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3 **1 TITLE PAGE(s)**
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8 4 When necessity meets opportunity: the role of Service-Learning projects to complement
9 5 training, community engagement and knowledge transfer in restoration
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12 **7 RUNNING TITLE**
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14 8 The potential of Service-Learning in restoration
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34 21 **ABSTRACT**
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36 22 Ecological restoration (ER) represents a key strategy for ecosystem recovery and society
37 23 development. ER is attracting global interest and restoration opportunities will increase in
38 24 upcoming decades, but it requires restorers, the participation of relevant stakeholders, and a better
39 25 adaptation to societal needs. Service-Learning (S-L), an educational methodology based on
40 26 community projects, represents a way to extend the range of action of ER and to involve society,
41 27 especially younger generations. We describe S-L for the learning/training of students in
42 28 environmental issues presenting initiatives that, using S-L to develop collaborative projects, have
43 29 been carrying out activities related to fire prevention or post-fire restoration. S-L projects provide
44 30 a context for training of future professionals and generate a working-collaborative environment
45 31 favoring the active participation of society in environmental actions. Indirectly, S-L projects can
46 32 increase knowledge transfer and inculcate the necessity for protection and conservation,
47 33 improving the capacity, involvement, and commitment of society on ER.
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50 35 **Keywords (6 max)**
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52 36 Ecological restoration, fire management, education and training, social participation, student
53 37 learning, collaborative projects
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3 384
5 396 40 **Author contributions**

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8 41 PSA, AM conceived the original idea of the paper; all authors discussed and provided the
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10 42 conceptual framework; PSA developed the structure and prepared a first version of the
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12 43 manuscript; all authors contributed to manuscript revision, read, and approved the submitted
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14 44 version of the manuscript

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18 47 **Implications for Practice**

19 48 Service learning (S-L) is a fundamental educational tool for the improvement of students'
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21 49 education and training.

22 50 Service-Learning projects ameliorate students' training from a holistic and humanistic point of
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24 51 view with an experience that integrates into their curriculum.

25 52 There is a clear need for qualified professionals to carry out restoration actions.

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27 53 Service-Learning projects fit well with the integrative and participatory vision of ecological
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29 54 restoration.

30 55 The development of service-learning projects increases citizen participation and involvement in
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32 56 environmental actions.

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5 60 ***The age of ecological restoration***

6 61 Ecological restoration (ER) is at the center of the environmental and political debate, appearing
7 62 as a key strategy for ecosystem healing but also as a system of coordinates to understand the
8 63 relationship between society and environment. The recognition of the 2021-2030 period as the
9 64 UN Decade on Ecosystem Restoration leaves no doubt regarding ER as a fundamental axis for
10 65 environmental policies in upcoming years, including its role in recovering biodiversity and
11 66 improving human wellbeing in times of rapid global change (Gann et al. 2019). But this point has
12 67 not been reached by chance. Motivated by the evidence that protective measures alone are
13 68 insufficient due to the high rate of degradation in some ecosystems, voices of alarm have been
14 69 launched from the climatic (IPCC 2022), the ecological (IPBES 2018; the Bonn Challenge), the
15 70 political-administrative (Sustainable Development Goals, SDGs), or the economic point of view
16 71 (World Economic Forum 2021) to focus conservation and the recovery of natural capital as
17 72 priorities for planet sustainability.

18 73 Restoring ecosystems should be linked to restoring natural capital starting by reducing the
19 74 negative impacts of daily living (production systems, cities, resource extraction, and transport),
20 75 and focus education and communication aspects (Aronson et al. 2007). However, ER is
21 76 challenging, and it is constrained by technical, social or economic limitations (EFTEC et al. 2017;
22 77 Gann et al. 2019; Cortina-Segarra et al. 2021). Despite the recent advances, there is still an
23 78 important gap between restoration necessities and the capacity of our society to satisfy these
24 79 demands.

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26 81 ***Forest represents a paradigmatic example for ER***

27 82 ER includes all types of degraded systems (Gann et al. 2019), but forest loss illustrates the current
28 83 environmental crisis. Critical in the regulation of global climate, forests extend along 1/3 of
29 84 terrestrial surface providing essential functions (FAO and UNEP 2020). Although the rate of
30 85 natural forest degradation has been progressively reduced, 10 million ha y⁻¹ were lost between
31 86 2015-2020 (Global Forest Resources Assessment 2020). Forests and other priority areas and
32 87 biomes as grasslands, shrublands, arid lands or wetlands are the focus of large-scale restoration
33 88 at national, regional and global levels (Strassburg et al. 2020; Chazdon et al. 2016)

