



# Adapting Common Resource Management to Under-Use Contexts: The Case of Common Pasture Organizations in the Black Forest Biosphere Reserve

## RESEARCH ARTICLE

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## ABSTRACT

Commonly used pastures have provided great socio-cultural, economic and ecological values across European mountain ranges. Since the last century, under-use is threatening these socio-ecological systems. Preserving common pastures as an integral part of cultural landscapes is the principal objective of the recently established Black Forest Biosphere Reserve in south-western Germany. We use the example of Black Forest common pasture organizations to scrutinize organisational arrangements, challenges and support of common resource sustenance in under-use contexts by drawing on Ostrom's Design Principles, the Socio-Ecological-Systems Framework and resilience theory. To this end, we use mixed methods for data collection (semi-structured interviews, expert survey, focus group discussion) rooted in qualitative empirical social-ecological science. The suggested tripartite framework offers insights for conceptual and theoretical advancements in under-use contexts. As such, this research shows that design principles for under-use should (1) consider broader social boundaries to include all actors benefiting from the resources, (2) achieve congruence of provision, appropriation and local conditions that focus on sufficient levels of landscape stewardship services involving new beneficiaries for burden sharing, (3) match appropriators' rights and duties as well as incentives for and motivations of pasture management. Concerning practical aspects, measures to support common pasture organizations' adaptation need to incorporate multi-level governance and to increase connectivity.

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## 1 INTRODUCTION

In western and central Europe, common property and joint agricultural land-use systems have been predominately maintained in extensive or unproductive land-use settings (Warde, 2015). In mountain ranges, such as the Alps (Bassi & Carestiato, 2016; Baur & Binder, 2013; Premrl et al., 2015; van Gils et al., 2014), the Pyrenees (Eychenne & Lazaro, 2014) or the Carpathians (Sutcliffe et al., 2014), common use of grassland-systems, in particular pastures, have been maintained under different arrangements. In the southern Black Forest of south-west Germany, common pastures, “Allmende”, are an emblematic feature of the traditional landscape, exhibit high-nature-value and are connected to the cultural heritage of common grazing (Bieling & Konold, 2014). The recognition of the southern Black Forest as an UNESCO biosphere reserve in 2017 directly connects to the preservation of common pastures (German Commission for UNESCO, 2017). In 2019, the biosphere reserve launched the project “Allmende 2.0” to develop pathways for sustainable grazing and landscape management (Black Forest Biosphere Reserve, 2020).

This article addresses the aforementioned endeavour of the biosphere reserve. One important challenge landscape stewardship in the southern Black Forest has in common with European mountainous regions are detrimental effects to the ecological (MacDonald et al., 2000; Recio et al., 2020; Schulz, 2015) and social (Hunziker et al., 2008; MacDonald et al., 2000; Vila Subirós et al., 2016) sphere brought about by under-use. Yet, this feature has been neglected in the debate on sustenance of European mountain commons even though it is characteristic for the context in many socio-ecological and commons studies (Bassi & Carestiato, 2016; Gatto & Bogataj, 2015; Premrl et al., 2015; Sutcliffe et al., 2014; van Gils et al., 2014). To our knowledge, there are five case studies applying socio-ecological frameworks on under-used common pool resources (CPR) in comparable socio-ecological contexts. Shimada’s (2015) case study on multi-level natural resource governance of Japanese semi-natural grasslands depicts governance changes to address under-use. Further, Miyanaga & Shimada (2018) stress drivers and consequences of under-use while Hirahara (2020) proposes elements that would help to solve this issue. In the Swiss Alps, Baur & Nax (2018, 2021) model policy responses to address under-provision and under-appropriation. None of the above-mentioned scholars has systematically applied Ostrom’s design principles (DPs) for validation to the under-use context. The case of the southern Black Forest demonstrates the suitability of applying a set of socio-ecological research frameworks to analyse common grazing with the goal to provide new

contextual and conceptual insights on the governance of under-use. In particular, we ask the following research questions:

- (1) What are organisational arrangements and socio-ecological components of common pasture organizations?
- (2) With the goal of increasing common pasture organizations’ resilience, which support measures and adaptations are required?
- (3) What changes to existing socio-ecological frameworks can be proposed to address common pasture resource management in an under-use context?

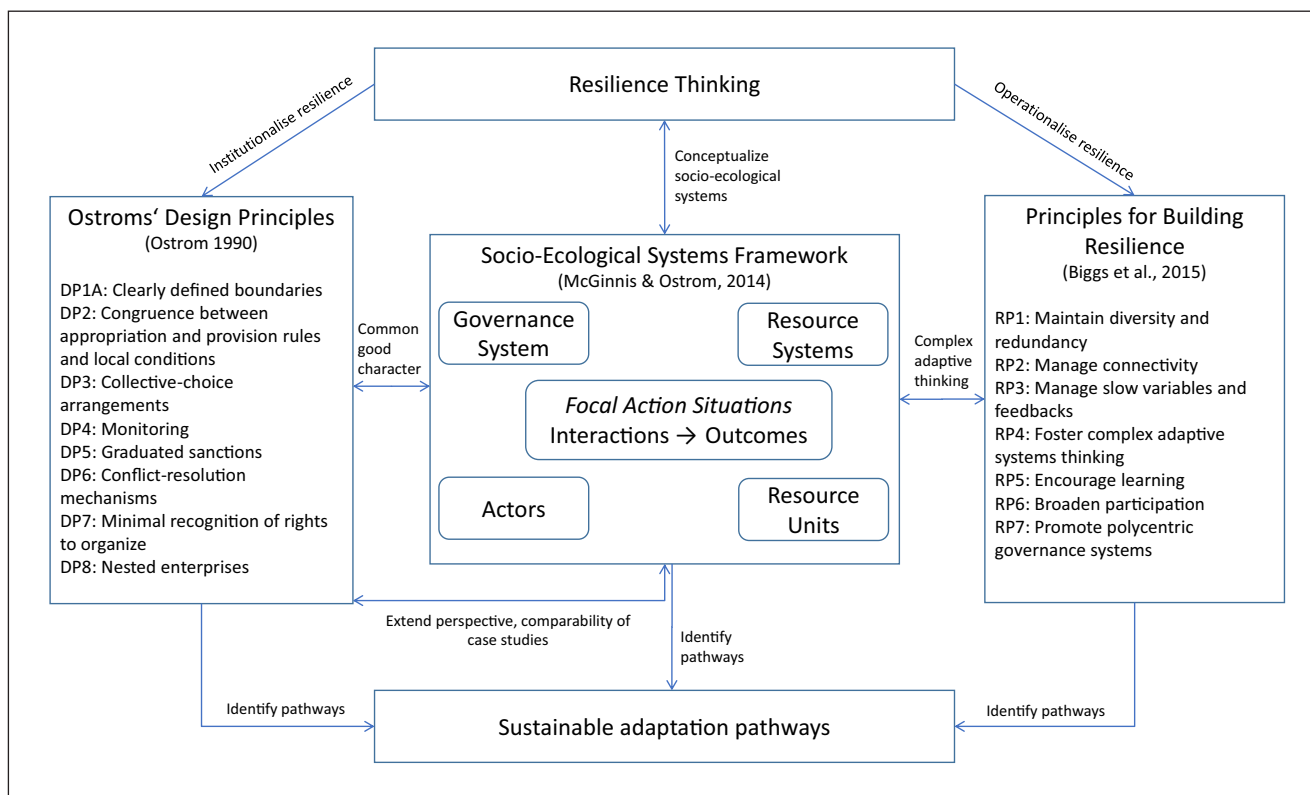
## 2 CONCEPTUAL ASPECTS

Our research draws on a set of socio-ecological frameworks, i.e. Ostrom’s DPs (Ostrom, 1990), the Socio-Ecological-Systems (SES) Framework (SESF) (Hinkel et al., 2014, 2015; McGinnis & Ostrom, 2014; Ostrom, 2007), resilience theory (Anderies et al., 2004; Biggs et al., 2015; Folke, 2006). These concepts are interlinked and partially overlap, but each provides a specific perspective on sustainable socio-ecological systems adaptation (cf. *Figure 1* for the conceptual relations), as we will demonstrate in this section.

