"From fAIrplay to Climate Wars" Supplementary Material: Additional Details about the Workshop Process

This Supplementary Material describes further details of the workshop process described in the main text, including demographic information about the participants, details about the ice breakers that facilitators used to set the stage for successful interdisciplinary collaboration, the VERGE framework that participants used to develop their narratives, and the performances by which each group presented their work to the other participants.

1. Introductory Presentations and Ice-Breaking Games

Participants spent the first half-day of the workshop playing and learning about the structure of a good narrative and the current paradigm for climate change scenarios,

After some brief introductory remarks from the organizers, three science fiction writers in the group opened the workshop with a lesson on the structure of a good narrative. This immediately conveyed the message that the workshop will not follow the typical pattern of an academic meeting.

They followed this with an ice-breaker designed to bring people out of disciplinary silos: they asked participants to introduce themselves not by their position or discipline, but by describing what they would do if the group were stranded on a desert island together. As an illustration, some participants suggested they could survey the landscape and find food, others suggested that they would try to identify the most powerful person and provide an analysis of how best to make decisions.

Building on this ice-breaker, they illustrated the content of their lesson on narratives by leading the group through a game called "fortunately, unfortunately." The game involves collaboratively concocting a story in which each person's contribution begins, alternately, with 'fortunately' or 'unfortunately'. In this case, the story focused on the group's experience on the hypothetical desert island.

After these ice breakers, Brian O'Neill of the University of Denver gave a remote presentation on the dominant scenario paradigm in climate science and climate policy, which combines the Shared Socioeconomic Pathways with Representative Concentration Pathways.

For the final group exercise, Andrew Jones of Climate Interactive led participants through a game developed by Pablo Suarez of the Red Cross Red Crescent Climate Centre. The game, which is a variation of the Climate Centre's "Decisions for the Decade" game, uses a set of dice to simulate extreme events hitting different communities and introduces the possibility of using an electric knife to alter those dice, if the groups so desire. The result was a rugby maul between the two competing groups that definitely broke down barriers and resulted in a reflection session amongst all the participants as to how their decisions and actions resulted in the complete breakdown of the game. These introductory processes set up the creative and interactive foundations for the rest of the workshop.

Overall, the introductory session played an important role in setting the collaborative, transdisciplinary, and highly unorthodox tone for the workshop (Fig A1).
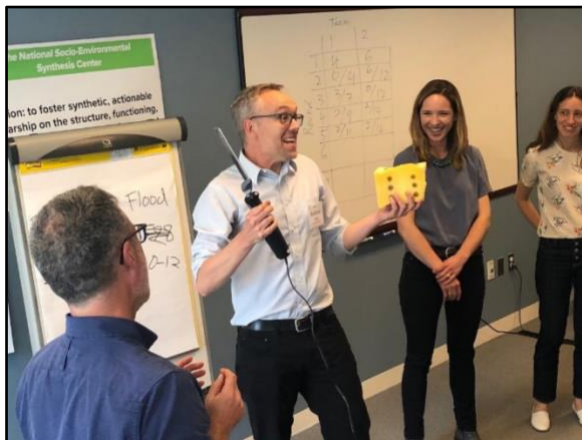

Fig. A1. Selected ice breakers from the workshop. Top: Sam Beckbesinger (left) and Lauren Beukes coach participants on good storytelling. Bottom left: Participants playing a variation of the Decisions for the Decade game. Bottom right: Andrew Jones (center, with electric knife) offers participants the chance to use technology to try to change the probability of certain outcomes in the Decisions for the Decade game.

2. VERGE Framework for Developing Narratives

The groups used the questions in Table A1 as prompts for filling in the details of their imagined futures. Table A2, on the next page, synthesizes their responses to these prompts.

Table A1: Core questions posed to each group to describe their visions.

