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Ecological Transition: how creativity can contribute to limit soil sealing.

Abstract: Land use is a major aspect of sustainable development, as it determines the production of ecosystem services. However, among the various uses, soil sealing is of particular concern, as it is the most dangerous land degradation process. It threatens our food security, water and air quality, climate regulation and biodiversity but it keeps on developing despite many public policies. This article considers soils as common goods and aims to examine how public action or market tools can be complemented by the mobilisation of several levels of public and private actors around a polycentric equilibrium. But, because of a frequent lack of shared vision about soil sealing, this equilibrium requires to make social norms evolve in favour of enhancing old buildings rather than using new soils. This requires creativity and a stakeholders engagement: a social innovation whose conditions this article is trying to specify.

Keywords: Behavioural Economics, Creativity, Social Innovation, Information, Institutional Change, Land Use, Polycentric Equilibrium, Soils Sealing, Sustainable Development

1. Introduction

Land use is a major aspect of sustainable development, as it conditions the development of ecosystem services, those benefits naturally offered to humans by ecosystems. However, among the various land uses, soil sealing raises questions, due to its growth and the irreversible modification of ecosystems that it implies: it is soil sealing. Defined as the total or partial covering of an agricultural, forest or natural area by impermeable materials, for example through buildings and roads, soil sealing not only weakens biodiversity and our food autonomy, but it also increases our vulnerability by affecting the ecological functions of the soils as water absorption and filtration or carbon storage (Intergovernmental Panel on Climate Change, 2020). For these reasons, soil sealing is currently considered as the most dangerous land degradation process on global, European and national scales.

Despite many public policies aiming to limit this soil threat, soil sealing continues to increase annually at global, (United Nations World Urbanization Prospects, 2021), European (European Union, 2021) and national scales (Agreste, 2021). Also, if Europe has set itself a "no net land take" target for 2050, one may wonder about the conditions of effectiveness of the recent measures that have been taken to achieve it, in particular the recent Climate and Resilience Act adopted in France in 2021 which depends largely on the choices made by local public authorities. Indeed, soil sealing represents a significant source of income for local communities. While public action seems naturally indispensable, will it be sufficient to create the necessary incentives for a rapid modification of these local choices? More generally, how can the diversity of local stakeholders be efficiently mobilised to limit soil sealing ?

In order to answer this question, we wish to understand first what can limit the effectiveness of public intervention when it aims to control land use. This does not mean condemning public action which remains essential, but rather considering how it can be supplemented by mobilising several levels of public and private actors around a cooperative, polycentric equilibrium (Ostrom, 2014). Because it concerns land use, this equilibrium implies a real stakeholder commitment to make social norms evolve in favour of enhancing old buildings rather than sealing soils. This change in social norms requires a real creativity within each community: a creativity that cannot only be expected from project leaders, but that can really emanate from each citizen. Indeed even a small local experiment can transform the

representations of certain actors and commit them to preserve soils in turn. To outline the conditions of the stakeholder engagement in such a social innovation (Leal *et al.*, 2022), this article mobilizes the recent developments of Behavioral Economics (Attanasi *et al.*, 2021),

2. Soil sealing: the limits of public action.

Although the European Union has currently set itself the objective of "no net land take" by 2050, many public authorities have been concerned with this phenomenon for over fifty years. The evolution of soil sealing therefore raises questions today about the limits of public intervention. These limits seem to be closely linked to the nature of soils and require more concrete consideration.

2.1. Legislative activity faced to a still too rapid soil sealing.

Many public authorities have been warning for a long time about the need to save natural, agricultural or forest areas. Thus, in England, a green belt was established around London as early as the 1930s and the principle was extended to other areas in 1955. In France, the Town Planning Code has been encouraging local authorities to use their land economically since 1983, and then, this concern seems to have never ceased : many laws have been passed up to the last, in August 2021, to limit land consumption. At the same time, at the European level, the Common Agricultural Policy is also trying to curb land take. Thus, since 2015, Basic Payment Rights (BPR) are partly defined according to the agricultural area: a farmer who makes a piece of land impervious loses his rights during the next allocation campaign.

