Bottom Up Solutions for Global Change

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Abstract:
A sustainable future requires a change of human activities at a global scale. Global agreements have not been very effective. At the local level there are many examples of successful efforts to solve collective action problems within social-ecological systems. The study of these examples has led to an understanding of the principles of self-governance. We propose to scale up these insights of self-governance using social media tools to address global change challenges.

Global Challenges

Human societies have been impacting the environment for thousands of years. These impacts were initially local, but left traces in the geological record. During the last century the scale of human impacts have become increasingly global. For example, our activities disrupt important biochemical cycles of phosphorus and carbon leading to eutrophication of waterways and climate change. The scale of human impacts on the environment may exceed the planetary boundaries within which human societies can be sustained (Rockström et al, 2009).

A common approach in addressing these increasingly global challenges is to define policies at the global scale. Some of these policies have been successful, such as the phasing out of several groups of halogenated hydrocarbons that have been shown to deplete the ozone layer. The Montreal Protocol from 1987 has led to a measurable reduction of halogenated hydrocarbons in the atmosphere and the ozone layer is expected to be fully recovered by 2050.

Despite some successes in global governance, many global challenges for a sustainable future are difficult to address. For example, climate change has been a topic of international policy negotiations since the early 1990s. At that time scientific studies showed that an immediate stabilization and future reduction of the global greenhouse gas emissions was needed to avoid an average temperature increase of 2 degrees Celsius. Despite various global treaties, the global emissions of fossil fuel–related CO_2 have increased by more than 40 percent. According to statistics of the Energy Information Administration (www.eia.gov) the global emissions due to fossil fuels in 1990 were 21.6 Trillion Metric Tons CO_2, which increased to 30.3 Trillion Metric Ton CO_2 in 2009.

Addressing global scale problems from the top-down has not been effective. This might be because of the nature of the problem. In 1968, biologist Garrett Hardin published an influential essay in Science titled "The Tragedy of the Commons," in which he concluded that overuse of common resources was inevitable since users would never self-organize. Hardin envisioned a pasture open to all, in which each herder received an individual benefit from adding sheep to graze on the common land and suffered costs from overgrazing only later (a cost shared with other herders). Besides private property rights, an intervention such as taxing the use of common resources would be the only possible intervention to avoid overharvesting of the commons.

Climate change policy is a commons problem. Each individual, firm or nation must absorb the costs of changing their lifestyle and production techniques to reduce emissions from the use of fossil fuels. The benefit will be a reduction in the level of climate change for future generations. But how do we overcome the tragedy of the climate commons? According to insights from Hardin, the options are to define carbon emission rights or a carbon tax. These are indeed the types of solutions discussed at international negotiations, yet, so far, they have not produced much concrete change in the trend toward greater greenhouse gas emissions.

Governing the Commons

Although the work of Garrett Hardin has been very influential, it has been proven to be correct only in specific cases. Political scientist Elinor Ostrom and her colleagues have studied for decades the conditions that led communities to solve collective action problems. In 2009, she was awarded the Nobel Prize in the Economic Sciences for her contributions to the understanding of how people self-organize when they share common resources.

If Hardin is right, why are so many common resources not overharvested? In the mid-1980s, a group of scholars from disciplines like anthropology, sociology, political science and biology started to compare case studies. These scholars began to discover that the empirical evidence was not consistent with conventional theory. They became concerned about the dominance of the conventional theory and the consequences of policies of privatization and nationalization, which were increasingly adopted for natural resource management. In order to understand the diversity of outcomes from individual case studies there was a need for synthesis. This happened through meetings of the National Research Council starting in 1983. A large number of case studies were discovered that showed both successes and failures of self-organization of resource users. The resources included local fisheries, irrigation systems, pastures and forests. Elinor Ostrom was a leading scholar in this community and performed an influential meta-analysis of the case studies that was published in 1990.

Hundreds of case studies were analyzed and coded in a systematic way with the aim to detect patterns in the data. What were the specific rules that lead to successful governance of common resources?

