24. The climate crisis: what sociology can contribute*

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1. CLIMATE CHANGE AND SOCIOLOGY

Climate change provides a major challenge to contemporary societies. Whether the problem is best portrayed as our house being on fire (Thunberg 2019) or as our house being imperceptibly eaten away by dry rot, there is little doubt that we do indeed have a problem. Global temperatures have risen substantially, and heatwaves, hurricanes, floods, and droughts have become increasingly common. There is overwhelming evidence that these trends are, at least for a large part, caused by human activity, with increases in greenhouse gas emissions being the prime culprit (IPCC 2015). According to some analysts, we have entered a new geological era, the Anthropocene, in which humankind has become a global geological force in its own right (Steffen et al. 2011).

Climate change is thus more than merely an environmental phenomenon. Not only are its causes rooted in societal practices, its consequences also extend far beyond its immediate natural impacts. Direct impacts such as rising sea levels and changes in the distribution of rainfall may make areas uninhabitable, disrupt critical infrastructure, impose health risks, threaten food security, and undermine livelihoods that depend on natural resources (Klinenberg et al. 2020). Critically, these impacts are unequally distributed, reflecting variation in exposure to climate change as well as in the extent to which people can adapt to it. Globally, this gives rise to the cruel fact that 'those nations most responsible for emitting greenhouse gases are best positioned to protect themselves [. . .] whereas nations with the lowest carbon footprint generally possess few resources to do so' (Klinenberg et al. 2020, p. 653). At the same time, climate change may also aggravate social inequalities within countries (Dietz et al. 2020).

When we view climate change as a problem that is social in both its causes and consequences, it requires little explanation that sociologists are well-placed to contribute to the study of climate change. In recent decades, many sociologists have already responded to this call, analyzing attitudes to climate change, the adoption of green behaviors, and issues of climate justice, to name a few examples. Nevertheless, the study of climate change continues to occupy a rather peripheral position within the sociological discipline. As becomes clear from two recent reviews (Dietz et al. 2020; Klinenberg et al. 2020), climate change rarely features outside field-specific journals, and there remain significant gaps in our

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understanding of the social nature of the climate change problem. This is a real pity, as improved insights on this front are indispensable for combatting the climate crisis.

Against this backdrop, this chapter gives an overview of some of the important research that sociologists have already done in relation to climate change. At least as importantly, we also highlight underexplored research areas where sociologists have something unique to contribute. While we can inevitably only scratch the surface on both accounts, we organize our discussion around three connected themes that capture key obstacles to solving the climate crisis: (1) attitudes to climate change, (2) diffusion of climate-friendly behaviors, and (3) opportunities and challenges for government intervention to address climate change. We start, however, with a brief look at the collective action problem that underlies human-driven climate change.

2. CLIMATE CHANGE AS A GLOBAL COLLECTIVE ACTION PROBLEM

Hardin's (1968) reflections on 'the tragedy of the commons' neatly demonstrate that individual actors often lack incentives to take public interests, such as the preservation of the environment, fully into account. When their goal is to maximize utility in the short run, it can be entirely rational for actors to exploit collective resources, even when the whole community will eventually suffer losses as a result. This represents a classic case of a collective action problem or social dilemma (see Diekmann's chapter on rational choice sociology in this *Handbook*), with every actor facing incentives not to take any precautionary actions, even though a collective failure to act will ultimately harm everyone's welfare.

Like the commons that Hardin wrote about, the atmosphere can be regarded as a common-pool resource, serving as a dump for greenhouse gases emitted through human activities. As for other common-pool resources, anyone can access the atmosphere (i.e., emit greenhouse gases), yet not without costs (i.e., a destabilized climate). The fact that the atmosphere is a *global* common-pool resource makes it especially challenging to avoid overexploitation, as problems related to the atmosphere inevitably transgress boundaries (cf. Dietz et al. 2003). Moreover, while one could think of a system of tradable emission permits, as exists for industrial polluters in the European Union, one would run into numerous problems when trying to roll out such a system on a global scale and for all greenhouse gas emissions (De Graaf & Wiertz 2019).

One of the key complexities is that the global character of the atmosphere implies that every person on our planet is involved, as potential culprit and victim. This makes it practically impossible to agree on common rules, to monitor behavior, and avoid free-riding. In addition, people cannot easily observe the effects of climate change in their everyday lives. For example, the rise in global temperatures – one of the prime symptoms of climate change – amounts to 'only' one degree Celsius over the past 50 years. For many, climate change is also a distant phenomenon, with the gravest consequences occurring far into the future and in areas far away. Another complexity is that human-driven climate change is a problem that humankind has not encountered before. As such, it remains uncertain how it will evolve, leaving ample room for disagreements about the urgency of the situation.

Altogether, we are still far from sustainable management of the atmosphere, with little action taken to combat climate change, whether we consider citizens, businesses, or governments. This lack of response represents a tantalizing puzzle: why, given the looming consequences of climate change, do we not take more effective action against it?