However, despite this persistent public intervention, soil sealing continues to progress. Thus, in France, the surveys carried out by the Statistical Services of the Ministry of Agriculture estimate that sealed areas represented 5.2% of land in 2012 and more than 10% in 2021 (Agreste, 2021). In Italy or Portugal, the growth of urbanised areas has been more than 2% every year since 1990 (European Environment Agency, 2021). This is therefore within this framework that Europe sets its objective of "no net land take" by 2050, because soil sealing is the most serious attack on soils and on their ecological functions : their biological function to shelter and feed living organisms, their water functions to guarantee the stability and quality of the water tables, or their climatic functions to absorb rainfall, produce sustainable energy, and limit the risks of flooding, drought or fire.

In order to reduce soil sealing, Europe has introduced a decentralised policy in which each region must set a target of reducing the amount of land being built up by 50% over the next 10 years in its urban planning documents. These regional objectives can of course be territorialised : each region can thus distribute its restrictions among the various communities that make up the region. This distribution will naturally take some time and each municipality might not have not its urban development documents revised before August 2027...

In addition to this question of timing, this territorialisation also raises unavoidable questions of local finances. Indeed many local authorities consider the sale of building land or the taxation of construction as a significant source of income, and many have invested in order to service lands: how can they reconcile the slowing down of soil sealing with the control of their costs? This question shows that public intervention is never simple when it comes to rapidly orienting land use. However, a large part of this difficulty seems to be linked to the characteristics of these particular goods that are soils.

2.2. Soils as common goods

Soils show both characteristics of rivalry and non-exclusion: they therefore seem to be real common goods whose allocation proves to be very delicate. Rivalry is obvious: the occupation of a piece of land limits another use, at least momentarily if not almost permanently in the case of sealing. As for non-exclusion, it depends on the way soils are understood. If we admit that soils are not just surfaces, but volumes of matter able to produce many ecosystem services, it is easy to understand the non-excludable nature of soils: a market transaction cannot be sufficient to appropriate these services. These two characteristics of rivalry and non-excludability therefore bring soils closer to real common goods (Samuelson, 1954), whose management may give rise to two types of negative externalities.

The first externality stems from the fact that any agent who contributes to the maintenance of these soils can only derive a partial benefit from them: he can neither appropriate the services provided by these soils, nor receive a remuneration, which takes into account all these services. He may therefore feel only a limited incentive to maintain this resource. But a second externality arises because, if an individual does not receive all the gains that soils can generate, he does not bear all the costs associated with their use: therefore he may be encouraged to overexploit these common goods. This is what Hardin (1968) calls the "Tragedy of Commons". These two sources of externalities are understood as market failures and often justify public action.

Recent developments in Behavioural Economics have confirmed this need of public action, by highlighting several psychological factors such as the immediacy bias which reinforces the tendency of individuals to postpone their ecological conversion, even if its cost is low, but only because its expected benefits belong to a longer term (Gabuthy *et al.*, 2021). However, if taxes, subsidies or laws can constitute necessary incentives to encourage economic actors to avoid soil sealing, these different levers seem today to show that they are probably not sufficient. Having to legislate again in 2021 to protect soils, after more than fifty years of public action, seems in fact, if not an admission of failure, at least a signal that a condition of effectiveness may have been missed before.

Any public policy can in fact generate externalities or crowding-out effects that will limit its effectiveness, or even make it counterproductive. We can mention the public policies that encouraged the production of biofuels before recognising it implied land use changes with a questionable environmental record (Bayramoglu and Jacques, 2016)... And what about public measures that have encouraged the creation of new housing or obliged the creation of parking spaces during building permits?... These measures seem to show the lack of a sufficiently global vision of what soils represent. But the difficulty is quite understandable because soils are such a polysemic and multifunctional object.

Indeed soils have not just an environmental function. Land use also determines social relations and the economic dynamism. Soil sealing can therefore be considered sometimes as a cost for one of these dimensions and turn out to be a benefit for others. Under such conditions, how to regulate related behaviours? In particular, if the European Union attempts to limit new buildings, which incentives will have local authorities to comply with these restrictions as quickly as possible? For many local authorities, new buildings represent significant budgetary resources, especially when they have already spent money to enable these buildings (land development, connection to sewerage networks or roads). If the resources of these communities are constrained, how to motivate a rapid change in the behaviour of local elected officials? While the complexity of these issues is essentially related to the nature of soils, it is important to reconsider the problem of allocating such goods.