Ostrom has not been able to find a specific rule using statistical analysis. However, by considering many case studies she discovered qualitative patterns, which she called "design principles." The following is a brief description of design principles found in cases of successful governance of common-pool resources:

1. Well-defined boundaries – Who is allowed to harvest from the resource? What are the boundaries of the resource system? Boundaries of resource systems may be clearly marked by fences, rivers, specific tree species, or other markers. Social boundaries such as permits, gender, kinship, ethnicity, can also be used to define who is allowed to have access.
2. Proportional equivalence between benefits and costs – The rules participants use in practice should avoid unequal distribution of net benefits among the participants. Unequal distribution of resources and revenues may lead to conflict.
3. Collective-choice arrangements – Are resource users involved in creating and modifying rules? Having local participation in rule crafting leads to better acceptance of the rules. It also prevents local elites from generating policies that benefits the elites disproportionally.
4. Monitoring – How is monitoring of the rules organized? Does monitoring take place and are rule infractions enforced? Monitoring should be cost effective and transparent. Reliable monitoring can raise confidence among resource users.
5. Graduated sanctions – Mistakes can happen, and therefore there should be some tolerance to mistakes. But with persistent violations of the rules more severe sanctions might be needed to guarantee compliance to the rules.
6. Conflict-resolution mechanisms – There should be low-cost ways to resolve conflicts among participants. Sometimes rules might be interpreted differently among participants, and easy ways to clarify such misunderstandings may reduce the amount of actual conflicts that arise and help to maintain trust among participants.
7. Minimal recognition of rights – The rights of local users to craft their own rules should be recognized by higher levels of governance. If this is not the case, participants can be dissatisfied and challenge the authorities.
8. Nested enterprises – When resources are part of a larger system, different nested layers should be organized to match the activities of the local users and the biophysical conditions. Findings ways to fit the social and ecological scales to the problem at hand is crucial to a sustainable future.

The proposed design principles have been tested in many publications since Ostrom and they are well supported empirically. Looking at the design principles, we see that one common feature of successful self-governance cases is that the rules people use in practice are understood and have been accepted by the participants. This is possible in small communities where the same common resource is shared over many years.

One of the questions that came out of the meta-analysis was the generalizability of the results. Since failing communities disappear and are therefore underrepresented in the data, an analysis of successful cases of self-governance is biased. Are these success cases historical artifacts? To study in more depth the principles of self-governance Elinor Ostrom and her colleagues started to use controlled experiments to test specific hypotheses and in the process made new discoveries.

Experiments

In the quest to derive an alternative theory of the governance of the commons, controlled experiments are being used more frequently. It is important to replicate the findings from field settings in more controlled situations. Since the late 1980s laboratory and field experiments have been performed that confirm the basic insights from the field studies (Ostrom et al., 1994). This is important for the development of theory since observations in field studies might be disregarded by some scholars as anecdotal. Replicating field observations in controlled

experiments with diverse populations around the world provides specific insights into what enhances the likelihood of self-governance of common-pool resources.

In a typical experiment, the experimenter creates a situation where a number of human participants make decisions in a controlled setting. Human participants voluntarily consent to take part in an experiment. They receive instructions on the actions that can be taken and the consequences of these actions that end up in monetary rewards. Decisions are made in private.

In a typical common-pool resource experiment, decisions are made during a number of rounds. In each round every participant receives an endowment that is used to make decisions to invest in harvesting from a collective resource, or a risk-free return. The more participants of the group invest in the collective resource the lower the rewards per units of investment. The best outcome for the group occurs when each participant harvests a moderate amount from the collective resource. However, a participant would be able to gain more earning individually if she increases her harvesting while the other participants stay at the same level. If each participant uses this reasoning, overharvesting of the common resource can be expected.

Ostrom and colleagues performed a series of experiments that showed that participants, undergraduate students of an American university, overharvest the resource if they cannot communicate or have any institutional arrangements to govern their common resources (Ostrom et al., 1994). On average the participants harvest the level of earnings similar to the predicted outcome of selfish rational participants. However, if cheap talk or costly sanctioning is allowed, participants are able to derive much higher earnings as a group and avoid overharvesting. In cheap talk participants are allowed to communicate, face-to-face or in chat-rooms on the internet, but cannot enforce their agreements. In the conventional theory cheap talk was viewed as irrelevant and therefore the findings of Ostrom and colleagues on its effectiveness were remarkable. The use of costly sanctioning was observed in field studies, but was not consistent with the theory of norm-free, completely rational selfish behavior of actors. In costly sanctioning, users pay a fee to reduce the earnings of someone else. It was shown that participants do choose to use costly sanctioning and that this leads to a reduction of the harvesting rate. As a consequence, while the gross earnings were higher, the net earnings did not rise due to the cost of sanctioning. Therefore the net benefits of costly sanctioning are debated.