In Ostrom’s textbook on commons’ governance (1990), eight DPs are proposed as a set of rule arrangements characterising sustainable governance of CPR. These DPs have proven to be relevant in various socio-ecological and governance arrangements (Baggio et al., 2016; Cox et al., 2010). To our knowledge, this is the first study applying Ostrom’s DPs to mountain pastures in Germany.

The SESF evolved on the basis of the empirical work on CPR systems, with the goal of advancing this research towards all socio-ecological systems regardless of the property rights regimes and to adequately address the interaction of both social and ecological realms (McGinnis & Ostrom, 2014; Partelow, 2018; Partelow & Winkler, 2016). SESF and Ostrom’s DPs have a common theoretical origin (Ostrom, 2007) and are connected in the sense that the set of (normative) prescriptions provided by the former are present in the latter, mostly in the “Governance System” tier (Partelow et al., 2018).

Resilience thinking, a concept used in both ecological as well as social sciences, describes a system’s ability to absorb perturbations (Holling et al., 1998), but also to transform, re-organize and develop when prompted by changing factors (Folke, 2006). The concept of robustness of SES is closely related to resilience theory (Anderies et al., 2013; Gatto & Bogataj, 2015), even though conceptual differences remain.



**Figure 1** Underlying conceptual links of Ostroms' DPs, SESF and Resilience principles.

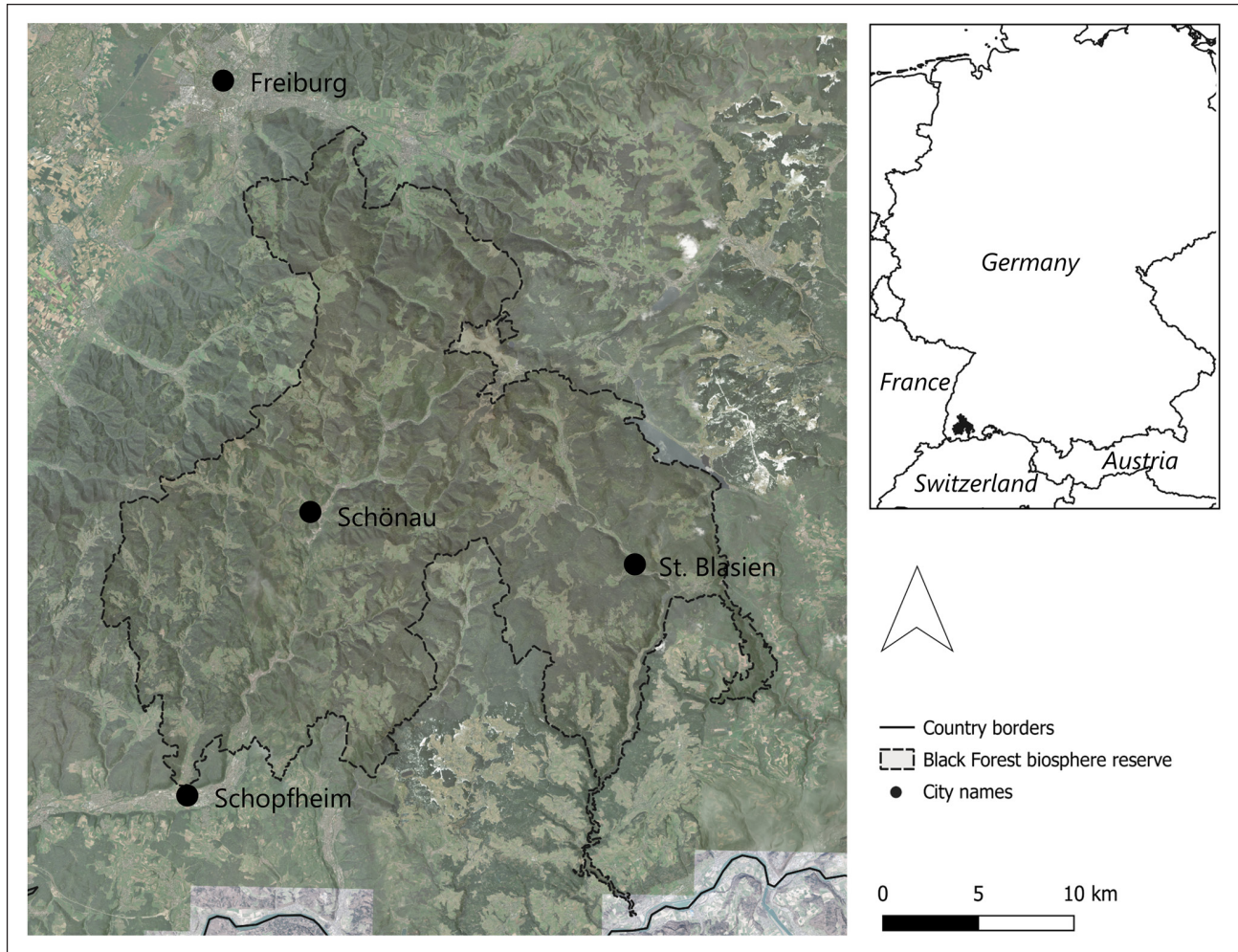
Both concepts are closely linked and applied to common studies (Anderies et al., 2004; Mosimane et al., 2012) as well as to the SESF (Leslie et al., 2015; Risvoll et al., 2014). While the DPs provide institutional resilience (Anderies et al., 2004), the SESF conceptualises complex adaptive thinking, a core of resilience thinking (Levin et al., 2013; Walker et al., 2002). One practical goal of resilience thinking is to identify mechanisms which promote a system's adaptive capacity. Drawing on a large empirical basis, Biggs et al. (2015) propose seven "Principles for Building Resilience" (resilience principles, RP, in the following) which provide intuition to operationalize resilience building measures of socio-ecological systems. As DP and SESF, RP can be applied to case study analysis and used for theory building. All three frameworks have been applied to CPR management (Cox et al., 2010; Mosimane et al., 2012; Partelow, 2018), however, not jointly.

### 3 CASE STUDY – COMMON PASTURE ORGANIZATIONS IN THE SOUTHERN BLACK FOREST

The southern Black Forest mountain range is the core of common grazing in the region. The study area comprises approximately 800 km<sup>2</sup>, of which roughly one-third are grasslands. A majority of this area (632 km<sup>2</sup>) is part of

the Black Forest biosphere reserve (cf. *Figure 2*). What distinguishes the southern part of the Black Forest from the rest of the mountain range are the wide open landscapes and an undulated topography ranging from 230 m to close to 1500 m above sea level. Climatic conditions are characterised by annual temperatures between 5 and 7 C° and precipitation between 1200 and 1900 mm without significant seasonal variability. Pasture season is usually from May to October. Pastureland has high ecological and societal value. Grazing activities are the basis for the designation of protected areas at national and European level and landscape based landscape-based touristic activities (cf. *Table 1*). Of all pastureland, approximately two-thirds are in municipal property, a part of which is still used for common grazing today.