34 89 Immersed in the UN Decade on Ecosystem Restoration, there is increasing willingness of
35 90 authorities and administrations to pursue environmental conservation, probably forced by the
36 91 larger concern of society on environmental issues. In fact, forest conservation is pointed out as
37 92 the most important environmental policy to fight climate change (UN Development Program
38 93 2021). However, the management of upcoming societal and environmental challenges will require
39 94 education on forest conservation and restoration. Collaboration and communication are
40 95 mandatory for successful (forest) restoration, an objective that will require motivated actors

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3 96 working together towards common objectives (Stanturf 2021). More than ever, targeted
4 97 campaigns to highlight the importance of restoration, ecosystem services and biodiversity
5 98 together with ambitious education programs are needed to train specialists, but also to inform the
6 99 public and generate social support for policy measures (Cortina-Segarra et al. 2021).
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11 101 ***Rebuilding social ties and the society-nature link***

12 102 Besides the environmental benefits of preserving its integrity, forests represent iconic ecosystems
13 103 for conservation and essential boundaries with nature. Identifying relevant upcoming
14 104 environmental risks for the next decades, the Global Risks Report (World Economic Forum 2021)
15 105 warns about the erosion of societal cohesion due to the loss of social capital and the fracture of
16 106 networks that maintain social stability, individual wellbeing, and economic productivity. Our
17 107 societies face an increasing risk for anxiety and mental health deterioration. Globally and across
18 108 multiple demographics, emotional, cognitive, and physical disorders are related to the increasing
19 109 disconnection with nature (Louv 2005), intensifying pathologies of childhood and adolescence
20 110 such as anxiety disorders or ADD (Taylor et al. 2001). Although the health benefits of contact
21 111 with nature are difficult to quantify, there is increasing evidence of benefits of biodiversity and
22 112 immersion in nature (Aerts et al. 2018; Kotera et al. 2022) for human health. Forests provide a
23 113 “health-bonus”, and forest-based initiatives represent good opportunities to support public health
24 114 (Doimo et al. 2020).
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34 116 ***Restoration and employment***

35 117 There is an unprecedented opportunity to transform degraded areas into functional ecosystems
36 118 that offer multiple benefits to society and future generations (Chazdon et al. 2019), including job
37 119 opportunities. In a context where the ER movement is gaining momentum and political leaders
38 120 are demonstrating disposition for achieving ambitious targets (Chazdon et al. 2017), restoration
39 121 opportunities will soon multiply (Armesto et al. 2007). The weight of restoration is already
40 122 increasing within the green economy (BenDor et al. 2015), generating more jobs per million
41 123 invested than traditional activities (Garrett-Peltier et al. 2009), providing short-term and long-
42 124 term employment opportunities and creating positive ecological and economic feedback loops
43 125 (Gann et al. 2019). If restoration targets are met, a country like Brazil could potentially create 1-
44 126 2.5 million jobs (0.42 jobs/hectare) related to restoration (Brancalion et al. 2022).
45 127 Restoration requires restorers and despite the increasing interest in forestry-related education
46 128 (Global Forest Resources Assessment 2020), there is a demand for trained and experienced
47 129 professionals to develop effective restoration activities (Covington et al. 2000; Smith-Ramirez et
48 130 al. 2015) since the availability of scientists and experience practitioners is insufficient to meet the
49 131 global demand (Aronson 2020). ER considers the multi-stakeholder perspective that will require
50 132 new competencies and transversal skills adapted to future scenarios (planning, moderation,

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3 133 restoration, and monitoring). In this way, restorers can be better considered as *facilitators*
4 134 (Stanturf 2021) but to this, we should bridge the gap between the needs of the society and the
5 135 student training process. Therefore, environmental (restoration), economic (employment) and
6 136 societal (education) requirements converge, bringing together social work and science, and
7 137 encouraging community engagement in nature protection.
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12 139 ***Educational tools to improve student training: Service-Learning***

14 140 Although limitations are numerous, different approaches can contribute to attract attention and
15 141 promote ER. Here, Service-Learning (S-L) represents an educational experience where students
16 142 get involved in an organized activity that meets community needs, broadening the technical
17 143 knowledge and theoretical concept learned in classes with the sense of civic responsibility
18 144 (Bringle & Hatcher 1996). S-L might serve as an educational methodology for some reasons: the
19 145 practical training of students, the possibility to dialogue between social agents, and the focus on
20 146 authentic learning (García-Romero & Lalueza 2019). S-L combines learning and community
21 147 service in a single project with a civic and academic base (Sotelino et al. 2016), providing
22 148 academic credit for the learning (Cayuela et al. 2020). In S-L, students learn not in a transactional
23 149 way, but because of intrinsic reasons: gaining competence to develop affectively relevant tasks,
24 150 understanding the meaning of the social action they care about, and becoming part of a
25 151 collaborating community (García-Romero & Martínez-Lozano 2022). This is referred as
26 152 *authentic learning*, entailing a holistic and humanistic education.