The collective action problem behind this puzzle can be analyzed using a macro-micro-macro framework as introduced in the chapter by Raub, De Graaf & Gërxhani on rigorous sociology. Figure 24.1 illustrates this, displaying the basics of the problem in a Coleman boat. The starting point of the figure is a small rise in global temperatures, with little action taken in response. This societal context influences the beliefs of individual actors about the nature of the problem ('perhaps it is not so bad') and the behavior of other actors ('others do not seem to care'). Based on such beliefs, actors may end up doing little to avoid climate change, thinking that their actions will make no difference, while they do involve costs. With many actors behaving this way, the aggregate outcome is that climate change continues to unfold unconstrained. That outcome subsequently forms the starting point of a new cycle through the diagram. In the remainder of this chapter, we zoom in on different segments of this Coleman boat, thereby demonstrating how sociological analysis can illuminate various aspects of the societal dynamics underlying the climate change problem.

3. ATTITUDES AND BELIEFS CONCERNING CLIMATE CHANGE

Understanding people's perceptions, beliefs, and attitudes to climate change goes a long way to understanding the climate crisis. For one thing, these views can affect behaviors, such as the car one drives or the party one votes for. Moreover, widely shared concerns about the climate can trigger public policies to combat climate change, with any such policy only standing a chance of making a difference when it is supported by a broad coalition of citizens. Since a detailed account of public opinion on climate change is beyond the scope of this chapter (we refer the reader to Shwom et al. 2015 and Capstick et al. 2015 for comprehensive reviews), we focus in this section on two questions that are particularly relevant for sociologists, namely: what explains attitudes to climate change and how do such attitudes influence climate-related behaviors?

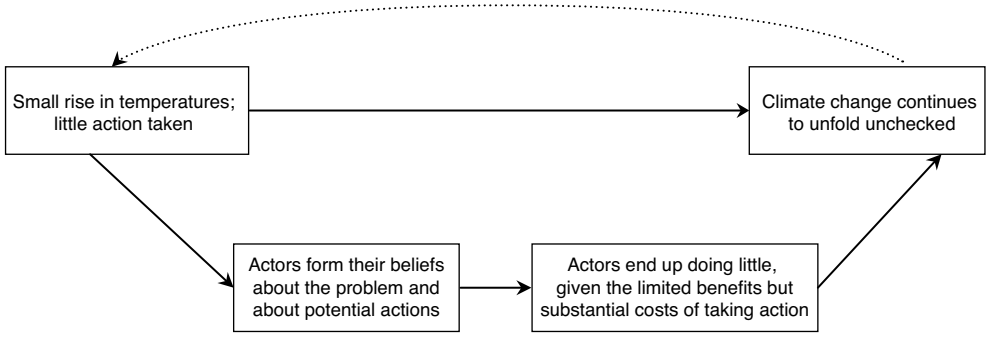


Figure 24.1 Summary of the collective action problem behind climate change

Concerning the drivers of attitudes to climate change, evidence indicates that beliefs in human-driven climate change, concerns about this, and support for policy responses tend to be stronger among women, the higher-educated, and younger generations (Poortinga et al. 2019). Common explanations are that women are more altruistic and risk-averse than men, that education boosts climate change awareness, and that younger people are more future-oriented, whilst older people have greater stakes in the status quo. Economic interests matter as well. Bechtel et al. (2019) show in this context that people who are employed in more polluting industries – and who would thus face a bigger burden of any mitigation efforts – are less supportive of action against climate change. At the same time, social norms and values are shown to be important, too: support for abatement of greenhouse gas emissions is stronger among reciprocal and altruistic individuals.

We can also link people's attitudes to climate change to the contexts they are embedded in, which brings us to the macro-to-micro link of the Coleman boat in Figure 24.1. One of the strongest divides in this regard is between people living in industrialized versus less-developed countries, with the latter being considerably more worried about climate change (Stokes et al. 2015). This gap may reflect variation in countries' exposure to climate change, their adaptive capacities, or their reliance on greenhouse gas emissions. Also within countries, contextual forces play a role. For example, public concerns about climate change tend to weaken as economic insecurity rises (Scruggs & Benegal 2012), in line with the 'finite pool of worry hypothesis' (Capstick et al. 2015). This is one reason why climate change – despite being considered an important global threat (Poushter & Cornibert 2019) – continues to rank low on domestic agendas, after issues such as unemployment, immigration, and local environmental problems such as air pollution (Steentjes et al. 2017). Evidently, this low salience is a major obstacle to collective action to tackle the climate crisis.

Finally, and now we really enter the area where sociologists have a comparative advantage, there are many cases where individual and contextual factors interact in shaping attitudes to climate change. A notable example concerns the role of political attachments. While progressives are generally more concerned about climate change than conservatives, the magnitude of this gap strongly depends on how polarized societies are along ideological lines. This explains, for instance, why there is a closer connection between political ideology and climate change attitudes in the United States than elsewhere (Hornsey et al. 2018). The susceptibility of climate-related attitudes to political influences stems directly from the complex and uncertain nature of climate change. This makes it difficult for people to form an independent opinion, with many instead relying on others – including politicians, media, and interest groups – for their understanding of the problem. Yet, many of these groups apply ideological filters in the information they share, and more so in polarized environments, such that only views that conform to the group's pre-existing beliefs trickle through.

Without a doubt, sociological work can be of great use for advancing our understanding of attitudes to climate change, especially in relation to the interplay between individual and contextual factors. For example, a recent study by Rüttenauer (2021) applies rigorous modeling to demonstrate that the extent to which extreme weather events bring about shifts in climate change beliefs depends on people's trust levels. However, when we consider the climate crisis, attitudes on their own ultimately only have limited relevance. After all, a solution to this crisis requires more than sympathy with the cause. This brings

us to the question of how attitudes to climate change influence behaviors: the micro-to-micro link of the Coleman boat in Figure 24.1 and another topic where sociologists have much to contribute.

