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ORIGINAL ARTICLE

# Including the perspective of stakeholders in landscape planning through the Ecosystem Services co-production framework: an empirical exploration in Le Marche, Italy

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## Abstract

Research on Ecosystem Services (ES) has become dominant in landscape planning to frame the relationship between people and nature. Increasingly, studies are stressing that most ES do not flow from nature alone but require a significant human contribution, known as ES co-production. However, there is a lack of understanding on how different stakeholders contribute to ES co-production. Here, we integrated stakeholders' perspectives in landscape planning using questionnaires and focus groups in a case study in Le Marche, Italy. We found that respondents acknowledge co-production in a wide range of ES with a major share of cultural ES. Mostly self-perceived as users and managers, local stakeholders invest in their activities mainly human and social capitals, while physical and financial capitals gain importance in the case of provisioning services. Our findings embraced the multiple aspects of human-nature interactions, offering the opportunity to bridge different sectors, such as agriculture, eco-tourism, and resilience against extreme events, toward a multifunctional vision of landscapes. The integration of the ES co-production framework proved useful in fostering the access of stakeholders to decision-making.

**Keywords** Landscape ecology · Social-ecological systems · Regional planning · Nature contributions to people · Land management · Stakeholders · Co-production

## Introduction

Integrating social aspects in environmental assessments remains a key challenge in regional planning. This approach is fundamental to account for the complexity of social-ecological systems, which are adaptive systems composed of interacting and interdependent social and environmental entities (Berkes and Folke 1992). The last decade has seen growing attempts to frame this interaction between nature and human activity through the concept of landscape, considered the most suitable spatial unit for managing ecosystems (Forman and Godron 1986; Tallis et al. 2015) given that its definition enables the assessment of both physical entities and their social perception (European Landscape Convention 2000). In this context, landscape planning faces the challenge of reconciling competing sectorial interests, in order to guarantee landscape multifunctionality and sustainable development (de Groot et al. 2010; Sargolini and Gambino 2016).

Landscape planners and decision-makers increasingly apply the Ecosystem Services (ES) framework to account for the variety of benefits humans derive from ecosystems (IPBES 2019; TEEB 2010) to raise environmental awareness

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(Grêt-Regamey et al. 2008; Calderón-Argelich et al. 2021), or to recognize socio-ecological interactions (Albert et al. 2016; Langemeyer et al. 2016; Grêt-Regamey et al. 2017). However, most of these studies only take into account the physical components of ES omitting crucial information from stakeholders' perception and their social roles (Felipe-Lucia et al. 2015; Grêt-Regamey et al. 2017). Yet, sustainable development strategies need to integrate the social dimension of ES to support communities in their role in landscape management (Bennett et al. 2015).

A way to incorporate social aspects on ES research is through the concept of ES co-production (Palomo et al. 2016; Fischer and Eastwood 2016; Lavorel et al. 2020; Jericó-Daminello et al. 2021), which stresses that benefits from nature to people do not occur independently but in most cases require a significant human contribution (Díaz et al. 2015). Co-production of ES includes several anthropogenic components related to natural systems, such as motivation or education (human capitals), values and norms (social capitals), machinery and infrastructure (physical capital), and credits or direct payments (financial capitals) (Palomo et al. 2016). ES can be co-produced by anthropogenic activities through the direct management of the ES flow (e.g., agricultural activity, forest management), what is known as physical co-production, or through the use of ES (e.g., the preference for a product or place), termed cognitive co-production (Palomo et al. 2016; Fischer and Eastwood 2016).

We applied the ES co-production framework to landscapes as social-ecological systems (Fig. 1), highlighting how those systems are co-produced by both natural and anthropogenic contributions, and their perception influences planning and management (Opdam et al. 2015; Turkelboom et al. 2018). The acknowledgement of the anthropogenic contribution to landscapes through the lens of ES co-production highlights the role of stakeholders in shaping landscapes and allows for their integration into landscape planning (Rieb et al. 2017).

Despite recent advances in the ES co-production literature, its application to landscape planning through real case studies remains scarce (Kachler et al. 2023). In particular, the perception of stakeholders regarding their role in ES co-production has not been yet incorporated nor translated into landscape management actions.

Here, we applied the ES co-production framework to integrate stakeholders' perception in landscape planning through their role in ES co-production. More specifically, we investigate (a) the main ES perceived by local stakeholders, (b) the anthropogenic contributions involved in ES co-production, and (c) the implications of ES co-production for stakeholders' involvement in participatory planning. We took as a case study the central Italian region recently affected by earthquakes (2016–2017), where proposals for the development of the area are now open to debate, and the inclusion of local communities is crucial to allow a resilient physical and social reconstruction. This case study offers a perfect opportunity to rethink a participatory model for rural territories based on landscape sustainability principles and resilience toward extreme events.

## Methodology

### Study site and stakeholder groups

The Fiastra Valley (43°9′N, 13°50′E) is a sparsely populated rural district, covering a hilly area characterized by ancient settlements and agricultural land crossed by the Fiastra river (Fig. 2). The land cover is mainly arable land, with a few forests occupying mostly riparian and high-inclination areas. The Fiastra Valley is constituted by six municipalities

