity to engage with citizens, members of Congress, industry, and civil society. The broad portfolio of the scientific agency, National Oceanic and Atmospheric Administration – that I led for four years – gave me insights into how science touches people's lives, and what they know and think of that science – from weather forecasting to climate change, from fishery management and aquaculture to protection of biodiversity and the benefits the ocean provides. My two years as a science diplomat with the State Department as the first U.S. Science Envoy for the Ocean provided additional rich interactions with scientists, industry leaders, decision-makers and citizens. Those experiences shaped how I think about science and society.

One of the most important and least appreciated roles of science is to inform people's understanding and decisions. And I do mean 'inform', not 'dictate'. Science does not dictate any particular outcome. Many scientists do not appreciate that numerous factors beyond scientific

information influence the decisions made by both institutions and individuals. Policy makers, for example, often take into account politics, economics, values, and more. I believe that science should also be at the table. Science should inform their decisions – but it does not dictate them. However, all too often, science is not at the table because it is not accessible, understandable, or seen as relevant, or credible. For science to inform decision-making, it has to be all of the above. Part of our social contract entails scientists playing a more active role in making scientific information accessible, understandable, relevant and credible.

A few stories about my experiences with science and policy makers will illustrate these points. The first highlights politicians' attitudes toward science. About a year after I was sworn in, in the middle of the Deepwater Horizon oil spill disaster, the President asked the Vice President to go to the Gulf to meet with fishermen and share what the federal government was doing and what we knew about the spill. The VP's team invited me to join him and brief him on NOAA's and other agencies' efforts. I briefed Vice President Biden on Air Force Two about key aspects of the spill—how oil impacts life in the ocean, what we were doing to halt the flow and spread of oil and minimize its impacts. Part way through my briefing, the VP stopped me and said, "*Hey, I thought you were a scientist!"* I replied nervously, "*I am, Mr. Vice President.*" Then he responded "*But… I just understood everything you told me*". A bit stunned, I thought "*Wow - what a commentary on other scientific briefings that was! How many times has he been briefed by scientists and he still thinks he can't understand us"?* That interaction reinforced for me that far too many smart politicians think they can't understand us. That's a problem. The VP embraces scientific knowledge and supports it. But, he still expects to not understand what we say. Once he realized that he and I could communicate easily, he peppered me with more questions and invited me to ride with him in his car after we landed so he could learn more.

My second story emphasizes the importance of not assuming your audience knows what you know about the topic. NOAA's National Weather Service provides life-saving weather forecasts and warnings and shares its weather data so others like the private weather providers can generate forecasts and various weather products. Over ninety-five percent of the data that go into the numerical weather forecasts come from NOAA's weather satellites. When I was at NOAA, after we completed a much-needed overhaul of the program that oversees construction of new weather satellites, I was on Capitol Hill to brief key members of Congress on the change. Since many of them were deeply immersed in the program, I mistakenly assumed they all knew the basics about how vital these weather satellites were to the entire weather enterprise. So I was unprepared when one key member scoffed at my pitch, saying "*Doctor, I don't need your weather satellites, I've got the Weather Channel*"! Unfortunately, neglecting to learn what your listeners know about your topic is a mistake we scientists often make.

So, twenty-plus years later, how are we doing in rising to the challenge of our Social Contract? I believe we can take a lot of pride in the changes that have happened in two decades. Things are remarkably different in terms of the attitudes and actions of scientists. Here are four significant advances that we have made.

1) Far more scientists today are actively communicating their science. They tweet, blog, post videos about their research, and speak to the media. SciComm is a 'thing' now. It didn't used to be. There are now numerous programmes designed to train scientists to be better communicators, but the demand still outstrips the availability of good programs. Fortunately, social scientists have shared valuable results about how to communicate science effectively ('the science of science communication'); much of that is being put to good use. I think about science communication as learning to be bilingual – speaking the language of science and speaking the language of lay people.

Avoiding technical jargon, telling stories, finding strong and useful analogies and metaphors, giving listeners a glimpse into your world, your passions, your feelings are all elements of effective communication.

I want to be clear that I am not suggesting that ***all*** scientists should communicate with the public. Some don't want to. Some aren't good at it. Some shouldn't do it. My hope is that we would all support our colleagues who do choose to communicate with the public. And we would all support our students who communicate publicly or seek to learn to do so effectively. We need to move past the outdated notion that younger scientists jeopardize their careers by sharing their knowledge widely. Rather, we should embrace, encourage, and enable all scientists who seek to connect science with society effectively.

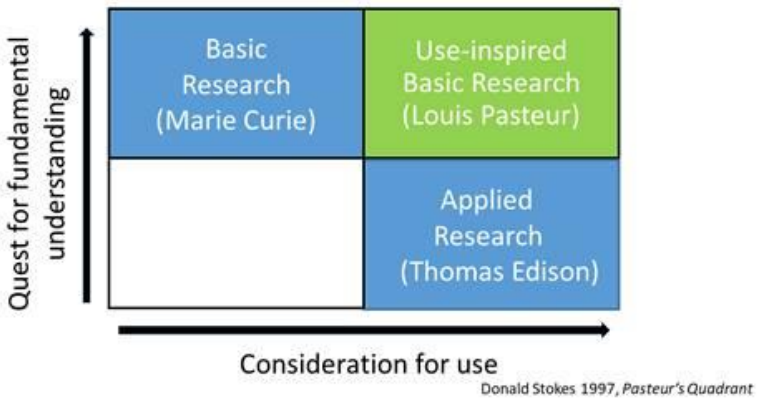


Figure 1 Use-inspired science

2) We've moved from doing mostly basic science to doing a combination of basic science plus what Donald Stokes calls 'use-inspired science' [2]. Stokes makes the case that the classical binary categorization of science into either basic or applied science doesn't do justice to the richness of the science that our world needs. He defines a third category, 'use-inspired' science (Pasteur's Quadrant – Figure 1), as pursuing fundamental knowledge to solve problems that are immediately relevant to societal needs. More and more scientists are doing just that – tackling big, wicked problems and producing knowledge that can be immediately helpful. We need all three categories. But until recently, 'use-inspired' science has gotten short shrift. This is changing rapidly.

3) Scientists today have realized that simply communicating scientific knowledge is insufficient; we need to also engage more with society. In my 1998 social contract paper, I focussed on *sharing* knowledge. I now realize that although sharing is indeed important and needed, it is not enough. We must also *engage* with society. We need to listen, to learn, and to co-create knowledge with non-scientists. Indeed, more and more scientists are working toward this end.

4) Scientists have moved from just diagnosing problems to devising and co-creating solutions. This often entails rich interdisciplinary interactions and partnerships with non-academics. These take time and often require special arrangements. Co-creating solutions is something that scientists had often shied away from, but are doing more and more today. There are a huge number of solutions that have been created in the last twenty years. These solutions provide powerful models to emulate, but most are far from being implemented at the scale needed to match the magnitude of the problem.

In short, scientists are responding to societal needs. They are moving from the ivory tower to embracing a social contract - whether they call it that or not - and moving to science being embedded in, engaged more with, and serving society. More and more environmental scientists are conducting use-inspired science. They are crafting solutions. There are a lot more of us, we are doing it better, we are learning from each other. Communities of practice now exist. This progress is thrilling. These individual scientists are fulfilling their social contract. However, as useful and important as their efforts are, the sum total is not yet commensurate with societal needs.

So why has this impressive progress been insufficient? My diagnosis is that these endeavours have largely been individual efforts. Individual scientists have broken stereotypes and expectations, because they were motivated to help. But, they have done so despite the reward structure within the academic system. For more scientists and science writ large to truly help society solve daunting environmental and social challenges, it will take collective, not just individual action.

To be sure, serious impediments to solving environmental and social problems exist within science, society, and academia. I focus only on the latter. I posit that the biggest impediment within academia is its culture. Simply put, the culture of academia does not value or reward scientists who communicate with or engage with society. It rewards numbers of grants, numbers of publications, status of the journals, amount of money raised, and more recently, the quality of teaching. These are the currency of hiring and promotion.

I take heart from the fact that the academic culture is capable of evolving. Quality of teaching is now more routinely part of the hiring and advancement decisions than it used to be. I believe it is time for a second evolution, one that seeks to actively cultivate a culture of service to society through teaching, fundamental contributions to knowledge, and engagement with society focused on problem-solving. Promotion and tenure decisions should include the expectation of scientists doing outreach, communication and engagement. We need to train and empower our students to do the same. We need to give them the tools and resources to be today's and tomorrow's problem-solvers. And we need those students and scientists to reflect a greater diversity of society than is the case today.

In short, I suggest that we have made impressive progress in the last two decades, enabled by individual scientists taking individual action. But without collective action we will not deliver what society needs. What does collective action mean? To me it means confronting these cultural barriers and creating an opportunity for dialogue about engagement as a core responsibility for many faculty. I envision all faculty supporting the importance of engagement, and any faculty who wish to engage being rewarded for doing so. Secondly, collective action means changing the incentives - in job descriptions, promotion and tenure criteria, recognition, and awards. Thirdly, collective action means providing training, mentoring and the expectation of engagement for students. Training might focus on useful skills including communication and engagement, conflict resolution, negotiation, systems thinking, and teamwork - the kinds of skills that are required for successful engagement. Fourthly, collective action is needed to enable the partnerships that are needed for successful engagement. For example, a university or a group of faculty might want to partner with the local community, or with a non-governmental organization. That may require legal, intellectual property, and financial arrangements with which universities struggle. Fifth, collective action is needed to create communities of practice to sharing best practices and knowledge about successful engagement or scalable solutions. Finally, funding will be required to implement some of the above changes and enable effective engagement.