That concerns about climate change will translate into actions to avert climate change can by no means be taken for granted. Even if people believe that climate change is a dangerous threat that requires immediate action, there are many factors that could still prevent them from taking any action, be it the influence of competing attitudes or expectations about other people's behaviors. Indeed, if there is a lack of trust that others will follow suit, society may end up in a social trap, where nobody is willing to adopt more climate-friendly behaviors (Smith & Mayer 2018). In line with this argument, Tam & Chan (2018) show that the link between environmental concerns and pro-environmental behavior is stronger for individuals and societies with higher levels of trust.

Another potential obstacle concerns the cost of the behavior in question. In this regard, the 'low-cost hypothesis' (Diekmann & Preisendörfer 2003) predicts that environmental concerns are likely to stimulate 'green' behaviors when there are low costs and little inconvenience involved, but less so in situations where costs are high (i.e., where it is more expensive to act on one's concerns). The underlying idea is that people are generally eager to avoid cognitive dissonance stemming from a discrepancy between their attitudes and behaviors, but that they are only willing to go to certain lengths to achieve this. An interesting implication is that the availability of low-cost options for green behaviors may possibly crowd out more effective behavioral reforms (Farjam et al. 2019). For example, using less paper and voting for a green party may already be enough to reduce the cognitive dissonance experienced by climate-concerned citizens, thereby reducing the incentives for more far-reaching actions such as flying less often or selling one's car.

More generally, any gap between attitudes and actions may reflect that surveys often fail to portray the problem of climate change as it is encountered in real life. When asked about climate change, it is easy for people to fall prey to 'ecological correctness' (Diekmann & Preisendörfer 2003) and to focus on their role as citizens while disregarding the implications of their responses for themselves as consumers or taxpayers. When individuals are, in contrast, informed about the costs involved, support for climate action drops substantially (Bechtel & Scheve 2013). What is more, support drops even further, at least in the United States, if the costs are labelled as 'taxes' rather than 'generic costs' (Bowman & O'Neil 2017).

Nonetheless, recent studies on the influence of climate concerns on personal behaviors demonstrate that it is not simply 'all talk and no action', with climate concerns being positively associated with environmentally responsible behaviors. This is true for self-reported behaviors (Bouman et al. 2020), which may still be biased towards ecological correctness, but also for more objective outcomes such as electricity usage (Bruderer Enzler et al. 2019). There is thus reason for some optimism as to whether increased concerns about climate change will bring about much-needed behavioral changes. This is especially so given technological innovations that make green behaviors such as the installation of solar panels increasingly affordable or even financially attractive.

A fruitful task for sociologists in this context is to identify the precise circumstances under which attitudes translate into actions. Such insights can help policymakers determine when to appeal to people's environmental consciousness or to promote climate change awareness and when to resort to other tools. Work on the low-cost hypothesis

sets a great example in this respect, even though this hypothesis may itself also be subject to scope conditions. Keuschnigg & Kratz (2018), for example, demonstrate that environmental attitudes only matter as drivers of green behaviors when costs are low *and* when there is no strong social norm prescribing the behavior in question. Otherwise, even people less concerned about the environment will take up the behavior.

4. HOW CLIMATE-RELATED BEHAVIORS SPREAD THROUGH SOCIETY

While there is by now a good amount of sociological research about the drivers and consequences of attitudes to climate change (albeit largely outside the discipline's flagship journals), the sociological community has remained relatively silent on the issue of how individual actors interact and how their behaviors add up to produce the climate crisis. This is a missed opportunity, as the study of such micro-to-macro links is a core feature of sociology (see also the chapter by Raub, De Graaf & Gërxhani and the chapter by Steglich & Snijders on stochastic network modeling), with a rich stock of insights and tools to draw upon. In this section, we capitalize on these resources, to show what is possible when we subject the micro-to-macro dynamics behind the climate crisis to a sociological analysis. We argue that the payoffs come in two forms: a better understanding of the climate crisis as well as some concrete pointers on how to tackle this crisis.

Recalling Figure 24.1, the key to the climate crisis is that, no matter how strongly one cares about climate change, there is always an incentive to hitch a free ride by taking advantage of the efforts of others while not getting one's own hands dirty. These free-riding incentives lead to a stable but suboptimal societal equilibrium, where virtually nobody takes action against climate change, even though most people would be better off if concerted action were taken. Nonetheless, recent sociological research suggests that reality might not be quite as gloomy: as long as there is some commitment to climate action within the population, this could set off social dynamics that may eventually overcome the collective action problem sketched in Figure 24.1.

Van de Rijt's (2019) work on self-correcting dynamics in social influence processes, included as a showcase chapter in this *Handbook*, offers a useful starting point. Van de Rijt studies settings where, for whatever reason, an 'inferior option' is initially more popular than a 'superior option'. In the current context, the inferior option could refer to making no effort to tackle climate change, while the superior option corresponds to taking effective action. It is commonly expected that we will in such situations observe self-reinforcing influence dynamics that lead 'the early popularity advantage for the inferior object over the superior alternative to be perpetuated' (Van de Rijt 2019, p. 1469). Crucially, though, Van de Rijt (2019, p. 1471) shows that 'accidental majority support for an inferior option will often self-correct', with the superior alternative recovering from the initial setback.