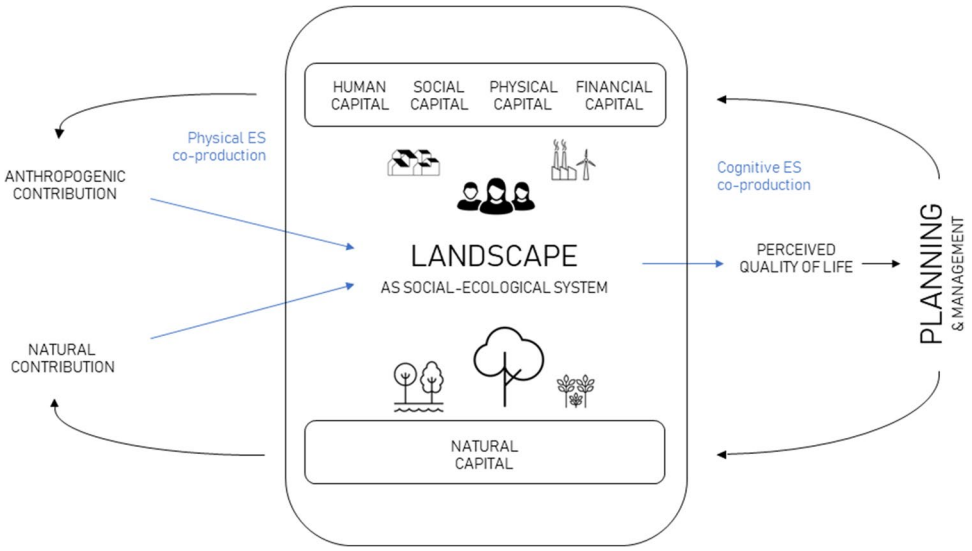


**Fig. 1** Ecosystem Services co-production in landscapes as social-ecological systems. The figure illustrates the theoretical framework of this study, distinguishing physical from cognitive co-production. The former refers to the physical action on ecosystems involving measurable external changes and relates to the anthropogenic and natural contributions on the landscape. The latter belongs to the cognitive processes related to the individual perception of ecosystem service benefits and addresses the importance of perceived quality of life for landscape planning and management

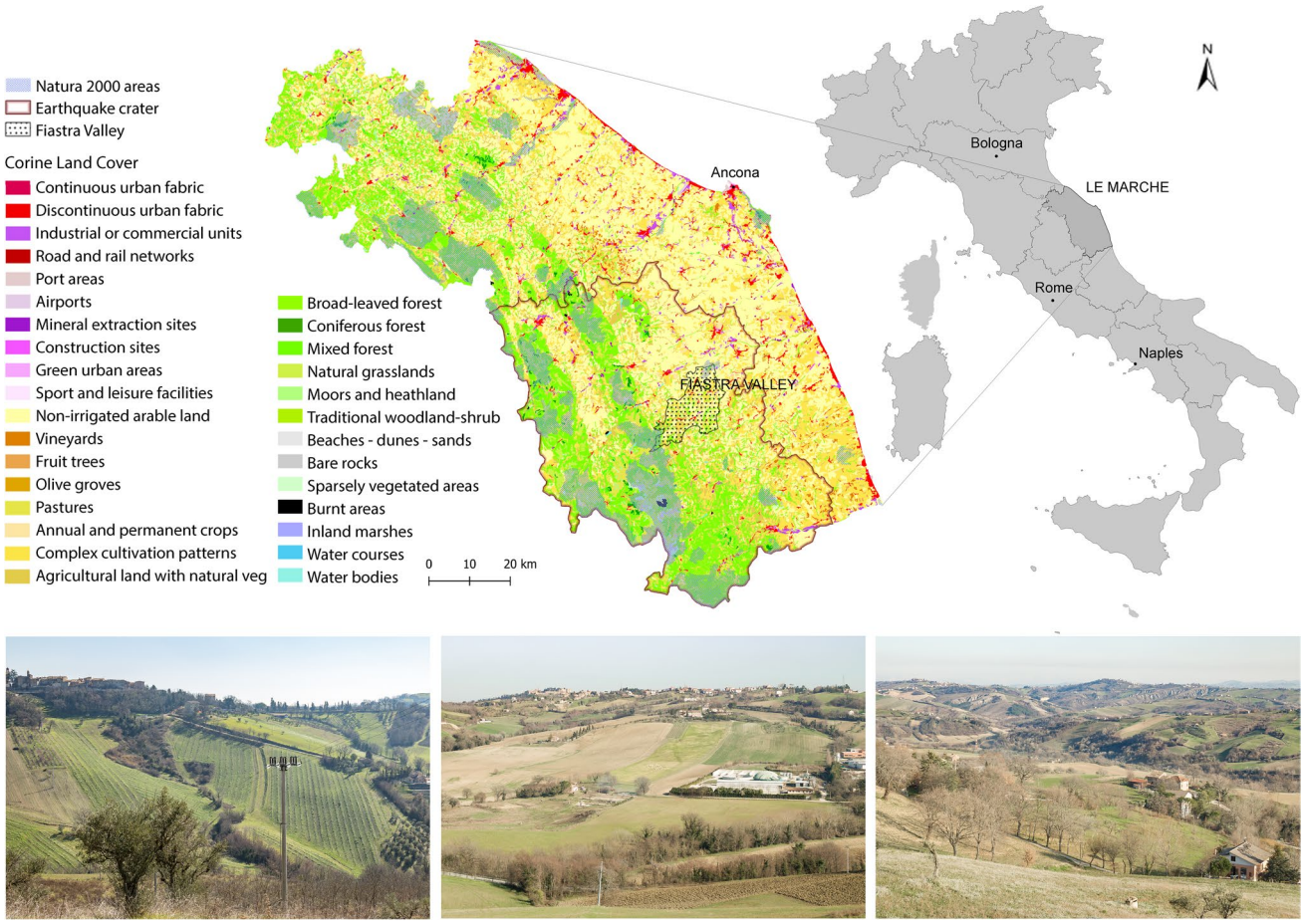


**Fig. 2** The Fiastra valley case study. Top: location in Le Marche Region, Italy (base map Corine Land Cover 2018). Bottom, from left to right: pictures of social-ecological interactions **a** agricultural landscapes contiguous to historic centre, **b** landscapes of production, **c** spread rural settlements. Photographs by Marco di Marco, 2022

and counts about 11.764 inhabitants for 181.2 km$^2$ of land (ISTAT, 2022). It is located in the inner part of Le Marche region, in central Italy, at the foothills of the Apennine mountains. Two protected areas are partially included within the study area: The *Monti Sibillini National Park* and the *Abbadia di Fiastra Natural Reserve.*

Faced with the phenomena of aging and depopulation, exacerbated by the consequences of the 2016–2017 earthquake, the area has experienced decreasing population trend of − 12.5% between 2012 and 2022. From an economic point of view, the decline of the primary sector (agriculture, forestry, and fishing represent the 11% of employees), has been countered by the process of tertiarization of the economy. Within this process, the role of tourism activities (9%) is expected to grow due to the increasing frequentation of mountain and rural areas, especially in the protected areas (SNAI Alto Maceratese 2019). Through a place-based approach, the local pilot area of the National Strategy for Inland Areas aims at the involvement of local people in the development of tourism and manufacturing activities, which overall represent 34% of employees, by supporting them in the post-earthquake occupational revitalization and establishing local economic-productive chains (SNAI Alto Maceratese 2019). On the same basis, a Local Action Group within the Leader+ EU Programme developed an Integrated Plan for the Fiastra Valley built on experiential tourism (GAL Sibilla 2019).

