An overview of policy instruments for sustainable peri-urban landscapes: Towards governance mixes

Marcin Spyra [a,b], Chiara Cortinovis [c,e,*], Silvia Ronchi [d]

[a] *Department of Human Geography and Regional Development, University of Ostrava, Czech Republic*
[b] *Department of Sustainable Landscape Development, Martin-Luther University Halle-Wittenberg, Germany*
[c] *Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy*
[d] *Department of Architecture and Urban Studies, Polytechnic University of Milan, Italy*
[e] *Department of Geography, Humboldt-Universität zu Berlin, Germany*

ABSTRACT

Peri-Urban Landscapes (PULs) are transitional areas composed of a mix of natural and anthropogenic land covers. The unsustainable character of many PULs is widely recognised, but their governance is particularly challenging. The paper moves from the hypothesis that addressing some of the sustainability challenges of PULs requires the combination of multiple Policy Instruments (PIs), i.e., a policy mix. An online survey was developed to collect cases of PULs governance with a twofold purpose: i) to identify and describe existing PIs implemented in PULs, and ii) to investigate which combinations of PIs are adopted to address specific categories of sustainability challenges. Fifty valid answers describing 47 cases of PULs governance from 26 countries were collected and analysed. The results confirm the presence of a policy mix approach, suggesting the need for a plurality of PIs to govern the dynamics and complexities of PULs. Moreover, the results indicate an important role of the regional governance level, a dominating presence of top-down instruments, and a need for more effective inclusion of citizens into policy-making processes related to PULs. A reflection on the findings considering the existing literature on governance experimentation suggests governance mixes for PULs as potential approaches to address some of the shortcomings of the analysed policy mixes.

1. Introduction

1.1. Peri-urban landscapes (PULs): definition, dynamics, and sustainability challenges

Peri-urbanisation is an ongoing and dynamic process characterised by the anthropogenic transformations of landscapes located beyond urban fringes (Zasada et al., 2011). It consists of expanding urban fabric on non urbanised areas instead of using already built-up or urbanised areas located mostly within existing urban landscapes. Observed since the 1960s (Hutchison, 2010), peri-urbanisation processes and the growth of urban peripheries are driven by diverse and context-specific forces linked to a variety of demographic, political, socio-economic, biophysical, and technological factors (European Environment Agency, 2006; Plieninger et al., 2016). For instance, they could be related to land acquisition pushed by the need for new, unpolluted, or flat investment areas; by people's willingness to live in large single-family houses; or by the necessity to live in informal settlements beyond urban fringes. This leads to emerging peri-urban landscapes (PULs), which are a fluid mixture of natural and anthropogenic land covers and land uses related to green open spaces, agricultural fields, and artificial areas with different degrees of urbanisation (Amirinejad et al., 2018; Spyra et al., 2021). PULs are dynamic and transitional systems, which makes their boundaries unclear (Gonçalves et al., 2017). Such landscapes are located between different administrative units and can be parts of metropolitan areas, functional urban areas, or cities.

PULs characteristics often contrast with those of a sustainable urban form (Jabareen, 2006). The dynamic increase of artificial landscapes through soil sealing and land take (European Commission, 2012; Gardi et al., 2015; Prokop et al., 2011) results in the loss of peri-urban open spaces (rural, natural, or seminatural) (Spyra et al., 2021) and in the reduction of ecosystem services (Rozas-Vásquez et al., 2022). The extension of transport infrastructures causes further fragmentation of ecosystems, making landscape restoration and biodiversity protection

problematic (Crossman et al., 2007). Moreover, new infrastructures promote the proliferation of low-density and diffuse built-up surfaces, typical of the urban sprawl phenomenon that affects many PULs, especially in global north contexts (European Environment Agency, 2006; Ronchi et al., 2021; Schneider & Woodcock, 2008).