These findings have been replicated by many other studies, including experiments in the field with traditional resource users with more complex resources and experiments with public goods. For example, experiments have been performed with forest resource users in rural Colombia. Instead of talking about abstract resources and monetary payments, the experiment was framed as investing hours in collecting fuel wood from the common resource. The participants received a payoff table that helped them to make decision on how much time to spend in fuel wood extraction and how much for alternative activities. The same conclusions were found for these field experiments as for experiments with abstract instructions with undergraduate students in the USA.

Another experiment used is a public good game. Here every participant also receives an endowment in each round. Now the question becomes how much to invest in a public fund and how much to keep. All the investments in the public fund will be increased by the experimenter and the resulting public good will be equally shared among the participants. Suppose the experimenter doubles the investments in the public fund in a group of five participants. All participants will see a doubling of their endowment by investing their whole endowment in the public fund. However, if a participant keeps the endowment and receives a share of the public good, this participant is freeriding on the investments of others. The expected outcome of selfish rational participants will be that nobody invests in the public good.

Public good experiments show that participants invest initially about half of their endowment in the public good (Fehr and Gächter, 2000). When communication and costly sanctioning is not possible, most groups will decline their investments in the rounds after. When communication or costly sanctioning is possible, we see an increase of investments into the public good up to 100 percent of the endowment.

In sum, controlled experiments show that participants overcome the tragedy of the commons if they can communicate and sanction free-riders. In line with the field studies, groups are able to self-govern their common resources under the right conditions. What are the underlying mechanisms that cause this? More in-depth analysis shows that a critical factor is that most participants are conditional cooperators.

Conditional Cooperation

Controlled experiments show that participants in experiments do not behave as selfish rational actors. There is increasing evidence that people value the earnings of others. But there is variation in preferences for earnings of others. Some individuals make decisions as if they are selfish and rational. Those participants never invest in the public good. Other participants are altruistic and invest a high amount independent of what others are doing. However, most participants will cooperate if others do the same. We call them conditional cooperators (Fischbacher et al., 2001). They will cooperate in collective action situations if they expect others will do so as well. In heterogeneous groups conditional cooperators will reduce their level of contributions to the public good if they see that there are others who do not invest the same level as they do.

Field experiments show that the percentage of conditional cooperators in a community, as identified from participation in experiments, is a good predictor of the success of governance of common resources. Rustagi et al. (2010) showed this in a study of a forestry program in Ethiopia. Individuals who were identified as conditional cooperators also invested more time in the actual monitoring of the rule-in-use of the villages and their common forests.

The observation that most participants are conditional cooperators explains why communication is so important. Communication enables participants to signal their intensions and trustworthiness. Not only do participants cooperate if they expect that others will, they also value and receive emotional benefits if others receive good earnings too and that the earnings are fairly distributed among the participants.

Various other studies show that when information is provided about the historical behavior of current participants in an experiment, this increases the level of cooperation (e.g., Chaudhuri and Paichayontvijit, 2006). If participants could choose with whom to participate, they will avoid free-riders (Ahn et al. 2005). Thus information on the characteristics of others in the group will affect the decisions of individuals. If a participant finds out that others in a group are not willing to cooperate, she will reduce the level of cooperation or leave the group if possible.

Critique and Challenges

The work of Ostrom focuses on small communities. There is a convincing amount of evidence that small communities are able to overcome the tragedy of the commons in the right context. They have the ability to develop and maintain trust relationships and monitor the behavior of the population. Larger groups will make it more difficult to evaluate the trustworthiness of all other participants and make it easier to free ride on the actions of others. The information that one can derive regarding the reputation of others can have an important influence of decision making.

A critique on the work of Ostrom is the small scale level. Her advice for a problem like climate change is to focus on a polycentric approach. Meaning that you need to have global and national level policies for certain aspects of the solution, but you also need to nurture and stimulate local initiatives. For a problem like climate change, local initiatives may focus on indicators appealing to the local level like carpooling to reduce air pollution, bicycling to improve health and using solar energy to reduce the energy bill.

Empirical studies have shown the abilities of communities to self-govern. They have the ability to develop and maintain trust relationships and monitor the behavior of the population. This does not mean that the local level is the only way to address collective action problems. However, we may put more emphasis on the strengths of bottom up approaches to address challenges of global change.

Despite the strength of communities, low hanging fruit of addressing large scale problems are not harvested. For example, research shows that the national carbon emissions can be reduced by more than seven percent without new regulation, technology or infrastructure simply by taking advantage of existing opportunities (Dietz et al. 2009).