Based on the analysis of the local context, we distinguished in this study five key stakeholder groups: *Production* includes workers from the agriculture sector, agronomy, and local producers; *Education and research* includes school teachers, university students, ecology experts, and environmental centers; *Tourism and commerce* includes tourist managers, hotel, agritourism and restaurant owners, café, and local shop owners; *Planning and administration* includes members of the local council, engineers, architects, and planners related to the study area, as well as the local water distribution company; *Society* includes members of local associations, artists, family doctors, local recreationists, and other inhabitants. The full list of stakeholder groups can be found in Appendix A.

### Assessing preferences for ecosystem services

Based on previous work on the study area (Vautereco project), and after consultation with the regional authorities, we selected a set of seven relevant ES based for Le Marche Region. The ES were defined according to CICES Classification in agricultural products, drinking water, hydroelectric energy, hydraulic regulation, climate regulation, eco-tourism, environmental education (Haines-Young and Potschin-Young 2018).

To assess the preference for these ES by the key five local stakeholder groups, we organized two focus groups in July 2021 involving a total of 27 people. The first group (focus group A) included 15 participants from the stakeholder groups *Education and research*, *Society*, and *Production*. The second group (focus group B) counted with 12 participants from the stakeholder groups *Planning and administration* and *Tourism and commerce*.

After introducing the concept of ES, participants were asked about the benefits that inhabitants of the Fiastra valley receive from the ecosystems in different ways: (i) What does nature in the Fiastra valley mean to you? what is the importance of nature for this area? (ii) What are the benefits that Fiastra valley provides for your well-being/to fulfill your organization goals? (iii) What goods and products does nature in the Fiastra Valley provide to society? How does nature support the local economy? (see focus group guide in Appendix B)

Participants had 15 min to answer these questions through a maximum of 5 sticky notes, allowing for a single response per sticky note. Answers were collected by the facilitators, who grouped individual concepts included in the sticky notes in ES categories. The ES identified were merged to the initial ES list described above, making a total of 14 ES. The final list of ES was displayed on a board and participants were asked to vote the three ES they considered most relevant for the Fiastra valley (see Table 1 (a)).

### Assessing ecosystem services co-production

To assess the role of local stakeholders regarding the co-production of ES, the participants of the focus groups were invited for a separate interview. Additional participants were identified through snow-balling technique, making a total of 35 respondents. Respondents were aged between 22 and 71, with a balanced proportion of men and women (see the characterization of respondents in Appendix A).

Due to safety precautions during the COVID-19 pandemic, interviews were mainly conducted by video-call, except in circumstances where respondents did not have access to online platforms, in which face-to-face interviews were held. Interviews took between 30 to 70 min per participant, and were organized into 2 sections (see interview guide in Appendix C):

1. *Role in ES co-production*. From the ES list obtained through the focus group (Table 1 (a)), participants were asked to select the ES in which they play a role. Then, they were asked to specify one of those ES and which role they play in it (i.e., users, managers, negatively influenced, interested, or investigator).
2. *Capitals involved*. Participants were asked to assess the level of anthropogenic capital inputs through which they are contributing to the ES co-production, namely human capital, social capital, physical capital and financial capital, using a Likert scale from 1 (low contribution) to 5 (high contribution) (see description in Table 1 (c))

### Data analysis

All data was analyzed using R software (RStudio Team 2021). The full code is available in Appendix E. We used the Shapiro-Wilk test to check for normality in data distribution. Given that our data departed significantly from normality, we used the non-parametric test Wilcoxon's rank sum test to assess the significance of the differences between the two focus groups, and the *chi-square test* to assess the differences on capitals involved in ES co-production (for more details on statistical analysis, see Appendix D).

## Results

### Preferences for ecosystem services

We collected a total of 147 statements related to ES from the two focus groups (Fig. 3). Most statements were related to cultural ES, namely *C7 Mental well-being*, *C5 Sense of Place*, and *C1 Eco-Tourism*. Only participants of focus group A listed *C2 Environmental education* and *R2 Climate regulation*, whereas only participants from focus group B named *P2 Drinking water*. The total number of answers by stakeholder group can be found in Appendix B.

Regarding preferences for ES, participants showed a higher preference for cultural ES (Fig. 3). The most voted ES were *C6 Aesthetic beauty* (19% of votes), *C5 Sense of place* (16% of votes), *C8 Artisan products* (15% of votes), and *C7 Mental well-being* (10%). Provisioning and regulating ES were voted by 6% of the participants (*P1 Agricultural products*, *P2 Drinking water*, *C1 Eco-Tourism*, *C4 Intrinsic value*) and the rest received less than 5% of the votes. Nobody expressed a preference for *P3 Hydroelectric energy.* These results were not significantly different between the two focus groups.

