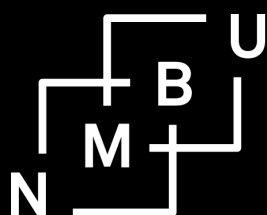


How can “tragedies of the commons” be resolved? Social dilemmas and legislation

Erling Berge



Norwegian University of Life Sciences (NMBU)



Norwegian University of Life Sciences
Centre for Land Tenure Studies

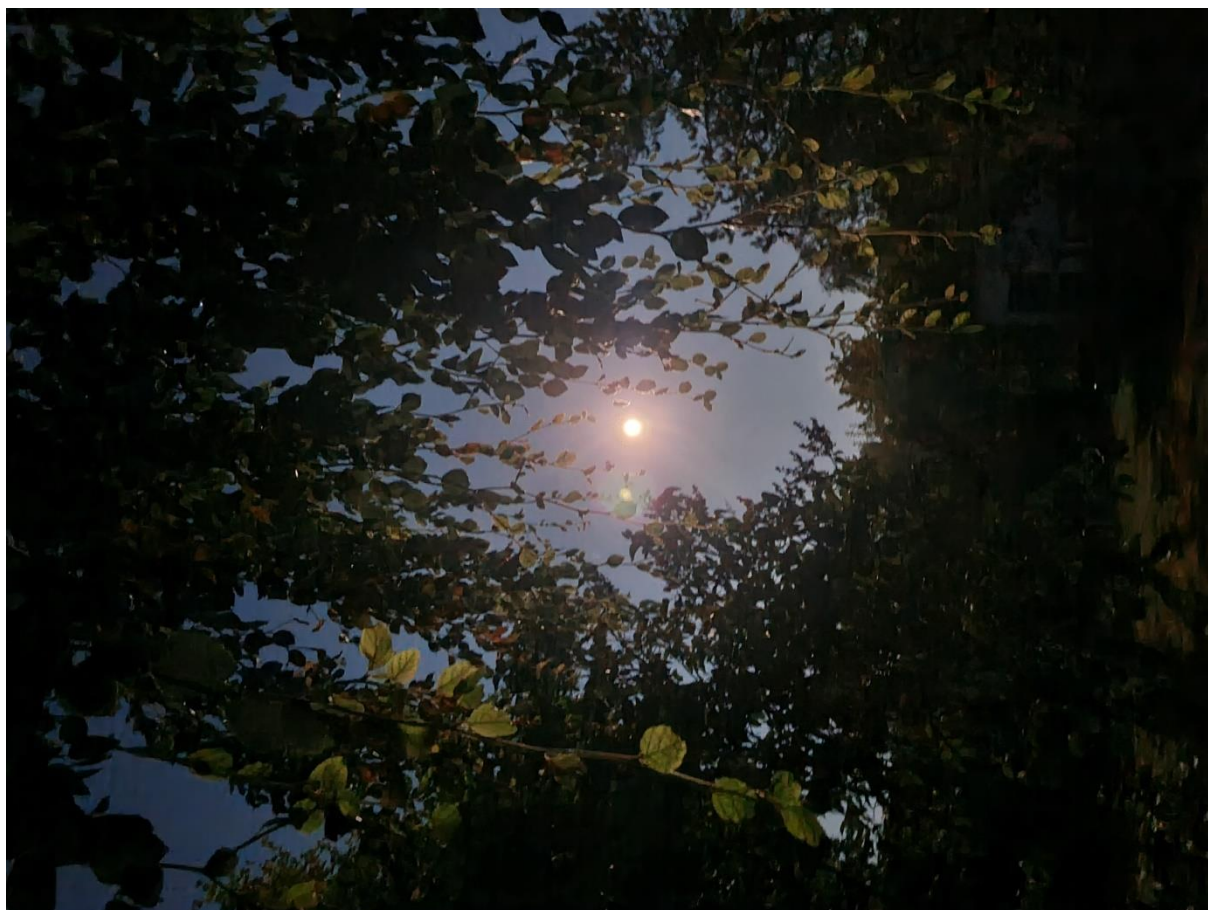
Centre for Land Tenure Studies Working Paper 01/23

ISBN: 978-82-7490-309-8



How can “tragedies of the commons” be resolved? Social dilemmas and legislation

Erling Berge



The Norwegian University of Life Sciences (NMBU)

How can “tragedies of the commons” be resolved? Social dilemmas and legislation¹

Erling Berge, The Norwegian University of Life Sciences (NMBU)

Abstract

Humanity’s problem with climate change has been likened to a “tragedy of the commons”. If the atmosphere is seen as an open access dump for gasses like CO₂ or methane, Garret Hardin’s conclusion from 1968: “Freedom in a commons brings ruin to all” is obviously correct. But how do we create a regime where access to the atmosphere is controlled? The problem of cleaning up the atmosphere has also been likened to a “public good” problem. Stopping the emissions and cleaning up the atmosphere will cost. Each nation may reason that this cost might be postponed a year or two. The immediate problems of the society have to be solved first. And – if the rest of the world manages to retard the emissions sufficiently *we* might not have to pay that much. In the provision of public goods there is this free rider problem.

This is the background for a closer look at Norway from our earliest legislation: Did we experience collective action problems involving social dilemmas like the tragedy of the commons or the provision of public goods? If we did, did we solve the problems by developing institutions? Problems were identified in our earliest cattle farming communities and in our medieval urban settlements. The problems could be resolved through legislation.

Key words: Climate, social dilemmas, Norway, legislation

JEL codes: P48, Q30, Q54

¹ This is a slightly revised version of a paper presented at *Landscape, Law & Justice – 20 Years Anniversary Symposium* at the Royal Swedish Academy of Letters, History and Antiquities (Vitterhetsakademien), Stockholm, 22–23 November 2022. Thanks to the participants at the symposium, and thanks to Stein Holden, NMBU, for alerting me to problems in the presentation. Not all of them were resolved, I am sorry to say.

Table of content

Introduction	5
Social dilemmas	7
Theoretic and experimental studies of social dilemmas	8
Rules developed in a model prehistoric community assumed to be very old	13
Coordination of pasturing on infields in the legislation until 1274	15
Observations on forest destruction from the period 1274-1687	18
Social dilemmas in urban development: protection against fire	20
Social dilemmas in urban development: protection against epidemic disease	21
A contemporary case of coordination problems	22
Social dilemmas and climate change	23
References	25
<i>Figure 1</i> Typical layout of a farming community in a fjord or in a valley	14
<i>Table 1</i> The Law of Gulating	16
<i>Table 2</i> The 1274 Law of Magnus Lagabøte	17

How can “tragedies of the commons” be resolved? Social dilemmas and legislation

Erling Berge,
Department of property and law,
The Norwegian University of Life Sciences (NMBU)

Introduction

Since 1994 the conferences of the parties (COP) to *The UN framework convention on climate change*² have met regularly to review the implementation of the convention and to adopt further measures to ensure progress of the implementation³. However, it is difficult to see any progress, for example in reduced release of climate gases.⁴ The development of climate change is looming large. Yet the COP27 of Sharm el Sheikh does not show much progress towards a solution to the problem.

United Nations Convention on the Law of the Sea was adopted in 1982⁵. The convention has resolved many conflicts related to borders and economic zones but the pollution of the high seas has not come under control. In article 194 on “Measures to prevent, reduce and control pollution of the marine environment” it is said in section 1:

“States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection.”⁶

² The framework convention was ready for signature May 9, 1992. It requiring 50 signatures to enter into force. By June 13 1992, 154 states had signed (UN Publication A/CONF.151/26/Rev.1 (Vol. I), ISBN 92-1-100498-5). It entered into force March 21, 1994.

³ Its first meeting was in Berlin in 1995. The tasks of the COP is detailed in (Bodansky 1993, 533-534)

⁴ Stoddard et al. (2021) reports that the emission of CO₂ in 2018 was 60% higher than in 1990. UN Emission Gap Report 2022 concludes that with current pledges the world is on track for a temperature rise of 2.4-2.6°C, see <https://www.unep.org/resources/emissions-gap-report-2022>.

