Rural social–ecological systems navigating institutional transitions: case study from Transylvania (Romania)

Tibor Hartel,[1,9] Kinga-Olga Réti,[2] Cristina Craioveanu,[3] Róbert Gallé,[4] Răzvan Popa,[5] Alina Ioniță,[6] László Demeter,[7] László Rákosy,[3] and Bálint Czúcz[8]

[1]Department of Environmental Sciences and Arts, Sapientia Hungarian University of Transylvania, Str. Calea Turzii 4, Cluj-Napoca, Romania
[2]Faculty of Environmental Science and Engineering, RO-400294, Fântânele street 30, Babes-Bolyai University, Cluj-Napoca, Romania
[3]Department for Taxonomy and Ecology, Str. Clinicilor 5-7, 400006, Faculty of Biology, Babes-Bolyai University, Cluj-Napoca, Romania
[4]Department of Ecology, Faculty of Science, University of Szeged, H-6726 Szeged Közép fasor 52, Szeged, Hungary
[5]Foundation ADEPT, Str. Principala nr. 166, Saschiz, Romania
[6]Propark - Fundația pentru Arii Protejate, Brasov, Strada Lungă, 175, 500051, Romania
[7]Misgurnus Association, 530204 Miercurea-Ciuc, str. Ion Caianu nr. 67, Romania
[8]MTA Centre for Ecological Research, Institute of Ecology and Botany, Alkotmány u. 2-4, 2163, Vácrátót, Hungary

Abstract. Traditional rural social–ecological systems (SES) share many features which are crucial for sustainable development. Eastern European countries such as Romania, are still rich in traditional cultural landscapes. However, these landscapes are increasingly under internal (e.g., people's aspirations toward western socioeconomic ideals) and external (institutional changes, globalization of the commodity market, connectivity with other cultures) pressures. Therefore, understanding the ways how traditional SES navigated past and more recent changes is of crucial importance in getting insights about the future trajectory of these systems. Here, we present the rural SES from the Saxon region of Transylvania through the lens of institutional transitions which happened in the past century in this region. We show that the rural SES went through episodic collapses and renewals, their cyclic dynamic being related to the episodic changes of the higher level formal institutions. These episodic collapses and renewals created a social–ecological momentum for the sustainability of these SES. While we recognize that policy effectiveness depends on institutional stability (and institutions are unstable and prone to collapses), maintaining those social–ecological system properties which can assure navigation of societies through the challenges imposed by global changes should be in the heart of every governance system. Such properties includes wide extent of native vegetation, fertile soils, wide range of provisioning ecosystem services, genuine links between people and landscapes and knowledge about the social–ecological systems. These features could provide important capitals and memory elements for the (re)emergence of social–ecological systems (old or new).

Key words: *adaptive cycles; collapse and renewal; resilience; social–ecological feedback; social–ecological memory; Special Feature: Ecosystem Management in Transition in Central and Eastern Europe; sustainability.*

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Introduction

There is a growing societal recognition about the human dependence on the natural systems (Fischer et al. 2015). In this respect one important challenge is how to reconnect humanity with the biosphere, that is, how to frame our socioeconomic activities in a way to not erode the life supporting and other ecosystem services (ES) on which we depend (Rockström et al. 2009). The social–ecological system (SES) approach has the promise to provide a theoretical framework for a holistic understanding of the complex dynamic of the interlinked social and ecological systems (Berkes and Folke 1998).

Traditional SES are special, because they are still tightly linked due to the strong reliance of the local communities on the ES provided by their surrounding landscape. Such traditional SES still occur in various parts of the world (Takeuchi 2010, Ranganathan et al. 2008, Liu et al. 2012, see also the "agricultural heritage sites" *sensu* FAO – http://www.fao.org/giahs/giahs-sites/en/). In Europe, extensive (traditional) farming and silvicultural prac-

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[9]**E-mail:** hartel.tibor@gmail.com

tices applied by the local communities during centuries in order to extract ES created cultural landscapes with exceptional ecological, cultural, historical, and esthetic values (Martín-López et al. 2012, Plieninger and Bieling 2012). Furthermore, several local (informal) institutions and knowledge types were developed in order to manage the surrounding landscapes in a way to not erode their capacity to provide diverse and high-quality ES (Solymosi 2011, Molnár 2012). Although extremely rich in biodiversity and cultural heritage values, these traditional SES are increasingly affected by endogenous and exogenous drivers of change. A typical endogenous driver is the aspiration of the local communities for the western type of socioeconomic development (e.g., Hartel et al. 2014, Milcu et al. 2014). Exogenous drivers on the other hand include the various facets of globalization such as stronger connections to global markets and the increasing influence of external knowledge, value, and technological systems on the local communities (e.g., Shen and Tan 2012, Fischer et al. 2012). From the perspective of the SES sustainability of traditional cultural landscapes a key challenge is to navigate change in a way maximizing the benefits of globalization while minimizing its negative consequences on the main structural and functional features of the local SES (Gunderson and Holling 2002, Boyd and Folke 2012, Hanspach et al. 2014). A crucial system related prerequisite for developing resilient SES is the adaptive governance (Boyd and Folke 2012).

Romania is a particularly interesting place to study the process of traditional rural SES navigating through global change for several reasons. (1) Almost half of the country's population still lives in rural regions (National Institute of Statistics 2015), by this, Romania being between the few countries with the largest rural population of Europe. The farming practices still retain many traditional elements, although shifts toward intensification or abandonment are imminent (Hanspach et al. 2014). (2) Romania experienced several major political, social, and economic perturbations in the past century, including the emergence and collapse of the communism, and the development of the multilevel governance system with the accession to the European Union (EU), with increasing influence of the EU policies on farming (most importantly the Common Agricultural Policy, CAP). (3) The aspiration of people toward a western type of development is strong, whereas new value systems important for social–ecological sustainability (e.g., the protection of life supporting services, species, habitats, and heritage values) are also reaching rural communities (Hartel et al. 2014, Milcu et al. 2014). Nevertheless (4), several economic initiatives coming from outside Romania are searching for fertile grounds in this country.

How does rural SES from Romania historically navigate multiple social, economic, institutional, and political changes and challenges? ES were and are in the hearth of the rural social-ecological systems from Romania; an important set of institutional drivers were related to ecosystem service use, access, and valuation. Examples include the institutions governing the extraction of provisioning ES, markets and trade, the social demand for the various services, and the technologies applied for their extraction.