If there is low hanging fruit, why don't individuals take advantage of them? To understand this we have to look into the factors that influence individual decision-making. Focusing on individuals and providing factual information alone may not be effective. Research in social psychology shows the importance of social influence on the motivations of individuals. As is common in scientific studies, similar findings are found in different

6

streams of research. This chapter aims to blend insights from collective action and the commons with insights from social psychology on social influence. This will enable us to provide some concrete ideas on how to develop a bottom-up approach for global change.

Larger groups will make it more difficult to evaluate the trustworthiness of all other participants and make it easier to free ride on the actions of others. The information that one can derive regarding the reputation of others can have an important influence on decision making. New information technologies reduce the costs to communicate with a larger number of people who are not necessarily physically co-located. What will be the implications for collective action situations? Since there has been a limited focus on the potential impacts of information technology on the governance of shared resources, we will explore different areas of research to identify potential impacts. New technologies can monitor activities and deliver accurate information on the consequences of one's decisions as well as the decisions of others. Such real-time feedback may have an important impact on the decisions people make.

Social Influence and Social Norms
Feedback is when we provide information about someone or some group's performance so that they may understand the effect of their actions and adjust them to some desired level. In energy use studies, for example, providing feedback could mean displaying current energy use to users, which enable those users to make more informed decisions to reduce energy use.

Feedback is more effective when it is specific, frequent and related to goals people set. Nowadays, one can install smart meters and monitor energy use in real time, and determine which appliances have the highest energy use. Such monitoring of energy use enables motivated users to reach their energy saving goals.

But this might not be sufficient. At least we know from studies in social psychology that providing feedback on how your actions relate to the actions of others impacts behavior. An illustrative example of this is a study by Robert Cialdini, one of the key scholars of social influence, and his colleagues on energy use. They study the effect of providing social feedback on energy bills in a few hundred households in California (Schulz et al. 2007). When residents' energy bills showed that their households had a higher energy use than similar other households in the neighborhood, they reduced their energy use in the weeks and months after households got this social feedback. However, households who received feedback that their energy use was lower than similar neighboring households increased their energy use. So there was no net effect of providing factual information.

But in the other half of the households in the study, additional information was added to the energy bill. Those with less energy use than average got a smiley face - ☺ - on their energy bill, and those with higher energy use than the average got a frowny face - ☹. In this treatment the energy efficient households continued to be efficient, and households who used more energy than the average household reduced their energy use. The net effect in this treatment was a positive effect of social influence.

The study of for Schultz et al. (2007) has been implemented by OPOWER, a customer engagement platform for the utility industry. OPOWER works with utility companies to send customers information on how they are doing compared to the neighborhood. Allcot (2009) performed an analysis of about 600,000 households, of which half derived the targeted feedback on their energy bills. The energy savings of about 2% is modest but statistically significant.

Many similar experiments have been done related to recycling of towels in hotels, voter turn out, drinking behavior of college students, littering, donations to charity, etc. All these studies show that providing information on what others do has an effect on the actions of individuals. In most cases there is an increase of contributions to the public good, but more understanding of the right social feedback in the right context is needed.

If we make the link to collective action and the commons literature we may suggest that information about contributions of others stimulate conditional cooperators to cooperate. Households who use more energy than their neighbors may be motivated by social pressure to comply with the social norm within their neighborhood. Households who got energy bills with information about others and see that they use less energy

than others may feel discouraged in their contributions to the public good. Getting an additional smiley face may motivate the conditional cooperator to remain cooperating although others don't meet the norm yet.

The studies from social psychology show that even small details in the feedback on social information can have an important impact on the effects. It will be too simple to say that showing others contributions to the public good will reinforce cooperation in every case. But the results also provide hope for possible tools to stimulate cooperation in collective action situations like energy use, water use, recycling, etc.

Using Social Media to Catalyze Collective Action

At the time of this writing, about five billion of the world's seven billion people have a mobile phone. In some regions in the world there are less people with proper sanitation than a mobile phone. Almost a billion people have an account on Facebook, and increasingly people text, tweet, poke, find their destinations based on GPS directions from their iPhone, take pictures with their phone and share them with friends, and video chat with people on the other side of the world. The world is becoming one village with an enormous amount of information.

Will it be possible to use the increasing amount of information people produce and have access to in order to develop tools to catalyze collective action? This is an open question to be addressed by scientific studies, but I will argue that there are a number of trends that may suggest a positive answer.