Although the drivers of peri-urbanisation usually differ between global north and global south contexts (Follmann, 2022), the outcomes regarding land-use changes and loss of agricultural land are similar (van Vliet et al., 2019). In the global north, PULs are often composed of low-density discontinuous residential areas (Shaw et al., 2020) with scarce accessibility to services and facilities, contrary to urban models like "the compact city" and "the city of short distances" which reduce the need to travel between employment, housing, and service spaces (Hamiduddin, 2018). In many cases, no effective public transportation is offered in peri-urban contexts, hence communication within and outside PULs is mostly based on private cars. This low density car-oriented development makes the use of land and resources inefficient and determines high energy consumption rates (Yiran et al., 2020). Differently, in global south contexts, peri-urbanisation often results in informal, illegal, and unplanned extensions of cities with a lack of access to main services like shops, schools, or health care (Follmann, 2022). Fast peri-urbanisation rates can lead to high levels of pollution and waste management problems in those landscapes (Schindler, 2015).

1.2. Governance challenges of PULs

While PULs share the same overall sustainability challenges of all urbanised areas (for example, the urban challenges introduced by Babí Almenar et al. (2021) apply to both urban and peri-urban contexts), their governance is particularly tricky. Firstly, in the case of PULs, even answering the basic question "*Where should governance be implemented?*" is not easy, as PULs are difficult to delimitate (Mortoja et al., 2020). Since urbanisation and peri-urbanisation processes often go hand in hand, it is complicated to draw a specific line where urban landscape finishes and PUL starts (Cattivelli, 2020). Some researchers suggest that it would be better to shift from a spatial to a process-based definition of PULs (Singh & Narain, 2020). Furthermore, PULs overlap different administrative units (Simon et al., 2005; Spyra et al., 2020), hence their governance occurs in regional or metropolitan contexts with blurred jurisdictional boundaries (Piorr et al., 2011).

Due to these specificities, PULs are managed by a plurality of governance actors and institutions that work at different scales and often in an uncoordinated way (Žlender, 2021). This aspect complicates answering the question "*Who are the governance actors for PULs?*". Governance actors related to PULs belong to different sectors (e.g., agriculture, forestry, urban planning) and often represent conflicting interests (Spyra et al., 2020) and different management approaches. At the same time, the awareness of the consequences of ongoing peri-urbanisation processes on landscapes' sustainable development is mostly low (Lin et al., 2010).

This situation, together with the dynamic land cover/use transformations in PULs, leads to frequent conflicts between governance actors (Patti, 2017). For example, conflicts emerge in relation to different land tenure and administrative overlaps (Lombard, 2016), including various land use conflicts related to noise pollution, visual blight, nature conservation, preservation of the past, and changes in existing neighbourhoods (Von Der Dunk et al., 2011). Other examples are conflicts between new and old inhabitants linked to agricultural production in PULs (Hayashi et al., 2010), where intensifying farming activities result in increased noise, odour, or pesticide usage (Zasada, 2011). Another case is PULs affected by a growing tourist pressure that threatens local biodiversity and causes conflicts between visitors, tourists, and inhabitants (Calò & Spyra, 2022).

Not much easier is answering the general question of "*How should the governance of PULs be implemented?*". A few challenges can be mentioned here as examples, starting by acknowledging that most often PULs are addressed only by sectoral planning or governance activities related to a single municipality or other local administrative units, making the governance and planning of such landscapes vertically and horizontally fragmented. At the same time, governance, management, and planning of PULs at the regional scale is often too vague, providing only general recommendations and suggestions on a region's sustainable development, without putting specific attention and resources to aspects of peri-urbanisation. In other cases, governance at the regional scale is absent (e.g., Slovenia in the EU), and the national level offers even more general approaches to address peri-urbanisation challenges (OECD, 2017). Moreover, the planning framework is often criticised for being static, lacking a strategic approach to the foreseen challenges, and adopting an urban-centric perspective (Llausàs et al., 2015).

Existing governance of PULs is frequently dominated by top-down approaches (Zhao, 2013). While often effective in peri-urban contexts (Spyra et al., 2021), top-down approaches may suffer from NIMBYism (Frank et al., 2017) and not adequately incorporate the opinions of a variety of governance actors (Faysse et al., 2014). At the same time, bottom-up initiatives have limited influence on the sustainable development of PULs, especially when they are not embedded in or taken up by binding local regulations. Moreover, research indicates that PULs suffer from poor governance, which can take the shape of unclear rights and co-responsibilities of governance actors (Caro-Borrero et al., 2024). As shown by various scholars, lack of or poor governance in peri-urban contexts could lead to various conflicts (Kleemann et al., 2023), like human-wildlife (Roth et al., 2024), or related for example to water security (Roth et al., 2019). It could also exacerbate vulnerabilities, for example by increasing the risks of flooding (Winter & Karvonen, 2022), or jeopardise wellbeing by hindering the provision of urban ES (Hedblom et al., 2017). Finally, existing governance and planning approaches are often "stuck" in rural-urban dichotomies, focusing exclusively on urban or rural landscapes (Allen et al., 2006). As such, they often neglect mixed and transitioning landscapes like PULs, or fail to acknowledge and address their peculiarities.