It is interesting to consider whether these findings also apply to the climate change problem. That is, if we are currently stuck in an inferior equilibrium where taking no action against climate change is the most popular behavior, could we then still, via

self-correcting dynamics, reach a situation where behavioral changes are implemented, such that dangerous climate change is curbed or avoided?

On the face of it, such self-correcting dynamics may well occur. The underlying idea is that people choose their behavior by balancing personal preferences against a social signal in the form of other people's behavior, which may carry normative pressures or reduce uncertainty about different courses of action. With people's behaviors reflecting an amalgamation of their personal preferences and this social signal, some people will plausibly end up acting against climate change even if nobody else does. The personal preferences of these 'climate activists' are so strong that they are willing to act no matter what. These acts will, in turn, convince some more people to jump into action, and so on and so forth. Hence, a small number of activists marching ahead of the troops may set off a feedback process whereby fence-sitters are persuaded to join the bandwagon. If these dynamics are strong enough, a new equilibrium may emerge that matches society's underlying preferences for climate action. The crux of these dynamics is that every actor's behavior has spillover effects, by altering the social signal received by others. The self-correcting process may accelerate further as more information becomes available about climate change. For example, if scientists increasingly agree that urgent action is necessary, this could strengthen the pull to the superior equilibrium.

Yet, whether such self-correcting dynamics materialize depends on multiple factors. To begin with, the superior option needs to be clearly better than the inferior option. Frey & Van de Rijt (2020) show in this respect that self-correcting dynamics are less likely to emerge when actors find it difficult to identify a superior option. Moreover, Van de Rijt (2019) assumes there are no strategic interdependencies between actors: other actors' behavior may exert normative pressures or convey information about the value of different options, but should not affect the actual costs or benefits of adopting a certain behavior. For example, for the study by Salganik et al. (2006), also included as a showcase chapter in this *Handbook*, this implies that the popularity of a song may provide information about the quality of the song, but that it should not make it any easier to download the song, nor should it affect people's enjoyment of the song.

While this assumption may be tenuous for music downloads, it is certainly untenable for actions to curb climate change. After all, because the battle against climate change resembles a public good, the value of individual efforts to slow climate change will hinge on the efforts of others. If enough others contribute, individual contributors may taste the fruits of their labor, yet if too few people contribute, a climate disaster remains possible. Therefore, if any self-correcting dynamics do not sooner or later result in a participation rate that is high enough to slow climate change, individual contributors may well decide to pull out, seeing no benefits of their actions despite incurring real costs. In this scenario, society may still end up locked into an inferior equilibrium. Conversely, if contributors witness that the climate movement is gaining momentum, even if only slowly and in their immediate surroundings, this may encourage them to sustain their efforts. The momentum can then continue to grow, possibly resulting in a positive feedback cycle towards more climate action.

A crucial factor thus seems to be how long it takes to make progress. What can we, in this context, say about the speed with which climate-friendly behaviors may spread through society? It is useful to draw a link here with the concept of complex contagions,

as introduced by Centola & Macy (2007). Starting from the conventional wisdom that any type of phenomenon will spread most quickly via weak ties (Granovetter 1973), Centola & Macy argue that a distinction needs to be made between simple and complex contagions. Simple contagions concern phenomena such as disease or information, which can be transmitted via a single contact. Complex contagions, on the other hand, concern phenomena that require contact with multiple sources of activation. They involve some cost, risk, unfamiliarity, or strategic interdependence, such that the decision to adopt depends more strongly on social confirmation.

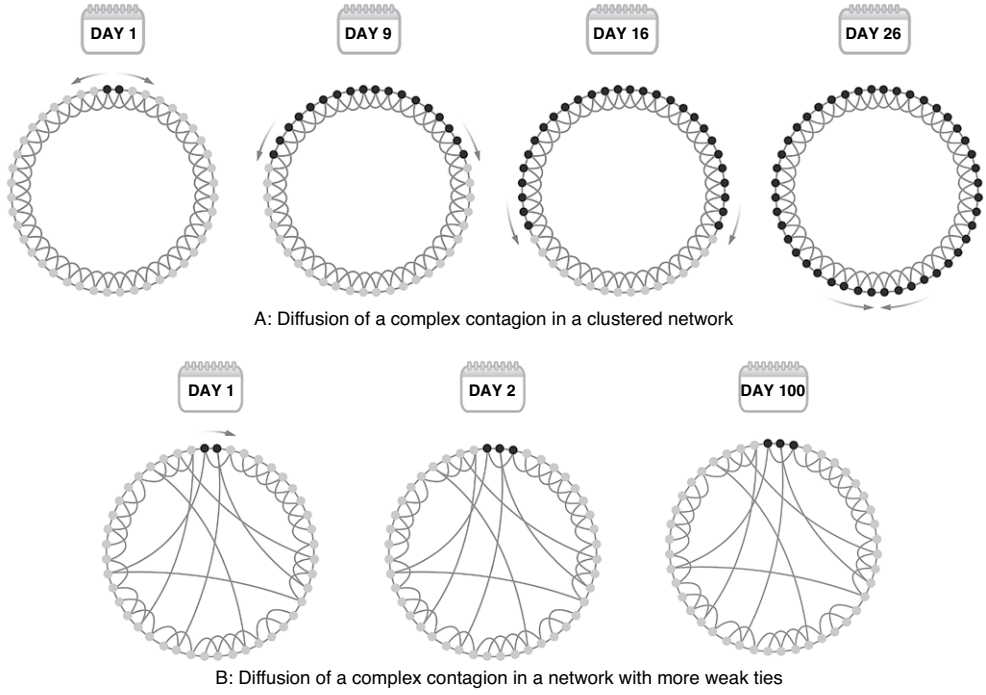
Taking action against climate change qualifies as a complex contagion on account of at least two social processes. First, there is a credibility mechanism: given uncertainties about climate change and the effectiveness of potential countermeasures, individuals require a strong social signal that a measure is worthwhile before being willing to adopt it. Second, there is a strategic complementarity mechanism: as for any public good, the benefits of individual investments to tackle climate change depend on how many others are making similar investments. Due to both mechanisms, people will often require confirmation from multiple contacts before adopting more climate-friendly behaviors. Indeed, even the spread of *information* about climate change may already constitute a complex contagion (despite information diffusion usually being regarded as an archetypical example of a simple contagion), given the complex, uncertain, and contested nature of climate change.[1]