2.3. *The need for more than just public action*

Hardin (1968) considered the allocation of common goods under very specific assumptions: a perfect information framework in which a large number of agents choose a non-cooperative equilibrium. But by revising some of these conditions, in particular by limiting the number of users or by multiplying the transaction possibilities, the Game Theory has already shown that other outcomes were possible and these did not necessarily require centralised management. For example, models such as the « Chicken Game » show how some agents may agree to bear costs alone in order to avoid a fatal non-cooperative equilibrium when a common good is vitally important. This behaviour can be observed in shared urban gardens, when individuals assume the cost of a clean-up so that others can have access to cultivable lands once again (Donadieu *et al.*, 2016).

This does not mean excluding all public intervention in favour of purely market-based instruments such as Payments for Ecosystem Services (PES). These market tools can create interesting incentives when it is possible to give a monetary value to a service, for example to value the carbon storage provided by forests or grasslands (Shapiro-Garza *et al.*, 2020). However, as far as land is concerned, it is often difficult to measure precisely all the services provided by the soils and the cost that soil sealing represents. In this case, public instruments remain useful. A tax on land development can thus allow to internalise a part of the externality by integrating its cost into the choice of land use

These two types of instruments, market tools and public action, can each have different effects depending on the territory and can therefore be combined to optimise their impact. Thus, PES and protected areas often complement each other. Similarly, experiments conducted in Germany with a quota market seem to show encouraging results: public authorities set a target for reducing built-up areas and this target defines a supply of rights to build up, which can then be traded between local authorities, as is done in the carbon market. Each locality can use its rights, but the possibility of selling them may encourage it not to waterproof its land and seems to slow down the building of new individual houses (Artmann, 2015).

If the coupling of market tools and public instruments offers therefore encouraging results, it seems to be possible to go further in subsidiarity, by rallying stakeholders in a collective action, so as to make them more responsible and hasten a change in behaviour. Indeed all of them rely on the services provided by the soil, so all can be made responsible. Far from being an utopia, this type of governance has been experimented with by Elinor Ostrom in particular contexts and for other common goods. This article aims to question the conditions to be met, on each territory, to encourage the cooperation of stakeholders around such an equilibrium.

3. Soil sealing : toward a new institutional équilibre

Elinor Ostrom (1990, 2014) observed many times the limits of public policies and market tools for environmental preservation. So she opened up a path that we would like to follow to encourage the reduction of soil sealing. This path does not reject public action or market mechanisms, but it offers to complement them by mobilising several levels of public and private actors around a cooperative equilibrium, known as "polycentric". Nevertheless, how to mobilise stakeholders to preserve soils, when they do not share a same vision of soil sealing, of its cost and of the cost of its limitation? In order to outline the conditions for such a cooperation which requires a real change of social norms, we combine the work of Ostrom (1990, 2014) with

recent developments of Behavioural Economics on creativity (Charness G and Grieco, 2019) and social innovation (Leal *et al.*, 2022).

3.1. For a polycentric soil management ?

Ostrom's works (1990, 2014) brought good news : they showed that the « "Tragedy of Commons" could be prevented if a resource was shared between a limited number of people, which is often the case of soils. In this case, arrangements between users can allow a reasoned exploitation of the resource. These arrangements are neither completely public nor completely private, but they already seem to show good results in communities committed to defending their forest soils (White and Martin, 2005). However, even if all the users of a common have an interest in protecting it, this common interest is not sufficient to make them act in a coordinated manner in favor of its preservation. The short-term gains of ones can overshadow the long-term costs borne by all.

If this coordination is not natural, it must therefore be encouraged by institutions, a set of formal or informal rules capable of securing transactions and creating positive incentives (North, 2005). These rules must define the resource, its beneficiaries, their obligations and the possible sanctions in case of breach. This institutional framework must naturally be specific to each community in order to integrate all its specificities and it will be even more effective if the rules are developed by the local actors and recognised by the public authorities (Ostrom, 1990). This coexistence of decision-making poles at different levels makes Ostrom qualifies this equilibrium as "polycentric".