Our main goal is to provide a broad, system-based historical perspective on the way how the current traditional rural landscapes of Transylvania (Romania) evolved from a largely local, informal institutional setting into a complex, multilevel governance system. We will show the historical interlinks between the dynamic of local informal and higher level formal institutions and their importance in shaping the trajectories of the rural SES, and the connections of people with the rural landscapes. We will highlight that the social, institutional, and political instability of the past decades, which had pushed rural communities in economic poverty, created however a unique social–ecological momentum for developing a multilevel governance system for social–ecological sustainability in this region.

Methods

Study area description

This study focuses on the Saxon cultural landscape of Southern Transylvania. The study region is dominated by hills, with altitudes ranging from *ca* 350 to 700 m above sea level. Biogeographically, the region belongs to the continental region. The dominant land cover types are woodlands (about 30% coverage), grasslands (around 35%), whereas arable fields, built areas, orchards, and other landuse forms are less represented (below 15%). From a social–cultural perspective, the studied region was always multiethnic (being inhabited by Saxons, Hungarians, Romanians and Roma), but was governed according to Saxon norms and rules for many centuries. Transylvanian Saxons colonized Transylvania in the 12th–13th century, when Transylvania was ruled by Hungary. They were largely autonomous right from the beginning of their arrival in Transylvania. Starting with the 19th century the increasing geopolitical instability affected the Saxon institutions and the relationship between people and their landscapes. Due to these changes the Saxon society collapsed. The last major wave of Saxon emigration from Transylvania to Germany occurred after the collapse of Romanian communism (Nägler 1992, Baltag 2004, Baier 2005). Current rural communities are characterized by an overall low social capital, diverse interest groups and lack of job opportunities (Hartel et al. 2014, Milcu et al. 2014, and Mikulcak et al. 2015). Human population size is relatively small (in average *ca* 5–600 people, Hartel et al. 2014). The current human population is lower than the average

population levels during the 19th and 20th centuries for many villages.

Source of information

We identified the most important historical and recent sources on the agriculture and forestry practices, as well as the institutional settings governing these practices specifically targeting the Transylvanian Saxons or other societies from the current territory of Romania and Hungary. This was made by (1) consulting local experts (local history teachers and historian researchers working at the History Museum of Sighisoara) for important books and other written information which are not accessible on the Internet, (2) searching on the Internet for gray literature, (3) searching for scientific publications on web of science, and (4) we went through all issues of the Hungarian journal "Forestry Files" (where all papers are available online, since its first publication in the 19th century, some being already overviewed in Hartel et al. 2015) and selected relevant information for Southern Transylvania. We found the historical books (e.g., Dorner 1910, Demetrescu 1942, Giurescu 1975, Nägler 1992, Oroszi 2004, Baltag 2004, Baier 2005) particularly important because they provided a comprehensive overview about the informal institutions and landuse types of the Saxons. We repeatedly reviewed these texts in order to identify written evidences documenting or mentioning the broad links between people and their landscapes. These included descriptions of *institutions* (see definition below) governing ES use and trade, landuse *technologies*, and social–ecological *feedback mechanisms* (see definition below), as well as the *socioeconomic aspirations* of people. Furthermore, we searched for written evidences about the *emergence of higher level formal institutions* (i.e., state level governance structures and beyond). These included the time period they started to appear and manifest, signs about their impact on the local, informal institutions, and possible conflicts they generated. We also searched for descriptions of *institutional instability*, including the collapse of institutions and their consequences on local SES. Finally, we searched for signs of *institutional diversification* around the use of ES and the ways how the emerging multilevel governance system influences local SES. As the institutional diversification happened recently, in a period largely overlapping with the adherence of Romania to the European Union (EU), we used the recent scientific publications from this region and our own experience in the study area to reconstruct this part of the dynamic of the SES (see below for details). Accordingly, we also quantified the evolution of the number of peer-reviewed papers and their topics published in Southern Transylvania, relevant for conservation biology and sustainability since 1999 (the year when research in the region started to intensify). The process of scientific knowledge accumulation, and within this, the topics addressed by research (i.e., to understand a particular taxa, to provide relevant information for policy) are of crucial importance for developing sustainability strategies for a region (Fischer et al. 2012).

Under the term "institution" we understand a set of rules, written or unwritten, which determine the access to and use of the ecosystem services by local communities, and determine their trade. Institutions can be "informal" (i.e., "unofficial," local, containing rich local knowledge) or formal (e.g., "official," ruled by formal experts and offices, as part of wider, national level regulations). Most often the informal and formal institutions co-occur in the same rural community (Helmke and Levitsky 2004). We defined as "social–ecological feedback," the motivation and capacity of the local communities to perceive the various "signals" coming from the ecosystems (e.g., the quality of ecosystem services or their erosion), and to respond to these signals by changing governance and management (Kant and Wu 2013). Depending on the nature of governance applied by the higher level formal institutions, these feedback mechanisms can be promoted or eroded.

Rural SES Dominated by Local, Traditional Governing Institutions

We set the end of the period of "tradition" roughly to the 19th century and the first decade of the 20th century. This period represented a major transition from a largely informal institutional governance of the natural resources toward the development of formal, state level institutions. Transylvanian Saxons up to this period had administrative autonomy (i.e., they were allowed to self-organize and apply local, informal rules in managing their land, Fig. 1A, Baltag 2004). Traditional rural communities largely relied on local ecosystem services (e.g., wood, pastures, arable land, and water) and the technologies used to extract these services were preponderantly labor intensive. Although there were important attempts for creating formal institutional grounds for developing scientific literature and knowledge related to forestry (e.g., Ungarischer Forstverein in 1851), the governance of the use of the provisioning ecosystem services was largely under local (cultural, informal) rules. Pastures and forests were communally owned, and the most important local institutional structures determining the rules of ecosystem service use by rural communities were the neighborhoods ("Nachbarschaft"). The large reliance of the local communities on the ecosystem services provided by their surrounding landscapes, and the strength of local informal institutions in governing the land management is presented by the green loop in the Fig. 1A. Box 1 presents few examples of use and

valuation of local ES by the rural communities in Southern Transylvania, based on historical descriptions. Toward the end of the 19th century higher level formal institutional regulations controlling ES use at local scale started to emerge (the blue arrows and loop in Fig. 1B). For example, the "Forestry Law of Hungary" (1879) favored the separation of grazing from forestry, prohibiting woodland grazing. The extraction of ecosystem services using traditional practices (e.g., woodland grazing, coppicing, pollarding) was perceived as damaging the forests from a national economy perspective (reviewed by Hartel et al. 2015, see also Box 2). The coppice forests started to be converted in high forests (Demetrescu 1942, Oroszi 2004). However, the local, informal rules and landuse practices were still well represented, and often dominated over the new, formal institutions (see the green loop in Fig. 1B). For example, Oroszi (2004) cites a document from 1898 according to which from 20,043 ha of forests, grazing was prohibited only in 9187 ha. The "resistance" of the local, informal institutions toward the application of the new formal regulations was also reported and in the 19th century there was a large debate around the application of the traditional woodland grazing *versus* the separation of grazing from forestry (Hartel et al. 2015). Lonkay (1903) emphasized the high importance of awareness rising, education, and experiencing the economic benefits by farmers for accepting the new, formal rules of forest and pasture management (see Box 1 for similar examples from the Saxon region of Transylvania). The economic aspirations of the local communities and the consequence of these on local institutions and landuse are exemplified in Box 2.