1.3. Hypothesis and objectives of the research

The research hypothesis is that addressing transitional landscapes such as PULs and the associated sustainability challenges requires not only the implementation of a single plan, programme or policy instrument related to a specific administrative unit, but more complex policy mixes composed of different instruments (e.g., plans, voluntary agreements, taxes) that work across administrative boundaries. The term "policy mix" originates in economic policy in the 1960s, gradually finding its way into different fields of science between the 1980s and 1990s (Flanagan et al., 2011). The development of this notion and its implementation in practice has gone hand-in-hand with replacing or supplementing traditional, centralised government models with more diffused, multi-level and multi-actors soft governance approaches like financial incentives, taxes, or awareness-raising strategies. Experiments with different types of PIs have fostered the development of policy mixes that proved effective under conditions of governance complexity and increased in popularity in the last 20 years (Pacheco-Vega, 2020).

A comprehensive review of policy mix definitions confirms that the key element of this notion is a set or a combination of PIs, strategies, and processes that interact to influence a certain policy domain (de Boon et al., 2021; Rogge, 2018; Rogge & Reichardt, 2013), for example in order to achieve defined policy objectives through complementary actions (Wilts & O'Brien, 2019). So far, the term policy mix was used across various sectors. In the field of ecological economics and landscape studies, it was popularised by Ring and Schröter-Schlaack (2011), who applied it to biodiversity conservation and ecosystem services protection. They defined a policy mix as a "combination of PIs which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors" (Ring & Schröter-Schlaack, 2011). According to IPBES, all PIs - classified as i)

legal and regulatory instruments; ii) rights-based instruments and customary norms; iii) economic and financial instruments; and iv) social and cultural instruments – can be and are generally used in combination as a policy mix (IPBES - The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2023).

Nevertheless, as noted by Rogge and Reichardt (2013), a policy mix is not only a combination of PIs but also of policy processes "by which such instruments emerge and interact" (Rogge & Reichardt, 2013). This suggests that policy mixes are complex and dynamic constructs that change over time and, if appropriately managed, adapt to changing conditions. On the other hand, limitations of this concept have been reported in the literature, including the observation that policy mixes cannot be assessed with standard analytical tools used for single PIs (Gawel, 1992), and, more recently, the fact that it is still unclear what constitutes an optimal policy mix, and how to assess it (Quitzow, 2015).

Despite the ongoing debate on how to advance policy mixes as a possible solution for the governance of various landscapes, a knowledge gap related to the implementation of policy mixes in PULs still exists. In fact, there is no exploration of how these policy mixes look in real-life practice and beyond single case studies (Marino et al., 2022). In particular, there has not yet been an investigation of existing practices and experiences aimed at identifying what types of PIs are combined to address different sustainability challenges of PULs. Similarly, little information exists on what actors are involved and how, what approaches in terms of resources as well as support tools and methodologies are adopted, and what impacts are produced.

The research addresses this gap by collecting and analysing a set of case studies related to different policy mixes applied in the context of PULs worldwide. The first aim is to characterise the PIs (categories and typologies) implemented in the case study PULs in terms of objectives, stakeholders' involvement, modes of implementation, and associated barriers. The second aim is to describe how different combinations of PIs have been adopted to address specific categories of sustainability challenges, considering the policy mixes conceptualisation introduced by Rogge and Reichardt (2013). It is not our aim to discuss in detail the individual policies addressing specific issues emerging in each single peri-urban context. Rather, we want to capture the commonalities in the policy approaches that have been applied to different worldwide PULs.