⁵ Signed 10 Dec. 1982, entered into force 16 Nov. 1994.

⁶ https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf

The rule is detailed in 4 more sections. Despite the Convention the oceans are filling up with debris of various kinds. Most visible is the plastics. The quantity of invisible pollutants is not so well known⁷.

Both the atmosphere and the oceans are clearly used as an open access dump. There is no one to police the activities.

One has to conclude that the many nations comprising the COP21 agreement from Paris 2015 probably are trapped in what theory calls a social trap⁸ (Kollock 1998; Ostrom 1998, 2010b). The same holds for the Convention on the Law of the Sea.

The reasons for this state of affairs are many. Many reasons are internal to each nation in terms of political power among those who emit climate gases⁹. Other reasons relate to the “polluter pays” principle. Nations that have emitted most of the gases historically must take responsibility¹⁰. A common argument is that since others do not do much, so why should we? Also each nation can argue for itself (and strong groups probably do internally) that if they can put off the needed policy measures just a few years they would be significantly richer, and, anyway, for most of them their own contribution would be too small to make a difference. This makes international policy on climate gas reductions, or on ocean pollution reduction, examples of social traps.

The literature discusses social traps under labels like “the tragedy of the commons”, “public goods provision (avoiding free riders)”, “the prisoner’s dilemma” or “the game of chicken”.

The problem of sufficiently reducing climate gas releases has been called a “collective risk social dilemma”:

“Will a group of people reach a collective target through individual contributions when everyone suffers individually if the target is missed? This “collective-risk social dilemma” exists in various social scenarios, the globally most challenging one being the prevention of dangerous climate change.” (Milinski et al. 2008, 2291).

⁷ But see <https://www.condorferries.co.uk/marine-ocean-pollution-statistics-facts>

⁸ “Social trap” is here used in the sense defined in Rothstein (2005, 12) and is seen as a type of social dilemma. A social dilemma obtain when individually reasonable behaviour results in a situation where all is worse off. The Nash equilibrium of the individual decisions is Pareto inefficient. The concept describes a standard outcome of the types of social dilemmas discussed by Ostrom (2005b, 37-68); (also see Ostrom 2010a). Stein Holden has used the term “power trap” for a similar phenomenon where the distribution of political power within a state prevents economic growth (Holden 2009). Applied to international politics, arguably, it is a more graphic term than social trap.

⁹ The history of Exxon’s activities as lobbying power is instructive (Supran and Oreskes 2017, 2020).

¹⁰ A big topic at this year’s COP27 in Sharm el Sheikh.

Understanding how to overcome social dilemmas must be a priority. The task of creating rules to solve a social dilemma is itself a (second order) social dilemma. The rules are a public good prone to the exploitation by free riders. But to be able to do anything about climate change, efforts at smaller scales within nations are as important as the game among nations.

In this paper the primary task is to see if social dilemmas encountered in Norwegian history have been solved by appropriate legislation.

Social dilemmas

Before going into history we need to survey the concept of social dilemmas and social traps and what we know about their resolution (Ostrom 2001). The best studied traps have gotten well known labels, the “tragedy of the commons”, “the prisoners’ dilemma”, and “the public goods game”. The “tragedy of the commons” was first labelled by Hardin in 1968 (Hardin 1968). In the choice between cooperation and defection in harvesting from a pasture, the theory predicts defection by all players and the open access resource is destroyed resulting in tragedy for all players. A similar dynamic had previously been discussed as a problem in ocean fisheries (Warming 1911; Gordon 1954; Scott 1955).

In early studies of the problem of cooperation the prisoner’s dilemma¹¹ featured prominently (Axelrod 1984). The dilemma arises as two prisoners have to choose between cooperation, meaning keeping silent about their common activities, and defection, meaning telling the police about what they had done. The rules of the game shows that defection is better for each no matter what the other does. But in the end cooperation will leave both better off than if both defect. Given the temptation to defect, how can the two agree on enforceable promises to cooperate?

Also the provision of public goods has been studied extensively (Camerer 2003). The problem here has been labelled “free riders”¹², persons that are enjoying

¹¹ The dilemma is depicted as involving 2 prisoners just arrested suspected of a serious crime which will give them up to 10 years in prison. What the prisoners do not know is that the police have no proof of the serious crime. But they can get 1 year for another crime. The dilemma is created when the prisoners are told separately that if they confess (defect) they will get only ½ a year provided the other prisoner remains silent. The silent one will then get 10 years in prison. If both confess to their crime they will get 8 years each. They are both rational calculating individuals. What is the rational conclusion in this case? Each one reasons that if I confess, ½ a year is better than 1 year, and if the other one also confesses, 8 years is better than 10 years. They both end up confessing.

¹² This is closely related to the problem of “hold-outs”.

results from efforts of producing public goods of the many actors without contributing anything to its production. Mancur Olson (1965) discusses this in relation to mandatory membership in labour unions. Fehr and Gächter (2000b) show that punishment is an effective ingredient in increasing cooperation. To this the building of reputation has been added as an essential ingredient in building cooperation: “Punishment and reputation do not seem to be substitutes that may easily replace one another, but omnipresent interacting mechanisms” (Rockenbach and Milinski 2006, 722).

In the area of international relations, the “game of chicken” and “prisoners dilemma” were early on core models for understanding behaviour. Snidal (1985) emphasize that such games are analytical models, not descriptions of the real world. Walker and Hipel (2017) take the game of chicken as a point of departure for exploring more complex games studying climate change negotiations between USA and PRC (Peoples Republic of China). One finding is that the attitudes of the negotiators matter.

Theoretic and experimental studies of social dilemmas

From game theoretic analysis of decisions that are interdependent we learn that a social dilemma, “*occur whenever the private returns to each participant are greater than their share of a joint return no matter what other participants do*” (Ostrom 2005b, 37). If the rules governing the decisions provide strong temptations for maximising the individual utility given that others are assumed to do the same, the social dilemma is usually called a trap. This means that all rational decision makers¹³ will be tempted to not cooperate, and all cooperation will disappear, resulting in the worst possible outcome. Cooperation would have benefitted all much more.

More formally one may express this as: „*There is a Pareto superior cooperative outcome that renders everybody strictly better off relative to the Nash equilibrium*“ (Fehr and Fischbacher 2005, 165, note 14). The Nash equilibrium is the outcome of choices that rational players will take assuming all other players are rational and choose their best strategy. Rational players will hence in dilemma situation go into the trap producing a tragedy. The tragedy of the

¹³ In the present discussion a rational decision maker is an actor as assumed by the Nash equilibrium of standard game theoretic analysis where each player chooses the action most beneficial the itself given that all other actors do the same.

commons (Hardin 1968) and the prisoners dilemma (Axelrod 1984) are examples of such social traps (Rothstein 2005).

One must keep in mind that the game theoretic models are models based on certain strong assumptions. Usually one stipulates that all players are rational and choose their best strategy based on full information about the possible rewards for different outcomes of the simultaneous choice of strategy. In real life this is far from true. Both degree of rationality and availability of information will be variable. Thus the institutional structure within which decisions are made will be important for decisions that may involve dilemmas.

Empirical studies of commons¹⁴ around the world have concluded that people usually are able to organise their exploitation of a commons resource to avoid resource destruction (Ostrom 1990, 2005b). Both the tragedy of the commons and the prisoner's dilemma tend to disappear if the commoners or the prisoners are allowed to communicate and make credible promises. Other factors identified as important are group size, heterogeneity, rewarding co-operators, and interpersonal trust. But in larger populations both communication and making credible commitments are difficult (Druckman et al. 2011, Ch24).

In the wake of the studies of decision making in interdependent situations there has been done a host of related studies to improve our understanding of how factors like trust, heterogeneity and communication affects interdependent decision making in dilemma situation.