The Rise and Establishment of Autocratic State Level Governance and the Collapse of Traditional SES

The 20th century was characterized by unstable and harsh institutional, political, and socioeconomic system in Romania. The world wars and then the communist socialist regime (1940s–1989) which culminated in a strong dictatorial political system ceased and cancelled nearly all key components of the traditional Saxon institutions. People had no other alternative for working than that assured by the state, that is, collective farms (where there was no salary, but they were paid by products) and factories in the nearby towns (Baier 2005). Local communities lost every control of the management of their lands (see the blue arrows and the disappeared green arrows in Fig. 1C), with even the number and type of livestock being kept

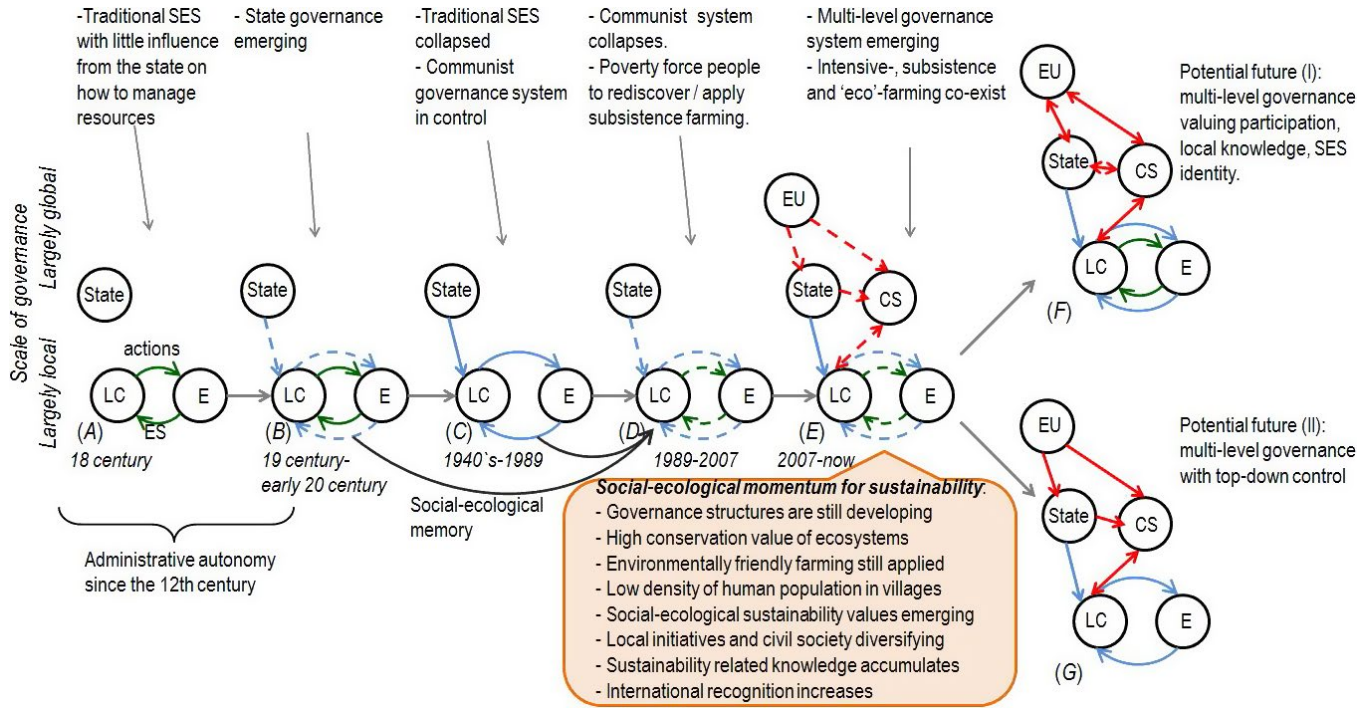

Fig. 1. Episodes of collapse and renewal of the social–ecological systems from the traditional rural landscapes of Southern Transylvania (Romania) in relation to the dynamic of higher level formal institutional structures. Continuous green arrow: strong local control on landuse. Green interrupted arrow: eroded local control on landuse. Blue interrupted arrow: forming state institutions. Continuous blue arrow: strong state control on landuse. Red arrows: forming (interrupted arrow) and established (continuous arrow) multilevel governance system around the local landuse. LC, local community; E, ecosystem; ES, ecosystem services; CS, civil society; SES, social–ecological system; EU, European Union.

Box 1. Tight SES feedback mechanisms in the traditional landuse practices during the 19th century. Some of the examples suggest awareness about the carrying capacity of the ecosystems, and a consequent adoption of practices to assure their sustainability while allowing economic development.

1. Maintenance of grasslands included the use of trees, controlling shrubs and dried vegetation, seeding grasslands with local seeds, delay of mowing to allow seed production (from 16th century).
2. Avoiding overgrazing of pastures by determining the number and type of livestock allowed in the pasture. Exclusion of certain livestock types (e.g., sheep) when the carrying capacity of the pasture was reached (19th century).
3. Planting trees in unproductive lands and employing "expert foresters" to manage forests and to teach local communities about basic forestry principles (since 18th century).
4. Delineation of "Forbidden forests" as a measure of protection (restriction of uses).
5. Experimenting for novelties in landuse in order to increase efficiency and production while not eroding the ecosystems. For example, this lead to the spread of domestic buffalo as traction and meat source, and the use of pear trees in pastures from the 18th century. Some of these are now considered as having high conservation value.
6. Quick response to Hungary's call to protect species and habitats, suggesting that Transylvanian Saxons were aware about the need for protecting certain vulnerable natural elements and were between the first who aligned with such initiatives (early 20th century).