Many of the solutions to challenging environmental problems are inspiring. But we need more, and we need to scale them. We have seen what is possible when scientists are motivated. Now it the time to unleash more of that creativity.

In conclusion, I think we face a Moment of Truth. Those of you working on climate change are well aware of the magnitude of the challenges. So, too are those working on the loss of biodiversity or the disruption and depletion of ocean ecosystems. These and other problems will require herculean efforts on the part of scientists and society. Time is running out. This is an all-hands-on-deck moment. The past two decades have shown inspiring solutions that have emerged from a subset of our community problem-solving and engaging despite the system. Just imagine what we could do if the system encouraged and enabled those approaches! It is time for a renewed social contract for science. It is time for the academic community to collectively make a quantum leap in our engagement with society. It's time for strategic, collective action to change the culture of academia, and mobilise enabling conditions for science to serve society more effectively. The question is "Will you help make that happen?"

Q&A following Keynote Address:

Chris Rapley: Thanks Jane for a terrific talk. Your 1998 'social contract' paper' had an enormous impact. It inspired a lot of us to ask the questions "What are we for, and what should we be doing – and are we doing it or not?" We felt that we weren't. Since then, as you have pointed out, individual scientists have done a lot. But in some respects, much is the same. You particularly implored the scientific institutions to act. So what do you think the barriers have been to the large institutions? Because up until now we haven't seen them shift in the way that we might have hoped.

JL: We have seen some action such as professional scientific societies being willing to make public statements, but we have not seen them change as much as is needed. Organisations like scientific societies respond to their members, so members have more power than they often think. One thing that would be useful would be to tackle some of the impediments to changing the culture of academia and of science. For example, some have suggested there is no good way to evaluate the calibre of scientific communication or engagement because we lack good metrics. There is a need therefore to give serious thought to the ways in which Promotion and Tenure committees might evaluate the quality of engagement or public communication. Another opportunity is to focus on what professional scientific societies could do to provide more compelling information to state legislatures, to governors, to members of Congress. Universities have opportunities as well. Some university Deans have enabled progressive, creative programs that engage students in problem-solving, create use-inspired science, and provide opportunities for training in engagement. Those could be praised and emulated. Simply taking stock of best practices could be useful.

CR: Reductionism is the only way you can really advance science. But you pay the price in that you create a multitude of silos. Specialist natural scientists find it hard enough to talk amongst themselves. But the social sciences, the science and technology studies, the neuroscientists, the researchers who understand values and how people make sense of the world – have generated a huge body of knowledge which would be helpful. Yet it's very hard to stitch that into the busy day of a natural scientist. Have you got any ideas on how we might get better at doing that?

JL: I believe that holistic approaches are a nice complement to reductionism. Understanding complexity is a case in point. The field of complex adaptive systems is providing a wealth of insights that are immediately relevant to understanding coupled human-natural systems. The emerging insights have yet to be applied to a plethora of social and environmental problems. How, for

example, might one change the perverse incentives for actors in an environmental issue in ways that convert a vicious cycle into a virtuous cycle? I've seen impressive progress from much of the interdisciplinary science underway. I see productive collaborations, especially within bio-geophysical sciences, but more and more between bio-geophysical and socio-economic sciences. We've learned a lot about what works and what doesn't work, and that knowledge is proving useful.

CR: When we talk about the social contract with early career scientists they say "We get this, of course we need to understand it". So have you got any ideas on how we could take advantage of that natural enthusiasm we find in young scientists - who like to see that their work is actually being beneficial to society.

JL: Young scientists give me hope, because there is so much passion, curiosity, and willingness to jump in with both feet. What is lacking is often the enabling conditions for them -- the tools, the funding, the training, the opportunities to engage and problem-solve. What we need to do is create the right environment for them to thrive, then get out of the way.

CR: What would be your final message? What is the one big thing that people should carry from this?

JL: Apart from my overarching message of the need for scientists to work together to enable science to be more useful to society, I'd like to mention the importance of thinking about incentives and ways to change them if they are not leading the desired outcomes. Incentives drive behaviour. It's worth asking what are the incentives for all relevant actors, from young people or faculty to deans? What are the incentives for leaders of scientific societies to lead change? What are the incentives for our elected representatives, or natural resource users, or business leaders to do what they do? And if the outcomes are not in society's interests, how can those incentives be modified? If we can figure out what the perverse incentives are and how to remove those, and how we can change the system to reward the kind of behaviours that are going to bring collective good as well as individual good, then I think will be in a better place.

References

1. Lubchenco, J., *Entering the Century of the Environment: A New Social Contract for Science.* Science Technology Human Values, 1998. **279**: p. 491-7.
2. Stokes, D.E., *Pasteur's Quadrant - Basic Science and technological Innovation*. 1997: Brookings Institution Press.

Jane Lubchenco https://orcid.org/0000-0003- 3540-5879
Chris Rapley https://orcid.org/0000-0002-2858- 3661

Transforming the stories we tell about climate change: from 'issue' to 'action'

Kris De Meyer, Emily Coren, Mark McCaffrey, Cheryl Slean

Keywords

Communication, storytelling, education, outreach, public engagement, social psychology, communication infrastructure

Abstract

By some counts, up to 98% of environmental news stories are negative in nature. Implicit in this number is the conventional wisdom among many communicators that increasing people's understanding, awareness, concern or even fear of climate change are necessary precursors for action and behavior change. In this article we review scientific theories of mind and brain that explain why this conventional view is flawed. In real life, the relationship between beliefs and behavior often goes in the opposite direction: our actions change our beliefs, awareness and concerns through a process of self-justification and self-persuasion.

As one action leads to another, this process of self-persuasion can go hand in hand with a deepening engagement and the development of agency - knowing *how* to act. One important source of agency is learning from the actions of others. We therefore propose an approach to climate communication and storytelling that builds people's agency for climate action by providing a wide variety of stories of people taking positive action on climate change. Applied at scale, this will shift the conceptualization of climate change from 'issue-based' to 'action-based'. It will also expand the current dominant meanings of 'climate action' (i.e., 'consumer action' and 'activism') to incorporate all relevant practices people engage in as members of a community, as professionals and as citizens. We close by proposing a systematic approach to get more reference material for action-based stories from science, technology and society to the communities of storytellers - learning from health communication and technologies developed for COVID-19.

1. Introduction

It is 2030. Around the world, the physical signs of a changing climate have become commonplace. As a concept in the public mind, 'climate change' is omnipresent and widely accepted. Popular media report it freely and frequently, mostly through stories of people and communities acting *on climate change. Society is decarbonizing at breakneck speed, and stories abound of individuals and communities at local, national and international level discovering new ways to limit or draw down carbon emissions. These discoveries are driven by general ingenuity, natural solutions and technological developments in energy, transport, construction and food. There are also testimonials of local communities overcoming the inequalities and risks of climate change already underway, and universal stories of challenges confronted and overcome. In brief, climate change has become part of the fabric of everyday life; the backdrop against which life's choices play out...*

This picture of 2030 shows the cultural mindset which we imagine would exist in a world doing its level best to tackle climate change. At present, society is far removed from this. Climate change is primarily conceptualized as a threat we should be concerned about (Section 2.1), rather than as something we know how to act on. This issue-based conceptualization of climate change, combined with a widespread but mistaken 'conventional wisdom' that awareness and concern are precursors to action (Section 2.2) gives rise to three interrelated problems. First, it leads to a **poverty of stories** about climate change. The vast majority of communications about climate change (scientific articles,

news reports, other media stories and even entertainment and arts projects) use the same language and overarching narrative which focuses on raising concern among its audiences. This approach, however, leads to the second problem: a widespread **lack of agency** (agency being defined as 'ability to act' - Section 3.2), because raising concern and calling for urgent action in the abstract does little to help people figure out how to respond concretely. Third, as a sign of this lack of agency, the **opportunities for citizens to engage in climate action are conceptualized too narrowly as consumer choice and climate activism** - with passionate disagreements raging about which forms of action are meaningful and which are not.

Delivering value to society and accelerating action on climate change (the core topics of this special issue) requires an alternative approach to communication and storytelling about climate change to address all three problems. The planet is changing and our technological advancement is progressing more rapidly than the systems for culturally assimilating that information - systems like science communication, outreach and citizen engagement; knowledge transfer from science to decision makers; formal and informal education; and social media, journalism, media, arts, culture and entertainment. The required change therefore applies to a wide ecosystem of researchers and practitioners in environmental communication, education and policy; technological infrastructure developers; and the content creators working in media and the creative industries.