**Table 1** Characterization of ES co-production by local stakeholders. (a) final list of Ecosystem Services considered, (b) definition of roles for stakeholders (c) capitals involved

a) Ecosystem services list

| Provisioning ES | Regulating ES | Cultural ES |
|---|---|---|
| P1 Agricultural products | R1 Hydraulic regulation | C1 Eco-tourism |
| P2 Drinking water | R2 Climate regulation | C2 Environmental education |
| P3 Hydroelectric energy | R3 Air purification | C3 Sport activity |
| | | C4 Intrinsic value |
| | | C5 Sense of place |
| | | C6 Aesthetic beauty |
| | | C7 Mental wellbeing |
| | | C8 Artisan products |

b) Stakeholder roles regarding ES and definitions

| User | Managers | Negatively influenced | Interested | Investigator |
|---|---|---|---|---|
| *Receive the benefits of the services* | *His/her/their activity supports the offer of this service* | *Bothered by the presence of the service* | *Not a direct user but believe in its importance* | *You care about this service from a research point of view* |

c) Anthropogenic capitals involved in ES co-production and definitions

| Human capital | Social capital | Physical capital | Financial capital |
|---|---|---|---|
| *Labor, knowledge, education, motivation, skills, or health* | *Values and norms, formal and informal networks, or trust* | *Machinery, tools, infrastructure, or built capital* | *Savings, credits, grants or direct payments* |

## The role of stakeholders in ecosystem services co-production

We retrieved a total of 76 ES co-production records, representing in average 2.2 responses per person (Fig. 4). Stakeholders acknowledged co-production in all ES of the list except for *P3 Hydroelectric energy* and *R3 Air purification*. The main ES identified to be co-produced were *C5 Sense of place* (13%), *C1 Eco-tourism* (12%), *C8 Artisan products* (12%), and *P1 Agricultural products* (11%).

Respondents described their role in ES co-production mostly as *Users* (50% of ES records) and *Managers* (40.8%). Minor roles were *Interested* (6.6%) and *Investigator (1.3%)*. Remarkably, we found that several roles could be identified for the same ES. For instance, for *C5 Sense of place*, 60% of roles was identified as *Users* and 40% as *Managers*. Other examples are *C1 Eco-tourism*, were 66.6% *Managers*, 22.2% are *Users*, and 11.1% *Investigators*; *C8 Artisan products* revealed 66.6% *Users* and 33.3% *Managers*; while *P1 Agricultural products* comprises 62.5% *Managers* and 37.5% *Users*. On the other hand, *C6 Aesthetic beauty* was related only to the role of Users.

Our results show that the stakeholder groups *Tourism and commerce* and *Production* self-identified themselves mostly as *Managers of ES* (80% and 78% of the ES records, respectively). The stakeholder group *Education and research* accounts for 71% of *Users*, 28% of *Managers*, and 11% of *Interested*, while *Planning and administration* share an equal composition of *Managers* and *Users* (47% each) with a 7% of *Investigators*. *Society* includes 75% of *Users*, and equal shares of *Managers* and *Interested* (*13% each*). Our results revealed that the stakeholders' groups *Society* and *Planning and administration* include more diversity of co-production roles than *Production* and *Tourism and commerce*.

## Anthropogenic capitals involved in co-production

Overall, most respondents acknowledged ES co-production via higher levels of human and social capitals, while physical and financial capitals had less relevance (Fig. 5). We found that the relevance of social capital was the most variable across ES categories, while all the other capitals did not show significant differences in their relevance across ES neither stakeholder groups (see Table 2).

We observed that both cultural and regulating services were mostly co-produced by social and human capitals, while physical and financial capitals were less relevant. Contrarily, in the case of provisioning services, physical and financial capitals showed larger relevance (Fig. 5).

In particular, the highest shares of human capital were identified for *C2 Environmental education* and *C6 Aesthetic beauty*, while the lowest were found for *P2 drinking water* and *C8 artisan products.* The share of social capital was highest for C2 *Environmental education* and *C1 Eco-tourism* and lowest for *P2 Drinking water* and *C8 Artisan products.*

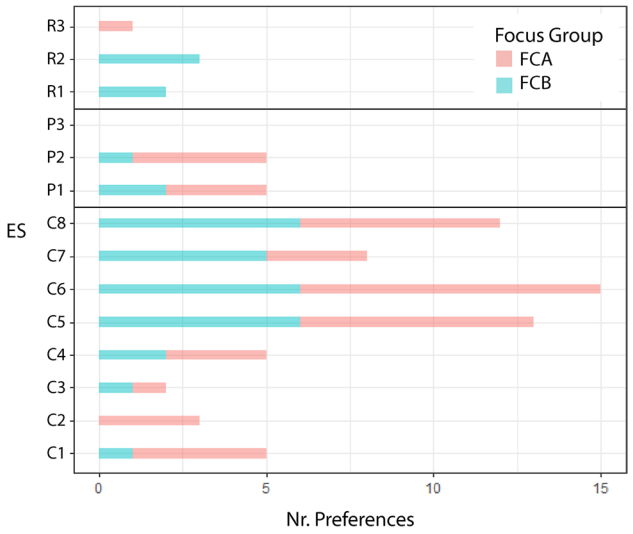


**Fig. 3** Preferences for Ecosystem Services in the local case study. See complete list of ES in Table 1 (a). Red bars are from focus group A (education and research, society, production). Blue bars are from focus group B (municipal and administration, tourism and commerce)

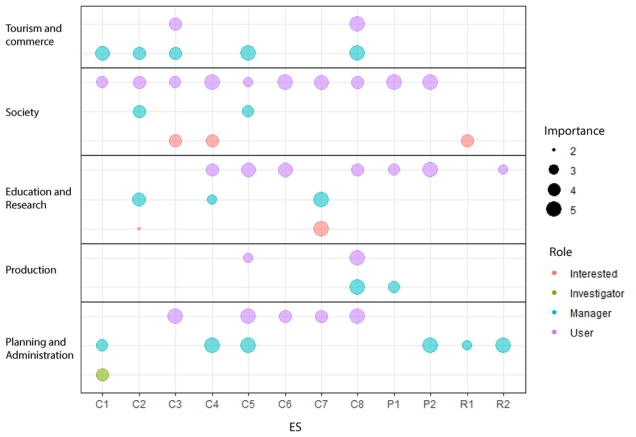


**Fig. 4** Perceived role of stakeholders in ES co-production. See complete list of ES in Table 1 (a). Note that P3 and R3 are not represented in the graph as none of the respondents acknowledged having a role in them

Regarding physical capital, it was highest in *P2 Drinking water* and *C1 Eco-tourism*; and lowest are *R2 Climate regulation* and *C4 Intrinsic value.* For Financial capital, it was highest in *P2 Drinking water* and *C1 eco-tourism*; and lowest in *C4 Intrinsic* value and C5 Sense of place.