2. Materials and methods

An online survey was developed and distributed among academics and researchers to collect case studies of PIs addressing the governance of PULs in different contexts. This method allows gaining an overview of the diversity of PIs implemented in PULs worldwide and capturing their main features. Among their many advantages (Evans & Mathur, 2018), online surveys can easily and quickly reach a high number of people through non-personalised means of distribution, such as social media, mailing lists, and websites. Compiling a survey does not require specific skills, can be done at the respondent's convenience, and takes a shorter time compared to an interview. Moreover, a structured survey with closed-ended questions helps to analyse and summarise the findings and to compare the different entries. For these reasons, other studies have adopted a survey to collect information about case studies (Nigam et al., 2022; Spyra et al., 2019) and to investigate the opinion of experts on concepts and approaches related to urban governance (Albert & Von Haaren, 2017; Li et al., 2022).

The survey was developed following existing guidelines (Boynton & Greenhalgh, 2004), and it is composed of 27 questions, of which 23 closed-ended and 4 open-ended questions. For the sake of clarity, the survey questions were arranged in seven sections focused on different aspects of PIs implemented in case study PULs: i) identification and general characteristic; ii) sustainability challenges addressed (for simplicity's sake, in the manuscript, they will be referred to as just "challenges"), iii) results and achievements, iv) implementation, v) governance actors, vi) obstacles and improvements, and vii) policy

support tools and methodologies. The respondents were asked to describe a PI that they know, which has been designed for or implemented in PULs. Detailed information about the survey is presented in Appendix A.

Before distributing it, five external experts representative of our target respondents' group tested the survey and provided feedback based on their experience. The pilot focused mainly on testing the clarity and intelligibility of the questions as the most important pre-requisite to draw valuable generalisations from the survey (Boynton, 2004; Boynton & Greenhalgh, 2004). The feedback from the experts were collected and the survey was modified and improved accordingly.

The survey was distributed online between June 2021 and November 2021 via various communication channels aiming to reach diverse groups of experts working in the field of governance and planning of PULs. The distribution strategy involved: i) the newsletters of several international scientific networks of which the authors are active members (including IALE - International Association for Landscape Ecology, ESP – Ecosystem services partnership, ELI - European Land-use Institute, and GLP – Global land programme), ii) sessions addressing relevant topics at two European conferences (i.e., third ESP Europe conference and the third Society for Urban ecology (SURE) World Conference), and iii) social media channels, including ResearchGate, LinkedIn, Facebook, and Twitter. In addition to this broad distribution strategy, we targeted potential respondents by email. We created three mailing lists: one including academics and researchers from the authors' networks who work or have worked on similar topics ($n = 49$), a second one with the corresponding authors of relevant papers retrieved through a systematic search in Scopus ($n = 221$), and a third one listing contacts of people involved in 21 European projects on peri-urban areas and landscapes and urban-rural governance identified in the EU database Cordis (https://cordis.europa.eu/) ($n = 191$).

After closing the survey, the records were screened and some potential overlaps in the entries emerged, requiring further investigation. In these cases, the respondents were contacted for further clarification. The inquiry confirmed that, in three cases, two authors had described the same case study. Hence, after reaching an agreement in case of partial inconsistency in the original records, the overlapping entries were merged into a single record of the final database. Moreover, three other respondents were contacted to ask for clarifications on specific answers.

Once the records were checked, the final database for the analysis was prepared by binary coding the answers to the closed-ended questions. The formal analysis consisted of two steps. First, simple descriptive statistics on the categories associated with each question provided an overall understanding of the sample. Then, relevant co-occurrences of the answers to different questions were investigated, focusing on how the different categories and typologies of PIs are combined to respond to other challenges and what aspects characterise the implementation of these policy mixes. To this end, we divided the sample into four clusters based on the number and typology of PIs that were applied: i) single legal and regulatory policy instruments, ii) single non legal or regulatory policy instruments, iii) policy mix composed only of legal and regulatory policy instruments, iv) policy mix composed of policy instruments of different types. We then investigated relevant differences across the clusters in terms of categories of sustainability challenges addressed, support tools and methodologies applied, resources used, results achieved, and barriers encountered in their implementation. The r package 'reshape2' (R Core Team, 2018; Wickham, 2007) and the 'RAWGraphs' (https://www.rawgraphs.io) web interface were adopted to manipulate and visualise data in the second stage.