In order to scale up the findings of self-governance, a challenge will be to capture the ability of people to develop and maintain trust relationships, know the reputations of others, and have the ability to contribute to the community. This may not be possible within an urbanized world where people may not know their neighbors. However, using social media people can connect with their friends in a small community, but these connections are not limited by physical constraints. Even though people themselves experience a small community, social network reach a global level.

Activities are increasingly monitored in real-time. On your smart phone you can check on traffic jams en route to your destination. Smart meters enable you to monitor household energy use in real time. Remote sensing provides information on energy efficiency of homes. Smart water meters monitor the use of water. Super markets scan your purchases and have accurate information on the stock and flows of consumer goods in your household. Car insurance companies provide devices to monitor your driving style and provide discounts for safe driving.

For all these activities we can provide rough estimates on carbon footprints, water footprints and other sustainability indicators. Such numbers will include a large amount of uncertainty but it should be possible to provide an indication of degrees of impact. A particular activity, such as purchasing an organic local lunch, provides information for a number of sustainability indicators. One of the challenges of collective action is monitoring. Making use of crowd sourcing techniques makes monitoring of self-reported activities a community activity.

Suppose there is technology that combines this information if individuals provide consent. As an individual you are able to keep track of the impact of your activities compared to the common known statistics. Compare this with apps for smart phones where you can keep track of the calories burned and consumed based on information collected by the individual. An app like "The Eatery" uses feedback from other users to rate the healthiness of your meals and enable you to track your eating habits over time.

This information might also be shared with others in your social network. Because an individual finds her water footprint important, a person shares this information with others using social media. This may affect her reputation, enables her to derive feedback and help from friends, and empower her to reach her own goals.

The technology described above may sound utopian. There are many technical, ethical and legal issues to be addressed. But if such a technology is available, we can perform more systematic analyses on the incentives that motivate people to change their behavior for the common good. We must also work out functional questions such as, how to avoid an information overload, how to keep people involved, and what indicators are most effective?

Why might this technology be effective? As we have discussed in the first part of the chapter, most people are conditional cooperators, and will contribute to the public good if others do the same. It has also been

shown that people are influenced by information on what others like them are doing. Providing people with accurate, real-time feedback on various indicators of sustainability may stimulate behavioral change. Such a behavioral change stimulated by social information feedback might affect a small portion of the population. But it may also provide opportunities for households to innovate and create sustainable lifestyles that will propagate to the broader population. In the recent past this was derived most effectively in small communities since activities could be monitored by others, but in an increasingly urbanized world information technology may enable us to scale up the strength of the community governance to higher levels.

There are also a number of ethical concerns with developing tools to catalyze collective action. Some people may argue that this is social engineering where people are manipulated to reach goals of those who control the software. Other may be concerned about the privacy of software. These are valid concerns, but already part of the debate in the common daily use of social media. The proposed tool will make use of existing trends in the use of social media tools and infrastructure. It is part of public debate to explore the changing social norms on privacy and use of information technology.

Conclusion

The rapid information technology development makes it possible to derive accurate, real-time information on the consequences of our decisions and the decisions of others. Increasingly people participate in various online social networks that make it possible to share and compare information and connect people with similar interests. This provides opportunities to scale up the strengths of self-governance as is observed in communities.

The opportunities to provide real time feedback on resource use has been successfully implemented in various projects on energy use. Energy is a logical starting place due to the availability of smart meters. However, increasingly, this kind of tools might be applied to topics like water use, vaccinations, the carbon footprints of your groceries, recycling, etc.

In this chapter I tried to connect the insights from collective action with social influence research. There are interesting opportunities to test whether the power of small group cooperation can be scaled up using modern information technology.

I am aware of various challenges of such an approach. Although individuals share a lot of their private activities with the public through social media networks, the idea of tracking behaviors of individuals might be a frightening infringement on the privacy of individuals. On the other hand we face global challenges in an increasingly urbanized world that we share with strangers. Top-down nation-state based approaches seem to be ineffective in addressing global challenges like climate change. Lessons from small-scale self-governance are inspirational, but cannot immediately scale up to an increasingly globalizing world.

There are opportunities emerging due to low cost monitoring devices that provide personalized feedback to others. Various initiatives are underway to implement such tools in practice, especially as related to energy use. Those applications are promising and need to be studied in detail to enhance our understanding how to scale up the power of self-governance to address global change challenges.

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