27 153 Besides the civic education and the impact of service, S-L promotes an environment of
28 154 interinstitutional collaboration between academia and social agents, promoting bidirectionality in
29 155 learning (McMillan et al. 2016), e.g., inclusion of local-traditional knowledge (LEK, TEK),
30 156 fundamental for ER (Gann et al. 2019). In this way, S-L projects can potentially gather
31 157 multidisciplinary teams with participants from distant fields, bringing different perspectives.
32 158 However, it is important to indicate that S-L does not represent a tool to *apply* ER but a tool for
33 159 *learning and training* in ER. Considering the dimensions of S-L and the ER principles (Gann et
34 160 al. 2019), S-L projects align with them at different points (**Figure 1**).

35 161 At the end, the restoration experience depends on the profile of the participants and efforts are
36 162 more successful when project components are informed by or (hopefully) shared with relevant
37 163 stakeholders that provide local specific knowledge (social, economic, cultural) (Gornish et al.
38 164 2021). Also, on-site work, hands-on participation, community engagement of S-L projects can
39 165 serve to fulfill the demand for conceptual grounding and training, and strategy to support the
40 166 United Nation's Decade on ER (Aronson et al. 2020).

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52 168 ***Here is when necessity meets opportunity***
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3 169 Learning process should go beyond knowledge collection to become a complete formative-
4 170 transformative process. S-L projects bring together students, academics, and community
5 171 stakeholders whereby all become educational referents, problem solvers and partners. Beyond the
6 172 direct benefits, S-L allows students to develop their responsibility and awareness, fostering social
7 173 long-term resilience. Involving young students through S-L contributes to education, serves to
8 174 restore ecosystems, builds relationships with nature, and inspires future land stewards (Cramer
9 175 2008): “*They have come to love the place in which they live*” say authors describing the
10 176 relationship between scholars and a restored wetland in Corvallis (Oregon, US).

11 177 Nevertheless, although S-L projects are common in the social sciences, its application in
12 178 environmental issues (and restoration) is still limited and published literature is scarce
13 179 (Knackmuhs et al., 2017; Vance-Chalcraft and Goodwillie, 2022). This is an important constraint
14 180 in a context that demands improving our teaching capacity in ecology (Cooke et al. 2021) and
15 181 other environmental disciplines. In addition to passing up the opportunities that the S-L possesses,
16 182 through student engagement practitioners could directly share up-to-date techniques and applied
17 183 research, facilitating new channels to transfer knowledge. S-L projects can be considered expert-
18 184 facilitated bottom-up approaches that provide better results with the local community support
19 185 (Stanturf 2021). Indeed, applied researchers should adapt the scientific information and act as
20 186 transmitters/translators of the specialized literature to the managers, stakeholders, and the public
21 187 (Gornish et al. 2018). Here, students make the message more accessible, becoming powerful
22 188 ambassadors (Gann et al. 2019).

23 189 The contribution of S-L to restoration is promissory for several reasons. In one hand, methodology
24 190 (S-L) and the discipline (ER) need context and depend on *in situ* conditions (Gann et al. 2019).
25 191 Also, S-L serve to canalize the restoration process, adapted to circumstances (regarding service
26 192 and learning objectives), working group size, leading organization, or the
27 193 country/region/community of application. Finally, S-L can be understood as an end itself:
28 194 although the outcome of the ER practice (service) can be unsuccessful (Suding 2011), S-L projects
29 195 assure a direct benefit (learning). Therefore, S-L projects should be considered within the
30 196 potential approaches for ER in the coming decades (Cortina-Segarra et al. 2021).

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32 198 ***Inside S-L projects focused on forest and soil restoration after fire***

33 199 In Galicia (NW Spain), forest fires represent a key environmental challenge placing the region as
34 200 one of the most fire-affected areas in Europe (San Miguel-Ayanz 2020). Recent advances in
35 201 prevention and restoration reduced the problem but fire impacts are still remarkable. Due to
36 202 environmental and socio-economic aspects, education and training programs do not have a long
37 203 tradition in Galicia. Therefore, technical approaches must be accompanied by strategies based on
38 204 environmental education, prevention, and restoration.

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3 205 The initiative *Plantando cara ao Lume* (PCL) started in 2016 as a multidisciplinary consortium
4 206 including the University of Santiago de Compostela (USC), a research institution, high school,
5 207 primary school, regional government, and forest community. Developing S-L projects, the
6 208 objective was to improve the training of students through local participatory projects aimed to
7 209 increase awareness (primary and secondary schools, university) on forest fires and post-fire
8 210 restoration. During the following years, academia, administration, and local communities actively
9 211 participated: >60 university students (> 50% as project leaders) and professors, >400 students and
10 212 30 teachers from high school, >15 local communities and NGOs and >10 forestry stakeholders
11 213 and researchers participated.