While common pastures and their management in the southern Black Forest have been well-documented in German scientific reports (Budig, 1990; Hellgardt, 2013; Konold, 2004; Reif & Katzmaier, 1997), they have received little attention internationally (Bieling & Konold, 2014). As regards content, an emphasis has been placed on historic common pasture management, as well as on challenges in the 20<sup>th</sup> and 21<sup>st</sup> century for agricultural and landscape management. Reports neither acknowledge the drastic change that common pasture management in the southern Black Forest has undergone in the last thirty years, nor do they discuss its role for addressing challenges in



**Figure 2** Map of the Black Forest biosphere reserve in south-western Germany. The map was created using QGIS, Geographic Information System open source software. Base maps from ArcGIS are intellectual property of Esri and used herein under license.

VARIABLE	VALUES
Nature protected area by German law (ha)*	9.784
Nature protected area by European law (ha)*	25.922
Vascular plant species on German red list (n)*	110
Bovine animal heads 2019 (n) <sup>†</sup>	10.654
Inhabitants (n)*	38.000
Overnight visitors 2018 (n)*	2.301.000
Day visitors per year*	1.729.000

**Table 1** Socio-ecological characteristics of the Black Forest biosphere reserve. Data from \* Black Forest Biosphere Reserve (2021) and <sup>†</sup> Statistics Office of Baden-Württemberg (2021).

landscape stewardship. From 1979 to 2016, the number of farms in the Black Forest biosphere reserve dwindled from 1520 to 636 (own calculation based on data from Statistisches Landesamt Baden-Württemberg, 2021).

Concerning common pasture organisations (CPOs), many dissolved and pastureland was re-distributed among the remaining farmers. The area of commonly managed pastureland was reduced from 7.420 ha in 1990 to approximately 1.200 ha in 2019 (according to Geiger (1990) and own estimation), with the Black Forest biosphere reserve covering 15.926 ha of grassland (Brockamp et al., 2016). Two key changes in the governance structure also contributed to this process. A 2003 reform of the European common agricultural policy (CAP) changed the subsidy system from per animal head to per hectare payments (decoupling) while a 2014 reform necessitated linking agricultural area to one farm. These changes required CPOs to adopt a legal structure (forming an agricultural enterprise) and subsequently led to further issues (liability, taxation, fees for agricultural pension scheme, etc.).

In terms of this study, we identified 35 CPOs in the Black Forest that fulfil the definition of common grazing in the next section (cf. 4.1.).



## 4 METHODS

The methodology of this paper is rooted in qualitative empirical social-ecological science. We use a mix of methods for data collection (case study, semi-structured interviews, expert survey, focus group discussion). DPs (Ostrom, 1990, p. 90), SESF (McGinnis & Ostrom, 2014, p. 4) as well as resilience theory (Biggs et al., 2015; Folke et al., 2010) were used in the design of the data collection methods.

As the first author (F. B.) is working at the Black Forest biosphere reserve office for the project “Allmende 2.0”, we could draw on a network of regional actors involved with common pastures as well as on insider knowledge on land-use and governance systems. A co-author (C.B.) has extensive experience in carrying out research in the area and is part of the “Allmende 2.0”’s work group. The insider perspective, on the one hand, allowed us to formulate research questions having both practical and academic relevance, as well as to identify important aspects of the present socio-ecological system. This knowledge, in turn, facilitated the drafting of interview guidelines for the questionnaire. On the other hand, it also required us to reflect on assumptions taken in this work during the research process.

### 4.1 INTERVIEWS

Semi-structured interviews were carried out with CPOs’ leaders. The interview guideline comprised a list of pre-defined questions concerning the organisation’s recent development, its current situation, ambitions for future development, challenges, reactions to changes as well as questions aiming at the presence of certain institutional arrangements according to the DPs (Ostrom, 1990). Interviews were concluded by an open discussion on prospective development pathways.

For the selection of the interviewees, we first created a list of all CPOs still present today that fall within the following definition. As CPO, we consider (1) a group of at least three members engaged in pasture activities, (2) exercising its activities predominantly on common land (i.e. in municipal ownership), (3) holding own cattle or taking animals into agistment (i.e. the taking of other livestock owner’s cattle for the grazing season), and (4) with all members engaged in appropriation and provision activities. We identified a total of 35 pasture organizations fulfilling these criteria. The interviewees were sampled in an iterative theoretical sampling process. Interviews lasted between 45 to 75 minutes, depending on the quality and novelty of the information provided. Given that the simultaneous analysis of interviews revealed a saturation of information (variance) on the study’s key variables after

a total of nine interviews, we did not carry out further interviews. Since one interviewee had a central role in two CPOs, this adds to ten cases. All interviews were conducted outdoors between May and September 2020 by the first author.

Data analysis took place directly after the interviews. A transcript was produced and analysed in the qualitative data analysis software MaxQDA 10 (VERBI software). In a first step, coding focused on the arrangements in which Ostrom’s DPs are present in the sample (Ostrom, 1990, p. 90), but also included other aspects mentioned by the interviewees. This helped to highlight equivocal aspects that could be stressed in further interviews. A content analysis was conducted with all coded material.

In terms of the analysis of DPs, we checked how rules are implemented and which organizational structures exist. As it became clear during the process of interviewing that substantial aspects responsible for a successful management of CPOs were not addressed by these design principles, we decided to extend coding to the SESF’s 2<sup>nd</sup> tier variables (McGinnis & Ostrom, 2014).

### 4.2 EXPERT SURVEY AND FOCUS GROUP DISCUSSION

Building on the analysis of Ostrom’s DPs, SESF-variables and additional inductive codes identifying other interview material directly relating to research questions but not coded as DP or SESF variables, we drew up a list of nine support measures for CPOs. The action options either were mentioned during the interviews as (1) successfully implemented, (2) propositions for positive change or (3) could be derived from the challenges CPOs are currently facing. They match at least one RP, DP or SESF variable. We then conducted an expert survey to evaluate the anticipated effectivity of the measures, their feasibility and the actors that could promote their implementation. Interviewees as well as members of the biosphere reserve’s project “Allmende 2.0” working group, comprising 20 representatives from practitioners, scholars, municipalities, local and regional administration as well as the farmers’ union were asked to participate in the survey. The survey results and means of implementation were then discussed during an online workshop with 13 members of the “Allmende 2.0” working group.

## 5 RESULTS

In this section, we provide an overview of ten CPO structures, the organizational modalities of the design principles, SESF 2<sup>nd</sup> tier variables and support measures for building CPOs’ resilience. Ostrom’s DPs and SESF are matched with the

support measures to showcase their empirical support for these.