DOMAIN OF EXPERIENCE	QUESTIONS
Worldviews, paradigms, social values and attitudes	● What do people value? ● How do people spend their time? ● Human rights? ● Is there a focus on the individual or the collective/community? ● How many people are in the world?
Adaptation	● How do people respond to climate risks? ● Finance & Insurance?
Family structures, governance structures	● Who is governing? Who makes the rules and takes decisions? ● Who has a voice? Who doesn't? ● How equal is society? What inequalities exist? (gender, poverty…) ● How are the most vulnerable treated (e.g., social protections)?
Connections	● How connected are people to each other? ● Are people connected to nature? How do they connect? ● How are people distributed (urban – rural)? ● How do people move? How much? Internal and int'l movement. ● What does trade of goods, services and ideas look like? ● What do transport networks look like?
Manufacturing, art & culture	● What is the role of technology? (health, infrastructure, agriculture…) ● What are people making?
Energy & Economy	● Where does energy come from (fossil fuels/ renewables/other)? ● Who controls the market? ● Where do people work? ● What work do they do? ● How do they get to work? ● Why do people work?
Environment (built/natural)	● What do landscapes/seascapes look like? ● Where is biodiversity? How much is there? ● What do cities look like? ● What do people look like?
Destruction Violence, killing, waste, undermining rules/norms	● What happens to waste? ● How do people deal with conflict? ● How likely is violent conflict? Why and amongst whom?
Food, Energy, Health	● What do people eat? ● Where does food come from? ● Where does water come from? Is there water security? ● Are people healthy? ● What is the state of mental health? ● How do people recreate?

Other	● What are we missing? What else is important?

*Table A2. Synthesis of Groups' Responses to VERGE Questions. Bold-faced abbreviations refer to specific scenarios within each scenario family (**CC**: climate chaos; **CCS**: coordinated city-states; **CC**: climate chaos; **CW**: climate wars; **EA**: eco-autocracy; **FP**: fAIrplay; **SOS**: suboptimal situation; **SS**: stumble & scramble). Text not prefaced by a bold-faced abbreviation applies to all scenarios within the relevant scenario family.*

	SRM&CDR	SRM	CDR
Values	**CCS**: Climate management as a shared value, allowing for technology-driven climate action Localized solidarity; global connection **CC:** Doomsday cultism; retreat of liberal freedoms	Human rights are subordinate to algorithmic best decision-making. Little privacy. **EA**: Focus on community over individual.	Variations on *ecohumanism* becomes dominant ethos: a view of the good life that combines valuing nature for its inherent value with an emphasis on social well-being rather than profit and material consumption. **SOS**: continued pursuit of convenience, material consumption; less emphasis on nature
Adaptation	Localized forms of adaptation in the face of climate risks and climate shocks is one of the drivers of increased place-based and identity-based forms of solidarity	**EA**: High adaptation to medium climate change. **SS**: Legacy of adaptation from BRI, but it's seriously insufficient post-termination. **FP**: Legacy of adaptation from BRI; Global South better adapted than North b/c of newer infrastructure. We can predict climate well, but how much do we want to interfere with it? (This sets adaptation goals.)	High capacity for adaptation and loss & damage finance; climate change under control, but sea-level rise continues.
Family Structures	Not looked at explicitly. Place-based forms of solidarity spring up, suggesting tight family units and family-based connectedness	Economic growth has reduced population growth.	Extended families tend to live in close proximity in most city-states.

	SRM&CDR	SRM	CDR
Governance Structures	Strong local management of decisions Cities and subnational units; but strong interconnection so that coordination possible Extremely distributed Increased participation and direct democracy More participation of women across decisionmaking Federal governmental and intergovernmental institutions face challenges in the face of climate shocks, migration pressures, rise of "walls" (not just physical structures but policing of borders by drones etc; also rise of new forms of citizenship – e.g. need a New York City or New York State or "I work for Amazon" identity card to access localized benefits, including localized forms of UBI and the ability to live in certain places). Intergovernmental institutions and states COULD remain strong. This becomes a pivot point in our story. Strong states and international institutions could facilitate global cooperation even as smaller sub-national units take or are granted more power. OR states could make a grab for maintenance of power leading to internal clashes (e.g. US federal government clashing with leadership and citizenry of New New Amsterdam) and increased level of international tension	People defer to AI in governance decisions. **FP**: AI is nationalized, so tech companies do not have free rein. UN has major regional blocs on reformed SC, which may include large corporations. **EA**: Nation-states exist but act in line with targets from global ecoautocracy.	Big 20 Corporations control 80% of Gross World Product, have taken over most government functions. Economically interconnected city-states have replaced nation-states because of geographic isolation. Equity in corporations broadly distributed. Inequality is relatively low both between and (especially) within city-states.