One important type of experimental games uses a simple reward structure called the trust game. This has provided some interesting results. The game is played between two players, the investor and the trustee. They are unknown to each other. Both are given an endowment X . The investor has the opportunity to invest all or nothing or something in between. The trustee receives the investment which now has increased by a factor of r and has the opportunity to return all¹⁵ or nothing or some amount in between. The Nash equilibrium is not to return anything. Hence the rational investor will not invest anything. Then the game stops. In reality, for a majority of plays the investor has sufficient trust in the trustee for investment to occur and the trustees often return sufficient for both of them to profit. In some studies of information exchange, its impact on

¹⁴ Hess (2008, 37) says "A commons is a resource shared by a group where the resource is vulnerable to enclosure, overuse and social dilemmas. Unlike a public good, it requires management and protection in order to sustain it".

¹⁵ The trustee receives $X(I+r)$.

outcome was tested by allowing the investor to indicate the amount expected in return. In additional plays it was opened for sanctions in the form of a fine if the trustee did not return the indicated amount. The interesting result was that use of sanctions gave the least success. Most successful were the investors that specifically refrained from sanctioning (Fehr and Rockenback 2003). The participants in the games were clearly not following the model of a rational decision maker, more like strong reciprocators (see also (Camerer 2003, 115-116)). Quite a few studies have explored the role played by moral and cultural precepts about trusting people (Bowles and Gintis 2011, Ch10; Gintis et al. 2005). The conclusions as far as sanctioning goes are summed up as (Ostrom 2005a, 260) :

- External interventions crowd out intrinsic motivations if they are seen as controlling.
- External interventions crowd in intrinsic motivations if they are seen as supporting.

Experimental studies of decision making in situations with common pool resources have from the outset focused on the impact of allowing face-to-face communication before each session of investment, allowing participants to covenant to determine investment levels and to adopt sanctioning. It is observed that communication improves outcomes also where there is heterogeneity of endowments, and that electronic communication does not do as well as face-to-face meetings. It is also seen that costly sanctioning (costly to the person requesting the sanctioning) increases compliance. Groups given the opportunity to communicate, craft their own rules, and sanction non-conformance to these rules were able to achieve close to optimal results (Ostrom 2005b). The process of crafting rules to govern a social dilemma has been called a second-order social dilemma¹⁶ and has been studied in public goods games (Fehr and Gächter 2000a). In these games the ability to sanction free riders increases cooperation significantly.

The conclusion is that humans are in general a cooperative species (Bowles and Gintis 2011). From available experimental studies and empirical cross-national studies Gintis et al. (2005, Ch1) conclude that the most salient characteristic of

¹⁶ The first order problem consists in the incentives that make a Nash equilibrium inferior to a covenant where participants promise to cooperate. The second order problem consists in designing rules that ensure that the promise of high reward from defection will not destroy the outcome of cooperation. On second order collective action problems, see Ingram and Clay (2000), Smith and Bird (2005), also see Gintis (2009).

humans is strong reciprocity. This they define as “*a predisposition to cooperate with others, and to punish (at personal cost, if necessary) those who violate the norms of cooperation, even when it is implausible to expect that these costs will be recovered at a later date*” (page 8)

The studies of behaviour in game theoretic inspired experiments, both in the laboratory and in the field, have come a long way, see e.g. Gintis (2000), García-Barrios et al. (2011), Ensminger and Henrich (2014). A possible genetic component in the propensity to trust and to cooperate has been investigated (Boyd and Richerson 2005). Experimental studies of negotiations have found that negotiators often prefer to compete for marginal gains rather than finding a solution providing joint gains. International negotiations about fishing rights, trade and tariffs as well as the Rio Declaration on Environment and Development are used as examples (Druckman et al. 2011, Ch29).

From the early studies we can note that the players roughly can be divided into altruists, who make unconditional efforts to cooperate, conditional co-operators (or strong reciprocators), who cooperate if others cooperate, and egoists, who only cooperate if they see it to be to their advantage, usually ending up in the Nash equilibrium. Simulations show that in a large population with full information or knowledge of past history the egoists (rational decision makers) will not survive in an indefinitely played game. But with no information the egoists will dominate. In a situation with a “noisy” signal of trustworthiness such as face-to-face communication, the conditional co-operators will survive in substantial proportions (Ostrom 2005b, 128).

The group of nations wanting to reduce climate gas emissions to ensure a sustainable future for the planet have not yet been able to reach an enforceable agreement despite the many conclusions like this one: “Preserving the global climate is the biggest public goods game ever. It is a game that concerns all of us, and we cannot afford to lose it.” (Dreber and Nowak 2008).

Elinor Ostrom’s (2010b) survey of the problems involved in this task¹⁷ emphasize a multi-scale approach with experiments designed to help individuals in reducing their emission as well as securing ecosystem services related to carbon sequestration. However, despite more than 70 years of research into social dilemmas the process of designing institutions for collective action is not well understood. It is particularly difficult at the international level, even though

¹⁷ Also see Pahl-Wostl (2009).

communication and deal making are frequent. Credible promises are rare. Tragedies do obtain.

At COP21 in Paris in 2015 the 196 participating countries chose an approach that arguably can be seen as conforming to the insights gained by studies of social dilemmas. They chose a system of non-binding commitments without enforcement mechanisms. The agreement of the parties would become binding as 55 countries totalling 55% of the world's greenhouse gas emissions ratified it. But the only enforcement mechanism would still be "naming and shaming" those who shirked. USA's withdrawal from the conference in 2017 retarded the possible development of a way out of the climate trap. They returned in 2021. As of today not much progress can be observed¹⁸. The second order public goods dilemma of crafting enforceable rules for climate gas emissions is still with us.

The ubiquity of social traps has prompted me to ask if one may find traces of it in Norway's older legislation. Notwithstanding the strong experimental results, the traps are most often solved by locally developed rules and local monitoring of performance. But we should be aware of differences in severity between the serious problems described as tragedy of the commons or provision of public goods and the more easily solved problems of coordination.

¹⁸ The results from the COP27 meeting in Sharm el-Sheikh are not encouraging: <https://unfccc.int/cop27/auv>

Rules developed in a model prehistoric community assumed to be very old

The following is based on the paper called “Learning cooperation from the commons” (Berge 2019). To explore the possibilities for social dilemmas leaving traces in Norway’s early regional legislation I constructed a model community. The basic features of the settlement are outlined in figure 1 below.

Among the many activities of a farming community in the age before the Viking age only one is imagined to constitute a collective action problem. It is a problem of coordination between pasturing cattle and tilling of fields¹⁹. Similar to Dahlman (1980)’s study of the “open field system” in English agriculture, the fields of the model village could profitably be used as pasture in early spring before the sowing of cereals as well as in autumn after harvest. In spring pasturing cattle would both work on the earth, loosening it somewhat, and leave some fertilizer. But all cattle had to be moved to outfields, the commons, before sowing. There would also be an advantage if all moved at the same time. Relatively fewer people would be needed to herd the cattle up to the seter (shieling). On the other hand, no one should be allowed to move animals to the seter before the others, since those arriving early would be able to pasture on the best grass. In the autumn animals could not return from the seter before harvest was more or less finished. But then animals were welcome on all the infields.

The problem of collective grazing on individually owned fields is not in itself a collective action problem. The problem lies in avoiding free riders both in being too late and too early in moving out of the fields in spring, and in being too early in moving home from the commons. It is a problem of coordination. It provides a second order collective action problem of designing rules to avoid free riders.

Creating institutions for collective action is not related to the commons in any particular way, but its solution has clear implications for the exploitation of the commons. A commons requires a system of rulemaking and sanctioning. The establishment of a community assembly with power to enact rules and to design a system for judging the rule breakers is a requirement for successful exploitation of the commons.

The discussion of the model village suggested one collective action problem, coordination of moving animals. We shall look for traces of a solution in the

¹⁹ Coordination problems have been relatively little studied in experimental game theory (Camerer 2003, Ch7)

two regional codes and the unified national code of 1274. If there are rules concerning the suggested problem, they will be interpreted as evidence of collective learning in solving a social dilemma. It is a fact from history that this was done. The required community assembly is called the bygdeting²⁰.