In such a framework, stakeholders can not only design rules but also try them out and review them. In this way, they can take into account a greater amount of information on the costs and marginal gains of each use. This joint involvement also allows a first empowerment of individuals and may limit a possible path of dependency which could hinder change (North, 2005). In order to facilitate the construction of such an institutional framework, Ostrom described several conditions, derived from her numerous experiments. These conditions are related to the biophysical characteristics of the resource, the attributes of the users (their heterogeneity, their previous interactions or their knowledges) and the rules already in use. These conditions seem to determine the chances of success of a decentralised management of a common resource.

This involvement of civil society may represent a real social innovation in the territories where it is implemented (Millard, 2018). But it raises a question: before cooperating, how can the different stakeholders be encouraged to come together, question the pre-existing rules and consider the collective development of a new framework for co-managing their common resource? We have observed: even in very small villages with less than 200 inhabitants, the lack of a shared vision on the importance of limiting soil sealing is evident. Because it means new constraints for many agents, the objective worries rather than enthuses. This lack of shared vision makes therefore spaces and times for exchange and dialogue indispensable. Indeed, it is important to listen to the concerns and respond to this "cost" by also making known the expected gains from soil preservation or the possibilities to modify behaviours without it being too difficult.

This exchange is a crucial step to ensure that the choice of soil sealing is not biased by incomplete information. Many empirical results (Poteete *et al.* 2010) confirm that a group of people who can easily communicate can easily implement efficient coordination to preserve a common resource, with low information costs and low transaction costs. Conversely, they demonstrate that the imposition of external rules, emanating from non-users of the resource,

can weaken coordination and put the common good at risk. Indeed land use covers too great a diversity of situations for administrative standards applied in a top-down logic to lead to always relevant solutions.

Once the agents have been well informed about the cost of soil sealing and allowed to discuss their different representations, it may be possible to let them choose their mode of action, define formal or informal rules and hope that these new rules increase the marginal cost of a new artificialization, to make it less attractive than the recycling of old buildings or the co-use of existing infrastructures. As this marginal cost is not limited to monetary terms, but also includes the loss of ecosystem services or the regret of seeing a landscape disappear, the effectiveness of these rules could depend on the fact that they integrate the specificities of each territory. But will individuals agree to enter into this creative process, and devote time and resources to it ?

3.2. A necessary burst of creativity

The polycentric management of a common resource by stakeholders requires an indispensable creativity within the territories. Indeed this polycentrism calls on each community to imagine new and relevant solutions, to evolve its formal and informal rules in order to preserve soils. As land use determines not only ecosystem services but also social relations, this creative process can represent a green and social innovation.

This process implies a creativity which is included as a necessary condition for sustainable development in the 1992 Rio Declaration (Principle 21). This creativity is linked to cognitive, environmental and conative factors (Heraud, 2017) : so it can be presented as the result of a freedom in a space of possibilities. It can therefore be approached by behavioral Economics, which approaches any human choice as the point of tangency between preferences and a space of possibilities. Creativity currently takes a central place in the analysis of authors inspired by marginalists, who link creativity and complexity and try to understand the evolution of complex systems through the interactions of heterogeneous individuals in collective processes (Gloria, 2020).

From this point of view, creativity appears as the result of two complementary processes: that of individuals forced to react to a systemic challenge and that of a system that evolves and provides a supportive framework for innovation, by reducing its cost and facilitating its diffusion. In order to activate both these endogenous forms of creativity, it seems essential to involve local actors. Thus, Toffanin and von Gessenek (2022) mention « innovation councils » set up by local governments in overseas territories, which seem to be a real social innovation to facilitate the meeting of local actors with experts, complete the information of all and change behaviours for a sustainable future.

The involvement of all is also necessary because limiting soil sealing implies a change in social norms. The social creativity that this requires can therefore not be sought only from a few project developers, but from all stakeholders. Indeed no one foresees which individual behaviour will have the greatest impact on the social norms of a community. Any community can be seen as an ecosystem of interacting beings: the choice made by some to enhance old buildings rather than build new ones may start a wider trend, encourage other agents to do the same. Even a small local experiment can transform the representations of stakeholders and commit them to transform their environment. That is why it seems important to involve a wide range of people in this creative process, in order to reach as many different people as possible.

But the question remains: how can people be encouraged to participate in such a creative process ? How can people agree to invest time and effort in order to change social norms and limit soil sealing? Recent developments in Behavioral Economics can provide some answers.