3. Results

3.1. Characterisation of the cases collected through the survey

Fifty respondents completed the survey with valid answers

describing case studies from 26 countries located in five continents (Africa, North and South America, Asia, and Europe) (Fig. 1). Considering some overlaps checked with respondents, we obtained a final sample of 47 case studies (called "cases" in the manuscript) related to PIs applications to PULs (Appendix B). The list of cases includes 12 plans at different levels, ranging from the regional level (e.g., two Italian landscape plans), the metropolitan or inter-municipal level (e.g., a metropolitan plan in Turkey and two inter-municipal plans in Chile), to the municipal level (e.g., a Swiss strategic plan and a Swedish comprehensive plan). The respondents also indicated several strategic policies at the supra-national (e.g., *EU Green Infrastructure Strategy*), national (e.g., *Framework for Green Infrastructure* in Hungary), regional (e.g., *Natural heritage and biodiversity strategy of Catalonia*), and local level (e.g., *Copenhagen Food policy*). Some national and regional laws, such as the *Environment and Planning Act* in the Netherlands and the law on *Sustainable food agricultural land* and related policies (LP2B) in India, were also identified as PIs addressing the sustainability of PULs. Several entries describe local projects and initiatives, e.g., parks and protected areas, pilot restoration projects, and training and education initiatives, as well as agreements and associations of local actors. Finally, some respondents described assessment tools and approaches and specific applications of implementation tools (e.g., Payment for Ecosystem Services - PES, transfer of development rights, conservation easements).

Respondents have classified the described PIs according to the four main categories defined by IPBES (https://ipbes.net/policy-instrument s) (i.e., LRG = Legal and regulatory instruments; RBC = Rights-based instruments and customary norms; EFI = Economic and financial instruments; SCI = Social and cultural instruments) and sub-articulated in typologies following Ronchi et al. (2019) (Fig. 2). Interestingly, in 33 cases the respondents chose more than one typology of PIs, suggesting that they were indeed describing not a single PI but rather a policy mix. This often happened in the description of local projects and initiatives, as well as of agreements and associations, which work as "umbrella policies" to be then implemented through a combination of instruments. However, the selection of more than one typology of PI was also frequent in the case of plans that include a combination of PIs (e.g., regulations, zoning, and incentive schemes) for implementation.

The large majority of cases include at least one PI falling into the category of *Legal or regulatory instrument - LRG* (45). Eleven records include *Social and cultural instruments - SCI*, and an equal number of entries mention *Economic and financial instruments- (EFI)*. *Rights-based instruments and customary norms - RBC* are the least represented (9). In

terms of specific PIs typology, *Planning and zoning* (25) and *Strategies and action plans* (25) are the most common, followed at a distance by *Binding legal/regulatory instruments* (15), *Non-binding legal/regulatory instruments* (13), and *Guidelines, including non-binding* (11). The most common non-legal or regulatory instrument types are *Strengthening of local communities* (7) and *Public information, including eco-labelling and certification* (7). Among economic and financial instruments, *Subsidies and grants* are the most popular (6), while *Liability schemes* were not mentioned in any case, therefore they were excluded from subsequent analyses.

Most case studies (11) address four different categories of sustainability challenges, but cases addressing many more challenges are not uncommon: nine of them consider more than 10 categories out of the total 18 possible categories. On the contrary, only 6 cases address a single category of challenges. Among the categories, *Biodiversity* (31) and *Climate change* (27) are the most frequently mentioned, followed by *Built environment* (27), *Water management* (27) and *Governance* (26), all present in the descriptions of more than half of the PIs. The least common are *Mental health* (6), *Digital connectivity* (2), and *Expenditure* (2). Among the different cases, it is possible to identify some clusters of challenge categories that combine topics strictly connected. For example, *Biodiversity* is usually addressed together with *Climate change* and *Water management*. Similarly, the category of challenges more related to social aspects (i.e., *Socio-spatial equity*, *Social cohesion*, *Social vulnerability*) are often treated together. A detailed description of the sustainability challenges that we used in our study can be found in Babí Almenar et al. (2021).