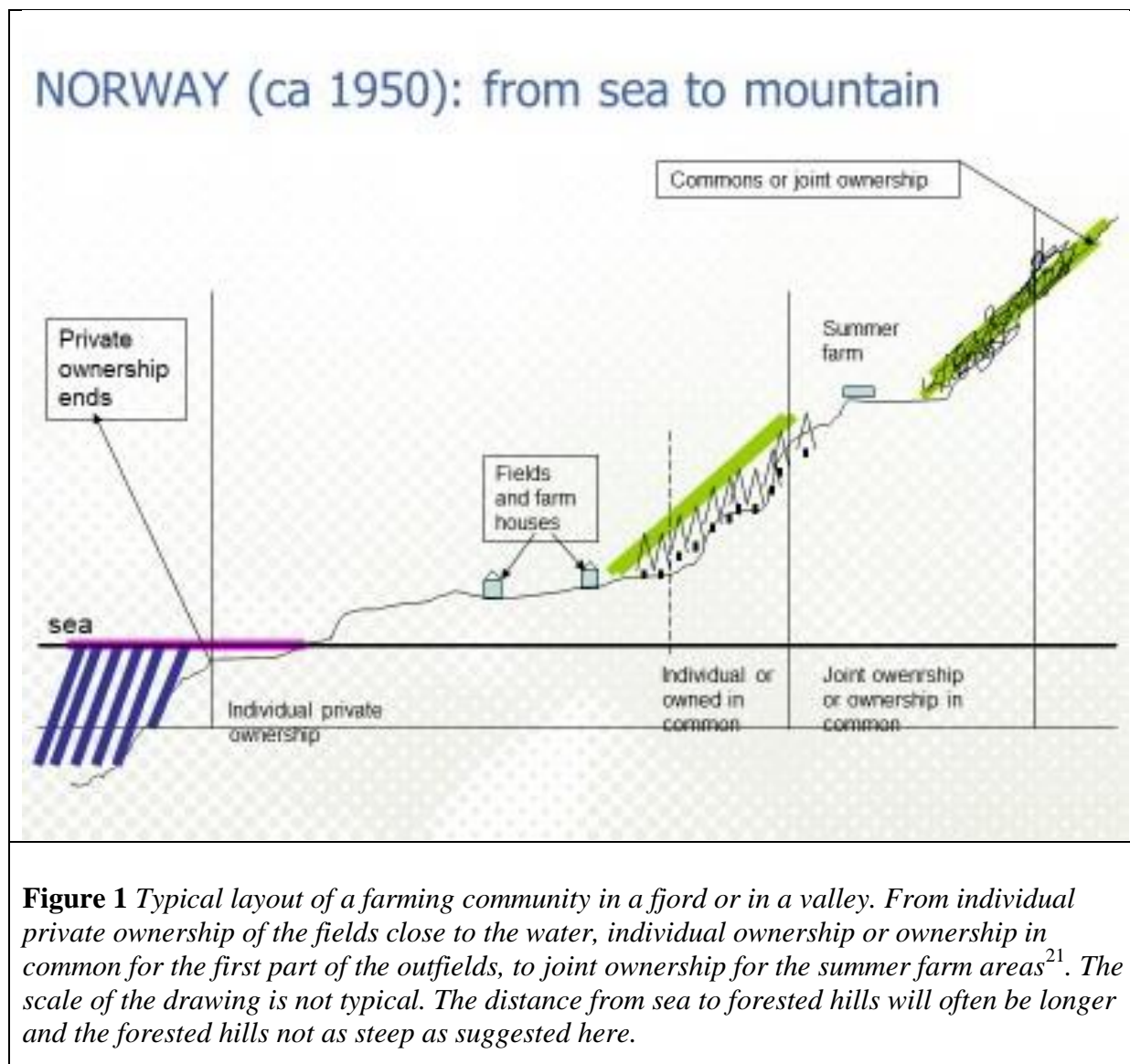


Figure 1 Typical layout of a farming community in a fjord or in a valley. From individual private ownership of the fields close to the water, individual ownership or ownership in common for the first part of the outfields, to joint ownership for the summer farm areas²¹. The scale of the drawing is not typical. The distance from sea to forested hills will often be longer and the forested hills not as steep as suggested here.

²⁰ The correct translation of "ting" in this context would be thing. In Wiktionary it is explained as interpretation no 15: "(chiefly historical) A public assembly or judicial council in a Germanic country." To remind the reader of the very particular assembly we are discussing it will be called "bygdeting" in this paper. On the origin of the bygdeting nothing has been found. But it seems reasonable to assume that as private property and commons appeared - and they necessarily had to appear at the same time - also the bygdeting had to be present to supply the basic feature of property rights: security of tenure.

²¹ If something is owned "in common" by 2 or more owners each owns a specified fraction which can devolve on descendants. If something is owned "jointly" by 2 or more owners each owner enjoys all of it as long as it does not exclude other owners. This right devolves on co-owners unless it is explicitly transferred to a new owner, see Black (1990). In Norway a right to exploit outfields jointly may be appendant to a farm and thus be transferred only as the farm is transferred to a new owner. If the new farm owner does not exploit the outfield the unused resource devolves on the co-owners (the other farmers who have such rights appendant to their farms).

Coordination of pasturing on infields in the legislation until 1274

The Frostating law does not provide rules for moving cattle to the seter (shieling). But the regional law code of Gulating provides rules for exactly this situation²² including a last date for moving to the seter and an earliest date for taking the animals home, as well as sanctions for those breaking the rule (Larson 1935, 94 (section 81)). The same rules are found in Magnus Lagabøte's Law (Taranger 1915 [1274] 138, Kap.40). The basic rules here are reproduced below.

In addition the Gulating Law provides more details about how neighbours shall behave, particularly in regards to animals straying out of bounds (Larson 1935, 93-96 sections 80-83). Magnus Lagabøte's Law adds more detailed rules about fences and how to handle cattle that strays onto land not owned by the cattle owner (Taranger 1915 [1274] 129-133 Kap.29-34).

²² The fact that the Frostating law does not include rules of coordination while the Gulating law does, might be interesting to explore. But it is not possible to go into that question at this time.

The Law of Gulating²³

Norwegian text	English text
<p>Source: Robberstad, Knut, and Carsten. Lien. (1981 [1969]). <i>Gulatingsslovi</i>. Vol. 33, <i>Norrøne Bokverk</i>. Oslo: Samlaget.</p>	<p>Source: Larson, Laurence Marcellus. (1935). <i>The earliest Norwegian laws: being the Gulathing law and the Frostathing law</i>. New York: Columbia University Press.</p>
<p>Book V [Landleigebolk], (Section 81) Kap.10 Her vert det utgreidd um grannehøve, page 108-109</p>	<p>"The law of tenancy", from section 81 "The legal relations of neighbors on the same farm are defined here", page 94</p>
<p>Um folk bur saman i grend, skal dei flytja or heimehagen når det har gått 2 månader av sumaren, um ikkje alle tykkjer at noko anna er betre.</p> <p>Vert ein sitjande nede lenger, skal grannen forbjoda han å sitje der. Sit han i ro likevel, skal han stemna han til tings for ran og ulovlegt tilhelde, då skal tingmennene døma til kongen ein baug, til jordeigaren dubbelt landnåm, og 6 øyrar til grannen for grasran.</p> <p>Saksøkjaren skal krevja so mange bønder og bygdemenn som han vil ha, til å føra bufeet åt den andre ut or heimehagen, saka 3 øyrar er kvar som nektar. Det same gjeld um han fer ned (frå sætri) fyre tvimånad.</p> <p>Hå har dei rett til um hausten. Då skal ingen beita [til skade] for den andre; den som gjer det, skal bøta grasransbaug.</p>	<p>If men live near together on the same farm, they shall drive [their cattle] out of the farm pasture [to the shieling] when two months of the summer are spent²⁴, unless some other plan seems better to all.</p> <p>If one keeps his livestock longer [on the farm] below, the other shall forbid him to remain there [with them]; if he continues to keep them there none the less, his neighbor shall summon a thing to try him for robbery and unlawful pasturing. And it shall be the duty of the thingmen to award a baug to the king, a double fine for trespass to the landlord, and six oras to his neighbors for stealing grass.</p> <p>And he [the complainant] shall call upon the freemen and the men of the herath²⁵, as many as he needs, to drive the offender's cattle out of the home pasture; everyone who refuses to join in this shall owe a fine of three oras. The penalty is the same if one leaves the upper pasture before the end of the fifth summer month²⁶.</p> <p>The aftermath [that grows] in the autumn shall belong to all; but no one shall begin to graze before the rest, and whoever does shall pay the penalty for stealing grass.</p>

²³ The Gulathing law is known to be older than 930 since the Icelandic Allthing in 930 at its creation adopted this law as the law of Iceland. It was "introduced by Úlfljótr who had spent three years in Norway studying their laws." https://en.wikipedia.org/wiki/Althing#Foundation:_c._930_-_1262

²⁴ Summer in the North was reckoned from April 14; moving to the mountain pasture would begin about June 14.