	SRM&CDR	SRM	CDR
Connections	Localized forms of solidarity. Strong sense of community. Increased happiness. Compassion and shared values means maintaining connection between and among units. Less mobility. People can't (and don't necessarily want) to move as much. Much reduced physical trade. 3D printing enables ideas rather than goods to be shared more easily; localized forms of solidarity and automation mean that much more can be done and experienced in local areas. Building up of "walls" in the earlier part of the century gave negative pressures in the same direction, making mobility more difficult as UBI and other benefits of citizenship given just to those in particular areas; keep out those who don't belong. **CC:** Above COULD give rise to xenophobic backlash and help push the descent into a darker world. OR xenophobia could be held in check in many places as those living in cities with UBI hold on to virtual connections and values of climate management coupled with place-based solidarity enable coordination even in the face of dispersed governance units	**SS**: Regional blocs of varying power. Cheap internet everywhere, but strict migration controls between blocs. **FP**: ??? **EA**: World is extremely connected via virtual reality but people travel less; strict quota on flights.	Extended families and social circles are important. Population density is bimodal, with many people living in dense "jungle cities" and the rest in the sparsely populated surrounding rural areas. Modal and fuel shifts in transport have all but eliminated transportation emissions. Technology facilitates international communication and tourism.

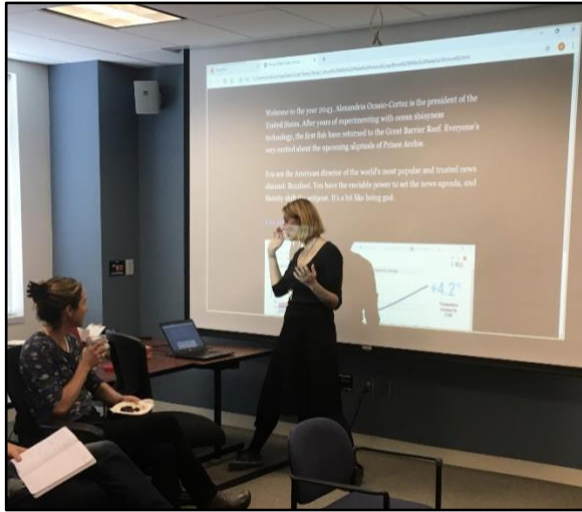|	SRM&CDR	SRM	CDR
Manufacturing, Art	Communications technologies and (perhaps) 3D printing at large-scale, along with workable forms of carbon capture and utilization, are keys in this world. People stay put for the most part but can still derive many of the benefits of mobility by sharing ideas and experiences with others far away and 3D printing rather than trade in goods Even those who are outside localized systems of UBI are able to tap into the connected carbon economy (carbon is pulled out of the atmosphere and into storage or use because the shared ethic of climate management demands it, and these acts are able to be coordinated to an extent because of economic motivations and the ability for distributed city and state governments to coordinate activities that have common benefit – a radical form of distributed global governance).	AI is pervasive. Manufacturing is highly automated. **EA**: Entertainment is produced/condoned by ecoautocracy.	Mostly globalized production of goods using zero-carbon energy, complemented by local "boutique businesses."