Box 2. Economic aspirations of the Transylvanian Saxons at the end of the 19th century. The attitudes and activities mentioned in this box sometimes coexisted with the practices mentioned in Box 1. As a general tendency, however, the traditional labor intensive landuse practices still dominating the early decades of the 19th century were gradually replaced by modern technologies wherever this became possible because these technologies allowed a faster alignment with the economic ideals of the majority of people.

1. Saxons renounced to the traditional local knowledge for new formal knowledge types if these fostered western type of economic development.
2. Saxons rapidly adopted machineries and chemicals as well as new crop and tree varieties, as these were available from Western Europe (19th–20th centuries).
3. Saxons valued fish in the 16th–17th century and created fishponds for fish production. These were massively abandoned in the 18th century and converted into intensive agricultural areas, when the industry started to develop.
4. The development of road networks to access and exploit forests, as the internal and external demands for timber increased. The over-exploitation of the oak forests and the lack of proper management of the large exploited woodland surfaces toward the late 19th century resulted in the domination of hornbeam over the oak. This was perceived as a signal of weak forest management by foresters of those times. These happened in some regions despite the fact that Saxons adopted several rules and new management types in order to assure the economic sustainability of the forests (see text and Box 1).
5. Massive killing of wildlife, which represented a threat for agriculture and had low economic value, including the removal of the autumn crocus (*Colchicum autumnale*) from pastures.
6. Massive pollution of rivers and the extirpation of fish and crayfish with industrial development (19th century).
7. Several economic associations emerging in the 19th century, such as "Gewerbeverein" (1837), farmer associations to specialize farmers for agriculture (1860), the "Grain Bins" association (1901), cultural associations (e.g., "Verein für Siebenbürgische Landeskunde," 1841) and touristic associations. These associations facilitated the transition process toward a globalizing socioeconomic system through the wide adoption of the new, formal regulations and creating effective institutional grounds for spreading and rooting new knowledge types in the society.

by the individual families being under strict state control. Agriculture was mechanized and high amounts of chemicals were used in managing farmlands (Romanian National Statistical Institute 2015). Several pastures were converted into arable fields. A large number of Saxons emigrated, and were replaced by other ethnic groups (Romanians, Hungarians, and Roma).

The Collapse of the Autocratic Governance and the Re-Connection of the Rural SES

With the collapse of the communism (1989) the whole institutional setting, from local to national, entered in a new (re)organization phase. This was characterized by political instability and low socioeconomic capital (see interrupted blue arrows in Fig. 1D). The closure of collective farms and factories (Hartel et al. 2014) resulted in the increase of the unemployment rate. As a consequence, many people moved back to the villages to (re)start subsistence farming (Guran and Turnock 2000). Elements of social–ecological memory such as the knowledge of how certain farming practices, land ownership regimes, knowledge of the landscape and its elements, the traditional varieties of crops and fruit trees in orchards and pastures and the drinking water from fountains constituted a very important source of knowledge for the rural inhabitants (re)starting farming (Fig. 1B, C, D) (Hartel et al. 2014). The technologies adopted by farmers were broadly similar with those used by the rural communities in the early 19th century (Dorner 1910). The Romanian state restituted farmland to the majority of the rural inhabitants. Due to the low economic capital of the farmers, large surface areas of pastures and arable lands were abandoned. The number of livestock dramatically dropped in every village, the buffalo almost disappeared (Romanian Institute of Statistics 2015). The amount of chemicals applied to farmland sharply decreased. For example, the amount of fertilizers and pesticides applied in farmlands from 1992 represented just a small fraction (*ca* 20%) of the amount of chemicals applied in 1990 (Romanian National Statistical Institute 2015). This resulted in the overall regeneration of many farmland ecosystems including the shrub development (and re-forestation) of grasslands and the development of grasslands on arable fields (Hartel et al. 2013). The subsistence farming practices (see above) maintained a high level of biodiversity in farmlands, which is still visible in many taxonomic groups including vegetation (Loos et al. 2015) amphibians (Hartel et al. 2010), birds (Hartel et al. 2014) and large carnivores (Dorresteijn et al. 2015). However, as the weak local informal and formal state level institutions together with the low social capital and corrupt governance in the villages resulted in several illegal resource extractions, thefts, several local conflicts, uncontrolled pasture fires which negatively impacted the farmland ecosystems in various sites (Hartel et al. 2014).

Emerging Multilevel Governance System: Social–Ecological Momentum for Sustainability

The adherence of Romania to the EU (2007) has brought novel institutional structures both at the local and the national levels (see red arrows in Fig. 1E), including new financial mechanisms (e.g., CAP) and new socioeconomic challenges and opportunities for the sustainability of Southern Transylvania. Farming started to expand with the financial help of the CAP, and large scale farming with modern technology still coexist with small scale, subsistence farming (Fig. 1E). The rural SES still maintains many features which are basically similar to the traditional land management (see above and the interrupted green loops and the interrupted blue formal institutional arrows in Fig. 1D, E), granting these landscapes a unique social–ecological momentum for sustainability. Notably, there are several local social–ecological features which can be identified as crucial defining factors for this momentum, including (1) the persistence of traditional, labor intensive farming practices (Fischer et al. 2012, Hartel et al. 2014), (2) the high reliance of local communities on the provisioning ES, (3) the overall low human population density in villages, (4) the low level of infrastructure, (5) the increase of the local conservation and research initiatives, which brings innovation and new value types in the SES (e.g., the institutional promotion of the esthetic and cultural ES), (6) the wide cover of highly diverse native vegetation in the landscape with keystone structural elements such as the large old trees (Hartel et al. 2013), (7) the high regenerative potential of the ecosystems, (8) the existence of established large carnivore populations (Dorresteijn et al. 2015) and (9) the social–ecological memory elements related to landuse and farmland ecosystems (see above). Box 3 exemplifies some important local initiatives which aim to contribute to the local and international recognition of the multiple values of the historic landscapes from Southern Transylvania including steps toward developing a socially and ecologically coherent conservation policy for them, using wood-pastures as example landscapes. Other practical initiatives targeting the valuable farming landscapes from Southern Transylvania approaches from this region are synthesized by Sutcliffe et al. (2015). The conservation- and sustainability relevant research is also intensifying in this region, this being evident not only on the increasing proportion of papers published in well-established journals, but also on the dominating research topics in the recent years (i.e., targeting landscapes and societies) (Fig. 2). The several social–ecological challenges associated with the sustainability of the SES in the current landscape were addressed by Hartel et al. (2014), Mikulcak et al. (2013, 2015), Milcu et al. (2014), Hanspach et al. (2014), Corsale and Iorio (2014) and includes low levels of social, economic, and institutional capitals, quickly changing land ownership regime, conflicting interests and value systems related to the cultural landscapes. Even with these challenges the formation of new local formal and informal leadership structures in some villages which promotes social–ecological sustainability

Box 3. The development of conservation actions over the past 15 years exemplified with wood-pastures. Traditional cultural landscapes of Transylvania are increasingly recognized for their multiple, social, economic, and ecological values. Wood-pastures are farming landscapes with exceptional social, cultural, economic, and ecological values. The diversity of initiatives was conducted with the overall aim to use these multiple values to re-establish SES feedback mechanisms (old and new).