²⁵ The Norwegian word is spelled «herred». It is one of several names used to refer to a local public unit, that which elsewhere in this text is called "bygd".

²⁶ August 14- September 14.

The 1274 Law of Magnus Lagabøte

Norwegian text	English text
Taranger, Absalon. 1274 [1915]. Magnus Lagabøter's Landslov. Translated by Absalon Taranger. Oslo: Universitetsforlaget.	Magnus Lagabøte's Law has not been translated into English. The texts taken from this law book are translated from Taranger [1915] into English by this writer.
VII Landsleiebolken Kap. 40 [Om folks sæterfærd], side 138	VII On Land Tenure. Ch.40 [On going to the summer farm], page 138
<p>1. Overalt hvor der er sætre til gaardene (til børa manna) da skal man fare fra hushagen (hjemmehagen) naar 2 maaneder er gaat av sommeren¹, medmindre de alle finder at noget andet er bedre.</p> <p>2. Nu sitter én lengre dernede, da skal man forbyde ham at sitte der.</p> <p>3. Nu sitter han allikevel rolig videre, da skal han (naboen) stevne ham til herredstinget for ran og for hans sæte dernede; da skal tingmændene tildømme kongen en halv mark sølv for græsran, men leilændingen en halv mark sølv for græsværdet.</p> <p>4. Nu skal han kræve bønder og herredsmænd saa mange som han tarv for at føre hans bufæ fra sin hushage; enhver som ikke farer med, skal bøte 1 øre sølv til kongen, hvis han var opnævnt.</p> <p>5. Samme straf rammer den, som farer hjem i hushagen før tvimaaned.²</p> <p>¹ Da sommeren begynder 14de april, blir sidste termin for sæterfærden 14de juni. ² Tvimaaned er maaneden fra 14de august til 14de september. Før midten av august maa ingen føre buskapen ned fra sæteren.</p>	<p>1. Everywhere where summer farms are present, one has to leave the home fields no later than after 2 months of the summer has gone¹, unless all agree something else is better.</p> <p>2. Now, one sits longer at the home fields, then he shall be forbidden to do so.</p> <p>3. Now, he continues to sit, then his neighbour has to call him before the bygdeting for theft, and for his sitting at the home fields; then the ting representatives shall judge that half a mark of silver goes to the king for theft of grass, and that half a mark of silver goes to the tenant for the value of the grass.</p> <p>4. Now he shall demand of farmers and men of the bygd a number of them as many as needed for driving his animals from the home fields; anyone who does not come along, shall be fined 1 penny [øre] to the king, if he was elected.</p> <p>5. The same punishment is due to those who go to their home fields before two-month [tvimaaned]².</p> <p>¹ As summer starts 14th April, the last date for going to the summer farm will be 14th June ² "Two-month" is the month from 14th August to 14th September. Before the middle of August, no one is allowed to take his livestock home from the summer farm.</p>

Observations on forest destruction from the period 1274-1687

Forest destruction has been observed during periods of Norwegian history. The problem is often discussed as examples of a tragedy of the commons. Ostrom and Nagendra (2006) explore solutions to the dilemma. However, this particular social dilemma does not seem to have had any direct impact on the Norwegian legislation.

The Law code of Magnus Lagabøte from 1274 was basically in force from 1274 until 1687 when Christian V's Norwegian law code was enacted²⁷. During this period forest destruction, later often compared to a "tragedy of the commons" might have been a topic for legislation.²⁸ In 1349-50 Norway and Europe was devastated by the bubonic plague. It is calculated that only by 1650 did the Norwegian population reach the level it had in 1300. The forest had a good time at least until about 1500 when the population size was at its minimum of about 40% of its 1300 size.

During the 16th century new markets for timbers grew. New technology in the form of the water driven sawmills, waterway based timber transportation, a growing work force, and foreign markets, particularly in Holland and England, led to forest depletion some places along the coast. In addition to the timber trade, population growth led to need for more timbers for housebuilding, the cooling climate led to need for more firewood for heating the houses, and the growing mining industry needed a lot of firewood and charcoal. In addition, production of tar should be mentioned as a significant consumer of wood.

From about 1550 the timber trade and saw milling reached a scale where their impact on the forests became noticeable, particularly those forests that the King identified as his, that is the old Crown lands, the "King's commons", and the church land taken over by the Crown after the reformation in 1537. The logging did not target the commons in particular. Land was logged, provided it was close enough to a point where ships could fetch the timbers (Ersland, Sandvik, and Dimola 1999, 182-184; Dyrvik et al. 1979, 41-47)

The King's commercial interests in sawmilling and later on in mining are also apparent. In 1568 there is a general prohibition of logging that may damage the forest. In 1587 the King prohibits all commercial logging on Crown lands and

²⁷ Christian IV's Norwegian law code from 1604 is an updated translation of Magnus Lagabøte's law from 1274. See also note 7 in Berge and Tretvik (2004).

²⁸ The following will be based on Berge and Tretvik (2004) and Berge (2019b).

orders the destruction of all sawmills not used by the King (Fryjordet 1968, 118). The degree of enforcement of these rules was not sufficient to produce much impact. From the early 17th century increased demand for wood used in mining and smelting industries adds to the demand of the sawmills. In 1627 for the first time a mining company gets privilege to forest resources within the “circumference” of its mine (44 km). The timber demands of these new industries were seen as competing with the traditional demands for high quality timbers for shipbuilding, particularly military vessels. The period 1550-1660 therefore experienced increasing public interventions to protect forest resources. The interventions are often export prohibitions of timber qualities that can be useful in building ships.

The overall conclusion in our context must be that neither the problem description (depletion of forests), nor the proposed solutions, approached it as a social dilemma. At first the problem seen from the King’s perspective was money. The Crown owned forests and sawmills, and earned good money, but it needed more. The timber trade became an object for many kinds of taxes. In the 17th century, this got worse. After losing many wars with Sweden, the king needed cash. The king sold logging rights to sawmill owners, and later on forestland to merchants and farmers. Over time, though, forest regrew and technological change made the timber trade less profitable.

Vevstad (1992, 12-14) notes some success in creating an “enduring forestry” around the mining towns. This led to an effort to extend this during the late 18th century by the establishment of the “Generalforstamt” (the older 1730-1746; the younger 1760-1771)²⁹. But nothing came out of it. A century later there was again concern about protecting the forest. Government commissions from 1848, 1859 and 1874 led to an administration for publicly owned forests and in 1875 to the establishment of a Forest Directorate. But legislation came hard. The forest law of 1863 concerned forests in the commons and on publicly owned land. A government commission from 1864 proposed general legislation on forestry in 193 paragraphs. By 1893 the proposal was reduced to legislation on use of fire in the outfields, and legislation on the protection of “Verneskog”³⁰. In 1932 we got our first law on forest protection. This was replaced in 1965 by the law on forestry and forest protection.

²⁹ See more in Fryjordet (1968).

³⁰ That is a forest that will protect productive forest or buildings, for example against avalanches.

Today the legislation is well aware of the problem of sustainable forestry. The forest destruction that a “tragedy of the commons” scenario predicts did not obtain in any large scale. A reasonable explanation may be that over time property rights to the forest had been established. A solution suggested also by Hardin (1968).