	SRM&CDR	SRM	CDR
Energy (fossil & renewables)	ENERGY A lot of carbon-free energy substantially deployed Lots of CDR deployed Small amount of SRM Some remaining fossil fuel; other climate forcers from agriculture etc ECONOMY Decentralized; lots of socially beneficial jobs. UDI removing pressure to do jobs just for money itself Circular carbon economy More trade in ideas and blueprints; less trade in physical goods (3D printing implemented)	**SS**: Energy production is regionalized. So is SRM. Confidence in renewables is reduced because of interference from SRM in other regions. Legacy of renewable and fossil infrastructure from pre-climate-emergency. **FP**: Decentralized energy w/ high renewables, including large-scale hydro from BRI. On the way to net-negative. Some fossil fuels from BRI legacy. Fossil interests using fact of SAI to resist complete phase-out. Discussion of dam deconstruction. **EA**: Centralized renewables w/ int'l electricity grids. AI has increased efficiency, reduced costs of renewables b/c of improved forecasts (weather, energy demand).	Ninety percent of energy comes from zero-carbon energy sources, with residual emissions (more than) compensated for by CDR. **SOS**: high residual emissions from fossil fuels, offset by large-scale CDR
Economy	Some addition local and regional biodiversity and landscape protection as people have more leisure (UBI + automation), spurring increased attention to looking after local landscapes Uncertain whether major hotspots of biodiversity are able to survive mid-century climate shocks, human migration, and resource grabs. Cities are new loci of political power and adaptation in the face of climate change	AI economy. AI-induced job losses prompt widespread UBI. Good infrastructure across Global South. **EA**: Mining of moon and asteroids by machines.	Most people work for the Big Corporations, while some work for local "boutique businesses." In most city-states, people choose their own hours and work part-time to get some money, contribute to society, and/or engage in fulfilling projects.

	SRM&CDR	SRM	CDR
Environment	More interest in place-based preservation Turn to technology, though, severing connections with self-willed nature; dominant ethos of management and control	Mass extinctions. **EA**: Massive carbon forest preserves, optimized for carbon storage, not biodiversity. **SS & FP**: Legacy of deforestation from BRI.	Much of the land is given over to wilderness, punctuated by large rural areas centered around dense, high-rise "jungle cities." Biodiversity is high in higher latitudes but remains severely damaged at lower latitudes, where massive ecological restoration efforts are underway. Marine biodiversity has declined significantly, especially in the tropics, but restoration efforts are underway there, too.
Destruction & Conflict	**CCS:** Conflict relatively unlikely, as solidarity within city-states and cooperation between city-states predominate. **CC:** Violent conflict quite likely.	**SS**: Flash wars started and completed by algorithms, sometimes in minutes, often over disagreement about regional SRM. Disruption from climate refugees, especially SIS and countries unable to deploy regional SRM (e.g., inland countries). **EA**: Strong rule enforcement through shaming and ostracization linked to ecocredit score.	Social conflict persists over the dominant ecohumanist ethos, especially between ecohumanist city-states and those that reject the ethos for one reason or another. **CW**: a series of devastating wars kill a significant percentage of global population and destroy a huge amount of economic infrastructure in the late 21st century, leading to strongly pacifist attitudes by the end of the century.
Food	Localized, highly efficient forms of production through embrace of genetic modification technologies and methods allowing intensification	**EA (All?)**: Reduced meat consumption; plant-based meat substitutes. Lots of fish and seaweed from Chinese-led aquaculture. **EA**: Meat is boutique good. Hunting in carbon preserves by permit.	Food systems are dominated by local production, with people eating primarily seasonal foods. Food is grown in rural areas surrounding dense cities, where farmers employ soil carbon-building agricultural practices and agroforestry.

	SRM&CDR	SRM	CDR
Water			Water is provided by The Water Company. Most people enjoy secure access to clean water, partly because people have abandoned many water-scarce areas and partly because The Water Company supplements existing water resources with wave energy/desalinization/ocean alkalinization projects.
Health		AI precision medicine. **EA & FP**: Malaria is eradicated. Better distribution of drugs because of infrastructure from BRI. **SS**: reemergence of disease with termination shock.	People generally live healthier lifestyles and have better mental health. The Rabid Monkey Problem of the 2080s has been brought under control with vaccination drones. Recreation often involves interacting with nature or virtual experiences. **SOS**: air pollution from fossil fuels remains a problem in some city-states. **CW**: the physical and psychological traumas of the climate wars linger, but otherwise people are living healthier lives.
Other	3D printing, AI, and automation all important to storylines	Precise, near-real-time satellite tracking of activities, emissions anywhere on Earth.	Social systems are highly managed, and the stability of the systems depends heavily on a relatively small group of corporate leaders' commitment to ecohumanism.