In this article, we outline elements of a system to shift this researcher/practitioner/citizen ecosystem from an issue-based conceptualization of climate change to an action-based one. Section 3 sets out what compels this shift: evidence from psychology and neuroscience showing that **in real life actions drive beliefs** - rather than awareness, beliefs or concern leading to behavior change. We also discuss research showing the effectiveness of stories of people taking action - rather than stories about issues or impacts - as the best way to create **agency**. In Section 4, we provide two examples of efforts already underway to build the agency of storytellers for an action-based approach to climate storytelling. In Section 5 we describe a set of systematic tools to coordinate a flow of reference materials for local and global action-based stories to the desks of communicators, educators and storytellers. Finally, in the conclusion we reflect on how our proposed approach differs from other calls to apply storytelling to climate change. We also reflect on the role that different professional communities (e.g., environmental scientists, journalists, creative writers, and funders) can play in this transition.

Table 1 provides a summary of the main insights and research fields providing the evidence base for our proposed shift to action-based storytelling. Each concept and research field in the table has been the subject of hundreds or more research studies and review articles. It is not the purpose of this article to provide a systematic review of these research domains, but to establish that there is a strong evidence base for the practice we propose. We also provide signposts into these research fields which are currently relatively unknown in climate communications research and practice. For each concept we provide references in the text to pivotal studies and review articles as entry points to the relevant literature.

Table 1. Insights and research fields underpinning the shift to 'action-based storytelling'.

Concept

self-persuasion

entertainment education

Origins

social psychology: cognitive dissonance

entertainment industry & communication research

Key Ideas

actions can drive beliefs and lead to deep engagement with issues

use our capacity to learn from stories of other people's actions as a way to build agency

agency social psychology: 'ability to act' in a particular context is a precursor social cognitive theory to action; it is lacking on climate change **positive** health communication start with stories of individuals and groups who **deviance** have already developed agency (positive outliers)

A clarification of terminology: we use 'storytelling' to cover a broad range of communication practices, from one-way to interactive, in fiction or nonfiction form, and in any media format. We are aware that different academic disciplines and sectors (e.g., the marketing sector) attach specific and sometimes conflicting meanings to words like communication, outreach, engagement,

education and story. For our proposed approach, we adopt 'storytelling' as a common label to bypass the complications of these disciplinary and sectoral differences. As the focus is on 'people doing things', these accounts contain the main elements commonly associated with stories, such as characters and events. In this broad designation, 'climate storytelling' includes content produced in journalism and news media, entertainment, arts and culture. It also includes science communication and outreach, environmental education and even policy outputs which are now mostly issue-based but will also benefit from a shift to an action-based perspective.

2. The current state of affairs in practice and research

2.1 Cultural mindsets about climate change

In media and popular culture, climate change is primarily conceptualized through 'doom and disaster' narratives - an existential threat to human society, the natural world and even the planet itself. In the first large-scale UK media analysis of climate change, Ereaut and Segnit (2006) wrote:

"*Climate change is most commonly constructed [...] as awesome, terrible, immense and beyond human control. This repertoire is seen everywhere [...] in broadsheets and tabloids, in popular magazines and in campaign literature from government initiatives and environmental groups. It incorporates an urgent tone [...] and uses a language of acceleration and irreversibility.*"

Little changed in the following years (Painter 2013, Painter *et al* 2017), and by 2020, highly evocative words like 'crisis', 'emergency' and 'breakdown' are used among large parts of the public to describe climate change (Bevan *et al* 2020). Opinion surveys show record levels of concern globally (Fagan and Huang 2019, Goldberg *et al* 2020) - which holds up even in times of COVID- 19 (Gray and Jackson 2020). People's willingness to take up pro-environmental behaviors is flat lining, however (ibid.). Instead, feelings of powerlessness run high. "But what can *I* do?" - is a question frequently asked but rarely answered satisfactorily (De Meyer *et al* 2019).

2.2 The unresolved question: How to turn belief and concern into action?

A common view among climate communication researchers and practitioners is that belief in, awareness of or concern about climate change are (or ought to be) drivers of climate-positive behaviors. Among some, this is combined with the recognition that in reality this is not happening much. In a review of climate communication research, Moser (2016) listed as one of the unresolved challenges for communication researchers and practitioners the question of "*how to move people from understanding, awareness and concern to action?*" Likewise, Hornsey and Fielding (2020) speak of "*an urgent need to test strategies for increasing climate-related concern in the general public and then translating abstract concern into concrete action.*"

There are several alternate versions of this view, each with different proponents and opponents. Some scientists and communicators continue to pursue an 'information deficit' approach, assuming that knowledge of the facts and future impacts of climate change will drive action (Pearce *et al* 2015, Seethaler *et al* 2019). Other communicators reject a focus on knowledge alone and speak of a need to connect to people's emotions. They are divided, however, whether the most productive emotional states are concern or worry (van der Linden 2017), fear and panic (Wallace-Wells 2019), or positive attitudes, like optimism and hope (see Hornsey and Fielding 2020 for a review). Despite their differences, what all these views have in common is the assumption that a certain mental state (knowledge, understanding, awareness, beliefs, values, positive or negative attitudes and emotions) is the key to unlocking climate action. So far, the evidence for this is in short supply. Be it beliefs about climate change (Hornsey *et al* 2016), concern (Gray and Jackson 2020), worry (Bouman *et al* 2020) or anxiety (Clayton and Karazsia 2020), in each case measures of the respective mental states are only weakly to moderately correlated with climate-positive behaviors (though the correlation with support for abstract climate policies tends to be stronger).

None of the questions, findings or differences of opinion in recent climate communication research and practice are surprising if one looks at the older research literature in environmental psychology and education, or the wider neuro-, psychological and social sciences. Two decades ago, environmental policy and education researchers were writing about an environmental 'value-action' or 'attitude-behavior' gap (Blake 1999, Kollmuss and Agyeman 2002). Worse, the weak to moderate relationship between environmental attitudes and behavior was already evident in environmental education research from the late 1970s (Marcinkowski and Reid 2019). In social psychology more generally, the study of attitude-behavior gaps can be traced back even further, to (LaPiere 1934). Elsewhere, psychologists have warned against seeing emotions as simple levers of behavior (Chapman *et al* 2017) or have explained why 'fear appeals' can be counterproductive and lead to apathy or denial instead of action (Witte 1992, Witte and Allen 2000, Aronson 2008).

3. The basis for an alternative approach

3.1 In real life, actions usually come before beliefs

If belief in and concern about climate change do not automatically lead to action, then what can be done instead? Starting with cognitive dissonance research in the 1950s, the realization emerged among some psychologists that belief, attitude change and emotional responses are often the *consequence* of behavior, rather than the causation of it. As Aronson (1997) wrote:

"*Dissonance also changed the way we think about attitudes and behavior. Prior to 1957, the general wisdom among psychologists was that, if you want people to change their behavior, you must first get them to change their attitudes. [...] Contrary to the general wisdom, dissonance*

theorists brashly asserted that a more powerful approach [...] would be to induce people to change their behavior first - and their attitudes will follow [...]."

A range of lab-based and real-world experiments provided evidence for the behavior-induced attitude change which cognitive dissonance theory predicted (Aronson 1997, Petty and Wegener 1998, Crano and Prislin 2006). The 'general wisdom' which Aronson referred to proved harder to dislodge, primarily because there seems to be so much evidence (empirical and anecdotal) in favor of it. To cut short a long and experiment-driven debate among psychologists, the conventional view ('beliefs drive actions') holds when attitudes are strong, and the available actions feel doable and meaningful. The converse ('actions drive beliefs') happens when attitudes are weak, we face a difficult choice, or do something that threatens our identity and self-image (the view we have of ourselves as smart, competent, ethical, kind, loyal etc). Under these conditions, an initial decision or action - perhaps taken without conviction at first - can initiate a cycle of self-justification which leads to further action and self-justification, meanwhile strengthening our attitudes, beliefs, feelings and knowledge about the issue. This gradual process of *self-persuasion* generally leads to deeper engagement, and to more profound behavior change and attitude change than what communication and persuasion can achieve (Aronson 1999). That in real life action often precedes ideology and commitment to a cause has also been noticed by social movement researchers (Munson 2008) and political campaigners (Goldsworthy 2020).

Between the 1970s and 1990s, research in environmental psychology and education, influenced by social psychology and dissonance research, occasionally experimented with the idea that actions drive beliefs. In more recent climate and environmental communication research, the conventional view is again pervasive. We found only one recent experiment testing the notion that environmental behaviors might change attitudes (Ertz and Sarigöllü 2019). Why is this so? On a high-stakes issue like climate change, examples abound of passionate advocates who believe strongly in what they do. On the surface, this seems to support the view that to change people's behavior, we need to change their attitudes. However, communication campaigns which focus on building awareness or concern do not lead to the same deep engagement as self-persuasion, nor do they necessarily set people on a path of self-persuasion. What is needed for that is the *opportunity* and *capability* to engage in action which is experienced as meaningful. For many people both of these are missing when it comes to climate change.

3.2 Agency

The second concept of importance is *agency*, which was developed by social psychologist Albert Bandura (1982, 2006, 2018) as part of his *social cognitive theory*. It means 'knowing how to act in order to bring about an intended effect' and is a fundamental aspect of human functioning. Agency is exercised in three forms (ibid.): *individual* agency applies to someone's personal sphere of

control; *proxy* agency applies to situations where people try to influence others to act on their behalf; *collective* agency happens when people pool their knowledge and skills to act in concert.