Social dilemmas in urban development: protection against fire

Since agglomerations of people started to appear in the 10th century fires became an increasing problem. Buildings were of wood and if a fire started in one house it could rapidly engulf all other buildings until it met a wide street not so easily jumped over. In our oldest urban code, Bjarkøyretten³¹, causing a fire that burns another man’s house is counted among the most serious of crimes. It is called “nidingsverk” (Hagland and Sandnes 1994, §34 page 50). There are 2 paragraphs concerning fire (Hagland and Sandnes 1994, §§109-110, pages 83-84). Both concerns what happens if a man cannot control the fire in his house including the penalties if anything goes wrong. §110 also describes the kind of tools a man is expected to have available in case of a fire spreading.

Fire protection is a public good. If one house is protected, all will be protected. As often is the case with public goods, free riders will be a problem. It is significant that people who do not have access to the mandated tools when a fire has started are heavily fined and denied justice³². Free riders in the fire protection were not tolerated.

We find these rules repeated and extended in Magnus Lagabøte’s urban law code from 1276 (Robberstad and Taranger 1923, see Section VI, Ch9-12). The duty of a house owner to let his house be broken down to aid in stopping a fire is emphasized. Of new elaborations we take note that newly constructed ovens are not allowed used until they had been inspected by the “gjaldker” (the King’s representative in the town). And enterprises like a sauna, or a bakery, or a blacksmith’s workshop are required to move out of town to where the urban authorities say they can stay.

³¹ Actually rules to be enforced in trading centres.

³² They will be called “raspar”, fined 3 marks to the king and the urban population, and shall be “rettslause” (disenfranchised), even if they are wounded by the fire.

Urban fire was a real and known threat. Bergen burned 10. June 1248³³ (Robberstad and Taranger 1923, 31) just as the work of Magnus Lagabøte started. The temptation for any house owner to shirk (free ride) on the duties of fire protection had to be stopped.

Protection against fire came to be a core part of the planning of urban settlements³⁴. But preventing house owners from rebuilding their houses as they were before the fire was almost impossible. Yet, Helle et al. (2006, 125) note, that after fires in 1476 and 1527 some building lots on the waterfront were left empty for fire protection. And later on they explain that after most of the fires (note 24 above) a new “commons” was established³⁵. But in general, making streets broad enough (to stop a fire) came to be a difficult point of dispute between authorities and house owners.³⁶

Social dilemmas in urban development: protection against epidemic disease

Conceivably the bubonic plague (“Svartedauden”) of 1349-50³⁷ and its recurrent outbreaks for the next 300 years³⁸ might have had some impact on how urban populations were required to behave. The social dilemma in choosing between helping those who fell ill or going away in isolation was clearly felt. But even at the international level nothing much affecting legislation can be found before mid-19th century when John Snow is credited with discovering the link between water contamination and cholera outbreaks in London in 1854. His discovery caused a significant change in the supply of water and disposal of waste (https://en.wikipedia.org/wiki/John_Snow).

³³ About every 20th year a fire occurred in Bergen between 1170 and 1955 (1170, 1198, 1248, 1332, 1393, 1413, 1429, 1439, 1455, 1476, 1489, 1527, 1562, 1582, 1589, 1623, 1640, 1660, 1675, 1686, **1702**, 1751, 1756, 1771, 1780, 1795, 1800, 1830, 1855, 1901, 1916, 1925, 1930, 1940, 1944, 1955). Of these 36 fires 7 were caused by wars. The worst fire occurred in 1702 when almost 90% of the city burned.

https://no.wikipedia.org/wiki/Bybranner_i_Bergen

³⁴ See also Mumford ([1961] 1966, 326). Eliassen in Eliassen and Ersland (1996, 194-217) notes that land lease documents from small urban settlements often contained so much details about open areas, roads, paths, rights of way, and other usages that little remained for public bodies to regulate (page 213).

³⁵ In urban settlements a commons (almenning) was a wide area (5-6 meters) from the waterfront and uphill as far as the settlement. Streets were located parallel to the waterfront (Helle et al. 2006, Ch2).

³⁶ Birgitte Akerhaugen in her dissertation manuscript “Road foundations and property rights” traces the development of fire regulations from Magnus Lagabøte 1276 until the Planning and Building act of 1924. See in particular Ch4 and Ch5.

³⁷ More than half of the Norwegian population are assumed to have died. See the section above on forest destruction. Also <https://lokalhistoriewiki.no/wiki/Svartedauden>

³⁸ The last outbreak is usually said to have occurred in 1654, see https://lokalhistoriewiki.no/wiki/Pestepidemier#Pest_p.C3.A5_1400-tallet

In Norway a government commission established in 1834 proposed in 1847 comprehensive legislation on medical issues (Kongelig Kommissjon av 23 juli 1834 1847) . Chapter 8 provides 11 sections on vaccination. Chapter 9 concerning quarantine contains 19 sections (pages 9-12)³⁹. The reasons for quarantining ships are, beside plague, smallpox, yellow fever, and cholera. The discussion of the proposals is mostly concerned with reducing or removing quarantine requirements for diseases other than the plague. We note that both the proposals and the discussion come before Snow's discoveries in London in 1854⁴⁰.

The latter part of the 19th century see a lot of waterworks to supply urban dwellers with clean water. Sewage was often built at the same time. The reason is both the need for clean water and in particular the hygiene concerns (Helle et al. 2006, 325-7). But no social dilemma can be seen behind this development.

This preliminary investigation of how social dilemmas of epidemiological character impacted Norwegian legislation conclude that except for quarantine requirement of ships (open access or controlled access), nothing has been found.

A contemporary case of coordination problems

On October 13th 2022, NMBU and NINA organised a one day seminar on visit-management in Norwegian outdoor and protected areas⁴¹. The number of visitors to Norwegian outfields, including protected areas, had for a long time, and in particular during the pandemic, increased to the extent that it threatened the sustainability of wildlife (e.g. wild reindeer), as well as the diversity of ecosystems and landscapes. At popular destinations they were clearly degrading. The goal of the discussion was to contribute to the design of a system for visitor management that would further sustainable use of outdoor areas.

The core problem in the key destinations was clearly too many visitors and the waste they left. The main obstacle for limiting the number seemed to be the rules of the "Law on Outdoor Activities" (Friluftsløven)⁴² commonly referred to

³⁹ The comments to the proposal on quarantine rules comprise 23 pages (99-122).

⁴⁰ Close to the end of the third pandemic of cholera 1839-1856 that reached Europe in 1848 https://no.wikipedia.org/wiki/Kolerapandemien_1839-1856.

⁴¹ <https://www.nmbu.no/fakultet/mina/aktuelt/node/45362>

⁴² LOV-1957-06-28-16 Lov om friluftslivet (friluftsløven) [Act of 28 June 1957 No.16 Relating to Outdoor Recreation. <https://www.regjeringen.no/en/dokumenter/outdoor-recreation-act/id172932/>]

as the All Men's Rights of Access⁴³. This means that all men with a legal right of stay in Norway have the right of walking in wilderness areas as long as they observe reasonable rules of behaviour in relation to the interests of the owner(s) of the ground and the resources attached to the ground. The discussion was based on the premise that it is impossible, given today's rules, to deny anyone access to any areas of Norwegian wilderness, including the most crowded hotspots.

The interesting fact here is that crowding seemed to be a key cause of the degrading of the nature. Crowding is a central concept in discussions of collective action and is usually seen as a decisive argument for regulation of the activities of the actors creating the crowding in the first place. But the crowding is then seen as affecting the quality or utility of the actions that create the crowding. Crowding on the motorway, congestion, affects the travel time and thus the utility of the travel for users of cars.

But crowding in hotspot wilderness areas will not only affect the wildlife and ecosystems, it will also affect the quality of the visit for each visitor. It is quite conceivable that visitors would accept regulations of access to keep the number of visitors at any one time under an agreed upon threshold. It is not reasonable to interpret the "All Men's Rights of Access" to mean that everyone can access all places in the wilderness at the same time.