Viewing climate-related behaviors as a complex contagion, we can draw on a broad set of insights to predict how these behaviors will spread through society (Centola 2018). The analytical underpinning of these predictions is a socially enriched version of the collective action problem depicted in Figure 24.1. Instead of framing this problem as the challenge of achieving cooperation among numerous separate entities, we now also consider the social networks that actors are embedded in, the structure of which can make a big difference for the diffusion of complex contagions.

While simple contagions spread fastest through networks with many weak ties, the opposite is true for complex contagions. Complex contagions may even fail to diffuse altogether in such networks. The reason is that individual actors will only adopt a complex contagion after receiving encouraging signals from multiple others, which is less likely to happen in a dispersed network with many weak ties than in a clustered network with many strong ties. As Centola (2018, p. 43) puts it: 'a signal that travels across a [weak] tie arrives alone, without any social reinforcement'. Moreover, if individual actors not only look at how many people in their network have adopted the behavior in question, but also at how many have not, weak ties impose an even stronger drag on the diffusion process.

For complex contagions, clustered networks thus do not only have a relational advantage – people are more likely to take cues from close ties – but also a structural benefit – with many wide bridges (i.e., nodes or neighborhoods are connected via

[1] This conceptualization of information as a complex contagion calls into question the effectiveness of mass information campaigns. Such campaigns focus on reaching as many people as possible with their message, yet when the information in question concerns a complex contagion, a more targeted approach may result in more people eventually taking on board the information. See also the discussion of Figure 24.2.



Notes: Dark nodes indicate actors who have adopted a new behavior; light nodes indicate those who have not yet done so. In this example, actors only adopt the new behavior if two of their social ties have already done so. These illustrations are reprinted with permission from *How Behavior Spreads: The Science of Complex Contagions* by Damon Centola (Copyright © 2018 by Princeton University Press).

Figure 24.2 Diffusion of a complex contagion for different social network structures

multiple overlapping ties). Figure 24.2 illustrates this point, comparing how a complex contagion spreads through a clustered network with only strong ties versus a network that has more weak ties but is otherwise the same. In this stylized example, the complex contagion spreads slowly but steadily through the clustered network (Panel A), whilst in the more dispersed network it already runs into a roadblock right after setting off (Panel B).

Based on the apparent importance of the social networks that people are embedded in, Figure 24.3 redraws the Coleman boat from Figure 24.1 by adding social networks as meso-level entities that sit between the macro level and micro level. Once we look at the collective action problem behind climate change through the lens of this three-level framework, we can start to see potential exit routes out of the suboptimal equilibrium in which nobody contributes anything to address the climate crisis. The general logic behind these exit routes is to carve up a seemingly insurmountable macro-level problem into more manageable meso-level chunks. After all, while it will be incredibly challenging to get numerous individual-level actors from across society to jointly commit to more climate-friendly behaviors, it will be more feasible to attain such cooperation within the bounds of social networks.

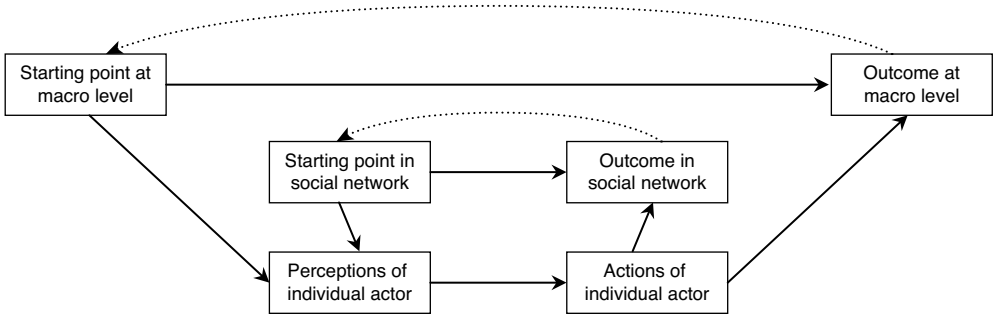


Figure 24.3 Incorporating social networks in our macro-micro-macro framework

In general, local pockets of social reinforcement can relatively easily arise in social networks of like-minded people, whilst such 'incubator networks' can simultaneously shield network members from countervailing influences from wider society. Thus, a process akin to Panel A of Figure 24.2 may lead to a meso-level equilibrium where everyone in a network adopts climate-friendly behaviors. This equilibrium can become self-sustaining if a stable social norm of climate-friendly behavior emerges. In that scenario, the new behavioral standards will 'stick' at the network level even if some network members revert to climate-unfriendly behaviors. Building up climate cooperation from within social networks might thus defuse the threat posed by individual acts of defection.