In social cognitive theory, an important source of agency is *social learning* (ibid.), meaning that we often develop our own agency as we learn from the actions and experiences of others. Social learning, agency and its related concept self-efficacy (the *belief* one has in one's ability to act) have been very influential across the social sciences; for example, in the study of work-related performance (Stajkovic and Luthans 1998), or to structure interventions promoting positive health behaviors (World Bank 2015). However, they are rarely applied in the context of climate change, a few recent exceptions notwithstanding. For example, Doherty and Webler (2016) found efficacy beliefs to be strong predictors of various types of public climate action (voting, protesting etc).

3.3 Self-persuasion leads to the development of agency - but only in a concrete manner

Self-persuasion is a double-edged sword. It has led many intelligent and good people to become stuck in unhelpful or harmful ideas (Tavris and Aronson 2020). However, in its positive forms, as one action inspires the next, it is accompanied by a deepening of one's agency and efficacy in dealing with a situation. Both the cycle of actions someone engages in as part of a self-persuasion process and the agency which develops as a consequence tend to be concrete and specific. For instance, self-efficacy which follows from easy water conservation behavior can result in people taking on harder water conservation actions (Lauren *et al* 2016). However, an action like using reusable shopping bags does not automatically lead to unrelated actions like energy conservation (Poortinga *et al* 2013). Self-persuasion and agency do not make one a master of tackling climate change in the abstract - but only in the concrete, through the types of actions one engages in.

3.4 Expanding the domains of climate agency

On climate change, there are two domains in which a sizable minority of the public have undergone self-persuasion behavior change and developed a degree of agency. The first domain is the reduction of one's own carbon footprint through changes in the consumption of goods and energy. As an example of the adoption of this kind of behavior, a recent US opinion survey showed that, on a number of food-related choices, on the order of 5-25% of participants 'always' or 'often' took certain pro-environmental actions, such as buying local food products or from companies which take steps to reduce their environmental impacts (Leiserowitz *et al* 2020). The second domain is climate activism, which can take several forms: from lobbying politicians to non-violent direct action. In a US survey on activism, 3% of respondents reported they were 'currently participating in a campaign to convince elected officials to take action on climate change' (Leiserowitz *et al* 2019). Beyond such isolated data points, it is not possible to provide comprehensive numbers for who is doing what. Public opinion research tends to focus on attitudes (e.g. support for a certain policy) and intentions to act, but rarely asks about actual behavior. What

is important, however, is that the actions which people become engaged in through self-persuasion (be they certain consumer actions or activism) are easily rejected as not doable or meaningful by others - even if by those who share a high degree of concern about climate change. The often- heard question "But what can *I* do about climate change?" may flummox those who *are* engaged in some form of action. However, this is the nature of self-persuasion. What comes to feel doable and meaningful to one person does not automatically feel so to others.

This problem goes beyond the sphere of personal consumer choices or civic engagement. In our work, we frequently encounter people who say, "I am very concerned about climate change personally, but I can't see how I can do anything about it in my work or professional context." Some - perhaps surprising - professional communities we have heard this sentiment from were creative writers, journalists, teachers, architects, business consultants, health professionals, lawyers, pension fund managers, senior managers in oil companies and even elected politicians. These individuals may have plenty of agency in their job context, but it does not extend to climate action.

What is needed to break through this lack of agency is a systematic approach to support the development of new, concrete ways of 'knowing how' to act on climate change. Rather than telling people *what* to do, they need to be supported in discovering *how* to bring climate action into the personal, professional and civic forms of agency, the social roles and identities they already have (De Meyer *et al* 2019). Instrumental to this context-dependent broadening of climate action is Wenger's (1998) 'communities of practice' idea. He defined it as groups of people who have a shared concern or passion and become better at tackling a situation through learning from each other, as a community. Here, we propose that both place-based, localized action storytelling, and practice-based action storytelling have a role to play in expanding climate agency. As examples of the latter,

for creative writers and journalists the required agency would be about knowing how to make action on climate change part of their stories; for architects, how to bring climate change into building design; for teachers, how to teach about climate action within the constraints of the curriculum; for fund managers, how to bring climate risk into their investment decisions; for health professionals, to support the creation of place-based community systems that respond to the health impacts of climate change. These examples of communities of practice provide different opportunities and challenges to expand the notions of climate action beyond the current notions of consumer choice and activism. Others have started to apply a 'communities of practice' lens to the creation of climate agency, e.g. for health professionals (El Amiri *et al* 2020) or weathercasters (Maibach - this issue). We will return frequently to this concept below, as it is an important lever to build agency in communities of people with shared expertise and concerns.

There are different aspects to creating agency, as 'ability to act' requires both 'opportunity' and 'capability', and there is more than one way to foster either of these. In this article we focus on one

way to operationalize the idea: by telling stories about people discovering how to act within a specific place- or practice-based context. In the following subsection, we will describe some of the evidence demonstrating that stories of 'people taking action' can create agency in others.

3.5 Education entertainment and positive deviance

Bandura's ideas about social learning as a vehicle for the development of agency became the foundation of *entertainment-education* (Singhal and Rogers 2002). It is an integrated communications approach that uses a fictional story (frequently broadcast via television or radio) as one piece of a larger strategy to build audience engagement around important topics of public concern, usually in the domain of health or social development. Despite having a fictional component, entertainment-education stories deliver reliable content from reputable sources. They model desired changes through the actions and experiences of the story characters. With a strong focus on entertainment value, there are many examples of projects which have been commercially successful, while also having large positive effects on public behaviors such as enrollment in adult literacy classes, adoption of family planning methods, and gender equality (Nariman 1993, Singhal *et al* 2011, 2013). The approach has proliferated over the past forty years to thousands of projects globally, becoming an influential health promotion strategy (Kincaid 2002, Moyer-Gusé 2008, World Bank 2015). In recent years, entertainment-education projects have also become *transmedia* - coordinating stories across multiple platforms, including social media (Lutkenhaus *et al* 2019).

A crucial aspect of entertainment-education narratives is that they are structured to facilitate the development of agency through social learning. A story character (called the 'transition' character) models a desired change of attitudes and behavior against a backdrop of support and opposition of other story characters (modelling 'positive' and 'negative' attitudes and behavior, respectively). Viewers or listeners, through their identification with the transition character, develop their own sense of agency and efficacy with respect to the change the transition character experiences.

Singhal and Dura (2009) integrated another health communication practice into the entertainment education story structure: *positive deviance* (Marsh *et al* 2004). Positive deviance starts from the premise that every community (place- or practice-based) has individuals or groups who are positive outliers - who on their own account have developed novel solutions or behaviors to deal with certain problems (Singhal and Dura 2017). Entertainment education narratives incorporating positive deviance thus start from existing knowledge of what works in a given community, rather than assuming that information needs to come from outside experts.

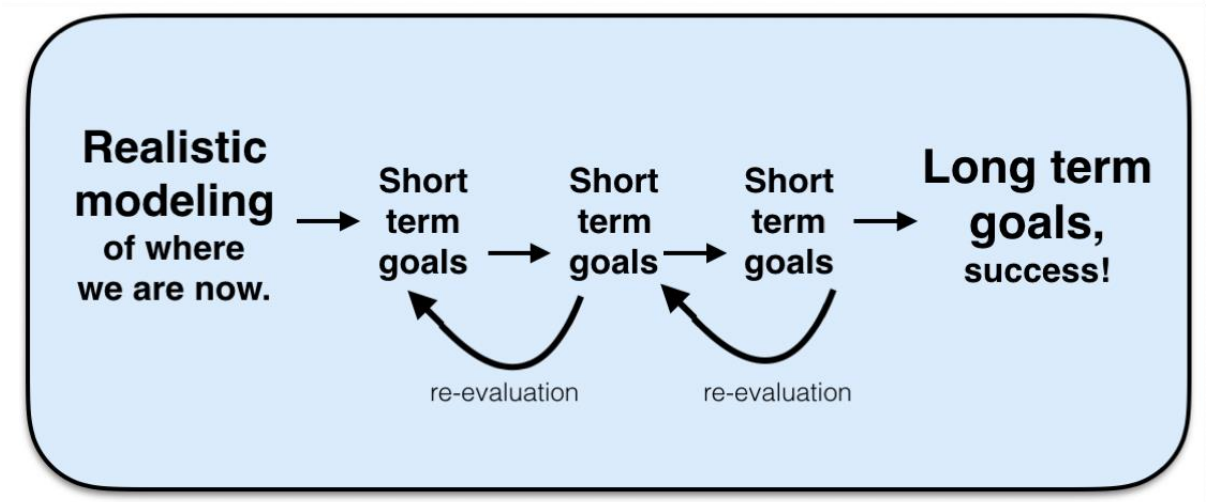
3.6 Agency as a story structure

Putting together the ideas of self-persuasion and agency with the established practices of entertainment education and positive deviance, we propose to apply **agency as a story structure** to climate change storytelling (see Figure 1). In this narrative structure, stories need to start from where people are; be tailored to a particular place- or practice-based context; be action-based; and follow a structure of 'iterative goal setting' (Coren and Safer 2020), showing individuals and communities solving concrete climate-related challenges one short-term goal at the time. Many such storylines may be interwoven to produce stories with rich and complex parallel plots (ibid.). Modelling the behavior of the positive outliers in each community ensures that actions are perceived as realistic, doable and meaningful by others. Stories can be fictional but do not have to be. They can also be the factual accounts of real people. What is crucial, however, is that they are not simply issue-based. They do *not* have as their prime objective the raising of concern as a precursor to action. Instead, they would take climate change as given. Against the backdrop of this reality, they model opportunities for people to engage in concrete actions to solve a specific challenge in a local context or in the context of a specific community of practice. Despite its prevalence in health communication and social development, this kind of storytelling has not been formally applied to climate change. One exception is 'Rhythm and Glue', a prototype developed by one of the authors (Coren and Safer 2020). We will describe this in more detail in Section 4.2. In the first instance, this approach can focus on generating agency among people who are already concerned about climate change but do not know what to do - providing them with opportunities to take their first steps of a self-persuasive process that enables them to develop their own agency.