1. The project "Multi secular oak reservation at Breite" aimed to promote the value of the Breite ancient wood-pasture near the town Sighisoara, to generate scientific understanding of this wood-pasture and to protect it from a damaging governmental project (Sustainable Sighisoara Association and Eco Breite Association, early 2000s).
2. The first civil protests against a governmental project threatening the Breite ancient wood-pasture in Sighisoara (Sustainable Sighisoara Association and Eco Breite Association, early 2000s).
3. Building milk collecting centers in villages and promoting markets for traditional products to help and motivate farmers to use their wood-pastures (ADEPT foundation, 2010 and ongoing).
4. The project "Conservation of biodiversity in the Breite ancient oak reserve, Sighisoara" targeted the in depth scientific documentation of the Breite ancient wood-pasture, the development of its management plan and implementing several on-ground conservation actions, such as the removal of shrubs, closure of drainage ditches and regenerating young trees (Mihai Eminescu Trust, MET, http://www.rezervatia-breite.ro/ (2006–2010)).
5. The Project "The implication of the local communities in the conservation of the wood-pasture habitats from the Saxon villages of Southern Transylvania" targeted a comprehensive inventory of wood-pastures from Southern Transylvania, and also resulted in the measurement of over 400 ancient oaks (MET, 2009–2010).
6. The projects "Find the oldest tree" and "One oak for every pupil" were first of all educational and awareness rising projects, targeting several schools and villages from Southern Transylvania (2009–2010). This project resulted in the identification of the oldest and largest oak (*Quercus robur*) from Southern Transylvania, and the second largest known living oak of Romania. The oak formally protected as natural monument, duo to the above initiative.
7. "The oak day" was a community event organized by MET in partnership together with over 50 institutions and important persons from Sighisoara. This event aimed to place back the Breite wood-pasture in the hearth of the local community, by renewing a traditional cultural Saxon community event (i.e., the "Skopationsfest") and adopting this to the current value systems of the society (2010).
8. "The Remarkable Trees of Romania" is a new, citizen science based project targeting the large, old trees of Romania. The project was launched by His Royal Highness Prince of Wales. A map of over 850 old trees the great majority of them being recorded from wood-pastures can be found here: http://arboriremarcabili.ro/en/map-and-trees/show-map/. (Pogány-Havas Association, WWF, MET, Eco Breite, Galeria Posibilă, Ancient Tree Forum, 2014, ongoing).
9. Approaching the Minister of the Environment of Romania to discuss possibilities for social–ecological sustainability of Romanian wood-pastures. A press release following this meeting coming from the Romanian Government expressed the need for finding solutions for wood-pastures (Pogány-Havas Assotiation, 2014).
10. Highlight of the wood-pastures as valuable landscapes needing protection in the management plan of a local Natura 2000 site of 85 000 ha area (WWF, 2014)
11. Initiation of a policy seminar in Brussels (European Commission) in order to recognize European wood-pastures within the Common Agricultural Policy (17th of November, 2015). Materials (presentations, booklet and video) available here: http://arboriremarcabili.ro/en/news-and-events/
12. Initiation of artistic event "Old Trees" in three major cities of Romania, to popularize the ancient trees (Galeria Posibilă organization, 2015)
13. Eight peer-reviewed scientific papers addressing the ecological and sociocultural values and threats for wood-pastures from Southern Transylvania.

are imminent. Fig. 1F, G shows two potential alternative future multilevel governance strategies and their consequences on the local SES. A more participative multilevel governance system which values pluralism, local knowledge and local SES contexts is expected to strengthen the multiple links between the SES and will promote the empowerment of locals to manage their ecosystems in a way to not erode their multiple

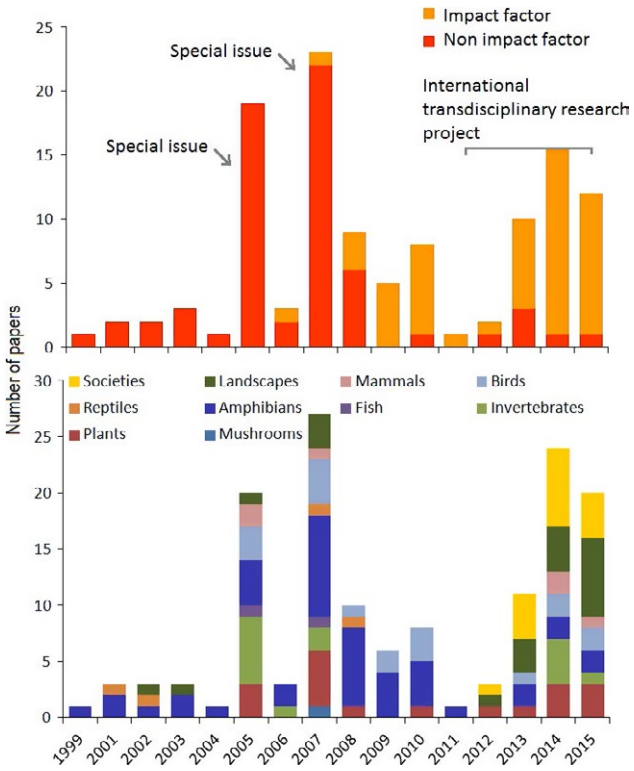

Fig. 2. The peer-reviewed scientific papers with the journal type where these are published and the predominance of the topics addressed for Southern Transylvania.