The next step is then for the desirable behavior to spread across networks. This sounds easier than it is: because we are dealing with a complex contagion, between-network diffusion requires wide bridges between networks (i.e., multiple overlapping ties), which may well be in short supply. A potential way out is to exploit cross-cutting social circles by considering different types of social networks. Take the example of a neighborhood where residents have given up their private vehicles in favor of membership of a car sharing scheme. If a non-negligible proportion of these residents are members of the same sports club or attend the same church, they may help to also establish a car sharing norm within this club or church. Other club or church members may subsequently help to spread this norm to their own neighborhoods, from where it can then travel further, for example via a company that many people in this neighborhood work for.

In short, rather than trying to universally stimulate the adoption of green behaviors across society, a more effective (and cheaper) strategy may be to take note of the structure of social networks and to exploit this to one's advantage, by focusing on first reaching a critical mass within specific segments of society, from where green behaviors can then spread to the rest of society. The rationale behind such 'clustered seeding' strategies is that by selectively targeting key players or communities one eventually stimulates change in the greatest number of people. From this perspective, there is once again cause for cautious optimism in the battle against climate change. Even though it may initially be difficult to get the diffusion of climate-friendly behaviors underway, once a norm takes hold in frontrunner communities, this can domino outwards. Recent increases in climate change concerns among younger generations could thus be the early signs of a movement that will ultimately translate into a large-scale societal response to climate change.

Importantly, however, more work remains to be done on how climate-related behaviors spread through society. In this section we have cast several hypotheses on these dynamics, but there is as yet hardly any empirical evidence to test these hypotheses against. Existing empirical work on complex contagions looks at topics such as the spread of health-related behaviors (e.g., Centola 2010) and information diffusion via social media (e.g., Mønsted et al. 2017), and it remains to be seen how generalizable the findings of these studies are. Furthermore, given that the success of diffusion processes depends on network structure, it is important that future studies of complex contagions mimic real-world networks more closely (Badham et al. 2021). It will, among other things, be relevant to allow for differential thresholds in terms of how much encouragement people require before adopting a green behavior, possibly mirroring variation in concerns about climate change as discussed in the section on attitudes and beliefs on climate change.

5. GOVERNMENT INTERVENTION TO ADDRESS CLIMATE CHANGE

There is a widespread belief, shared across nearly the entire political spectrum, that governments have a role to play in combating the climate crisis. From our preceding discussion it should be clear that sociological research could offer valuable recommendations in this regard. Indeed, the section on attitudes and beliefs on climate change provides clear pointers on when it is useful to appeal to citizens' environmental consciousness or to promote climate change awareness. The section on the diffusion of climate-related behaviors, in turn, calls attention to interventions that exploit social network structures to expedite the spread of sustainable behaviors.

In the latter context, there is ample evidence that social networks matter for the spread of climate-related behaviors. For example, households' propensity of installing solar panels rises sharply with the number of neighbors that have previously adopted this technology (Graziano & Gillingham 2015), especially when neighbors' solar panels are clearly visible (Baranzini et al. 2017). Nevertheless, while such evidence underscores the scope for policies that exploit social network mechanisms, most public interventions to date do not fully capitalize on this potential, making them less effective and potentially more costly. Universal subsidies for the installation of solar panels are a good example. A more promising approach may be to first identify households whose actions are likely to influence others and then to selectively target these households with stimuli, so as to create incubator neighborhoods from where the innovation can spread.[2] This process might be accelerated by subtle changes in people's 'choice infrastructure' (Thaler & Sunstein 2008) that encourage them to consider the behavior of others when making their own choices. In the solar panel example, households might for instance be told how many neighbors have already taken the plunge. Similarly, it may help to present green behaviors as default options.

In any case, all policies will need to be carefully crafted and evaluated, because what works in one setting does not necessarily work elsewhere, and there are many examples

[2] A recently launched project in the Netherlands, intended to stimulate households to move away from natural gas towards greener alternatives, takes exactly this approach. See http://enrgised.nl for details.

of policies that did not work out as intended. For example, an intervention whereby households were told about their neighbors' energy usage led households that were initially relatively eco-friendly to converge to the neighborhood average by *increasing* their own energy consumption (Schultz et al. 2007). Another case in point concerns local, non-commercial energy cooperatives, which have been subsidized by governments to help bring about the transition to renewable energies. Evidence, however, indicates that such cooperatives often struggle to become self-subsistent, facing cutdowns or collapsing altogether when government support is tightened (Wierling et al. 2018).