3. Performance-based Presentations of Scenarios

Near the end of the workshop, each group performed their stories in ways that showcased not only their visions of the future, but also how different choices at critical moments led to different futures. Each of the three groups presented their visions very differently.

The SRM&CDR group used the 'choose your own adventure' story they had built in Twine to lead an interactive game (Fig. A2) in which the audience was able to make decisions that led to different futures. This process informed the basis of a longer term collaboration that became the online Survive the century game: https://survivethecentury.net/.

Fig. A2: Sam Beckbessinger from the SRM&CDR group presenting a 'choose your own adventure' story from her group using software called Twine.

The SRM group started with a "Fortunately, Unfortunately" story (Table A3) inspired by one of the workshop ice-breakers. They then presented a series of vignettes (Fig. A3, Table A4) illustrating how different choices had led to three different futures, one of which did not even land up deploying the SRM technology.

Fig. A3: Members of the SRM group presenting one of their three contrasting futures using vignettes.
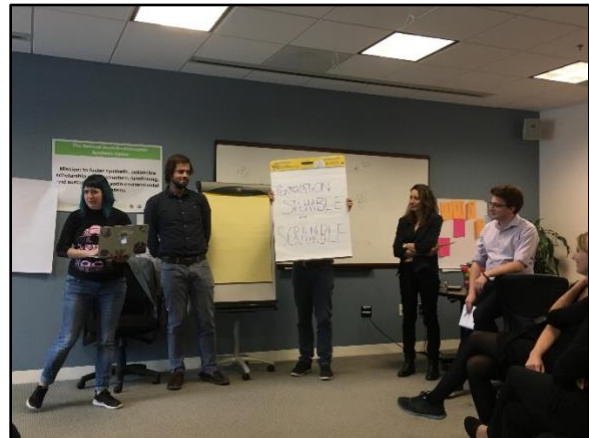
Table A3: Branching "Fortunately, Unfortunately" stories from the SRM group

Short-term	Mid-term	Long-term
Unfortunately, Donald Trump was re-elected in 2020. *Fortunately*, Expansion of Belt & Road infrastructure means more economic growth and improved climate adaptation across global south. *Unfortunately*, automation leads to job losses & climate change to coral reef collapse in the 2030s. *Fortunately*, in response, Indo-Pacific countries launch Universal Basic Income and test solar radiation management locally. *Fortunately and unfortunately,* the social credit score becomes a thing. *Fortunately*, AI algorithms helps predict weather and optimize insurance and help us make decisions. *Unfortunately*, the Everything Leak of 2031 means everyone is doxxed. *Fortunately*, so are corporations, increasing tax compliance and revenue for development.	**[A]** *Unfortunately*, Belt & Road leads to deforestations and emissions go up! *Fortunately*, renewables are still scaling up as is carbon removal infrastructure. *Unfortunately*, unexpected permafrost collapse in the 2060s drives rapid warming. We deploy SAI!	**[A1]** *Unfortunately*, it only kind of works. *Unfortunately*, again, hackers attack the control system for the drone jets crashing them into buildings for 911 2.0. There's a Termination Stumble. We freak out and decide not to deploy again We scramble to get regional SRM up. *Unfortunately*, there are AI flash wars.
		[A2] *Fortunately*, Eco-Intersectionalist activists hack the AI algorithm and expose racial bias. *Fortunately*, this pushes discussion of more equitable SRM deployment.

	[B] *Fortunately*, Belt & Road drives innovation in clean energy and carbon capture.
	
	Fortunately, the newly empowered global south has more political influence to push China and the US to more rapid decarbonization.
	