ES (Fig. 1F). Alternatively, a multilevel governance system which prescribe certain landuse types without building genuine links between the local community and their landscapes (Fig. 1F) may be less resilient in the front of global changes and therefore more vulnerable to more drastic changes (Fischer et al. 2012). A recent study based on participative scenario planning in our study region (Hanspach et al. 2014) showed that the economic strategy adopted at national and supranational levels (i.e., on pro-environment or pro-economy) together with the capacity of locals to capitalize these opportunities are important in shaping the future trajectory of the rural SES.

Discussion

Above we showed that there was a strong interaction between the local informal and higher level formal institutional changes across spatial scales and these also included institutional collapses and renewals. These cyclic changes associated with the socioeconomic instability of the rural areas and the lack of options for the majority of the rural inhabitants for a modern, western type of economy "re-connected" rural SES. These changes also re-activated memory elements of the past social and ecological system. We identified a social–ecological and institutional momentum for developing sustainable development strategies for the future of the rural SES.

The potential of the local (informal and formal) institutions to diversify was an inherent and emerging property of the local communities of the Saxon Transylvania. The high diversification of the Saxon institutional structures from the 19th century (Box 3) was triggered by the increasing interplay between the local social conditions (such as the economic aspirations of people), the increasing demand for resources and the increasing connectivity with external socioeconomic systems which represented attractive models to follow (e.g., the availability of complex, modern technology from Austria and Germany). The higher level institutional settings up to the end of the 19th century represented a source of stabilizing factor for the local institutions while allowing local communities to self-organize (to strengthen local, informal, and formal institutional structures) and autonomously manage their lands (see e.g., the Saxon autonomy, below and Fig. 1A). A typical example for the stabilizing effect of the higher level formal institution (the state) on the local formal and informal Saxon institutions, was the quick intervention of the "state" (represented by Hungarian kingdom) to solve local conflicts around the resource (e.g., forest) use (Oroszi 2004).

The interaction between institutional developmental cycles across space was described by several authors (e.g., Holling 2001, Gunderson and Holling 2002, Chaffin and Gunderson 2016). This can be also followed in the history of the social–ecological systems in Transylvania (see Fig. 1). The changing geopolitical conditions dur-

ing and after the two world wars and the emergence of a new higher level institution—the socialist-communist regime of Romania pushed the Saxon regional and local level institutions into a collapse, leading to the massive emigration of the Saxons. This triggered several major changes at the level of local communities, such as ethnic change, increased social conflicts and emigration into urban areas (Hartel et al. 2014). The collapse of the socialist-communist regime increased poverty while maintaining the low social capital because of the corrupt local and higher level governance systems. Traditional farming practices were re-discovered, after the enclosure of the state owned farms and factories where people worked. Farmland provided, therefore, an important source of resilience for the families during the economic crisis period (see also Barthel et al. 2013 for urban gardens in Sweden and Oteros-Rozas et al. 2013 for transhumance systems in Spain). Several traditional crop and fruit varieties survived (Antofie et al. 2015). The internal (e.g., seed banks) and external (e.g., recolonization from less affected areas) ecological memory is thought to play an important role in facilitating ecosystem resilience (Bengtsson et al. 2003, Nykvist and Heland 2014). Indeed, the massive abandonment of agricultural lands in the socioeconomic crisis period resulted in the regeneration of ecosystems, which have currently outstanding natural importance at international level. The increase in sociocultural and economic connectivity between the local communities and the western systems after the adherence of Romania to the EU had a very important "triggering effect" on the emergence and diversification of the local institutional structures, often resulting in novel institutional and cultural configurations. For example, the two major local NGO's (the ADEPT Foundation and Mihai Eminescu Trust) appeared as a result of the interplay of the locally emerging leadership structures and the connection with western (conservation, sustainability) value systems. While the traditional Saxon communities cannot re-organize (because most of the Saxons emigrated), the Saxon culture is still very living in the memory of the local rural people (some directly, while the others indirectly experiencing the Saxon culture) (Hartel et al. 2014, Campeanu and Fazey 2014), serving as social re-organization model or some local communities. For example, the principles of neighborhoods and the communal pasture use are re-invented in some villages (Caroline Fernolend *personal communication*).

It was shown that societies with attributes like strong social capital, diverse, and collaborative leadership structures and innovations are more adaptive (Adger 2003, Dietz et al. 2003, Fazey et al. 2010) are more likely to cope with change and ultimately are more likely to develop sustainable management strategies and to perform economically (Knack and Keefer 1997, Varughese and Ostrom 2001, Rustagi et al. 2010). We learned from our analysis that the higher institutional structures can promote or in contrary, can erode the above mentioned features of the rural societies. Chaffin and Gunderson (2016) defined as adaptive environmental governance, the emergence of governance structures which are able to better address the social and ecological issues which can make the social–ecological system more vulnerable to undesired changes. Adaptive environmental governance structures typically evolve after natural catastrophes (e.g., hurricanes, tsunami, Adger et al. 2005) which induce severe social crisis. In Transylvania the situation is different, because the nature of the crisis is caused by the low formal institutional and political capitals and corruption which resulted in increase of economic poverty. The rise of the environmental awareness in Transylvania in the recent years was a reaction to the depletion of the natural resources and the destruction of cultural, natural, and historical values and heritage elements by a fundamentally corrupt and weak political and institutional system (Hartel et al. 2014, see e.g., the "Romanian autumn" protests Bejan et al. 2015). The fast development of the social networking websites in Romania (e.g., Facebook, Twitter) catalyzed quick community organization and fast spreading of the relevant information by connecting people and places.

The above enumerated highly contrasting sides of the current rural societies of Southern Transylvania (i.e., mistrust in one hand and the developing new social structures based on participation on the other hand, and the highly diverse types of values attached to the landscape and heritage elements) suggests that Transylvania is in a "twilight" period in terms of value systems and institutions built around them. The governance strategy of the multilevel institutions will have a large role in determining the developmental path and configuration of the rural SES, which can be more resilient (Fig. 1F) or more rigid and potentially more vulnerable (Primmer et al. 2014, Fig. 1G).