This is of course my personal opinion. Here it can serve as an example of one of the fundamental problems of collective action. The consequences of individual actions may add up to some collective result that diminishes or negates the goal of the individual action. Inventing an information system telling prospective visitors in real time the amount of crowding as well as the expected crowding at any hour of the day might lead to self-governed regulation of visits.

Social dilemmas and climate change

Climate change has been on the international agenda since the United Nations Conference on the Human Environment in June 1972⁴⁴. Its current focus on climate started in Rio de Janeiro in 1992 by adopting the UN framework

⁴³ The ancient tradition of open access to non-arable lands is called "allemannsretten" in Norwegian legislation.

⁴⁴ Climate is the topic of Recommendation 70 in the Report of the United Nations Conference on the Human Environment, Stockholm 5-16 June 1972.

convention on climate change. In the general discussion at the conference the concern was more to ensure information on how climate developed and what the impacts might be. The Intergovernmental Panel on Climate Change (IPCC) had been established in 1988, and the report from the Rio conference notes frequently, often referring to IPCC, that relevant information is missing. Since 1994 there has been yearly meetings, starting in 1995, called Conference of the Parties (COP). This November 2022 COP27 took place. Not much progress from 1992 can be observed. Our current path of development promises as much destruction as a major world war.

In my mind the atmosphere is an open access commons in the process of tragic destruction by countries using it as a sink for gases contributing to the rapid climate change we observe. Since the international system do not have institutions that can monitor and enforce agreements among states, promises to reduce the exploitation of the atmosphere are not credible.

However, from the study of traditional commons it is known that the social traps that produce tragedies of the commons can be overcome in certain circumstances. In a paper from 2010 Ostrom (2012 (2010)) emphasizes the importance of diverse small scale institutions in building up knowledge to implement the large scale institutions that are needed. She calls this a polycentric approach. Today, 12 years after Ostrom wrote this paper, the outlook is far from as promising as it was in 2010. We have had the 2015 Paris agreement. It had a promising start emphasizing voluntary contributions. But before one could see any progress USA withdrew in 2017 (Zhang et al. 2017) with significant setbacks, but also underlining the importance of Ostrom's recommended polycentric approach.

What one may conclude from Norwegian legislation is that if the tragedy is near enough, rules are coming forth. But even with enforcement mechanisms at hand fire protection was difficult. Protection against climate gases will not be easier. What one might hope for is that for some wealthy actors protecting the climate will be more important than a just distribution of the costs. This has happened often enough with provision of public goods to be noted in the literature (Olson 1965).

References

- Axelrod, Robert. 1984. *The Evolution of Cooperation*. New York: Basic Books.
- Berge, Erling. 2019. "Learning cooperation from the commons." Workshop on "The Value of the Commons", 20-22 March 2019, Utrecht, 12 April 2019.
<https://www.nmbu.no/en/faculty/hh/research/centers/clts/research/working-papers>.
- Berge, Erling, and Aud Mikkelsen Tretvik. 2004. "History and management institutions for forests and pastures of northern Fenno-Scandia with an emphasis on Norway." The Fifth European Social Science History Conference, Berlin, Germany, 24 - 27 March 2004.
- Black, Henry Campbell. 1990. *Black's Law Dictionary. Sixth Edition*. St. Paul: West Publishing.
- Bodansky, Daniel. 1993. "The United Nations framework convention on climate change: a commentary." *Yale J. Int'l l.* 18: 451.
https://openyls.law.yale.edu/bitstream/handle/20.500.13051/6301/28_18YaleJIntlL451_1993.pdf?sequence=2&isAllowed=y.
- Bowles, Samuel, and Herbert Gintis. 2011. *A Cooperative Species - Human Reciprocity and Its Evolution*. Princeton; Oxford: Princeton University Press.
- Boyd, Robert, and Peter J. Richerson. 2005. *The origin and evolution of cultures*. Oxford: Oxford University Press.
- Camerer, Colin F. 2003. *Behavioral Game Theory. Experiments in Strategic Interaction*. Princeton: Princeton University Press.
- Dahlman, Carl J. 1980. *The Open Field System and Beyond*. Cambridge: Cambridge University Press.
- Dreber, Anna, and Martin A. Nowak. 2008. "Gambling for global goods." *Proceedings of the National Academy of Sciences* 105 (7): 2261-2262.
<https://doi.org/doi:10.1073/pnas.0800033105>.
<https://www.pnas.org/doi/abs/10.1073/pnas.0800033105>.
- Druckman, James N., Donald P. Green, James H. Kuklinski, and Arthur Lupia, eds. 2011. *Cambridge Handbook of Experimental Political Science*. Cambridge: Cambridge University Press.
- Dyrvik, Ståle, Anders Bjarne Fossen, Tore Grønli, Edgar Hovland, Helge Norvik, and Stein Tveite. 1979. *Norsk Økonomisk Historie 1500-1970. Band 1 1500-1850*. Oslo: Universitetsforlaget.
- Eliassen, Finn-Einar, and Geir Atle Ermland. 1996. *Power, profit and urban land : landownership in medieval and early modern northern European towns. Historical urban studies*. Aldershot: Scolar Press.
- Ensminger, Jean, and Joseph Henrich. 2014. *Experimenting with Social Norms: Fairness and Punishment in Cross-Cultural Perspective*. New York: New York: Russell Sage Foundation.
- Ermland, Geir Atle, Hilde Sandvik, and Una Thoresen Dimola. 1999. *Norsk historie 1300-1625 : eit rike tek form*. Vol. B. 2. Oslo: Det Norske Samlaget.
- Fehr, Ernst, and Urs Fischbacher. 2005. "The Economics of Strong Reciprocity." In *Moral Sentiment and Material Interest. The Foundations of Cooperation in Economic Life.*, edited by Herbert Gintis, Samuel Bowles, Robert Boyd and Ernst Fehr, 151-191. Cambridge, MA: The MIT Press.
- Fehr, Ernst, and Simon Gächter. 2000a. "Cooperation and punishment in public goods experiments." *American Economic Review* 90 (4): 980-994.

- Fehr, Ernst, and Simon Gächter. 2000b. "Cooperation and Punishment in Public Goods Experiments." *The American Economic Review* 90 (4): 980-994.
<http://www.jstor.org/stable/117319>.
- Fehr, Ernst, and Bettina Rockenback. 2003. "Detrimental effects of sanctions on human altruism." *Nature* 422 (13 March): 137-140.
- Fryjordet, Torgeir. 1968. *Generalforstamtet 1739-1746. Norsk Skogbruksmuseum Særpublikasjon Nr 1*. Elverum: Norsk Skogbruksmuseum.
- García-Barrios, Luis, Raúl García-Barrios, Andrew Waterman, and Juana Cruz-Morales. 2011. "Social dilemmas and individual/group coordination strategies in a complex rural land-use game." 5 (2): 364-387.
<http://www.thecommonsjournal.org/index.php/ijc/article/view/289>.
- Gintis, Herbert. 2000. *Game Theory Evolving. A Problem-Centered Introduction to Modeling Strategic Interaction*. Princeton: Princeton University Press.
- . 2009. *The Bounds of Reason. Game Theory and the Unification of the Behavioral Sciences*. Princeton, NJ: Princeton University Press.
- Gintis, Herbert, Samuel Bowles, Robert Boyd, and Ernst Fehr, eds. 2005. *Moral Sentiment and Material Interest. The Foundations of Cooperation in Economic Life*. Cambridge, MA: The MIT Press.
- Gordon, H. Scott. 1954. "The Economic Theory of a Common-Property Resource: The Fishery." *Journal of Political Economy* 62 (2): 124-142.
<https://doi.org/10.2307/1825571>. <http://www.jstor.org/stable/1825571>.
- Hagland, Jan Ragnar, and Jørn Sandnes. 1994. *Frostatingsloven*. Oslo: Samlaget i samarbeid med Frosta historielag.
- Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science* 162 (3859): 1243-1248.
- Helle, Knut, Finn-Einar Eliassen, Jan Eivind Myhre, and Ola Svein Stugu. 2006. *Norsk byhistorie : urbanisering gjennom 1300 år*. Oslo: Pax.
- Hess, Charlotte. 2008. "Mapping the New Commons." The 12th Biennial Conference of the International Association for the Study of the Commons: "Governing Shared Resources: Connecting Local Experience to Global Challenges", University of Gloucestershire, Cheltenham, England, July 14-18, 2008.
<http://ssrn.com/paper=1356835>.
- Holden, Stein. 2009. "Power Traps or Poverty Traps? Institutions, Markets, and Environmental and Livelihood Restoration." NFU conference.
- Ingram, Paul, and Karen Clay. 2000. "The Choice-Within-Constraints New Institutionalism and Implications for Sociology." *Annual Review of Sociology* 26 (1): 525-546.
<https://doi.org/doi:10.1146/annurev.soc.26.1.525>.
<https://www.annualreviews.org/https://www.annualreviews.org/doi/abs/10.1146/annurev.soc.26.1.525>.
- Kollock, Peter. 1998. "Social Dilemmas: The Anatomy of Cooperation." *Annual Review of Sociology* 24: 183-214. <https://doi.org/doi:10.1146/annurev.soc.24.1.183>.
<http://arjournals.annualreviews.org/doi/abs/10.1146/annurev.soc.24.1.183>.
- Kongelig Kommissjon av 23 juli 1834. 1847. *Angaaende en ny Medicinallovgivning for Norge* Vol. 13. xx#: [s.n.].
- Larson, Laurence Marcellus. 1935. *The earliest Norwegian laws: being the Gulathing law and the Frostathing law*. New York: Columbia University Press.
- Milinski, Manfred, Ralf D. Sommerfeld, Hans-Jürgen Krambeck, Floyd A. Reed, and Jochem Marotzke. 2008. "The collective-risk social dilemma and the prevention of simulated dangerous climate change." *Proceedings of the National Academy of Sciences* 105 (7): 2291-2294. <https://doi.org/doi:10.1073/pnas.0709546105>.
<https://www.pnas.org/doi/abs/10.1073/pnas.0709546105>.