	    Adaptation is good in the global south because they have newer infrastructure.
		[B1] *Fortunately*, when permafrost collapses, mitigation is good enough that we don't need to deploy SRM. Politically high confidence in CDR. The Bureau - AI machine learning data and analysis helps us make informed decisions.
		
		    Social credit score has an increasing influence on people's lives including their emissions behaviour and controlling society . . . . We're heading to an AI-led eco-autocracy.

Table A4: Vignettes from the SRM group's performance

Future	Vignette
Stumble and Scramble	My backache wakes me up. The lights don't turn on, so I imagine that the portable nuclear reactor has broken down again. I guess the entire neighborhood will be powerless again for two weeks. The Cornetto synthesizer doesn't work, of course. Luckily my grandson downstairs still has a can of synthetic Facon and Eggs, from the last military distribution of rations from last month, when war with Morocco seemed inevitable over their will to deploy MBC over the Mediterranean to save their fisheries. Groggy, I head over the Church of Our Cyberlady of Lovelace, to see if the refugees from Madagascar need anything. On my way to the Church, I look at the sky. I miss seeing birds soaring by. I miss birds.
fAIrplay	The response from the AI arrived yesterday. They were the longest 2 days of our life. Yes, SAI can be deployed to save 97% of the human population and 99% of all ecosystems, but our great country will never see rain again. I went through the data the AI gave us. There seems to be no other way. Any other deployment but this would save India, but kill at least 5 times more people. The first World referendum will be on for another 30 hours. What do we do? Do we sacrifice our country for the good of the planet? Russia has already promised to host us in their new Arctic colonies. But can we trust them? The computer flashes on, reminding me I haven't voted yet. My old friend from Italy has invited me to give a web-talk in two hours. Quite a turn, he's had. From climate scientist to Pope. What do I tell all those people in Rome? Is it okay for them to vote Yes? Are they only looking at an easy way to clean their conscience? This is the land of my father, and of his father before him. What would they do, in this crazy new world?
Eco-autocracy	Walking back from the trash mines, I feel so tired and I'd like to take a Elonmobile, so I check my phone. Damn, I finished my Carbon Credits for today! I knew I should have just had the locally grown beans today, but the watermelon looked so good, and I forgot to check how far away it was produced. Starting tomorrow I'll be more careful. XI Jinping, looking quite good for a 150 years old, has promised that starting in 2095 the CO2 quotas will be raised for everyone. He even said that, by 2100, we'll be able to fly again, twice per year! Maybe I can finally go and visit my fifth wife in the US, I haven't seen her in ages. She moved there after Mexico was bombed for turning off one of their coal factories. She told me she got her gene spliced and now she can see in the near infrared. That's cool, I guess. But I'm too old for this shit.

The CDR group started with a musical, adapted from *Wicked,* describing the desirable future to which their narrative led (Box A1), but which alluded to the turning points in the narrative at which more problematic outcomes could have arisen.

Box A1: Lyrics for the CDR group's adaptation of "One Short Day" from *Wicked*
With apologies to Stephen Schwartz

One fine day
In our forested city
I work today
Removing one carbon ton

Every way that you look
In our forested city
There's something that they own
That's something that you own
'Cause they're owned by you

There are buildings made of quoxwood trees
On land all owned by the Big Three
Electric trams and bikes ten million strong
It runs on solar energy
It's all planned!
It's all green!
The future Greta wanted all along

It's perfect here!
That's what they say
In ads they show to me all day
But if you want a holiday
The wild lands are not so far away

One fine day
In our forested city
I work today
Removing one carbon ton

There's a sign on the city
When you come in it
Saying it's named for
Jeff Bezos's son

Fig. A4: The CDR group explains the skit that illustrates their scenarios. David Morrow (left, in monkey costume) gestures at David Keller (right, with electric knife), who represents the constantly encroaching threat of climate change. Mohale Mashigo (center, on floor), in the role of Dead Fish, represents the catastrophic collapse of coral reefs that plays a pivotal role in the scenarios.