Figure 1: Agency as a story structure

.

Adopting this approach for climate storytelling resolves the three problems outlined in Section 1. By creating stories which embed climate action into a wide variety of societal contexts, it resolves the poverty of stories. By focusing on the development of agency, it resolves the lack of agency.



Finally, by focusing on developing agency that fits with different place- and practice-based contexts, it expands the range of opportunities for citizens to engage in climate action.

4. Building the agency of storytellers for action-based climate storytelling

Creative professionals, journalists and other content creators are key communities of practice which have a pivotal role to play in helping society to shift to an action-based conceptualization of climate change. Here we describe two examples of projects already underway to help those communities build their agency for action-based storytelling. The first is a training program for creative professionals; the second is a prototype of an entertainment-education series that shows how to bring place-based climate action and health communication approaches together.

4.1 Climate storytelling training for Hollywood creative professionals

One of the authors (CS) works closely with creative professionals (e.g., TV screenwriters) in the entertainment industry, having recently co-founded "Rewrite the Future", a new climate storytelling capacity building initiative (NRDC 2020). The program aims to help entertainment professionals see that they, uniquely, can answer the question “What can I do about climate change?” with their creative work – the stories that writers and producers choose to pitch and develop, and those that the studio executives choose to greenlight.

We have found that getting Hollywood professionals interested in inventing and programming climate stories is requiring a shift of thinking within an industry that has heretofore resisted climate content. While there is growing interest in social impact entertainment (SIE) - that is, content and promotional campaigns that add social impact “surplus” to a product’s entertainment value (UCLA Skoll 2019) - it has been primarily focused on social justice, diversity and inclusion and remains a small proportion of the entertainment landscape. Our content advocacy is therefore partly educational—exposing content creators to the large range of possible climate angles that can be mined for stories; and partly aspirational—calling upon the industry to embrace and leverage the powerful cultural influence they have toward elevating climate action and justice in the Zeitgeist.

The entertainment professionals we have spoken to have, without exception, expressed great concern about climate change. However, it either has not occurred to them that their stories could engage with the topic, or else it has, and the prospect is perceived as too daunting, off-putting or unrelated to their current portfolio. More than once we have heard “I’d love to tell stories about climate, but I don’t know how” - exemplifying the lack of agency discussed earlier. Content creators express worry that they may impair their story’s entertainment value by focusing too much on the *issue* of climate change which they equate with didacticism, fact-based dullness, or polemic.

Entertainment value often corresponds to how well the narrative imaginatively transports the viewer into the world of the story. (Carpenter and Green 2012). In a successful story, any information has to be required by the story, not tacked on by some desired educational outcome. In response to these constraints and opportunities, we start with the assurance that storytellers should lead with their usual aims to entertain the audience with “good stories well-told.” Good stories are about people, not issues. For a writer it can be overwhelming to think about telling a story about something as vast, issue-based and seemingly impersonal as global warming. The antidote is to invite creators to do what they do best – keep telling stories about people. People made the climate crisis, people are impacted by it, and people can act on it too. In our workshops and story consultations, we unpack climate storytelling as the innumerable specific ways that people interact with situations of crisis and their solutions, including intersections with social issues that may be easier for a writer to personalize, like racial and economic injustice, women and families, immigration, national security, and health.

We offer lay-language information such as climate storytelling tip sheets and customized memos that may include narrative case studies, data visualizations and profiles of activists, thought leaders and sustainability innovators. In rare cases these real-world stories may be optioned for adaptation

to the screen; mostly they provide inspiration for fictional characters, events, plots and subplots that weave through storylines of existing shows or inform new projects in development.

We create frameworks and relationships that allow a writer's imagination to freely engage with the information we provide about green jobs, climate psychology, regional impacts, or the range of possible climate futures. We provide individual consultations, both with writers on specific projects, and in meetings with executives to help grow a buyer's market, as well as industry panels and workshops. These various forms of content education are meant to creatively explore the various climate angles that are available to almost any genre and time frame of story, from recent past to contemporary to near and far future fictions. Our intention is not just to support more meaningful climate entertainment but to nourish a community of climate story practitioners who bring their experience and knowledge into every writers' room and project. At some point we expect the industry to become self-educating.

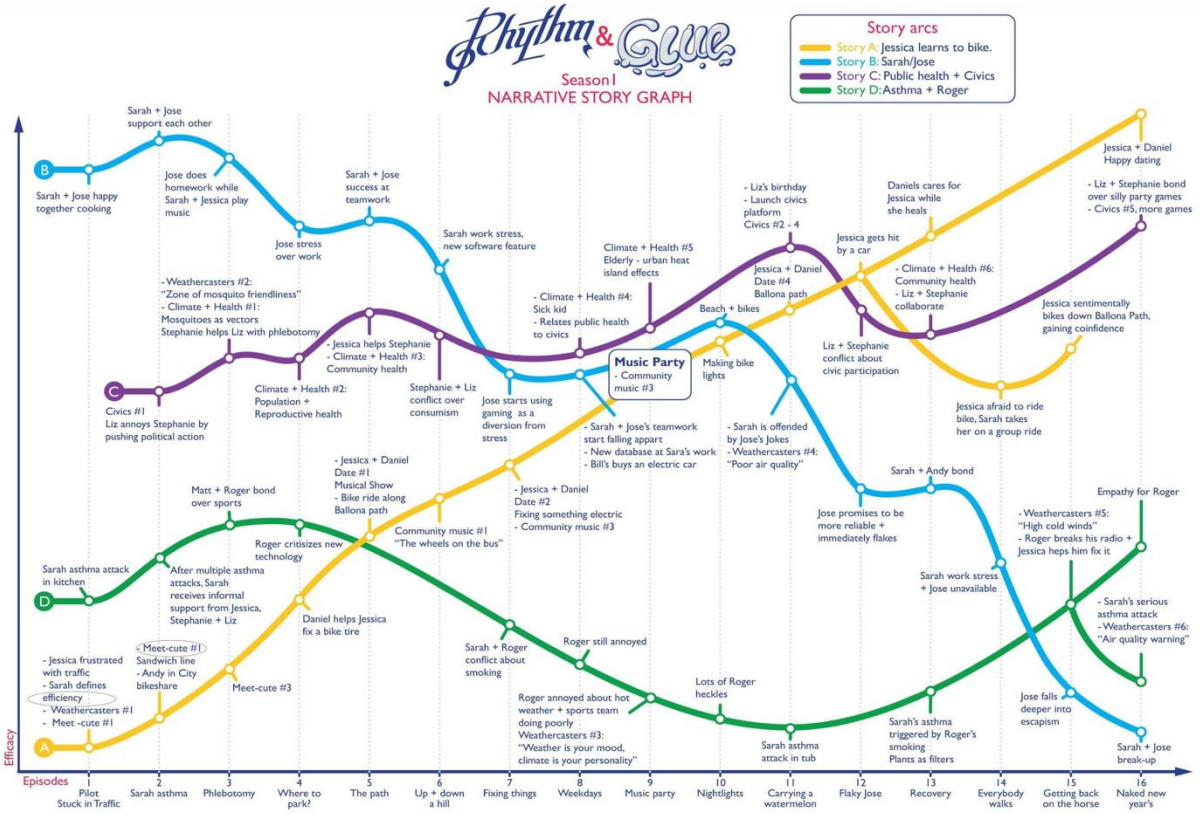
4.2 Rhythm and Glue

The entertainment-education series Rhythm and Glue was developed by one of the authors (EC) as a prototype example of a health communication strategy with multiple, parallel climate interventions. The story is based on audience profiling following the Global Warming Six America's audience segmentation (Goldberg *et al* 2020) to mimic perspectives from each of the six groups (from 'alarmed' to 'dismissive') in proportionate representation to match the intended audience.

Set in Los Angeles, Rhythm and Glue tells the story of a community of twenty-somethings growing into adults as they learn to collaborate, sharing their skill sets, to build a safer city. The story follows the characters through multiple parallel behavioral interventions at individual and collective levels. Slapstick, romantic entanglements, and career advancement anchor the story. Real-time participation would drive audience engagement with climate topics. Each season presents an overarching climate change issue. Season One tackles transportation and the current health effects of climate change, with subsequent seasons addressing; energy, water, food and waste. The show highlights the day-to-day realities of climate change and models realistic solutions and behaviors that citizens can take to mitigate those effects, for themselves and their communities.