## Discussion

### Multiple roles of stakeholders in landscape transformations

This study sought to include the perspective of stakeholders in landscape planning through the application of the ES co-production framework to a local case study. Our findings confirm that stakeholders associate to local ecosystems multiple ES across different categories. Most of the ES identified through the focus groups were acknowledged as co-produced by the respondents by taking different roles. The stakeholder groups *Production* and *Tourism and commerce* were mostly self-identified as managers of ES, while the stakeholder groups *Society* and *Education and research* were mostly self-identified as users—in the sense that the act of using a service states a preference and implies cognitive co-production (Fischer and Eastwood 2016). As a general result of our work, the theoretical framework proposed in Fig. 1 proved useful in highlighting the multiple roles of stakeholders that should be taken into account in landscape management. The different roles identified by stakeholders, as well as the importance they attribute to ES (Fig. 4), reveal different power relations among them and in relation to the key ES. For instance, stakeholders with a *Manager* role exert power over stakeholders with a *User* role in relation to the ES important to them. Moreover, integrating the knowledge of the relevant stakeholders involved in the co-production of ES into landscape planning could support a sustainable and resilient development of rural areas facing extreme events (Gret-Regamey 2008).

Our study revealed that local stakeholders take active roles in the co-production of ES through their knowledge, values, instruments, and credits invested in natural capitals (Palomo et al. 2016). Our empirical exercise highlights that human and social capitals are perceived to play the largest role in ES co-production in a rural landscape. For example, Figure 5 shows the role stated by stakeholders in relation to education or knowledge (human capitals) as drivers of interactions with natural capital, and to values and norms (social capitals) as incentives for their businesses. These results are in line with other studies emphasizing the importance of highlighting the intrinsic role of humans in the supply of cultural ES (e.g., Comberti et al. 2015; Spangenberg et al. 2014). In addition, our findings agree with a recent literature review showing that most co-production evidence for non-material NCP (Nature Contributions to People) involves social and human capitals (Kachler et al. 2023). However, our study revealed that most local stakeholders acknowledged the co-production of cultural ES, whereas Kachler et al. (2023) found most evidence of co-production for provisioning ES. This is likely related to the large cultural value associated to the small-scale agricultural landscape of Val di Fiastra (Bevilacqua 2013)

Our study proved useful not only in showing how stakeholders act physically on the environment (physical co-production), but also how anthropogenic capitals shape the perception of a service (cognitive co-production) supporting

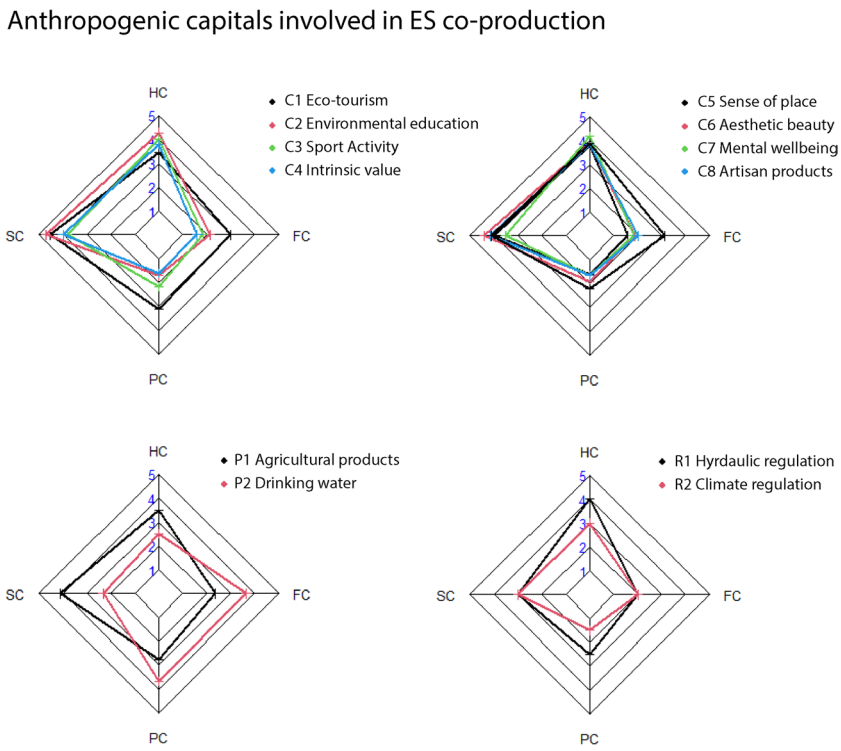


**Fig. 5** Proportion of anthropogenic capitals (from 1: low to 5; high) involved in the co-production of ecosystem services as stated by local stakeholders. Human capitals (HC), social capitals (SC), physical capitals (PC), financial capitals (FC)

**Table 2** Distribution of answers (chi-square test) on the capitals involved in ES co-production, per Stakeholders groups (SH groups) and per Ecosystem Service (ES)

| Variables | | Df | *P*-value |
|---|---|---|---|
| SH groups | Human capital | 16 | 0.691 |
| SH groups | Social capital | 16 | 0.223 |
| SH groups | Physical capital | 16 | 0.065 |
| SH groups | Financial capital | 16 | 0.080 |
| ES | Human capital | 44 | 0.163 |
| ES | Social capital | 44 | 0.033 |
| ES | Physical capital | 44 | 0.216 |
| ES | Financial capital | 44 | 0.329 |

the assessment and protection of the environment (Fischer and Eastwood 2016). In this sense, in accordance with other studies on relational values (Arias-Arévalo et al. 2017), we argue that pluralistic assessment approaches should be included into planning to take into account the complexity of landscapes and consider the diverse motivation and interests that brings stakeholders to interact with the environment.

Surprisingly, our findings showed a low interest of stakeholders in regulating services. This could be due to the fact that the specific case study is located in a rural area that is not particularly exposed to air quality or hydraulic risks. In this way, our study provides further evidence about the connection between risk exposure and perception of regulating services, which emphasizes the importance of integrating people's perceptions for the adoption of conservation measures (Lewis and Harvey 2001). This is especially relevant for resilience thinking in landscape planning, where socio-economic characteristics and hazard exposure are significant predictors of structural damage (Highfield et al. 2014).