12 214 The project extended its action range to the national level in 2020, obtaining the national project
13 215 *Plantando Cara al Fuego* (<https://www.plantandocaraalfuego.org/>). PCF was nourished by the
14 216 collaboration of >150 participants from different regions (**Figure 2**), including researchers,
15 217 university staff, students from primary and secondary schools, researching organizations, public
16 218 administrations (local and regional), environmental companies and associations, municipalities,
17 219 or NGOs. The ongoing second edition (2022-2023) expanded PCF to more communities and
18 220 participants. With a similar structure, the project *Facing Fire: Service-Learning to improve*
19 221 *training and employability in wildfire management* (FF, 2021-2023), currently funded by the
20 222 Erasmus+ program (<https://facingfire.eu/>), is carrying out S-L projects in Mediterranean countries
21 223 annually affected by wildfires (Spain, Portugal, Italy, Greece).

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225 **Conclusions**

226 At this point, stopping the degradation process, protect and restore degraded natural systems is a
227 necessity, a debt to our environment and an existential obligation. We must use methodologies at
228 our disposal and collect different types of knowledge to undo the distance between society and
229 nature, and for this, education is essential. Here, S-L represents a useful tool to improve student
230 learning and training to address environmental challenges, such as those identified by ER. The
231 development of participatory and multidisciplinary S-L projects contributes to improve the
232 training of future environmentalists and restorers, setting a real context for learning while
233 providing a direct service to the community. To this, it is necessary to involve different
234 educational stages and interdisciplinary collaborators to address environmental issues, fostering
235 the reciprocal learning between academia and diverse social actors.

236

237 **Acknowledgements**

238 We truly thank the advisory and collaboration of partners belonging to different institutions and
239 also to those involved in the researching networks FIRElinks and FuegoRED. We also thank the
240 comments and suggestions provided by the Managing Editor, the Coordinating Editor and three
241 different anonymous reviewers that served to improve the final version of this manuscript.

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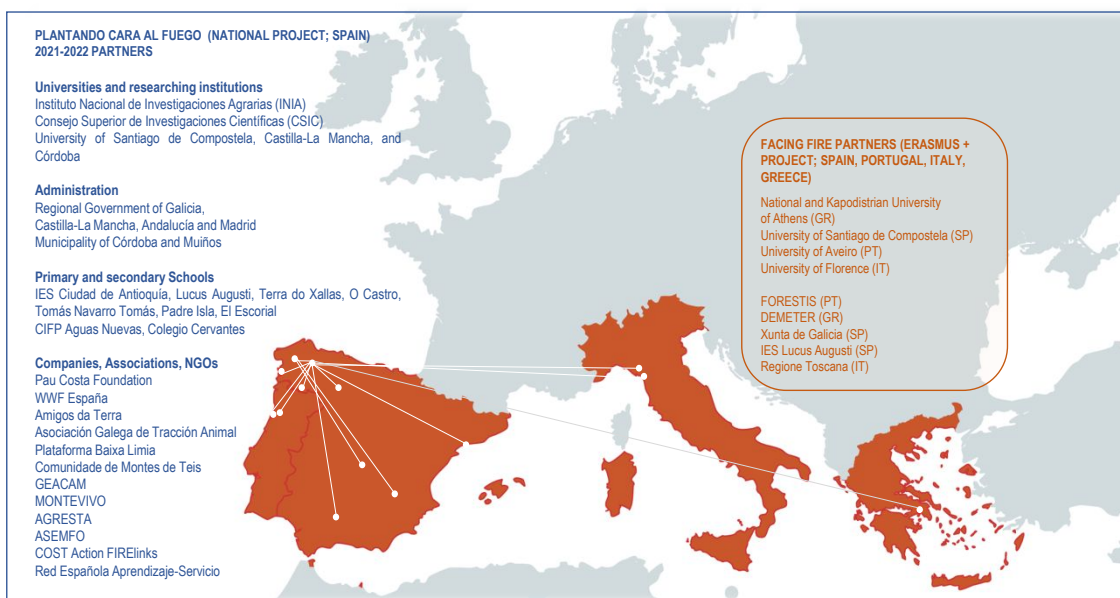
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Figure 1. Representation of the main characteristics of ecological restoration (ER, left) and Service-Learning (S-L, right). In the middle, those characteristics aligning with principles of ER (Gann et al., 2019) shared by both ER and S-L projects. *TEK* (traditional ecological knowledge), *LEK* (local ecological knowledge).



Figure. 2. Schematic representation of Europe highlighting the participant countries and a list of partners of the Erasmus+ project (brown color), and the list of partners involved in the Spanish national project (PCF, 2021) (blue color).



Review

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