Most of the described cases are still in the implementation stage (29), while six of them have just been proposed and six have already been completed. Respondents declared that only in a few cases the described PIs have already reached their first objectives (8). In one case the described PIs failed to reach their objectives, according to the respondents, but seven other cases did not include any monitoring action, so it was difficult to assess the outcomes of their implementation. Among the results already achieved or expected from the implementation, impacts on the current state of PULs and effects on the way they are planned and managed were mentioned with the same frequency. *Increased provision of ecosystem services in the area* (25) and *Increased quality of life for the local residents* (24) are the impacts most frequently mentioned among those affecting the actual condition of the analysed PULs, while *Stakeholders engagement in policymaking processes* (28) and *Multi-scale governance* (23) are the most common effects of PIs implementation -achieved or expected- on the way PULs are planned and
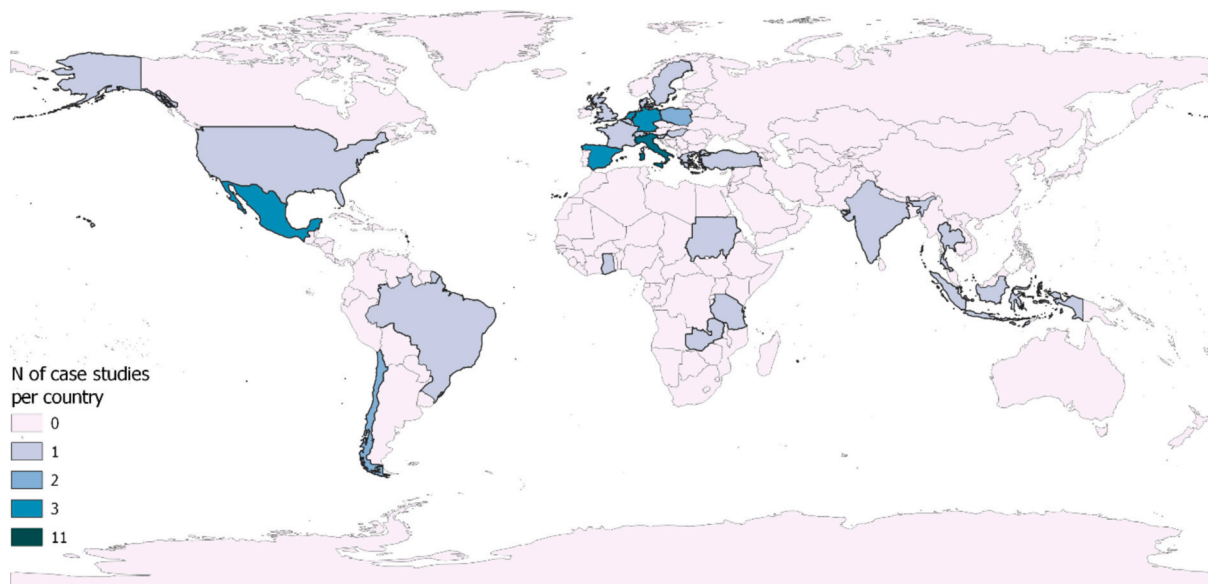