Embracing the multiple aspects of human-nature interactions, the ES framework offers the opportunity to identify the role of co-production in different sectors and supports a multifunctional vision of landscapes (Mascarenhas et al. 2014; Díaz et al. 2015; Fischer et al. 2015; Felipe-Lucia et al. 2018). While the general results show a larger role of social and human capitals, co-production of provisioning services requires a larger share of physical and financial capitals, in line with the findings by Isaac et al. (2022). For example, the delivery of fresh water involves infrastructure construction and maintenance while agricultural systems need machinery and tools. A similar argument applies to eco-tourism, which, given the role played by physical and financial capitals in their co-production, can be considered as a provisioning service (Pueyo-Ros 2018). In this sense, we argue that our theoretical framework (Fig. 1) can support integrated actions in landscape planning by uncovering the capitals involved in the different ES, which makes it possible to identify specific management interventions tailored to the different sectors of the study area.

### Cultural values of landscapes

This empirical exercise on a local case study underscored the usefulness of the ES co-production approach to display cultural values of rural landscapes. Cultural values are becoming more important as European policies (among others, *European Landscape convention 2000*) call on governments to recognize landscapes as an essential component of people's lives and expression of their cultural and natural heritage. Our study exemplarizes how the ES co-production framework can capture the cultural values of landscapes. Often neglected by mapping exercises and economic valuation assessments (Comberti et al. 2015), cultural ES have indeed the potential to foster new conceptual links among social and ecological issues (Milcu et al. 2013). Addressing human perceptions, attitudes, and beliefs, cultural services can highlight important linkages between environmental and social sciences shifting the focus from individual to collective needs (Milcu et al. 2013).

The preference of local stakeholders for cultural ES such as Aesthetic beauty or Mental wellbeing shows the relevance of intangible benefits in human-nature relationships. These benefits are often not captured by planning practice (de Groot et al. 2010; Ruckelshaus et al. 2015) but we argue that they should be pushed ahead as indispensable elements of landscape planning as they could provide a rich basis for development strategies in rural areas. These efforts could lead to the realignment of heritage preservation agendas, especially in areas recently affected by catastrophic events where cultural elements are seen as the main connections to their original areas for displaced populations (Emidio di Treviri 2018). The prominent rate of co-production regarding a sense of place as an ES found in our study shows the awareness among local stakeholders of the interdependence of nature and communities in the sense of belonging to a place. Hence, reconstruction strategies must account for local environmental relations when planning emergency housing or the regeneration of rural settlements (Emidio di Treviri 2018; Sargolini et al. 2022).

With regards to tangible cultural services, rural development strategies often account for the tourism sector as potential driver for economic diversification, income, and employment (Petrosillo et al. 2007; Aretano et al. 2013; Pueyo-Ros 2018). Nevertheless, our study did not show large preferences for Eco-Tourism as an ES. This may be related to the high seasonality of the tourism industry and the minor shares of local society involved in this sector (Guaita Martínez et al. 2019). On the other hand, eco-tourism was the ES most identified by stakeholders to be co-produced, with a high rate of managers (66%), not only from the *Tourism and commerce* group but also from *Planning and administration*, proving their direct involvement in the sector. For these reasons, development strategies should consider eco-tourism as a main node of human-nature interaction, while accounting its seasonality (Aretano et al. 2013).

### Strengths and shortcomings in using the concept of ecosystem services co-production for participation in landscape planning

The integration of the ES co-production framework in landscape planning proved useful in highlighting the role of stakeholders in the management of ES at the landscape scale. While participatory mapping of ES is gaining momentum within researchers and practitioners (e.g., Mascarenhas et al. 2016; Spyra et al. 2019; Giacomelli and Calcagni 2022), participatory processes are explicitly recommended by policies at the European level (among others, the Territorial Agenda 2030, 2020). As shown by this study, the ES co-production concept offers a common ground between stakeholders where to build a cohesive understanding and can offer paths of inclusion of local stakeholders in different planning sectors (Spyra et al. 2019).

However, the literature emphasizes that the outcome of participation is strictly dependent on the processes leading to them (Reed 2008). To bring valuable results, participatory process design needs to encompass empowerment, trust, and learning of participants while integrating an understanding of the complexity of landscapes as socio-ecological systems. In rural contexts, the distance from places of decision-making (i.e., cities and urban centers) can determine refractory in participation, and the minor availability of economic and human resources can present challenges in implementations (Henderson et al. 2020).

In addition, further studies might enlarge the territorial scope of the analysis to urban case studies, as well as natural protected areas, in order to facilitate the analysis of the differences in social roles in areas more related to the demand of ES (e.g., urban areas) or to the offer of ES (e.g., rural/peripheric areas) (Baró et al. 2017; Giacomelli et al. [unpublished]). Also, it is important to notice that the ES that are not directly used or managed by the local stakeholders are often not recognized as ES. This is the case of P3 hydroelectric energy, stated as a relevant ES at the regional scale (Vautereco project), but not perceived by the respondents in the Fiastra Valley as no power plants are present there.

As a general remark, as our assessment of ES is related to participant perceptions, it is not possible to exclude a bias of respondents in representing a category of stakeholders. Therefore, our results should be taken with caution when extrapolating to other locations.

## Conclusions

To our knowledge, this study represents the first explicit application of the ES co-production framework to landscape planning through an empirical work on a real case study. Our results reveal that rural stakeholders show a preference for

cultural ES. A wide range of ES are identified as actively co-produced by stakeholders mostly in their role as managers, acting on the state of ecosystems (i.e., physical co-production), and as users, benefiting from the ES and valuing them (i.e., cognitive co-production). The former refers to the physical action on ecosystems involving measurable external changes, the latter belongs to the cognitive processes related to the individual perception and addresses the importance of perceived quality of life for landscape planning.

Our results highlight the importance of including local stakeholders in landscape planning through their role in ES co-production. This framework allows planners to identify the relevant stakeholders in relation to different ES key for the local context, which could now be integrated in participatory planning processes. Stakeholders' roles involve different planning sectors and a range of human-nature interactions (from agricultural products to eco-tourism), revealing crucial power relations (e.g., between managers and users). Making these human-nature interactions explicit allows planners to address the complexity of social-ecological systems, bridging the social and environmental fields through a systemic look to the landscape. In turn, this study contributes to developing rural landscape management plans tailored to the needs of local stakeholders.