- Mumford, Lewis. [1961] 1966. *The city in history: its origins, its transformations, and its prospects*. London: Penguin.
- Olson, Mancur. 1965. *The Logic of Collective Action. Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.
- Ostrom, Elinor. 1990. *Governing the Commons. The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.
- . 1998. "A Behavioral Approach to the Rational Choice Theory of Collective Action. Presidential Address American Political Science Association 1997." *American Political Science Review* 92 (1): 1-22.
- . 2001. "Social dilemmas and human behaviour." In *Economics in nature: Social dilemmas, mate choice and biological markets*, edited by Ronald Noë, Jan A.R.A.M. van Hooff, and Peter Hammerstein, 21-41.
- . 2005a. "Policies That Crowd out Reciprocity and Collective Action." In *Moral Sentiments and Material Interests. The Foundations of Cooperation in Economic Life*, edited by Herbert Gintis, Samuel Bowles, Robert Boyd and Ernst Fehr, 253-275. Cambridge, MA: The MIT Press.
- . 2005b. *Understanding Institutional Diversity*. Princeton: Princeton University Press.
- . 2010a. "Beyond Markets and States: Polycentric Governance of Complex Economic Systems." *American Economic Review* 100 (3): 641-72. <https://doi.org/doi:10.1257/aer.100.3.641>.
<http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.3.641>.
- . 2010b. "A Multi-Scale Approach to Coping with Climate Change and Other Collective Action Problems." *Solutions* 1. <http://hdl.handle.net/10535/5774>.
- . 2012 (2010). "Nested externalities and polycentric institutions: must we wait for global solutions to climate change before taking actions at other scales?" *Economic Theory* 49 (2): 353-369. <https://doi.org/10.1007/s00199-010-0558-6>.
<https://doi.org/10.1007/s00199-010-0558-6>.
- Ostrom, Elinor, and Harini Nagendra. 2006. "Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory." *Proceedings of the National Academy of Sciences* 103: 19224 - 19231.
- Pahl-Wostl, Claudia. 2009. "A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes." *Global Environmental Change* 19 (3): 354-365.
<https://doi.org/10.1016/j.gloenvcha.2009.06.001>.
<http://www.sciencedirect.com/science/article/pii/S0959378009000429>.
- Robberstad, Knut, and Carsten Lien. 1981 [1969]. *Gulatingslovi*. Vol. 33. Vol. 4. utg. *Norrøne Bokverk*. Oslo: Samlaget.
- Robberstad, Knut, and Absalon Taranger. 1923. *Magnus Lagabøters bylov*. Kristiania: Cammermeyers boghandel.
- Rockenbach, Bettina, and Manfred Milinski. 2006. "The efficient interaction of indirect reciprocity and costly punishment." *Nature* 444 (7120): 718-723.
- Rothstein, Bo. 2005. *Social traps and the problem of trust*. Cambridge: Cambridge University Press.
- Scott, Anthony. 1955. "The Fishery: The Objectives of Sole Ownership." *Journal of Political Economy* 63 (2): 116-124. <https://doi.org/10.2307/1827047>.
<http://www.jstor.org/stable/1827047>.
- Smith, Eric A., and Rebecca Bliege Bird. 2005. "Costly Signaling and Cooperative Behavior." In *Moral Sentiments and Material Interests. The Foundations of Cooperation in Economic Life*, edited by Herbert Gintis, Samuel Bowles, Robert Boyd and Ernst Fehr, 115-148. Cambridge, MA: MIT Press.

- Snidal, Duncan. 1985. "The game theory of international politics." *World Politics* 38 (1): 25-57.
- Stoddard, Isak, Kevin Anderson, Stuart Capstick, Wim Carton, Joanna Depledge, Keri Facer, Clair Gough, Frederic Hache, Claire Hoolohan, Martin Hultman, Niclas Hällström, Sivan Kartha, Sonja Klinsky, Magdalena Kuchler, Eva Lövbrand, Naghmeh Nasiritousi, Peter Newell, Glen P. Peters, Youba Sokona, Andy Stirling, Matthew Stilwell, Clive L. Spash, and Mariama Williams. 2021. "Three Decades of Climate Mitigation: Why Haven't We Bent the Global Emissions Curve?" *Annual Review of Environment and Resources* 46 (1): 653-689. <https://doi.org/10.1146/annurev-environ-012220-011104>. <https://www.annualreviews.org/doi/abs/10.1146/annurev-environ-012220-011104>.
- Supran, Geoffrey, and Naomi Oreskes. 2017. "Assessing ExxonMobil's climate change communications (1977–2014)." *Environmental Research Letters* 12 (8): 084019.
- . 2020. "Addendum to 'Assessing ExxonMobil's climate change communications (1977–2014)' Supran and Oreskes (2017 Environ. Res. Lett. 12 084019)." *Environmental Research Letters* 15 (11): 119401. <https://doi.org/10.1088/1748-9326/ab89d5>. <https://dx.doi.org/10.1088/1748-9326/ab89d5>.
- Taranger, Absalon. 1915 [1274] *Magnus Lagabøter's Landslov*. Translated by Absalon Taranger. Oslo: Universitetsforlaget, 1979.
- Vevstad, Andreas. 1992. *Norsk Skogpolitikk*. Oslo: Landbruksforlaget.
- Walker, Sean B, and Keith W Hipel. 2017. "Strategy, complexity and cooperation: the Sino-American climate regime." *Group Decision and Negotiation* 26 (5): 997-1027.
- Warming, Jens. 1911. "Om grundrente af fiskegrunde (on ground rent for fishing grounds) [in Danish, for translation see Andersen, P. 1983 'On rent of fishing grounds': a translation of Jens Warming's 1911 article, with an introduction, History of political economy Vol. 15(3)]." *Nationaløkonomisk Tidsskrift*: 499-505
- Zhang, Yong-Xiang, Qing-Chen Chao, Qiu-Hong Zheng, and Lei Huang. 2017. "The withdrawal of the U.S. from the Paris Agreement and its impact on global climate change governance." *Advances in Climate Change Research* 8 (4): 213-219. <https://doi.org/https://doi.org/10.1016/j.accre.2017.08.005>. <https://www.sciencedirect.com/science/article/pii/S1674927817300849>.