3.3. *The contribution of Behavioral Economics*

We are looking for the conditions of a group cooperation in a mission of creativity, that could be described as 'close' (Charness and Grieco, 2019), since the expected creativity is not entirely spontaneous but constrained by a specific problem: avoiding soil sealing. How to incite individuals to devote together time and resources to avoid soil sealing on their own territory? Following the work of Benabou and Tirole (2006), recent developments in Behavioral Microeconomics highlight three types of incentives: intrinsic, extrinsic and reputational incentives. Indeed, individuals may decide to contribute to a common goal, such as limiting soil sealing, if this decision seems to bring them at the same time, a marginal gain at least greater than the marginal cost it represents. However these gains and costs are not only monetary but can be linked to a feeling of personal satisfaction (intrinsic incentive), to the prospect of an external reward or sanction (extrinsic incentive) or to their social image (reputational incentive).

The intrinsic incentive could motivate individuals to preserve natural, agricultural and forest soils, without expecting any other reward than the knowledge that this preservation is necessary. It can be reinforced by informations given to citizens, on the expected benefits of less artificialization. But this incentive is very difficult to measure. With no guarantee that it represents a sufficient level of motivation, the public authorities must therefore create an additional incentive, a motivation that is called "extrinsic" because it can be associated with an external sanction in order to weaken the expected utility of soil sealing. Far from being opposites, intrinsic and extrinsic incentives can therefore be complementary (Akers and Yasue, 2019).

However, it is important to be particularly careful about the message that external incentives send to stakeholders. Indeed, when they concern common goods, monetary incentives can generate crowding-out effects and inhibit cooperation and group creativity (Attanasi *et al.*, 2021). The main reason for these crowding-out effects is imperfect information. Thus, if agents have an imprecise signal about the cost of what they are asked to do, their probability of success or what they can gain, a monetary incentive may be interpreted as bad news about their abilities or the difficulty of the task. This affects their confidence and may reduce their intrinsic motivation: even if some people respond positively in the short term, the effect will rarely be significant and lasting.

Many studies and experiments mobilise intrinsic and extrinsic motivations, but we would like to point out here that a third type of incentive can probably be called upon to preserve soils: the reputational motivation, *id est* the self image that people wish to have and give. For example, if many people or charismatic individuals choose to renovate old buildings rather than consume new lands, following the same approach may not be glorious, but the stigma will increase for agents who will continue to set up new buildings. This incentive is probably not yet sufficient in all territories, but like intrinsic motivation, it must not be neglected because it can reinforce extrinsic incentives set up by the public authorities (Benabou and Tirole, 2006). For example, information on renovation projects can make soil sealing less trendy...

These different studies on individual motivations and what shapes them lead us to underline two points that seem important if one wishes to motivate different agents to cooperate on new solutions in order to avoid soil sealing. The first concerns public intervention: as soil preservation is still neither a heroic nor a completely banal act, the law as an extrinsic

motivation remains essential. With regard to Ostrom's works (2014), the possibility given to the regions to distribute the constraints imposed by the law differently among the territories that make up the region may improve the effectiveness of this public instrument.

A second point highlights a condition mentioned by Leal *et alii* (2022) in order to favour social innovation and supported by recent experiences of Behavioral Economics (Attanasi *et alii*, 2021): the importance of collecting and sharing information from open communities. Indeed sharing information allows to limit the possible crowding-out effects of the extrinsic motivation and increases the intrinsic and reputational motivations of the agents concerned by the same common good. It therefore seems crucial to promote spaces for dialogue or means of information. For example, it could be useful to communicate the different ecosystem services lost each year because of soil sealing or share ideas for renovation. Indeed it is important that the discourse remains positive, in order to limit discouragement and crowding out (Charness and Grieco, 2019).

Creativity can foster this positive communication, emphasising benefits rather than constraints of limiting soil sealing. For this, any agent can play an important role, even if he is not specifically a bearer of creative projects. Indeed one's creativity depends on one's capacity to evolve social norms by activating the reputational incentive of one's neighbours. Thus, by making the choice to renovate rather than build, by demonstrating a higher marginal gain in this choice, each person can send signals and contribute to changing the way in which the consumption of natural, agricultural and forestry land can be perceived from now on. The impact of these signals can of course be increased by promoting communication between agents who share the same territory or who are called upon to do so. Once again, information sharing is crucial and may become a real mission for each of stakeholders, private or public agents.