### 5.1 OVERVIEW

Black Forest CPOs are facing similar socio-ecological conditions and are confronted with comparable challenges. CPOs consist of 4 to 18 members and pasture size varies between 17 to 81 hectares. The governance setting is the same with the exception of the municipality, whose context-specific impact on CPOs' activities varies strongly. Livestock farming is a part-time activity for all CPO members, meaning that there is no financial dependence on grazing for sustenance. CPOs' activities are in line with maintaining the extensive pasture conditions and pastures' high ecological value. Yet, CPOs can be classified into two groups that exhibit substantial differences. These are traditional grazing collectives ("Weidegemeinschaften") and landcare groups ("Landschaftspflegevereine"). **Table 2** summarizes main differences between these two groups. These groups are not self-contained, with some CPOs exhibiting characteristics of both grazing collectives and landcare groups. The most important difference between landcare groups and grazing collectives in terms of their perception by local actors lies in their historical development. While the latter are traditional CPOs which date back for centuries of continued common grazing activities, the former were established in the 1990's by local people with the aim of preserving open land from forest overgrowth. These differing backgrounds translate into a series of structural differences. As **table 2** illustrates, the collective aspect of

landcare groups exceeds grazing collectives in aspects as pasture equipment, animals and investments. However, grazing collectives greatly appreciate the long tradition of common grazing, whereas landcare groups consider themselves as an innovation answer to changes in land use structures.

### 5.2 DESIGN PRINCIPLES

#### DP1: Clearly defined boundaries

For all CPOs, members are clearly defined (by either membership to or contract with the legal form of the CPO) and related resource boundaries set. Legal and administrative frameworks require the delimitation of pastureland to forests and assignment to an agricultural holding. Hence, fences are present for reasons of liability but also for pasture management. CPO members come from the municipality or locality the pasture is associated to. CPO members are those that are currently affected by appropriation and provision rules (DP2), while the realm of beneficiaries of wider ecosystem services (ES) produced, such as scenery, was not considered by our interview partners.

#### DP2: Congruence between appropriation and provision rules and local conditions

In the under-use context of pastures, provision and appropriation activities as well as local conditions include regulating under-provision of pasture quality in terms of pasture management, fencing, mowing or shrub cleaning. CPOs emphasise burden sharing instead of benefit sharing

REALM	VARIABLE	GRAZING COLLECTIVES	LANDCARE GROUPS
Members' situation	Demographic situation	Regional average and diverse situation	Mostly advanced age structure
	Link to grazing	Members are livestock farmers	Members are no active farmers, but some have a background in grazing
	Motivation	Preservation of the landscape, maintenance of tradition of collective farming, financial interests	Preservation of the landscape, social commitment, leisure activity
Resource	Pasture quality	Regional average in terms of productivity, high in terms of environmental value	Below regional average in terms of productivity, high in terms of environmental value
	Livestock	Dominance of cattle	Dominance of goats
	Property of pasture equipment (machinery, buildings, animals)	Dominance of private property, i.e. of the individual member	Dominance of collective property, i.e. of the landcare group
	Use of financial gains	Division among CPOs' members	Investment in pasture equipment towards a continuity of CPO
Legal framework	Legal form	Mostly private corporations ("Gesellschaften bürgerlichen Rechts" according to German federal law)	Mostly associations ("eingetragene Vereine" according to German federal law)

**Table 2** Distinction of common pasture organisations: grazing collectives and landcare groups.

to address the challenge of ensuring enough provision of pasture management services needed to maintain the environmental and societal values. Pasture appropriation services include fodder supply (rearing animals, meat production, etc.) and public financial support. The latter aspect is of particular importance for CPOs' activities given the high financial gains agri-environment-schemes can provide compared to low productivity levels of the grassland and animal value. Pasture provision includes elements that are fulfilled individually (e.g. checking cattle and fences on a daily basis) or collectively (e.g. clearing woody plant encroachment, entertainment of pasture infrastructure, etc.). Traditionally, provision was assured in the form of compulsory work duties ("Fronddienst") for cattle brought to common pastures. Nowadays, provision requirements have adopted a liberal form, for instance in offsetting CPOs' members' supplied manual or machine provision by higher financial appropriation levels. In grazing collectives, congruence of appropriation and provision aligns on a gradient from compulsory to self-contained execution of provision activities (i.e. compulsory provision duties, provision targets combined with financial compensation, voluntary provision levels and financial compensation). Financial appropriation levels in landcare groups are lower than in grazing collectives, since in landcare groups, infrastructural costs related to goat farming are covered by the CPOs, whereas such costs in grazing collectives must be covered by the individual farmers. Further appropriators, such as local population and tourists, were mentioned by three CPOs as using pastures for leisure activities.

### **DP3 – Collective choice arrangements**

All CPOs studied in this context provide collective choice arrangements that allow appropriators to change operational rules. In the cases of CPOs that do have the legal form of an association (mostly landcare groups), collective choice rules are defined in the organizations' statutes. Despite this, acceptance and execution of operational choice decisions relies on CPOs' members' consent and is expressed informally. CPOs' decision-making depends on the level of magnitude of the decision. Day-to-day decisions on pasture management are taken directly by either the CPOs' chairperson or herder. Aspects with medium-term impact such as modifying pasture rotations or discussing pasture maintenance require consultation and exchange with CPOs' members and are taken in informal meetings. Long-term decisions that impact CPOs' functioning, setup, financial aspects and collective choice rules are taken at general meetings on an annual basis.

### **DP4: Monitoring**

Monitoring of appropriators' provision activities is present to differing extents in seven out of ten CPOs. Chairpersons

or herders control the reported provision activities on a monthly or annual basis, relying on members' or herders reporting. The absence of active monitoring of provision activities in the remaining CPOs is due to the inexistence of incentives for abusing appropriation (i.e. no financial gains) or mutual trust. One grazing collective recently abandoned strict monitoring, a move that was considered as a sign of future-oriented collective action. However, this case illustrates that factual monitoring could be intermitted due to the presence of arenas for trust building, a preponderance of joint provision over individual work duties and a small number of appropriators. In addition, monitoring in this case goes beyond conventional audits. Transparency of each member's provision and appropriation activities, arenas for communication and collective choice decisions are as much a means of incentivizing adherence to operational rules as active audits. The monitoring of resource state is conducted in accordance to provision rules (DP2) by CPOs' members or herders. These influence pasture management, i.e. fertilization strategies, pasture rotations.

### **DP5: Graduated sanctions**

Formalized or institutionalized graduated sanction systems are present in two CPOs. Even though a small degree of freeriding on joint provision activities or other minor internal conflicts are inherent to CPOs, the implementation of severe sanctions was rarely an option. Verbal admonitions or warnings by CPOs' chairpersons or herders, presumably as a first level of sanctions, often suffice in this respect. One example of a graduated sanction system is from one grazing collective, whose member was excluded from the common pasture as a final step after several increasingly severe sanctions due to repeated and multiple violations of operational rules (insufficient provision, unreliability, and insufficient care for animals).

### **DP6: Conflict-resolution mechanisms**

The degree to which conflict-resolution mechanisms are present, active and institutionalised, varies across the sample CPOs. In one municipality, a structured and multilevel conflict resolution approach exists, which involves a municipal staff member, a representative of the municipal council, and the chairperson of the federating common grazing collective of the municipality. This tripartite mediation body is defined in the municipality's pasture charter ("Weideordnung"). In the other cases, informal and formal CPOs' meetings are used as arenas for conflict resolution.