Figure 2 shows the multiple interwoven story arcs for Season One. These different storylines model different types of agency, from personal agency to make lifestyle changes, to agency for climate action in community, professional or civic contexts. Storyline A (yellow) models iterative goal setting where one friend guides another to learn to navigate active and multimodal urban transport. Storyline B (blue) is the introduction to social-emotional skill building for the character Sarah, who by Season Five of the show grows from a computer programmer into a community leadership role eventually getting elected to local office. Storyline C (purple) demonstrates local health impacts for a variety of community members in a medical procedural setting. In Storyline D (green), air quality conflicts in a residential setting lead a climate skeptic to collaborate in solar panel installation in his apartment complex due to his support for energy independence.

Figure 2. Interwoven story arcs of Season One of Rhythm and Glue.



As a prototype, Rhythm and Glue was developed to demonstrate how the storytelling approaches of entertainment-education can be applied to action-based storytelling for climate change. A range of stories following this structure can be designed for a variety of regionally and demographically specific groups, then linked together through transmedia platforms. The transmedia approach provides the opportunity for facilitating a broad conversation from a variety of stakeholder perspectives. Improving the coordination between programs through a transmedia interface can help them "click" into a coordinated series synchronizing the real-world responses and the digital storytelling. This strategy would result in a much more intentional storytelling format that can work in conjunction with climate journalism programs focusing on actions and solutions.

5. Tools to accelerate and coordinate delivery of action-based storytelling

The agency of storytellers to bring an action-based perspective to climate storytelling is one factor. Another requirement is sufficient reference material to feed a constant stream of relatively simple action-based news stories told at high frequency through journalism and various forms of media, and more complex entertainment-education stories which run over longer time periods. To coordinate such a flow of reference materials for all place- and practice-based communities, a systematic approach is required. Based on expertise in entertainment-education, health communication research, and developments in response to COVID-19, Figure 3 and Table 2 propose the outline and elements of a system to accelerate the delivery of action-based stories from society to the desks of communicators, journalists and storytellers.

Figure 3. A system to coordinate the flow of reference material for action-based storytelling.

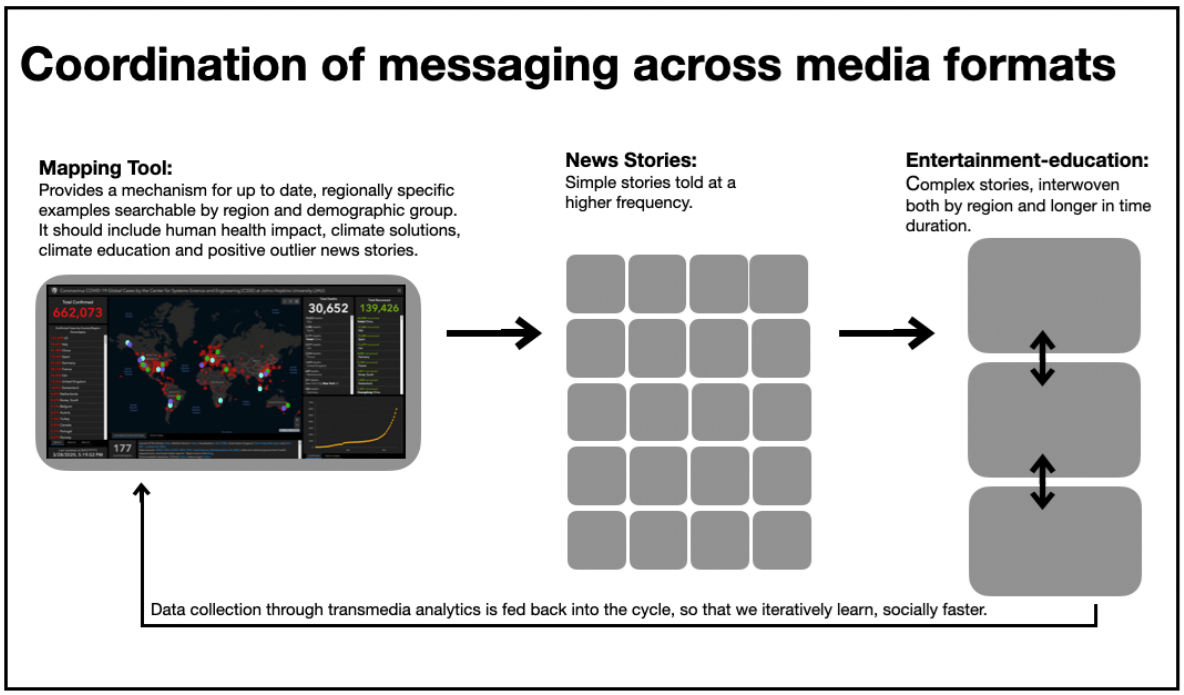


Table 2. Elements of the message coordination system explained. References to the health communication literature where some of these elements are used already are included.

Element

Mapping

Description

A database with reference materials for place- and practice-based climate action stories. The visual mapping front-end accommodates regional variations. Geographic Information System (GIS) tools can overlay cultural visualizations of place-based positive outliers. There is a long history of geospatial analysis in public health analysis and intervention (Davenhall and Kinabrew 2011, Graham *et al* 2011) but this has not yet expanded to include comprehensive climate actions and solutions. Recent applications of GIS in health communication for managing COVID-19 demonstrate how fast these tools can now be built and applied (Perkel 2020). The sweet spot/best fit for most climate solutions of Project Drawdown (Hawken 2017) seems to lie between 10,000 and 100,000 people (Bhowmik *et al* 2018). Stories told at this scale of place-based community may provide the optimal scale to connect local solutions with the global problem of climate change.

Local level markers can be incorporated into the built environment, similar to guides for navigating a metro system, to help people discover action pathways more easily. This assists people who would like to participate, find pathways for them accommodating their relative interest, time availability and skill levels. While visual nudges are common and recommended, to accommodate a diversity of learning styles, including other sensory guides (visual, auditory, sensory) will improve accessibility and equity for people unable to participate in digital resources (Dreibelbis *et al* 2016).

Markers Purposely incorporating digital "markers"— new words, phrases, visual representations, and practices that are well-aligned with a project's social

objectives — promote new social realities and can also be used to track how audience members engage with them over time. Markers need to connect to events in the real world to be effective (Bouman *et al* 2012, Lutkenhaus *et al* 2020), so real events and the narrative fiction should be interwoven. For climate communication, this would include markers for each of the actionable behaviors.

Physical Nudges

Glue People who serve to coordinate and curate the system. Content curators for the database can be based on existing models, such as Wikipedia's. These include local/regional coordinators and community-of-practice coordinators,

who localize and mobilize place-based and practice-based climate responses. A third type of coordinator, transmedia story coordinators, track and support the integration of campaigns across media types and territories (Lutkenhaus *et al* 2020). To fit with the optimal scale for local action/solution stories, there should be at least one regional curator for every 100,000 people. For the US, that would translate to around 3,500 local coordinators.

The goal of this system is to deliver “clear simple messages told often from a variety of trusted sources” (Maibach 2019). To achieve that kind of messaging density, while still maintaining two- way public engagement ideals of science communication, is going to require more sustained communication resources to build and maintain these efforts. This is not one static set of stories; it allows for a fast-moving set of stories full of cultural nuances. The speed of the collective response

to COVID-19 demonstrates our ability to rapidly collaborate in service of public health goals. This speed applied to climate collaborations can provide transformative public health benefits.

6. Conclusion

There have been many calls before for the application of storytelling, literature, drama and the arts to the communication of climate change (e.g. McKibben 2005), resulting in a profusion of projects. For a series of reviews, see (Galafassi *et al* 2018, Hawkins and Kanngieser 2017, Johns-Putra 2016, Nurmis 2016). However, simply applying creative storytelling to climate communication is insufficient. A recent study showed that the reading of climate fiction may have short-term positive effects on attitudes and beliefs about climate change, but after one month, those attitude changes had drifted back to baseline (Schneider-Mayerson *et al* 2020). The same effects were observed with film (Howell 2014) and news reports (Happer and Philo 2016): immediate attitude shifts occur but rarely lead to long-lasting changes in either attitudes or behavior. The issue is therefore not just one of pitting fact-based accounts against creative narratives, nor of looking for the 'right' media format (e.g. written or visual). Rather, the problem is that in the absence of an action-based conceptualization of climate change, many creative storytelling and arts projects themselves fall prone to an issue-based conceptualization. Notable exceptions can be found in the *solarpunk* arts movement (Springett 2018, Johnson 2020) which, unfortunately, remains a fringe phenomenon.

In contrast, our proposed 'agency as story structure' differs from the generic application of creative storytelling to climate communication. It places 'people taking action' at the heart of each story, fact-based or fictional, and regardless of level of interactivity or media format. In Section 3, we provided the scientific evidence base for this alternative approach. Firstly, there are the concepts of self-persuasion and 'actions driving beliefs'. They are rooted in experimental traditions in social psychology going back to the 1950s and challenge the currently widespread conventional wisdom that awareness and concern are precursors to climate action. Secondly, there is the proposition from

social cognitive theory that people develop agency through learning from the actions of others. Thirdly, the projects in entertainment-education provide the empirical evidence that stories about people taking action - when told well - do succeed in creating agency in others.

There have been calls before to include an action perspective in climate communication, education and storytelling, e.g., (Nesta 2008, Vaughter 2016, de Vries 2020). These have not had the required effects yet. There are two reasons for this: the capability among content creators to shift their storytelling style from issue to action; and the availability of enough reference material to craft the variety of action-based stories needed. We addressed both requirements in Sections 4 and 5.