Conclusions

In conclusion, this study presented the alternating periods of institutional stability and instability, with interlinked cyclic changes of local, informal, and higher level formal institutions and governance systems (Holling 2001, Gunderson and Holling 2002, Chaffin and Gunderson 2016). These cyclic changes of the complex social, ecological, and institutional systems also resulted in crises (collapses), pushing societies in undesired socioeconomic states. However, these cyclic changes also created windows of opportunity (referred by us as "social–ecological momentums") for the development of new, more adaptive, and environmentally sustainable institutional configurations (Chaffin and Gunderson 2016). Crucial SES properties of these momentums are the developing governance systems (which can be still influenced), the high conservation value of the farmland ecosystems, the tight connection between rural communities and their ecosystems, the existence

of local ecological knowledge types and the emergence of new value systems, important for the sustainability of SES (Fig. 1). If this momentum will not be capitalized, the rural social-ecological systems may loose several features which are crucial for sustainability. Below we mention three main levels at which formal and informal policies could act to capitalize the above mentioned SES momentum for sustainability: (1) The EU policies, for example, the CAP could play a major role by being more open and flexible toward adopting more context placed policies. For example, the Rural Development Program (RDP) of the CAP is essentially about re-connecting rural social–ecological systems. Several unique cultural and landscape (i.e., social–ecological) heritage elements are not included in the RDP, therefore local communities cannot capitalize on them in developing a socially and environmentally more sustainable local economy. For example, structural elements of wood-pastures such as the large, old trees, shrubs, and wetlands are considered ineligible elements in the CAP direct payment system, although these are crucial for the resilience of the farming landscape and are important components of the farming landscape identity (Hartel and Plieninger 2014); this results in the structural simplification of these landscapes and the erosion of their biodiversity and resilience even with the cross-compliance rules, whereas none of the above mentioned structural properties are barriers toward food production (see Beaufoy 2015). (2) Romanian policy makers could be also more aware about the unique and highly fragile SES properties of the Romanian traditional farmlands, including Southern Transylvania, for example, by including these unique features in the national development strategies. Finally (3) further increasing the awareness and cooperation between the civil initiatives (i.e., NGO's) and formal governance structures acting at local level would be very beneficial in better communicating the common heritage values to local communities and higher level institutional structures (see Box 3 e.g., regarding ancient wood-pastures). These new types of institutions could foster social transformations through rooting new value and knowledge types in a similar way as those did in the 19 and early 20th centuries (see Box 2, point 7). This can only be effective if the diversification of the civil initiatives happens around a common vision.

The present paper presents the rural social–ecological systems through the lens of institutional collapses and renewals. As the policies are strongly nested in the institutional structures which create them, developing policies for sustainable multilevel governance systems is highly challenging when the institutions are prone to collapse. Increasing societal and institutional awareness about the strong dependencies between functional ecosystems and human well being (e.g., through SES) and about the need to maintain the most important ecosystem properties (see e.g., Dorresteijn et al. 2015) for social–ecological sustainability could assure navigation of societies through the challenges imposed by global changes.

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Literature Cited

Adger, W. N. 2003. Social capital, collective action, and adaptation to climate change. Economic Geography 79:387–404.

Adger, W. N., T. P. Hughes, C. Folke, S. R. Carpenter, and J. Rockstrom. 2005. Social-ecological resilience to coastal disasters. Science 309:1036–1039.

Antofie, M. M., I. Barbu, C. Sava-Sand, and R. Blaj. 2015. Traditional orchards in Romania: case study Fântânele, Sibiu County. Genetic Resources and Crop Evolution. doi: 10.1007/s10722-015-0299-2

Baier, H. 2005. Germans in Romania: 1944–1956. Honterus, Sibiu, RO. (in Romanian).

Baltag, G. 2004. Sighisoara, Schässburg, Segesvár. Nemira Napocae, Cluj Napoca, Romania (in Romanian).

Barthel, S., C. L. Crumley, and U. Svedin. 2013. Biocultural refugia: combating the erosion of diversity in landscapes of food production. Ecology and Society 18:71.

Beaufoy, G., editor. 2015. Europe's wood-pastures: condemned to a slow death by the CAP? A test case for EU agriculture and biodiversity policy. Booklet produced for the wood-pasture policy seminar in the European Parliament, Brussels, in 17th of November, 2015. http://arboriremarcabili.ro/en/news-and-events/

Bejan, R., P. Murvai, I. Mihăilă, and M. Cherciov. 2015. Transnational responses to global capitalism: the case study of the Roşia Montană campaign. Transnational Social Review 5:199–207.

Bengtsson, J., P. Angelstam, T. Elmqvist, U. Emmanuelsson, C. Folke, M. Ihse, F. Moberg and M. Nystrom. 2003. Reserves, resilience and dynamic landscapes. Ambio 32:389–396.

Berkes, F. and C. Folke, editors. 1998. Linking social and ecological systems. Cambridge University Press, Cambridge, UK.

Boyd, E. and C. Folke. 2012. Adapting institutions – governance, complexity and social-ecological resilience. Cambridge University Press, Cambridge, UK.

Campeanu, C., and I. Fazey. 2014. Adaptation and pathways of change and response : a case study from Eastern Europe. Global Environmental Change: Human and Policy Dimensions 28:351–367.

Chaffin, B., and L. H. Gunderson. 2016. Emergence, institutionalization and renewal: rhythms of adaptive governance in complex social-ecological systems. Journal of Environmental Management 165:81–87.