### **DP7: Minimal recognition of appropriators' rights to organize by external governmental authorities**

CPOs existence and rights to self-organize are not challenged by municipalities (legal owner of common pastures)

or any government authority. Yet, the degree of autonomy that CPOs are granted by municipalities varies from case to case. This concerns, for instance, CPOs' autonomy to decide on the amount of cattle each appropriator can bring to the pasture. On a more general level, decision-making of CPOs is constrained by legal, administrative and funding requirements. In order to fulfil legal and administrative constraints, such as being eligible to support schemes or to be covered by insurances, CPOs were driven with the 2003 CAP reform to constitute a legal form that would be accepted by state authorities. In many cases, CPOs devised around the legal form of private corporations ("Gesellschaften bürgerlichen Rechts" according to German federal law) to meet this requirement. This led to a mismatch between customary CPOs and private corporations. Members of CPOs include all those who appropriate of or provide to CPOs, whereas private corporations only constitute a legal body for fiscal and judicial issues. These corporations are often formed by some CPOs' members only or even outside of the circle of the CPO.

#### **DP8: Nested enterprises in the organization of the aforementioned principles**

Currently, nested enterprises as meant by this design principle do exist only in the case of one municipality. Since this municipality consists of several localities and common pastures in each locality form separate entities, a head organization interlinks CPOs and municipality. In addition, this head organization serves as mediator in case of conflicts, distributes cattle between the CPOs, etc. Next to this, machinery associations exist at the level of each locality, which support local farmers in collectively buying, using and maintaining farm machinery. CPOs complex multi-layered structure is framed in the municipality's pasture charter. This situation is a harsh contrast to CPOs from other municipalities, where nested structures do not exist. There, CPOs and municipalities are main actors to be considered for decision-making with varying autonomy of CPOs.

### **5.3 SOCIO-ECOLOGICAL SYSTEMS FRAMEWORK 2<sup>ND</sup> TIER VARIABLES**

*Table 3* provides an overview of SESF 2<sup>nd</sup> tier variables according to McGinnis & Ostrom (2014). These variables mentioned by interviewees without further prompting, thus underlining their importance. The following sections describe the variables that go beyond the scope of Ostrom's DP and have relevance for CPOs' resilience in terms of their applicability to support measures.

#### **S4: Other governance systems**

In addition to the requirement to adapt legal frameworks (DP7), the common pasture category ("Gemeinschaftsweide") was eliminated with the 2014 CAP reform in the application for support schemes. At the local level, municipalities' outdated pasture charters (DP6) and partial hands-off approach in common pasture-related issues underline the decreased importance attached to common grazing. CPO members claim that fiscal consequences from the adopted legal frameworks discriminate against common grazing and against CPOs members in particular. CPOs' revenue transfer to their members is subject to taxes that would not arise if pasturelands were discretely managed.

#### **RS4: Productivity of system**

The southern Black Forest's common pastures produce relatively low amounts of fodder but high levels of ES in comparison to other grassland in the region. Extensive grazing is widely agreed upon as optimal for sustaining ES production. In recent years, pasture productivity has decreased due to compliance to contractual nature protection schemes which constrain CPOs from spreading manure. More manure would increase productivity but potentially lead to a loss in biodiversity. In addition, existing agricultural policies are contradictory to ecological goals, since they favour homogeneous vegetation structures that fulfil the eligibility criterion for basic support schemes. Furthermore, livestock density at times is too low to ensure the grazing intensity required to sustain local pasture quality (DP 2).

#### **A2: Socioeconomic attributes**

CPOs' members usually work in a secondary sector, such as commerce, industry or crafts. The demographics of CPOs vary. Some grazing collectives are characterised by an ongoing generational change, whereas others show the advanced average age of farmers in the southern Black Forest. Furthermore, demographics play an important role for landcare groups. Overaging of members threatens the ability of landcare groups to fulfil provision activities.

#### **A5: Leadership**

All CPOs studied here are characterised by the presence of leaders. These are chairpersons or herders who take on key roles in CPOs' operations (DP3 and DP4). Interviewees in this study are leaders of their respective CPOs. CPOs' leaders hold a wide array of roles (i.e. federating members, initiating change, monitoring, conflict resolution, and representation). Negative effects of leadership were reported in one CPO, where an overly dominant herder deters new members from entering the organization.



SESF VARIABLES	2NT TIER VARIABLES	VARIABLE SUMMARY
S (Social, economic, and political settings)	S4 Other governance systems	CPOs and common grazing are considered increasingly less important in local to state governance systems.
RS (Resource systems)	RS3 Human-constructed facilities	Pasture infrastructure includes fences, provision of drinking water for cattle, stable or shelters and machinery. This infrastructure is either owned by CPOs or CPOs' members. Infrastructural support by municipalities exists in some cases.
	RS4 Productivity of system	Pastureland is unproductive but exhibits high ecological value. Agri-environmental schemes incentivize / favour non-intensive grazing.
	RS6 Predictability of system dynamics	Pasture dynamics are relatively well predictable (constant rainfall, vegetative season from April to October). In recent years, summer droughts occurred, as a foreboding of increased weather variability induced by climate change.
RU (Resource units)	RU4 Economic value	The economic value of the resource lies in its ability to generate agricultural subsidies, which exceeds pasture productivity.
	GS4 Property rights system	Since communal property reform of 1966, municipalities are, de jure, owners of common pastures in the southern Black Forest. CPOs are "claimants", i.e. they withhold access and withdrawal, as well as management rights.
	GS7 Constitutional choice rules	Formal constitutional choice rules have reduced importance of CPOs' activities. Leadership and readiness of CPOs' members to take on responsibilities are decisive for constitutional and operational choice rules.
A (Actors)	A2 Socioeconomic attributes	CPOs' members originate from the municipality of the pasture and are predominantly male.
	A3 Historic or past experiences	Grazing collectives have a long tradition in the region. However, administrative requirements at the beginning of the 21 <sup>st</sup> century led to important transformations in pasture systems (cf. DP 7). Landcare groups were established in the 1990s by local people with the aim of preserving open land from vegetation overgrowth.
	A5 Leadership	Chairpersons and herders take on important roles in CPOs (cf. DP 3). Leadership is an important aspect to functioning of CPOs.
	A6 Norms, trust, social capital	Social cohesion, mutual trust and following norms are important elements of CPO functioning.
	A7 Knowledge of SES, mental models	CPOs' socio-ecological-systems knowledge and mental models are distinctive for the functioning of common grazing. Both are important for sustaining CPOs' activities.
	A8 Importance of resource	Pastures generate economic value important for landscape sustenance (cf. RU4). Next to this, pastures have ecologic, cultural and touristic importance that goes beyond the scope of CPOs.
I (Interactions)	I2 Information sharing	In most CPOs, there are arenas for low-cost and efficient information sharing (cf. DP3).

**Table 3** SESF 2nd tier variables mentioned in interviews.

### A6: Norms, trust, social capital

Social cohesion, trust and shared values are important for CPOs. To this end, arenas for communication are established (DP6). Another aspect that is mentioned is that having shared values, knowledge and motives of common grazing is beneficial for building cohesion. For instance, grazing collectives say that it is important that all members are farmers and hold cattle over winter. Fulfilling these conditions assures similar levels of knowledge on grazing, a sense of responsibility for cattle, dual obligation of helping in CPOs and having another farm enterprise next to it. Another aspect mentioned for building cohesion and trust is in sharing responsibilities and empowering CPOs' members to take decisions and provide initiatives.