Like storytelling professionals, climate and environmental scientists have an important role to play in the ecosystem shift from issue-based to action-based communication. In most domains of

science communication, scientists and communicators naturally adopt an action perspective. Scientific information is often communicated through stories of the day-to-day research activities that scientists take part in. In climate and environmental sciences, however, the issue and impact framing dominates science communication, thereby reinforcing the 'poverty of stories' problem. Climate scientists could be a rich source of reference material for other storytellers (journalists, writers etc.), but not if they focus on the issues alone and forget to communicate the rich variety of research activities they undertake to come to their conclusions. Although the 'doing' in this context is different from the 'doing' that models context-specific forms of climate action for different communities, adopting an action perspective in climate science communication is another lever to address the poverty of stories problem.

A final community of practice with a role to play in the ecosystem shift are funders. Overland and Savacool (2020) analyzed research grant funding allocations, observing that the split between natural and social science funding for climate change research has been roughly 95% to 5%. These numbers are indicative of the imbalance that exists between science in discovery mode versus delivery mode - which is the central topic that this special issue set out to address. To deliver the transformation to an action-based conceptualization will require rebalancing of the discovery/delivery modes, with more support for the implementation and evaluation of initiatives to foster action-based storytelling. This shift will require the development of skills and agency in key communities of practice, of infrastructure and curation to coordinate the flow of reference materials for stories, and of multidisciplinary strategies such that we can cooperate more effectively across academic disciplinary boundaries, but also with practitioners in other communities of practice.

At present, climate communication and storytelling, with their focus on the transfer of information, awareness or concern, are not having the required effects of mobilizing climate action across society. In the absence of agency, awareness and concern do not automatically lead to action. Rather, they can lead to long-term anxiety, apathy or denial. In this article we proposed an alternative to the currently dominant approach to climate storytelling, one that is rooted in how people develop a sense of deep engagement and agency in other areas of life.

A focus on actions and agency does not make accurate information about the science and impacts of climate change obsolete. What it does mean, however, is that people who engage with climate change through a self-persuasive process are intrinsically motivated to engage with climate change information - rather than that they need to be persuaded to care. The focus should be on providing people with opportunities for action to allow them to start a self-persuasive process and develop agency. Rather than telling them what to do, climate storytelling should support them in discovering *how* to act. As a community we need to create an array of agency-provoking stories of existing positive outliers across different communities, supported by transmedia coordination

strategies proportionately scaled to the magnitude of the public health impacts. What is needed now are not the menus - but the recipes, cookbooks, and cooking classes of climate action.

References

Aronson E 1997 Back to the Future: Retrospective Review of Leon Festinger's "A Theory of Cognitive Dissonance" *Am. J. Psychol.* **110** 127

Aronson E 2008 Fear, denial and sensible action in the face of disasters. *Soc. Res.* **75** 855–72 Aronson E 1999 The power of self-persuasion. *Am. Psychol.* **54** 875–84
Bandura A 1982 Self-efficacy mechanism in human agency. *Am. Psychol.* **37** 122–47
Bandura A 2006 Toward a Psychology of Human Agency *Perspect. Psychol. Sci.* **1** 164–80 Bandura A 2018 Toward a Psychology of Human Agency: Pathways and Reflections *Perspect.*

Psychol. Sci. **13** 130–6
Bevan L D, Colley T and Workman M 2020 Climate change strategic narratives in the United

Kingdom: Emergency, Extinction, Effectiveness *Energy Res. Soc. Sci.* **69** 101580 Bhowmik A K, McCaffrey M S, Ruskey A M, Frischmann C and Gaffney O 2018 *Powers of 10:*

national policy and local experience *Local Environ.* **4** 257–78
Bouman M P A, Drossaert C H C and Pieterse M E 2012 Mark My Words: The Design of an

Innovative Methodology to Detect and Analyze Interpersonal Health Conversations in Web

and Social Media *J. Technol. Hum. Serv.* **30** 312–26
Bouman T, Verschoor M, Albers C J, Böhm G, Fisher S D, Poortinga W, Whitmarsh L and Steg L

2020 When worry about climate change leads to climate action: How values, worry and

personal responsibility relate to various climate actions *Glob. Environ. Change* **62** 102061 Carpenter J M and Green M C 2012 Flying With Icarus: Narrative Transportation and the

Persuasiveness of Entertainment *The Psychology of Entertainment Media* (Routledge) pp

187–212 Online: https://www.taylorfrancis.com/
Chapman D A, Lickel B and Markowitz E M 2017 Reassessing emotion in climate change

communication *Nat. Clim. Change* **7** 850–2
Clayton S and Karazsia B T 2020 Development and validation of a measure of climate change

anxiety *J. Environ. Psychol.* **69** 101434
Coren E and Safer D L 2020 Solutions Stories: An Innovative Strategy for Managing Negative

Physical and Mental Health Impacts from Extreme Weather Events *Climate Change, Hazards and Adaptation Options* Climate Change Management ed W Leal Filho, G J Nagy, M Borga, P D Chávez Muñoz and A Magnuszewski (Cham: Springer International Publishing) pp 441–62 Online: http://link.springer.com/10.1007/978-3-030-37425-9_23

Crano W D and Prislin R 2006 Attitudes and Persuasion *Annu. Rev. Psychol.* **57** 345–74 Davenhall W F and Kinabrew C 2011 GIS in Health and Human Services *Springer Handbook of*

Geographic Information Springer Handbooks ed W Kresse and D M Danko (Berlin, Heidelberg: Springer Berlin Heidelberg) pp 557–78 Online: http://link.springer.com/10.1007/978-3-540-72680-7_29

De Meyer K, Jackson A, Hubble-Rose L, Gingold P and Rapley C 2019 *New Ways to Shape Meaningful Action on Climate Change?* (UCL Policy Commission on Communicating Climate Science) Online: https://bit.ly/ccspcmaw2019

Doherty K L and Webler T N 2016 Social norms and efficacy beliefs drive the Alarmed segment's public-sphere climate actions *Nat. Clim. Change* **6** 879–84

Dreibelbis R, Kroeger A, Hossain K, Venkatesh M and Ram P 2016 Behavior Change without Behavior Change Communication: Nudging Handwashing among Primary School Students in Bangladesh *Int. J. Environ. Res. Public. Health* **13** 129

El Amiri N, Abernethy P, Spence N, Zakus D, Kara T-A and Schuster-Wallace C 2020 Community of practice: an effective mechanism to strengthen capacity in climate change and health *Can. J. Public Health.* Online: http://link.springer.com/10.17269/s41997-020-00400-8

Ereaut G and Segnit N 2006 Warm Words: How are we telling the climate story and can we tell it better?

cross-scale optimization of social agencies for rapid climate and sustainability action

(EarthArXiv) Online: https://osf.io/feaq5
Blake J 1999 Overcoming the 'value-action gap' in environmental policy: Tensions between

Ertz M and Sarigöllü E 2019 The Behavior-Attitude Relationship and Satisfaction in Proenvironmental Behavior *Environ. Behav.* **51** 1106–32

Fagan M and Huang C 2019 A look at how people around the world view climate change *Pew Res. Cent.* Online: https://pewrsr.ch/2UpGcq7

Galafassi D, Kagan S, Milkoreit M, Heras M, Bilodeau C, Bourke S J, Merrie A, Guerrero L, Pétursdóttir G and Tàbara J D 2018 'Raising the temperature': the arts on a warming planet *Curr. Opin. Environ. Sustain.* **31** 71–9

Goldberg M, Gustafson A, Rosenthal S, Kotcher J, Maibach E and Leiserowitz A 2020 For the first time, the Alarmed are now the largest of Global Warming's Six Americas *Yale Program Clim. Change Commun.* Online: https://climatecommunication.yale.edu/publications/for-the- first-time-the-alarmed-are-now-the-largest-of-global-warmings-six-americas/

Goldsworthy A 2020 Depolarizing *Four Thought* Online: https://www.wearepolesapart.com/depolarizing_for_bbc_radio_4

Graham S R, Carlton C, Gaede D and Jamison B 2011 The Benefits of Using Geographic Information Systems as a Community Assessment Tool *Public Health Rep.* **126** 298–303

Gray E and Jackson C 2020 Two thirds of citizens around the world agree climate change is as serious a crisis as Coronavirus *Ipsos* Online: https://www.ipsos.com/en/two-thirds-citizens- around-world-agree-climate-change-serious-crisis-coronavirus

Happer C and Philo G 2016 New approaches to understanding the role of the news media in the formation of public attitudes and behaviours on climate change *Eur. J. Commun.* **31** 136–51

Hawken P 2017 *Drawdown: the most comprehensive plan ever proposed to reverse global warming* (New York, New York: Penguin Books)

Hawkins H and Kanngieser A 2017 Artful climate change communication: overcoming abstractions, insensibilities, and distances *WIREs Clim. Change* **8** Online: https://onlinelibrary.wiley.com/doi/abs/10.1002/wcc.472

Hornsey M J and Fielding K S 2020 Understanding (and Reducing) Inaction on Climate Change *Soc. Issues Policy Rev.* **14** 3–35