Corsale, A., and M. Iorio. 2014. Transylvanian Saxon culture as heritage: insights from Viscri, Romania. Geoforum 52:22–31.
Demetrescu, I. C. 1942. Forestry economy with specific consideration of Romanian forests. Editura Societatii 'Progresul Silvic', Bucuresti. (in Romanian)
Dietz, T., E. Ostrom, and P. C. Stern. 2003. The struggle to govern the commons. Science 302:1907–1912.
Dorner, B. 1910. The agriculture of Transylvanian Saxons. Győr, Hungary (in Hungarian).
Dorresteijn, I., J. Loos, J. Hanspach, and J. Fischer. 2015. Socioecological drivers facilitating biodiversity conservation in traditional farming landscapes. Ecosystem Health and Sustainability 1:art28.
Fazey, I., J. G. P. Gamarra, J. Fischer, M. S. Reed, L. C. Stringer, and M. Christie. 2010. Adaptation strategies for reducing vulnerability to future environmental change. Frontiers in Ecology and the Environment 8:414–422.
Fischer, J., et al. 2015. Advancing sustainability through mainstreaming a social-ecological systems perspective. Current Opinion in Environmental Sustainability 14:144–149.
Fischer, J., T. Hartel, and T. Kuemmerle. 2012. Conservation policy in traditional farming landscapes. Conservation Letters 5:167–175.
Giurescu, C.. 1975. The history of the Romanian forest – from the oldest times till nowadays. Editura CERES, Bucuresti (in Romanian).
Gunderson, L. and C. S. Holling. 2002. Panarchy. Island Press, Washington, D.C., USA.
Guran, L., and D. Turnock. 2000. A preliminary assessment of social risk in Romania. GeoJournal 50:139–150.
Hanspach, J., et al. 2014. A holistic approach to studying social-ecological systems and its application to southern Transylvania. Ecology and Society 19:32.
Hartel, T., I. Dorresteijn, C. Klein, O. Máthé, C. I. Moga, K. Öllerer, M. Roellig, H. von Wehrden, and J. Fischer. 2013. Wood-pastures in a traditional rural region of Eastern Europe: characteristics, management and status. Biological Conservation 166:267–275.
Hartel, T., J. Fischer, C. Campeanu, A. I. Milcu, J. Hanspach, and I. Fazey. 2014. The importance of ecosystem services for rural inhabitants in a traditional rural landscape. Ecology and Society 19:42.
Hartel, T., and T. Plieninger, editors. 2014. European wood-pastures in transition: a social-ecological approach. Earthscan from Routledge, New York, New York, USA.
Hartel, T., T. Plieninger and A. Varga. 2015. Wood-pastures of Europe. Pages 61–76 *in* K. Kirby, and Ch. Watkins, editors. Europe's changing woods and forests: from wildwood to managed landscapes. CABI Press, Oxfordshire, UK.
Hartel, T., O. Schweiger, K. Öllerer, D. Cogualniceanu, and J. Arntzen. 2010. Amphibian distribution in a traditionally managed rural landscape of Eastern Europe: probing the effect of landscape composition. Biological Conservation 143:1118–1124.
Helmke, G., and S. Levitsky. 2004. Informal institutions and comparative politics. A research agenda. Perspectives on Politics 2:725–770.
Holling, C. S. 2001. Understanding the complexity economic, ecological and social systems. Ecosystems 4:390–405.
Kant, P. and S. Wu, 2013, Forest Transitions across Ages and Continents: Implications for REDD, IGREC Working Paper IGREC- 27. Institute of Green Economy, New Delhi, India.
Knack, S., and P. Keefer. 1997. Does social capital have an economic payoff? A cross-country investigation. Quarterly Journal of Economics 112:1251–1288.
Liu, Y., M. Duan, and Z. Yu. 2012. Agricultural landscapes and biodiversity in China. Agriculture, Ecosystems and Environment 166:46–54.
Lonkay, A. 1903. The question of grazing. Erdészeti Lapok 8:687–697 (in Hungarian.).
Loos, J., P. D. Turtureanu, H. Von Wehrden, J. Hanspach, I. Dorresteijn, J. P. Frink, and J. Fischer. 2015. Plant diversity in a changing agricultural landscape mosaic in Southern Transylvania (Romania). Agriculture, Ecosystems & Environment 199:350–357.
Martín-López, B., et al. 2012. Uncovering ecosystem service bundles through social preferences. PLoS One 7:e38970.
Mikulcak, F., J. Newig, A. I. Milcu, T. Hartel, and J. Fischer. 2013. Integrating rural development and biodiversity conservation in central Romania. Environmental Conservation 40:129–137.
Mikulcak, F., J. L. Haider, D. J. Abson, J. Newig, and J. Fischer. 2015. Land Use Policy Applying a capitals approach to understand rural development traps : a case study from post-socialist Romania. Land Use Policy 43:248–258.
Milcu, A. I., K. Sherren, J. Hanspach, D. Abson, and J. Fischer. 2014. Navigating conflicting landscape aspirations: application of a photo-based Q-method in Transylvania (Central Romania. Land Use Policy 41:408–422.
Molnár, Z. 2012. Classification of pasture habitats by Hungarian herders in a steppe landscape (Hungary). Journal of Ethnobiology and Ethnomedicine 8:28.
National Institute of Statistics Romania. 2015. http://www.insse.ro/cms/en/content/dissemination-statistical-information
Nägler, T. 1992. The arrival of the Saxons in Transylvania (in Romanian). Kriterion, Bucharest, Romania.
Nykvist, B., and J. von Heland. 2014. Social-ecological memory as a source of general and specified resilience. Ecology and Society 19:47.
Oroszi, S. 2004. The forest management of Transylvanian Saxons, Budapest (in Hungarian). Erészeti Egyesület, Erdészettörténeti Szakosztály, Budapest, Hungary.
Oteros-Rozas, E., B. Martín-López, C. A. López, I. Palomo, and J. A. González. 2013. Envisioning the future of transhumant pastoralism through participatory scenario planning: a case study in Spain. The Rangeland Journal 35:251–272.
Plieninger, T. and C. Bieling, editors. 2012. Resilience and the cultural landscape: understanding and managing change in human shaped environments. Cambridge University Press, Cambridge, UK.
Primmer, E., et al. 2014. An approach to analysing scale-sensitivity and scale-effectiveness of governance in biodiversity conservation. Pages 241–262 *in* F. Padt, P. Opdam, N. Polman and C. Termeer, editors. Scale-sensitive governance of the environment. John Wiley & Sons, Oxford, UK.
Ranganathan, J., R. J. R. Daniels, M. D. S. Chandran, P. R. Ehrlich, and G. C. Daily. 2008. Sustaining biodiversity in ancient tropical countryside. Proceedings of the National Academy of Sciences USA 105:17852–17854.
Rockström, J., W. Steffen, K. Noone, A. Persson, F. S. Chapin, E. F. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. J. Schellhuber, et al. 2009. A safe operating space for humanity. Nature 292:641–642.
Rustagi, D., S. Engel, and M. Kosfeld. 2010. Conditional cooperation and costly monitoring explain success in forest commons management. Science 330:961–965.
Shen, X., and J. Tan. 2012. Ecological conservation, cultural preservation, and a bridge between: the journey of Shanshui Conservation Center in the Sanjiangyuan region, Qinghai-tibetan Plateau, China. Ecology and Society 17:38.
Solymosi, K. 2011. Indicators for the identification of cultural landscape hotspots in Europe. Landscape Research 36:3–18.
Sutcliffe, L., J. Akeroyd, N. Page, and R. Popa. 2015. Combining approaches to support High Nature Farmland in Romania. Hacquetia 14:53–63.

Takeuchi, K. 2010. Rebuilding the relationship between people and nature: the Satoyama initiative. Ecological Research 25:891–897.

Varughese, G., and E. Ostrom. 2001. The contested role of heterogeneity in collective action: some evidence from community forestry in Nepal. World Development 29:747–765.