### A7: Knowledge of SES, mental models

Formal qualifications (vocational training, studies) in agriculture or grazing do not exist among CPOs' members. Hence, practical and ecological knowledge relies on traditions and learning from neighbouring farmers. Main motivations of CPOs' members include landscape maintenance, keeping up traditions, and seeing the activities as a meaningful task next to a full-time job. Common grazing is considered to have positive effects on social aspects (community building, reduction of individual workload) and in ecological regards (high cattle numbers allow for more flexible pasture management). In addition to this, nature protection is viewed as a by-product of grazing. In recent years, subsidies from environmental schemes

increased consistently (SESF-RS4). The resulting decrease in productivity of fodder plants is viewed negatively by CPOs regardless of the potential increase in ecological value. This development illustrates CPOs members' mental models focusing rather on the role of farming for production of provisioning ES than regulating or cultural ES.

#### A8: Importance of resource

CPOs' dependence on pastureland is due to its ability to generate subsidies, rather than due to a productivist understanding of pasture as a resource. Without these financial aids, CPOs would be hard pressed to survive. However, the amount of subsidies is subject to political decisions that are, mostly, unaffected by CPOs' behaviour. In addition, pastures exhibit cultural and touristic importance that go beyond what is covered by CPOs and the characterized governance systems (SESF-S4).

### 5.4 SUPPORT FOR BUILDING CPOs' RESILIENCE

Support measures for building CPOs' resilience were compiled by carefully analysing and combining elements that interviewees stated as existing challenges, desirable changes and successfully implemented innovations to CPOs by the first author. A total of nine support measures was proposed and these were subject to both expert survey and focus group discussion. These measures link with design or resilience principles, or SESF variables (cf. [Table 4](#)) in the sense that they address issues that were identified as crucial by applying the above-mentioned frameworks.

The expert consultation revealed a consensus that specific support schemes for CPOs are required and that, conversely, doing nothing would worsen the situation. The efficacy of all measures was overall positively assessed, even though support levels vary. During the focus group discussion, it became evident that actual implementation depends on the respective actors' readiness, capacity and sense of responsibility for common grazing.

## 6 DISCUSSION

### 6.1 COMBINING DIFFERENT APPROACHES

As we have demonstrated in section 2, DPs, SESF and resilience thinking are interconnected concepts (Anderies et al., 2004; Partelow et al., 2018). Yet, each concept provides its own analytical articulation in addressing socio-ecological systems. Integrating these approaches into one case study allows for theoretical advancements through reinforcing framework perspectives (Folke et al., 2013; Partelow, 2018) as well as for a multifaceted understanding of practical management issues. For example, Ostrom's DPs suggest that certain aspects of the institutional architecture of CPOs, i.e. a consistent setup of rules and rights in

governance, forms the basis for sustainable resource use. In addition to this, SESF provides a unified vocabulary to study CPOs as one entity, i.e. to integrate social and ecological aspects (Cole et al., 2019). Resilience thinking is suitable for analysing evolutions of socio-ecological systems and drawing conclusion on how to navigate them. In this study, this leads to insights on resilience-building that allow for the CPOs-system to thrive (Folke et al., 2010). In case studies of (common) grazing systems, scholars tend to apply a single framework (Bassi & Carestato, 2016; Baur & Binder, 2013; Eychenne & Lazaro, 2014; Risvoll et al., 2014). One challenge for bridging the above mentioned frameworks lies in harmonizing underlying hypotheses and terminology (Partelow et al., 2018). The conceptual understanding we propose ([Figure 1](#)) allows to recognize that concepts and suggested pathways overlap. For instance, collective choice arrangements (DP3), manage connectivity (RP2) and deliberation processes (I3) follow the hypothesis that those concerned by the outcomes of decision-making processes must have a say in this for successful collective action; i.e., they all call for participation. Likewise, nested enterprises (DP8), polycentric governance (RP7), and the maintenance of diversity and redundancy (RP1) share the idea that institutional resilience relies on multifaceted governance structures, which provide checks and balances as well as openness to innovation. SESF-variables such as knowledge of SES and mental models (A7) or norms, trust, social capital (A6) advance understanding of CPOs and highlight feedback loops for complex adaptive thinking (RP4) and concurring appropriation, provision and local conditions (DP2).

In accordance with our research questions and research design, we focus on Ostrom's DPs in making use of complementarities and differing articulations of SESF and resilience thinking in an under-use situation. This tripartite analysis of rich contextual data allows for a theory-informed reconsideration of Ostrom's DP in the under-use context of the southern Black Forest.

### 6.2 TOWARDS FORMULATING DESIGN PRINCIPLES FOR UNDER-USE SYSTEMS

The application of Ostrom's DPs shows that institutional arrangements are essential parts of southern Black Forest CPOs, but that the level of importance of these modalities varies. Scholars have agreed on case specificity as a prime principle, and consequently, on the need to find tailored responses to contextual governance challenges of socio-ecological systems (Cox et al., 2010; Hinkel et al., 2015; Ostrom, 2007; Schlüter et al., 2015). Yet, use dynamics of southern Black Forest CPR distinguish the set-up in this study from traditional case studies of common-pool resources affected by challenges of over-use, which

MEASURE	MEASURE DESCRIPTION	ASSESSED EFFECTIVITY (NUMBER OF VOTES FOR “EFFECTIVE”/ “EFFECT UNCLEAR”/ “INEFFECTIVE”)	ACTOR GROUP PROPOSED FOR IMPLEMENTATION	LINK TO FRAMEWORK COMPONENTS TARGET BY MEASURE
Continuous consulting and advisory services	Establishment of voluntary annual or bi-annual meetings for each CPO with an advisor to facilitate exchange between CPOs and administration, following CPOs’ development and needs.	12/2/1	Agricultural and nature protection advisory agents	RP2, RP5, SESF-A7
Inter-connecting CPOs	Provide an arena for discussing issues common to all CPOs, such as dealing with pressing challenges, adjustments of institutional rules or meeting administrative requirements.	10/2/3	Agricultural advisory agents and Black Forest biosphere reserve	RP1, DP8, SESF-A5
Federating CPOs in higher-level organization	Establishment of a higher-level association of CPOs. In addition to interconnecting CPOs and serving as a basis for addressing internal issues (including conflict resolution, institutional rules, etc.), a higher-level association could be active in lobbying and representing CPOs’ interests.	9/2/4	Black Forest biosphere reserve and agricultural advisory agents	RP1, RP2, RP5, RP7, DP8, SESF-A5
Addressing legal and fiscal issues	Regardless of legal form, CPOs expressed the need to address fiscal and legal issues. This measure proposes to bring together relevant actors in this field and to jointly look for solutions.	12/3/0	Farmers’ association, administration, CPOs, independent tax consultants	RP4, RP7, DP6, DP7, SESF-S4
Pasture festival – improving visibility, appreciation and added value of CPOs	An existing festival organized by a landcare group is a means to showcase common grazing, to strengthen visibility and appreciation of this unique feature and to have a positive financial effect. Extending this model to other CPOs seems possible given the popularity of existing pasture festivals.	12/3/0	CPOs, municipalities	RP5, RP6, DP1, SESF-A6
Making CPOs attractive for new members	This proposal addresses CPOs facing low levels of appropriation and provision and that would be open to extend membership. Activities in this respect include (1) increasing visibility of CPOs, (2) calling attention to the need of adding members, (3) increasing attraction of CPOs’ membership (for instance by allowing machinery use for private purposes).	8/3/4	Municipalities, CPOs	RP3, RP6, DP1, DP2, SESF-A2, SESF-S4
Making provision activities more attractive	This proposal addresses CPOs facing low levels or unequally distributed provision activities. By increasing the assumed payoff for provision activities (wage rate for work effort), the balance between appropriation and provision can be re-established towards the required level for CPR sustainment.	6/8/1	CPOs	RP6, DP2, SESF-A8
Infrastructural support	Providing special support for services of fencing and water supply for cattle (fencing material, maintenance, renewal of existing infrastructure) to CPOs would make investment in these activities more attractive.	11/2/2	Municipalities	DP1, SESF-RS4