Hornsey M J, Harris E A, Bain P G and Fielding K S 2016 Meta-analyses of the determinants and outcomes of belief in climate change *Nat. Clim. Change* **6** 622–6

Howell R A 2014 Investigating the Long-Term Impacts of Climate Change Communications on Individuals' Attitudes and Behavior *Environ. Behav.* **46** 70–101

Johnson I 2020 "Solarpunk" & the Pedagogical Value of Utopia *J. Sustain. Educ.* Online: http://www.susted.com/wordpress/content/solarpunk-the-pedagogical-value-of- utopia_2020_05/

Johns-Putra A 2016 Climate change in literature and literary studies: From cli-fi, climate change theater and ecopoetry to ecocriticism and climate change criticism: Climate change in literature and literary studies *Wiley Interdiscip. Rev. Clim. Change* **7** 266–82

Kincaid D L 2002 Drama, Emotion, and Cultural Convergence *Commun. Theory* **12** 136–52 Kollmuss A and Agyeman J 2002 Mind the Gap: Why do people act environmentally and what are

the barriers to pro-environmental behavior? *Environ. Educ. Res.* **8** 239–60
LaPiere R T 1934 Attitudes vs. Actions *Soc. Forces* **13** 230–7
Lauren N, Fielding K S, Smith L and Louis W R 2016 You did, so you can and you will: Self-

efficacy as a mediator of spillover from easy to more difficult pro-environmental behaviour

J. Environ. Psychol. **48** 191–9
Leiserowitz A, Ballew M, Rosenthal S and Semaan J 2020 *Climate change and the American diet*

(New Haven, CT: Yale University and Earth Day Network)
Leiserowitz A, Maibach E, Rosenthal S, Kotcher J, Bergquist P, Gustafson A, Ballew M and

Goldberg M 2019 *Climate Activism: Beliefs, Attitudes, and Behaviors, November 2019.*

(New Haven, CT: Yale University and George Mason University)
van der Linden S 2017 Determinants and Measurement of Climate Change Risk Perception,

Worry, and Concern *Oxford Research Encyclopedia of Climate Science* (Oxford University Press) Online:
http://climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acrefo re-9780190228620-e-318

Lutkenhaus R O, Bouman M P A, Wang H and Singhal A 2020 *Using Markers for Digital Engagement with the Audience of Main Kuch Bhi Kar Sakti Hoon Season 3. A Transmedia Entertainment Education Initiative for Sanitation, Family Planning, and Gender Equality in*

India Online:
https://www.dropbox.com/s/0lzm3p1jn5tlwsi/Exec%20Sum_MKBKSH3_CMH_FinalReport_Dig%20Track.PDF?dl=0

Lutkenhaus R O, Jansz J and Bouman M P A 2019 Toward spreadable entertainment-education: leveraging social influence in online networks *Health Promot. Int.* daz104

Maibach E 2019 Increasing public awareness and facilitating behavior change: Two guiding heuristics. *L. Hannah and T. Lovejoy (eds.) Climate Change and Biodiversity, 2nd edition* (Yale University Press.) Online: https://yalebooks.yale.edu/book/9780300206111/biodiversity-and-climate-change

Maibach E Supporting communities of practice as a strategy to accelerate uptake of environmental science for climate action: TV weathercasters as a case study. *Environ. Res. Lett.*

Marcinkowski T and Reid A 2019 Reviews of research on the attitude–behavior relationship and their implications for future environmental education research *Environ. Educ. Res.* **25** 459– 71

Marsh D R, Schroeder D G, Dearden K A, Sternin J and Sternin M 2004 The power of positive deviance *BMJ* **329** 1177–9

McKibben B 2005 What the warming world needs now is art, sweet art *Grist* Online:
https://grist.org/article/mckibben-imagine/

Moser S C 2016 Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say?: Climate change communication research and practice *Wiley Interdiscip. Rev. Clim. Change* **7** 345–69

Moyer-Gusé E 2008 Toward a Theory of Entertainment Persuasion: Explaining the Persuasive Effects of Entertainment-Education Messages *Commun. Theory* **18** 407–25

Munson Z W 2008 *The making of pro-life activists: how social movement mobilization works* (Chicago: University of Chicago Press)

Nariman H N 1993 *Soap operas for social change: toward a methodology for entertainment-education television* (Westport, Conn: Praeger)

Nesta 2008 *Selling Sustainability: Seven lessons from advertising and marketing to sell low-carbon living* (National Endowment for Science, Technology and the Arts) Online:
https://media.nesta.org.uk/documents/selling_sustainability.pdf

NRDC 2020 Rewrite the Future *NRDC* Online: https://www.nrdc.org/RewriteTheFuture
Nurmis J 2016 Visual climate change art 2005-2015: discourse and practice: Visual climate change

art 2005-2015 *Wiley Interdiscip. Rev. Clim. Change* **7** 501–16
Overland I and Sovacool B K 2020 The misallocation of climate research funding *Energy Res. Soc.*

Sci. **62** 101349
Painter J 2013 *Climate Change in the Media: Reporting risk and uncertainty* (I.B. Tauris & Co) Painter J, Erviti M C, Fletcher R, Howarth C, Kristiansen S, Leon B, Ouakrat A, Russell A and

Schaefer M 2017 *Something Old, Something New: Digital Media and the Coverage of*

Climate Change (Oxford: Reuters Institute for the Study of Journalism)
Pearce W, Brown B, Nerlich B and Koteyko N 2015 Communicating climate change: conduits,

content, and consensus: Communicating climate change *Wiley Interdiscip. Rev. Clim.*

Change **6** 613–26
Perkel 2020 Behind the Johns Hopkins University coronavirus dashboard *Nat. Index* Online:

https://www.natureindex.com/news-blog/behind-johns-hopkins-university-coronavirus-

dashboard
Petty R E and Wegener D T 1998 Attitude change: Multiple roles for persuasion variables *The*

handbook of social psychology (McGraw-Hill) pp 323–90
Poortinga W, Whitmarsh L and Suffolk C 2013 The introduction of a single-use carrier bag charge

in Wales: Attitude change and behavioural spillover effects *J. Environ. Psychol.* **36** 240–7 Schneider-Mayerson M, Gustafson A, Leiserowitz A, Goldberg M H, Rosenthal S A and Ballew M

2020 Environmental Literature as Persuasion: An Experimental Test of the Effects of

Reading Climate Fiction *Environ. Commun.* 1–16
Seethaler S, Evans J H, Gere C and Rajagopalan R M 2019 Science, Values, and Science

Communication: Competencies for Pushing Beyond the Deficit Model *Sci. Commun.* **41**

378–88
Singhal A and Dura L 2017 Positive Deviance: A Non-Normative Approach to Health and Risk

Messaging *Oxford Research Encyclopedia of Communication* (Oxford University Press)

Online:
https://oxfordre.com/communication/view/10.1093/acrefore/9780190228613.001.0001/acref ore-9780190228613-e-248

Singhal A and Dura L 2009 *Protecting children from exploitation and trafficking: Using the positive deviance approach in Uganda and Indonesia,* (Washington DC: Save the Children)

Singhal A and Rogers E M 2002 A Theoretical Agenda for Entertainment Education *Commun. Theory* **12** 117–35

Singhal A, Rogers E M and Routledge 2011 *Entertainment-education: a communication strategy for social change* (London; New York: Routledge Taylor & Francis Group)

Singhal A, Wang H and Rogers E M 2013 The Rising Tide of Entertainment–Education in Communication Campaigns *Public Communication Campaigns* (SAGE Publications, Inc.)

Springett J 2018 Solar Punk - A Reference Guide *Medium* Online: https://medium.com/solarpunks/solarpunk-a-reference-guide-8bcf18871965

Stajkovic A D and Luthans F 1998 Self-efficacy and work-related performance: A meta-analysis *Psychol. Bull.* **124** 240–61

Tavris C and Aronson E 2020 *Mistakes were made (but not by me) third edition: why we justify foolish beliefs, bad decisions, and hurtful acts* (Boston: Houghton Mifflin Harcourt)

UCLA Skoll 2019 The State of SIE Report — Mapping the landscape of social impact entertainment *State SIE Rep.* Online: https://www.thestateofsie.com/

Vaughter P 2016 *Climate Change Education: From Critical Thinking to Critical Action* (UNU-IAS) Online: https://www.uncclearn.org/sites/default/files/unuias_pb_4.pdf

de Vries G 2020 Public Communication as a Tool to Implement Environmental Policies *Soc. Issues Policy Rev.* **14** 244–72

Wallace-Wells D 2019 Opinion | Time to Panic *N. Y. Times* Online: https://www.nytimes.com/2019/02/16/opinion/sunday/fear-panic-climate-change- warming.html

Wenger E 1998 *Communities of Practice: Learning, Meaning, and Identity* (Cambridge University Press) Online: https://www.cambridge.org/core/product/identifier/9780511803932/type/book

Witte K 1992 Putting the fear back into fear appeals: The extended parallel process model *Commun. Monogr.* **59** 329–49

Witte K and Allen M 2000 A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns *Health Educ. Behav.* **27** 591–615

World Bank 2015 *World Development Report 2015: Mind, Society, and Behavior* (The World Bank) Online: http://elibrary.worldbank.org/doi/book/10.1596/978-1-4648-0342-0