Whatever one expects from policies that address climate change from the bottom up (even from cleverly designed applications), the sheer scale of the climate change problem implies that more radical interventions, in all likelihood, remain necessary. In this context, climate scientists, environmental activists, and economists agree that there is one intervention that can make a particular difference, namely emission taxes. Such taxes – often referred to as carbon taxes – directly charge consumers, businesses, and other actors for the greenhouse gas emissions associated with their activities. They thus force actors to internalize the environmental externalities of their behaviors. Compared with other interventions, carbon taxes have the advantage of bringing in money rather than requiring money, of being relatively easy to understand, and of being less susceptible to rent-seeking behavior (Nordhaus 2013). Importantly, they could also be rolled out on a much larger scale than many other interventions, requiring less tailoring to local circumstances.

Yet, if carbon taxes have so many benefits and are advocated by so many groups, why then do we still have no effective system of carbon taxes in place? One obstacle is that governments lack the incentives to unilaterally introduce a carbon tax. The costs of a unilateral carbon tax would be felt locally, in the form of higher living costs and a worsened competitive position, whereas the benefits in terms of slowing down global warming would be dispersed globally. This combination implies that individual governments face incentives to free ride on the efforts of other countries – like past and current generations are enjoying 'dirty' lifestyles at the expense of future generations. The situation is quite different for local pollutants such as nitrogen dioxide, the impacts of which are bound to the localities where they are emitted. This reduces governments' free-riding incentives and various governments have, as a result, introduced taxes to address this type of pollution. In 2019, for example, London launched its Ultra Low Emission Zone, charging vehicles to enter this zone depending on their nitrogen dioxide emission levels.[3] To persuade governments to act against greenhouse gas emissions, by contrast, seems to require cross-national coordination.

Achieving such coordination has, however, proven difficult. The Kyoto Protocol of 1997 only had 36 full participants and many of them only managed to deliver on their emission reduction targets via buying so-called carbon credits or outsourcing polluting activities to other countries, or thanks to the economic downturn following the financial crisis of 2007. The Paris Agreement of 2015, on the other hand, comprises nearly all countries in the world, but is more modest and less binding in its commitments, and

[3] Already in 2003, London introduced a charge for driving during prime hours through its central district. However, this policy on balance *increased* nitrogen dioxide emissions, as many people ended up switching from their petrol-run private vehicles to diesel-run buses or taxis, which were exempt from the charge yet more damaging in terms of nitrogen dioxide emissions (Green et al. 2020).

several countries have already withdrawn from the agreement. Most revealing perhaps, neither agreement includes any mentioning of a carbon tax.

What is going wrong here? The crux is that any promises made in these agreements ultimately have a voluntary character, because there is no global authority that can keep countries accountable and sanction them if needed. Any climate agreement can thus only be effective if it becomes self-sustaining, with no reason for individual countries to deviate from what has been agreed. But reaching such an agreement is an immense challenge. This can be illustrated using game theory, which analyses how the behavior of individual actors is influenced by institutional contexts and the behavior of other actors. As such, game theory is fundamentally sociological and offers another perspective through which sociologists can contribute to the study of climate change.

In the simplest set-up, the challenge of reaching an international climate treaty can be modelled as a one-shot prisoner's dilemma involving two countries. In the societal optimum, both countries take environmental action, thereby slowing down climate change. However, this optimum is unstable, as each country can – given the efforts of the other country – improve their outcome by not taking any steps themselves. If both countries act accordingly, the result will be a suboptimal but stable equilibrium where neither country takes any action against climate change. Nevertheless, this bleak outcome partially reflects the simple set-up of this game and there are many ways to modify the game to make it more resemblant of real-world climate negotiations.

Milinski et al. (2008) apply several such modifications, framing the problem as a collective-risk social dilemma. They consider repeated interactions between players and introduce the possibility of dangerous climate change, whereby players run the risk of losing all their resources unless some collective target is reached (e.g., the avoidance of a temperature rise of more than 2ºC, beyond which natural disasters would become very common). Repeated interactions imply that parties have incentives to invest in cooperation. The existence of a dangerous climate threshold, in turn, transforms climate treaty negotiations into a coordination game, aligning individual and joint interests, although there remains a potential conflict between short-run and long-run interests. Together, these two features increase the chances of cooperation between actors. As Milinski et al. (2008) show, this is especially the case when there is a high risk of losing everything if the collective target is not met; for lower-risk scenarios, free-riding incentives may still dominate.

These results provide some hope for the achievement of international climate cooperation, only more so given that countries are not anonymous players but entities that can communicate, build relationships, and learn about each other's strategies, interests, and motivations (Tavoni et al. 2011). However, more recent experimental evidence indicates that uncertainty and ambiguity about the exact location of a dangerous climate threshold (e.g., is it about a temperature rise of 1, 2, or 3 degrees Celsius?) turns the game back into a prisoner's dilemma. Free-riding then becomes hard to resist, such that 'countries are very likely to propose to do less collectively than is needed to avert catastrophe, pledge to contribute less than their fair share of the amount proposed, and end up contributing even less than their pledge' (Barrett & Dannenberg 2012, p. 17375).

Uncertainty about the costs of climate change is not the only obstacle for climate negotiations. Another complication is that there are not just a few countries involved – e.g., Milinski et al. (2008) consider groups of six players – but around 200, making

coordination more difficult to achieve. In addition, countries also have different stakes, histories, and resources. For example, while poor countries are most exposed to the consequences of climate change, climate change is mainly caused by rich countries. Such inequalities make coordination more difficult to realize. Tavoni et al. (2011) suggest that successful climate cooperation under these circumstances hinges on whether rich countries are willing to take on a sizeable share of the abatement burden early on and whether they can signal this commitment convincingly to other countries. But this is easier said than done.