MEASURE	MEASURE DESCRIPTION	ASSESSED EFFECTIVITY (NUMBER OF VOTES FOR “EFFECTIVE”/ “EFFECT UNCLEAR”/ “INEFFECTIVE”)	ACTOR GROUP PROPOSED FOR IMPLEMENTATION	LINK TO FRAMEWORK COMPONENTS TARGET BY MEASURE
Lobbying for CPOs and protecting CPOs from dissolvent	In order to prevent further individualization of grazing, CPOs call for a statement of preference of municipalities of common over individual grazing. The proposition also includes preferential treatments of common grazing in terms of infrastructural support as well as preferential access to pastureland owned by municipalities.	9/5/1	Municipalities	DP7, SESF-A6

**Table 4** Support measures for building CPOs’ resilience. Effectivity assessment took place in the expert survey and the proposition for actor groups responsible for implementation in focus group interviews. Measures’ link to the following frameworks are depicted: RP = resilience principles, DP = Ostrom’s design principles; SESF = respective 2<sup>nd</sup> socio-ecologic-systems framework variable (cf. Figure 1).

have been used for inferring the empirically validated DPs. Shifting from an over-use problem to an under-use-problem alters systems’ functioning fundamentally. As we have pointed out previously, under-use problems in CPR management have gained little attention thus far. In addition, there is only a scarce empirical knowledge-base on what under-use situations mean for DPs (Hirahara, 2020; Miyanaga & Shimada, 2018; Shimada, 2015). In the case of southern Black Forest CPRs, under-use occurs as resource dependence shifts on the traditional practitioners’ level from livelihood sustenance and appropriators’ need towards appropriators’ self-determined motives (i.e. identity building, culture, landscape maintenance, nature protection). In addition, new actors such as tourism and local population are directly benefiting from farmers’ landscape stewardship, without contributing. This aspect, upon which we will expand in the next section, should receive strong consideration in the DPs for under-use contexts (in particular DP1, DP2, DP7, DP8). Likewise, incentive structures for grazing moved from the economic value of grass fodder for producing food to financial compensation for overall ES production, but with the collective aspect being left out both by European and regional scale policies. Regional actors such as municipalities and farmers’ associations lack feasible strategies and lobbying power to strengthen the role of common grazing, which is being ignored by European CAP. Despite differing socio-ecological and governance contexts, this reconsideration (for DP1, DP2) is in line with Shimada’s (2015) previous analysis of under-use CPR governance. This research advances the scope of analysis in structurally applying the Black Forest case to DP, SESF and RP. This allows for a framework-based discussion on reconsideration or potential adaptation of DPs in under-use contexts.

Resource boundaries (DP1): The existing DP considers clearly defined boundaries as key for restricting access

of land and preventing resource exploitation. Cox et al. (2010) disaggregate this DP into resource and social boundaries. In the under-use context of the Black Forest case, the boundaries of resource and social systems that interviewees perceived as clearly defined lead to negative socio-ecological consequences. A clear-cut distinction of natural entities (i.e. assignation of agricultural land, forests and land for nature protection) specified in support schemes (SESF-RS4, SESF-A8) disaggregates landscape units, which from an ecological perspective should be managed in an integrated way (Erds et al., 2018). Moreover, taking full advantage of the resource has been made subject to external governance schemes (such as CAP and its application, national tax systems, social security system) that discriminate against collective grazing (DP7). Social boundaries in our case study are currently fixed to CPO members. However, the evolution of landcare groups in the under-use system next to grazing collectives illustrates appropriators’ extension beyond the range of traditional farmers. A DP on boundaries in under-use systems might acknowledge the requirement of including wider ES producers and beneficiaries (e.g., tourists) and thus extend the actors’ range for service provision needed to maintain resource quality. Expansion of the range of participants and widening social boundaries have already been discussed (Hirahara, 2020; Shimada, 2015), even though there is no consensus if these should be open (Göttl & Penker, 2020) or clearly defined (Penker, 2017). Resilience thinking suggests broad participation (RP5) but acknowledges the requirement of managing boundaries (RP1, RP2). Studying the emergence and development processes, agents and modalities of broadening participation as a successful element of under-use CPR management would provide further valuable insights.

Congruence between appropriation and provision rules and local conditions (DP2): Our findings suggest



congruence between provision and appropriation of the natural resources in differing arrangements suitable for the context of CPOs. However, given the notion of broad boundaries (DP1) in under-use situations, congruence does not aim at attaining a certain carrying capacity (over-use in the given Ostrom DP), but minimum landscape stewardship services needed to sustain the resource (under-use). This highlights that congruence of appropriation and provision with local conditions is only partial. In fact, CPOs' provision activities focus on sustaining natural CPR aspects (provision of cattle and manual work) whereas appropriation emphasises financial aspects. Cox et al.'s (2010) disaggregation of this original DP into a dual understanding of "appropriation and provision rules congruent with local social and environmental conditions" (2010, p. 15) is useful for illustrating missing arrangements in Black Forest CPOs. Congruence with environmental conditions is influenced by external requirements (compliance with legal framework and adherence to agri-environment support schemes). The extension of CPOs to social and ecological realms (in particular SESF-RS4, SESF-A6, SESF-A7, SESF-A8) and resilience theory (RP2, RP4) showcases missing feedback loops. Livestock densities are often too low from an ecological perspective due to ill-fitting incentives of agricultural policy (payments are per hectare instead of per animal heads). We suppose that mountain common pastures across Europe face this same issue. Baur & Nax (2018) identify the same shortcoming in the context of under-use in the Swiss Alps. They propose increasing provision requirements and incentivizing overprovision or appropriation subsidies as starting points for Swiss policy makers (Baur & Nax, 2021). A further aspect that we want to put forward is that in under-used grassland systems, provision and appropriation are reversed from their initial understanding. As incentives move from grass fodder to financial compensation, livestock becomes a means (provision) of CPOs rather than its end (appropriation). Consequently, the main difference between the original DP and one that proves useful for under-use cases is in changes in the variables' (appropriation, provision, local, societal and environmental conditions) interaction, rather than in a need of additional variables.