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## References

Albert C, Galler C, Hermes J, Neuendorf F, von Haaren C et al (2016) Applying ecosystem services indicators in landscape planning and management: the ES-in-Planning framework. Ecol Indic 61:100–113. https://doi.org/10.1016/j.ecolind.2015.03.029

Aretano R, Petrosillo I, Zaccarelli N, Semeraro T, Zurlini G (2013) People perception of landscape change effects on ecosystem services in small Mediterranean islands: a combination of subjective and objective assessments. Landsc Urban Plan 112:63–73. https://doi.org/10.1016/j.landurbplan.2012.12.010

Arias-Arévalo P, Martín-López B, Gómez-Baggethun E (2017) Exploring intrinsic, instrumental, and relational values for sustainable management of social-ecological systems. Ecol Soc 22:43–56. https://doi.org/10.5751/ES-09812-220443

Baró F, Gómez-Baggethun E, Haase D (2017) Ecosystem service bundles along the urban-rural gradient: insights for landscape planning and management. Ecosyst Serv 24:147–159. https://doi.org/10.1016/j.ecoser.2017.02.021

Berkes F, Folke C (1992) A systems perspective on the interrelations between natural, human-made and cultural capital. Ecol Econ 5:1–8. https://doi.org/10.1016/0921-8009(92)90017-M

Bennett EM, Cramer W, Begossi A, Cundill G, Díaz S et al (2015) Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. Curr Opin Environ Sustain 14:76–85. https://doi.org/10.1016/j.cosust.2015.03.007

Bevilacqua, P (2013) Marche, in: Agnoletti, M. (Ed.), Italian historical rural landscapes: Cultural values for the Environment and Rural Development. Springer, Dordrecht, pp 343–361. https://doi.org/10.1007/978-94-007-5354-9_15

Calderón-Argelich A, Benetti S, Anguelovski I, Connolly JJT, Langemeyer J et al (2021) Tracing and building up environmental justice considerations in the urban ecosystem service literature: a systematic review. Landsc Urban Plan 214:104130. https://doi.org/10.1016/j.landurbplan.2021.104130

Comberti C, Thornton TF, Wyllie de Echeverria V, Patterson T (2015) Ecosystem services or services to ecosystems? Valuing cultivation and reciprocal relationships between humans and ecosystems. Glob Environ Change 34:247–262. https://doi.org/10.1016/j.gloenvcha.2015.07.007

de Groot RS, Alkemade R, Braat L, Hein L, Willemen L (2010) Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. Ecol Complex 7:260–272. https://doi.org/10.1016/j.ecocom.2009.10.006

Díaz S, Demissew S, Carabias J, Joly C, Lonsdale M et al (2015) The IPBES conceptual framework — connecting nature and people. Curr Opin Environ Sustain 14:1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Emidio di Treviri (2018) Sul fronte del sisma. Un'inchiesta militante sul post-terremoto dell'Appennino centrale (2016-2017) - Emidio di Treviri. Derive Approdi, Bologna

Felipe-Lucia MR, Martín-López B, Lavorel S, Berraquero-Díaz L, Escalera-Reyes J et al (2015) Ecosystem services flows: why stakeholders' power relationships matter. PLOS ONE 10:e0132232. https://doi.org/10.1371/journal.pone.0132232

Felipe-Lucia MR, Soliveres S, Penone C, Manning P, van der Plas F et al (2018) Multiple forest attributes underpin the supply of multiple ecosystem services. Nat Commun 9:4839. https://doi.org/10.1038/s41467-018-07082-4

Fischer A, Eastwood A (2016) Coproduction of ecosystem services as human–nature interactions—an analytical framework. Land Use Policy 52:41–50. https://doi.org/10.1016/j.landusepol.2015.12.004

Fischer J, Gardner TA, Bennett EM, Balvanera P, Biggs R et al (2015) Advancing sustainability through mainstreaming a social–ecological systems perspective. Curr Opin Environ Sustain 14:144–149. https://doi.org/10.1016/j.cosust.2015.06.002

Forman RTT, Godron M (1986) Landscape ecology. Wiley, New York

GAL Sibilla (2019) Progetto Integrato Locale "La valle del Fiastra: luogo di esperienze". https://www.galsibilla.it/news/pil-la-valle-del-fiastra-luogo-di-esperienze. Accessed 06 April 2023

Giacomelli M, Calcagni F (2022) Borgofuturo+. Un progetto locale per le aree interne. Quodlibet, Macerata

Grêt-Regamey A, Altwegg J, Sirén EA, van Strien MJ, Weibel B (2017) Integrating ecosystem services into spatial planning—a spatial decision support tool. Landsc Urban Plan 165:206–219. https://doi.org/10.1016/j.landurbplan.2016.05.003

Grêt-Regamey A, Walz A, Bebi P (2008) Valuing ecosystem services for sustainable landscape planning in Alpine regions. Mount Res Dev 28:156–165. https://doi.org/10.1659/mrd.0951

Guaita Martínez JM, Martín Martín JM, Salinas Fernández JA, Mogorrón-Guerrero H (2019) An analysis of the stability of rural tourism as a desired condition for sustainable tourism. J Business Res 100:165–174. https://doi.org/10.1016/j.jbusres.2019.03.033

Haines-Young R, Potschin-Young MB (2018) Revision of the Common International Classification for Ecosystem Services (CICES V5.1): a policy brief. One Ecosystem 3:e27108. https://doi.org/10.3897/oneeco.3.e27108

Henderson F, Steiner A, Farmer J, Whittam G (2020) Challenges of community engagement in a rural area: the impact of flood protection and policy. J Rural Stud 73:225–233. https://doi.org/10.1016/j.jrurstud.2019.11.004

Highfield WE, Peacock WG, Van Zandt S (2014) Mitigation planning: why hazard exposure, structural vulnerability, and social vulnerability matter. J Plan Educ Res 34:287–300. https://doi.org/10.1177/0739456X14531828