Altogether, we arrive at the sobering prediction that a global climate treaty that is both broad (in terms of its number of participants) and deep (in terms of its ambitions) is unlikely to become a reality in the foreseeable future. Analysts have, therefore, shifted their attention to an alternative approach. Rather than aiming for a global climate deal, their idea is to establish decentralized agreements or 'climate clubs' (Nordhaus 2015; Pacheco et al. 2014). Such agreements would involve smaller and more homogeneous sets of countries, thus reducing problems related to unequal endowments, conflicting interests, and communication. These agreements would also make it possible for countries to share the 'first-mover burden' and to capitalize on mutual loyalties and shared norms. For example, if there is a strong norm of reciprocity, obligations for each country could be based on other countries' prior efforts. Additionally, a sanctioning mechanism may be added whereby non-compliance with the climate agreement is tied to other 'club business', and non-members might be levied tariffs on their imports into the club region.

Similar to the section on the diffusion of climate-related behaviors, the idea behind climate clubs is that breaking up the challenge of reaching a global climate deal into smaller parts will make it more likely that any progress is made at all. Moreover, it is expected that a decentralized approach involving multiple bottom-up agreements provides a foundation from where ultimately more widespread cooperation may emerge. Political leaders seem to increasingly subscribe to this vision. The European Union, for example, recently launched its European Green Deal, including a proposal for a European Climate Law that stipulates climate-neutrality by 2050. Time will tell whether this approach proves successful. For now, the proposed European Climate Law admittedly still looks a little toothless: it puts goals into law and monitors the progress of member states, but if this progress is deemed insufficient, a mere 'recommendation' will be issued, based on the principle that 'the Member State concerned shall take due account of the recommendation in a spirit of solidarity between Member States and the Union and between Member States' (European Commission 2020, article 6.3a).

Building on the research discussed in this section, sociologists can help to identify institutional regimes and social contexts that are conducive to international cooperation to tackle climate change. In doing so, they should, however, pay attention to the fact that governments are not unitary agents or 'corporate actors' (see the chapter by Raub, De Graaf & Gërxhani) with consistent beliefs and preferences, who base their choices on costs and benefits that are simple national aggregates (Marchiori et al. 2017). Instead, they represent populations that exhibit considerable variation in terms of their views and how they are affected by particular measures and events. In developing their policies and strategies towards climate change, governments may thus have to negotiate conflicting

pressures, for instance from an industrial lobby that tries to limit any regulations and environmental activists who call for the exact opposite.

Such cross-pressures may lead to policies and strategies that are less consistent than one might expect if governments were true 'corporate actors'. Among other things, any change in a country's government may bring about a change in its climate policies. A clear example is the United States' involvement in the Paris Agreement: the US originally signed this agreement under President Obama, then withdrew from it under President Trump, and then joined again under President Biden. Aside from actual transitions of power, just the prospects of an election may also lead to changes in climate policies. After all, since governments are usually eager to be re-elected, they will in the lead-up to elections carefully weigh which actions maximize their popularity, possibly cutting back on costly environmental policies that only deliver benefits in the longer run, in favor of measures such as immediate tax reductions, which can gain them more votes in the short run. Improved insights into such domestic dynamics and any resulting policy swings represent an essential supplement to the insights gleaned from the game theoretic studies discussed earlier in this section. Once again, sociologists are well-equipped to make a valuable contribution on this front.

6. CONCLUDING REMARKS

The goal of this chapter has been to show that sociologists can productively contribute to the study of climate change. The underlying idea is that, although climate change may express itself first and foremost as an environmental phenomenon, it is deeply rooted in human actions and interactions. As such, sociological insights can be of great value for illuminating the causes of climate change, its consequences, and what can be done about it. More specifically, we have proposed a macro-micro-macro approach to the climate crisis, followed by an in-depth analysis of: (1) what individual actors think about climate change and how this affects their behavior; (2) how climate-related behaviors may spread through society; and (3) how governments can and do respond to the climate crisis.

We have demonstrated how sociological analysis can help to answer all of these questions. This partially reflects the breadth of methodological approaches applied within sociology. Indeed, much research discussed in the section on attitudes and beliefs on climate change was based on social surveys. The section on the diffusion of climate-related behaviors subsequently covered insights from social network analysis and agent-based modeling. Finally, the section on government interventions focused on game theory and experiments. To date, this rich toolkit, however, remains underutilized for the study of climate change, as is evident from two reviews of the 'sociology of climate change' that recently appeared in the *Annual Review of Sociology* (Klinenberg et al. 2020; Dietz et al. 2020). This is indisputably a missed opportunity for our understanding of the climate crisis as well as for the wider relevance of the sociological discipline (see also Turner 2019).

We therefore encourage sociologists to engage more with the topic of climate change. This endeavor does not necessarily require the development of new ideas from scratch though, as sociology already harbors many insights that may be fruitfully applied to the

problem of climate change. The insights about the diffusion of complex contagions discussed in the section on the diffusion of climate-related behaviors provide a good example. Ultimately, the broader message of this chapter is that sociology can advance our understanding not only of the climate crisis, but also of many societal challenges of our time. This knowledge can, in turn, help to find new ways of tackling these challenges, whether we are considering refugee crises, the rise of fake news, or pandemics.

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