Conclusion

Controlling soil sealing represents a threefold challenge: a climatic challenge through the preservation of wetlands, grasslands and forests which allow carbon storage, a food challenge through the preservation of agricultural land and an economic and social challenge through the revitalisation of urban centres instead of their sprawl.

To achieve this objective, a real political will is being asserted throughout the world and particularly in Europe with the objective of "no net land take" by 2050. But how to guarantee its achievement when many laws have previously failed to change behaviours? How to provide the conditions that can favour this objective? We have drawn on Elinor Ostrom's works (1990-2014) to take up the idea that public intervention can not be sufficient when it comes to preserving common goods. Even if the idea is not yet fully accepted, soils can indeed be considered as common goods. Therefore, public action should not be renounced, but should be complemented by involving other actors.

The coupling of public instruments and market tools such as Payments for Environmental Services has already shown encouraging results for many natural resources such as forest or water. However, the polysemic and multifunctional nature of soils makes their management more complex. Because soils are the source of an essential diversity of ecosystem services, the management of their use does not seem to be able to rely only on regulations and market mechanisms. It seems to require further subsidiarity, by mobilising a further coordination of stakeholders, so as to make them more responsible and hasten the change in behaviours. This is why we have taken up the idea of a 'third way' experimented within the work of Elinor Ostrom (1990-2014), advocating more cooperation between stakeholders.

Beyond an heterodoxy/orthodoxy dichotomy that is now outdated, Elinor Ostrom (1990) has indeed designed models of repeated games within a framework of bounded and procedural rationality in order to outline a polycentric management model that allows small communities to manage their commons in a sustainable way, by letting them develop new rules adapted to their situation. This capacity to create new and relevant solutions can represent not only a green innovation, but also a real social innovation as the use of land also conditions many social aspects such as housing or social relations (Millard, 2018). But it raises questions about the conditions that can encourage such a movement: how to encourage people who share a same territory to come together and draw up a new institutional framework?

In order to involve stakeholders, each must find, in avoiding soil sealing, a marginal gain greater than the cost it represents. It is of course not just about monetary gains or costs. Gains can also depend on intrinsic or reputational motivation (Benabou and Tirole, 2006). The weak impact of previous public actions and the recent evolution of artificialisation may suggest that the intrinsic incentive of agents to preserve land is relatively weak. Similarly, soil preservation is probably not yet a widespread enough choice to stigmatise its opposite and activate a reputational incentive. An extrinsic incentive, activated by a legal framework, seems therefore essential.

But recent experiences in Behavioural Economics show that such an extrinsic incentive can itself generate crowding-out effects in a context of imperfect information (Attanasi *et al.*, 2021). For the law to be effective, it is therefore necessary to supplement the information made available to stakeholders, inform them about costs of soil sealing, but especially about expected gains from soil preservation or possibilities of modifying behaviours without it being too costly. However, the legal framework must ensure that it transmits positive information so as not to discourage agents.

Sharing information is also crucial to activate intrinsic and reputational motivations. Indeed, if they are explicit, the choices of some economic actors who limit artificialisation can influence others. Avoiding soil sealing implies a change of social norms, in order to make the consumption of new soils less attractive. The whole community of actors sharing the same territory is therefore invited to innovate, find new and relevant solutions to avoid soil sealing in their own territory. This creative process is not just a matter of a few innovative project developers. Each individual operates within a group and his choices may be the spark to activate the intrinsic and reputational incentive of the others.

For this reason, it is important to involve as many agents as possible in discussion forums so that everyone can learn about the costs of soil sealing and exchange views on the value each places on land. In some overseas territories, such forums have been organised for other issues and have proved to be real social innovations (Toffanin and von Gesseneck, 2022). Since soils do not only have an ecological function but also a social function, they can also justify such spaces for exchange, to stimulate social creativity which is necessary both for the emergence of new formal rules and for the evolution of social norms that can make renovation or co-use more attractive. Recent laws does not provide for such discussion forums about land use. Will local authorities in charge of implementing these laws think about this?

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