Monitoring (DP 4): Due to the under-use configuration, CPOs monitoring activities focus on fulfilling animal and work provision requirements rather than exceeding levels of appropriation, as in over-use situations. Concerning the pastures' environmental state, government actors monitor pasture conditions and compliance with both agricultural and nature protection regulations, whereas CPOs' members focus on adapting pasture management to changing environmental and local conditions (RP1). Our research shows that, on the one hand, formal monitoring

of CPO's members can become obsolete if certain factors of CPOs change (i.e. congruence of appropriation and provision rules, small group size, and absence of financial incentives in landcare groups). On the other hand, the presence of financial interests in grazing collectives requires some kind of, at least, informal monitoring. The reduced or adapted function of monitoring of CPOs is also reported in other case studies on European common pasture organizations in under-use configurations (Gatto & Bogataj, 2015; Premrl et al., 2015; van Gils et al., 2014). Monitors' presence and accountability to resource users as central notions in Ostrom's (1990) DP 4 are not contested in the under-use context. One way to achieve sustainable under-use CPR management and ES production could be to place more emphasis on monitoring burden-sharing within beneficiaries of landscape stewardship instead of monitoring appropriation or provision services within CPOs. To ascertain this, further research is required to understand how implicit monitoring in CPOs functions and how this interacts with the external monitoring of the resource users' group (i.e. compliance with legal and support scheme requirements).

Recognition of appropriators' rights (DP7): Our results show that minimal appropriator rights to organize and take decisions are not challenged by municipalities, which suggests that the original DP is fulfilled. Yet, external governance requirements, such as the need to adopt a legal framework recognized by the governance system for controlling nutrient supply to pastures, impede the ability of self-relying CPOs to make decisions and thus hamper CPOs' autonomy (RP7). Regardless of over-use or under-use systems at hand, the analysis of rights and duties is crucial for Ostrom's DPs SESF and resilience theory (Partelow, 2020; Schlager & Ostrom, 1992). But what is distinct in under-use situations is the notion of duties and burden-sharing. On a theoretical note, as resource dependence of appropriators decreases with a situation changing from resource over-use to under-use, so too will their willingness to cope with imposed constraints, such as prohibiting manure spreading. This is why managing users' rights and duties in under-use situations requires particular caution when incentives for CPR use are small. For instance, CPOs' members' mental models (A7) favour the aspect of commodity production over being landscape stewards. We argue that the main rationale in the unequal appreciation of "agriculture" and "landscape management" among providers and appropriators stems from different levels of autonomy and self-fulfilment enjoyed by farmers, as providers. Meat, as an output of grazing activities, is a farmer's sovereign product in contrast to landscape, for which farmers have to follow predefined and societally agreed upon rules. Further research could clarify if DP7 in under-use situations requires a certain ratio

of autonomy and top-down decisions. A working hypothesis could be that this ratio is positively correlated with the level of burden shared by these appropriators for ES production in the under-used CPR.

The support measures proposed by CPOs' members illustrate the requirement to adapt institutional arrangements and rearrange governance systems within and beyond Ostrom's DPs. Most influential in that regard are the principles for building resilience. While Ostrom's DPs describe already established institutional arrangements that provide resilience, the RPs highlight transformative pathways towards resilience. In the case of southern Black Forest CPOs, arenas that encourage learning (RP5) or foster complex adaptive systems thinking (RP4) are either missing or ineffective. In addition, CPOs' structures exhibit low levels of connectivity (RP2) with only one case exhibiting positive polycentric governance (RP7). Further case studies with comparable contexts, such as on under-used European mountain pasture commons, are encouraged to broaden the understanding of institutional adaptations of CPR users' groups and to move towards a conceptual framework on sustainable management of under-use CPRs.

### 6.3 WAYS FORWARD FOR PRACTICAL COMMON PASTURE MANAGEMENT

As previously pointed out, CPO members are concerned with decreasing pasture productivity because of reduced nutrient feedbacks to pastures. Resilience thinking in changing socio-ecological contexts suggests equally maintaining an ecosystems' provisioning, regulation and cultural ES (Biggs et al., 2015; Partelow & Winkler, 2016; Plieninger et al., 2014). Consequently, governance should allow multifaceted land use intensities and management diversity, an end to which integrating practitioners' SES knowledge and concerns is a suitable means (Winter et al., 2011).

A driver for common grazing's decline in the last decades is a lack of attention for the issue on state to local governance levels. The importance of identifying a legal framework adapted to CPOs' legal and fiscal requirements was underlined in interviews and during expert discussions. It was also made clear that local and regional actors must put more effort into adapting CPOs. This point ties into the EU's CAP, which causatively provides room to manoeuvre for regional to local actors. The interplay of European, national and regional legislators in the design of agricultural policies for common grazing was not a focus of our study design. Nevertheless, these findings stress the need to integrate common approaches in agriculture into agricultural policies at all levels.

Given the demographics of CPOs, particularly fragile in landcare groups, other actors need to work towards sustainable development and preservation of common grazing in the southern Black Forest. Even though this

study focuses on CPOs, it has become apparent that the changes accompanying the under-use context call for an increased accountability of all beneficiaries from ES production. Considering Ostrom's DP, landscape-level congruence of provision and appropriation of all beneficiaries (Penker, 2017; Shimada, 2015) is one principle that is currently unfulfilled. For instance, local population and tourism are two actor groups taking advantage of the landscape but contributing insufficiently. Public landcare days ("Landschaftspflege tage") provide occasional opportunities for the general public to support CPOs (Bieling & Konold, 2014). However, these rely on voluntary action and would require support in organizing and advertising such events to a much broader audience. Tourism also benefits from the southern Black Forest landscape, but does not contribute to landscape provision activities. To shrink this gap, the municipality of Münstertal adjoining the Black Forest biosphere reserve has been the only municipality in Germany transferring a portion of the visitors' tax (Kurtaxe) to goat farmers for the past 20 years (Liesen & Coch, 2015 and personal statement). Due to the COVID-19 pandemic, the Black Forest experienced extraordinarily high numbers of tourists seeking nature escapes in summer 2020, during which we conducted fieldwork. This development sparked discussions about new strategies for sustainable tourism management. These discussions would be an ideal opportunity to consider tourism's support of livestock farming, which has not occurred so far.

## 7 CONCLUSION

In this study, we used DP, SESF and resilience thinking to identify challenges that southern Black Forest CPOs are facing and propose theory-informed measures to address these. Given the under-use context characterising common pastures in this study, and drawing on empirical insights, socio-ecological and resilience theory, we made propositions towards modifying existing design principles and highlighted elements that can serve as starting points for new principles. These are, most importantly (1) broaden social boundaries to include all actors benefitting from the resource, (2) achieve congruence of provision, appropriation and local conditions that focus on how sufficient levels of landscape stewardship can be attained within CPOs, but also include new potential beneficiaries for burden sharing, (3) match appropriators' rights and duties as well as incentives for and motivations of CPR management. The CPOs under study exhibit a rather homogeneous perspective of CPR management, by providing an example of common pasture management in a mountainous region in Western Europe. Further case studies identifying challenges for sustainable CPR use in various under-use

context are required to allow a better understanding of what these systems have in common.

Concerning practical development pathways for southern Black Forest CPOs, we suggest a holistic understanding of social and ecological dimensions and advocate multi-level governance. In a context in which the importance of common pastures shifts from provisioning services to regulating and cultural ecosystem services, actor groups outside the range of CPOs are called on to assume responsibility. The Black Forest biosphere reserve provides an adequate arena to address this. In this sense, sustainable development of common pastures might imply systemic transformations. In this process, adaptations the CPOs have been and still are dealing with are only one phase. In order to successfully further this transformation, it is vital to follow resilience principles.


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## COMPETING INTERESTS

The authors have no competing interests to declare.

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