Isaac R, Kachler J, Winkler J, Albrecht E, Felipe-Lucia MR, et al. (2022) Chapter Ten - Governance to manage the complexity of nature's contributions to people co-production. Adv Ecol Res 66:293–321. https://doi.org/10.1016/bs.aecr.2022.04.009

Jericó-Daminello C, Schröter B, Mancilla Garcia M, Albert C (2021) Exploring perceptions of stakeholder roles in ecosystem services coproduction. Ecosyst Serv 51:101353. https://doi.org/10.1016/j.ecoser.2021.101353

Kachler J, Isaac R, Martín-López B, Bonn A, Felipe-Lucia MR (2023) Co-production of nature's contributions to people: What evidence is out there? People Nat 5:1119–1134. https://doi.org/10.1002/pan3.10493

Langemeyer J, Gómez-Baggethun E, Haase D, Scheuer S, Elmqvist T et al (2016) Bridging the gap between ecosystem service assessments and land-use planning through Multi-Criteria Decision Analysis (MCDA). Environ Sci Policy 62:45–56. https://doi.org/10.1016/j.envsci.2016.02.013

Lavorel S, Locatelli B, Colloff MJ, Bruley E (2020) Co-producing ecosystem services for adapting to climate change. Phil Trans R Soc B 375:20190119. https://doi.org/10.1098/rstb.2019.0119

Lewis GJ, Harvey B (2001) Perceived environmental uncertainty: the extension of Miller's scale to the natural environment. J Manage Stud 38:201–234. https://doi.org/10.1111/1467-6486.00234

Mascarenhas A, Ramos TB, Haase D, Santos R (2014) Integration of ecosystem services in spatial planning: a survey on regional planners' views. Landsc Ecol 29:1287–1300. https://doi.org/10.1007/s10980-014-0012-4

Mascarenhas A, Ramos TB, Haase D, Santos R (2016) Participatory selection of ecosystem services for spatial planning: insights from the Lisbon Metropolitan Area, Portugal. Ecosyst Serv 18:87–99. https://doi.org/10.1016/j.ecoser.2016.02.011

Milcu A, Hanspach J, Abson D, Fischer J (2013) Cultural ecosystem services: a literature review and prospects for future research. Ecol Soc 18:44. https://doi.org/10.5751/ES-05790-180344

Opdam P, Albert C, Fürst C, Grêt-Regamey A, Kleemannet J et al (2015) Ecosystem services for connecting actors – lessons from a symposium. Change Adapt Socio-Ecol Syst 2:1–7. https://doi.org/10.1515/cass-2015-0001

Palomo I, Felipe-Lucia MR, Bennett EM, Martín-López B, Pascual U (2016) Chapter Six - Disentangling the pathways and effects of ecosystem service co-production. In: Woodward G, Bohanand DA (ed) Advances in ecological research, vol 54. Academic Press, pp 245–283. https://doi.org/10.1016/bs.aecr.2015.09.003

Petrosillo I, Zurlini G, Corlianò ME, Zaccarelli N, Dadamo M et al (2007) Tourist perception of recreational environment and management in a marine protected area. Landsc Urban Plan 79:29–37. https://doi.org/10.1016/j.landurbplan.2006.02.017

Pueyo-Ros J (2018) The role of tourism in the ecosystem services framework. Land 7:111–124. https://doi.org/10.3390/land7030111

Reed MS (2008) Stakeholder participation for environmental management: a literature review. Biologic Conserv 141:2417–2431. https://doi.org/10.1016/j.biocon.2008.07.014

Rieb JT, Chaplin-Kramer R, Daily GC, Armsworth PR, Böhning-Gaese K et al (2017) When, where, and how nature matters for ecosystem services: challenges for the next generation of ecosystem service models. BioScience 67:820–833. https://doi.org/10.1093/biosci/bix075

RStudio Team (2021) RStudio: integrated development environment for R. RStudio, http://www.rstudio.com/. Accessed 06 April 2023

Ruckelshaus M, McKenzie E, Tallis H, Guerry A, Daily G et al (2015) Notes from the field: lessons learned from using ecosystem service approaches to inform real-world decisions. Ecol Econ 115:11–21. https://doi.org/10.1016/j.ecolecon.2013.07.009

Sargolini M, Gambino R (2016) Mountain landscapes. List, Trento

Sargolini M, Pierantoni I, Polci V, Stimilli F (2022) Progetto Rinascita Centro Italia. Nuovi sentieri di sviluppo per l'Appennino Centrale interessato dal sisma del 2016. CARSA Edizioni, Pescara

SNAI Alto Maceratese (2019) SNAI Local development strategy "La rinascita dei territori nel rapporto lento-veloce". Unione Marca di Camerino. https://www.unionemarcadicamerino.it/snai-alto-maceratese/schede-di-intervento-e-a-p-q. Accessed 06 April 2023

Spangenberg JH, von Haaren C, Settele J (2014) The ecosystem service cascade: further developing the metaphor. Integrating societal processes to accommodate social processes and planning, and the case of bioenergy. Ecol Econ 104:22–32. https://doi.org/10.1016/j.ecolecon.2014.04.025

Spyra M, Kleemann J, Cetin NI, Vázquez Navarrete CJ, Albert C et al (2019) The ecosystem services concept: a new Esperanto to facilitate participatory planning processes? Landsc Ecol 34:1715–1735. https://doi.org/10.1007/s10980-018-0745-6

Tallis H, Kennedy CM, Ruckelshaus M, Goldstein J, Kiesecker JM (2015) Mitigation for one & all: an integrated framework for mitigation of development impacts on biodiversity and ecosystem services. Environ Impact Assess Rev 55:21–34. https://doi.org/10.1016/j.eiar.2015.06.005

Territorial Agenda 2030 (2020) A future for all places. https://ec.europa.eu/regional_policy/en/information/publications/brochures/2021/territorial-agenda-2030-a-future-for-all-places. Accessed 06 April 2023

Turkelboom F, Leone M, Jacobs S, Kelemen E, Garcia-Llorente M et al (2018) When we cannot have it all: ecosystem services trade-offs in the context of spatial planning. Ecosyst Serv 29:566–578. https://doi.org/10.1016/j.ecoser.2017.10.011