Fig. 1. Distribution of the cases of PULs governance collected via the online survey.
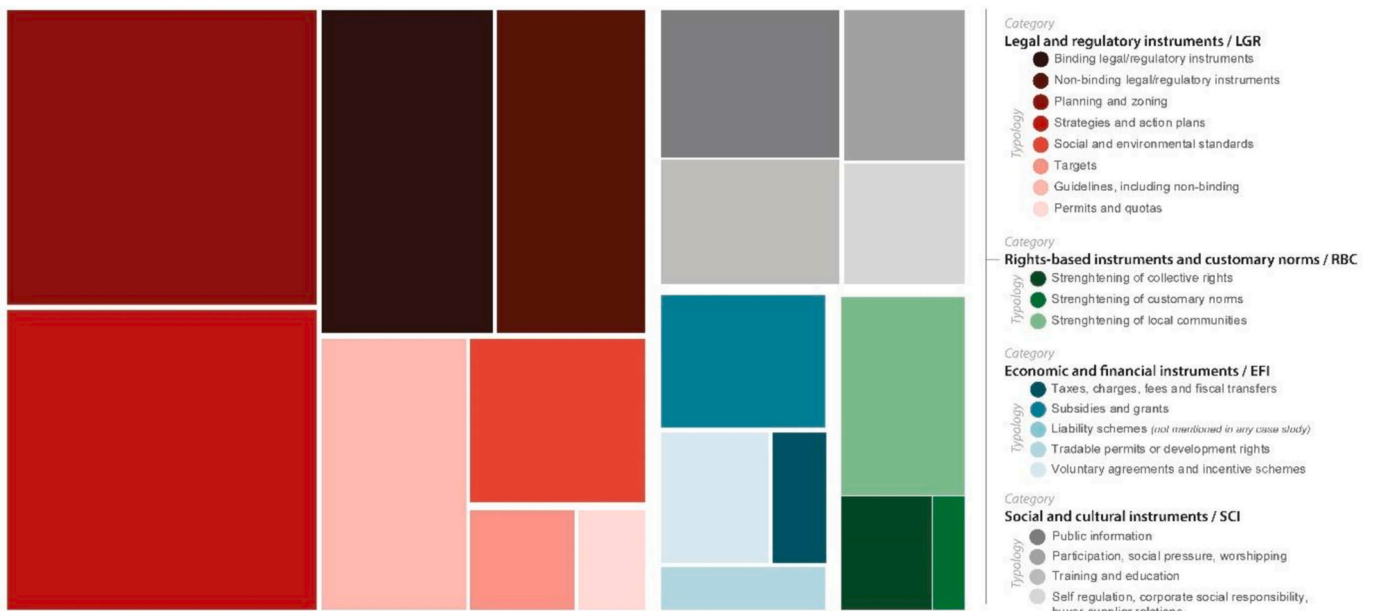
Fig. 2. Policy instruments: general categories and specific typologies considered in the analysed cases of PULs governance. The size of each box represents the share of the corresponding PI typology in the total sample.

managed. *Awareness about peri-urbanisation processes (in general) and their role for landscape sustainability* has also been indicated as a common result of the implementation of almost half (23) of the described cases.

Concerning the modes of implementation, half of the cases of PULs governance described in the survey (24) are framed within existing governance schemes and 45 % (21) involve multiple governance levels. The cooperation of governance actors at the regional level is more frequent (16) than that at the national (7) and international levels (6). The majority of cases (27) rely only on public funds, but almost 40 % (18) combine public and private funds. Only two of the described PIs rely exclusively on private funds. Public funds are most often competitive funds at the local (e.g., municipal) level (17) or at the national and international levels (14 each), but direct funds at the regional (14) and local (13) levels are common too. More than two-thirds of the private funds come from businesses and enterprises (11), while funds from NGOs are mentioned only in four cases. Tools and methodologies for assembling data and knowledge (32); for assessment and evaluation (28); and for public discussion, involvement and participatory process (25) were the most commonly applied to support the implementation of the described PIs. However, all categories of support tools and methodologies in our list were chosen more than ten times.

Regarding the level of involvement of different categories of governance actors, in the analysed cases (Fig. 3), as it can be expected, the level of involvement decreases from policy- and decision-makers to experts, to representatives of society, to individual citizens. In more than half of the cases, PIs are tools to empower policy-makers to implement their decisions. In almost two-thirds of the described cases, experts and consultants were either involved or collaborated to design the PIs, and similar results emerge about the involvement of academics and researchers. The percentage goes down to slightly more than 40 % for the representatives of the civil society and the economic sectors, who were however at least consulted in more than 60 % of the cases (83 % if the two categories of actors are summed). On the contrary, in the large majority of the described PIs, individual citizens were not targeted by specific participation activities, with around 40 % of the cases in which they were just informed, and more than 20 % in which information initiatives did not even address them.

All the nine elements in the list of potential barriers to PI implementation proposed in the survey (based on the existing literature, e.g., Phulkerd et al., 2017, and experiences collected on the ground) were confirmed by the respondents. The least popular, i.e., lack of cooperation between municipal sectors and across governance levels, were mentioned eight times each. The most common obstacle is the lack of financial resources (24), followed by issues related to governance fragmentation (22) and coordination between policies and instruments that address different aspects of a PUL (21). Seven respondents elaborated on specific barriers faced or expected during the implementation of the described PIs. They mentioned the difficulties of sustaining local
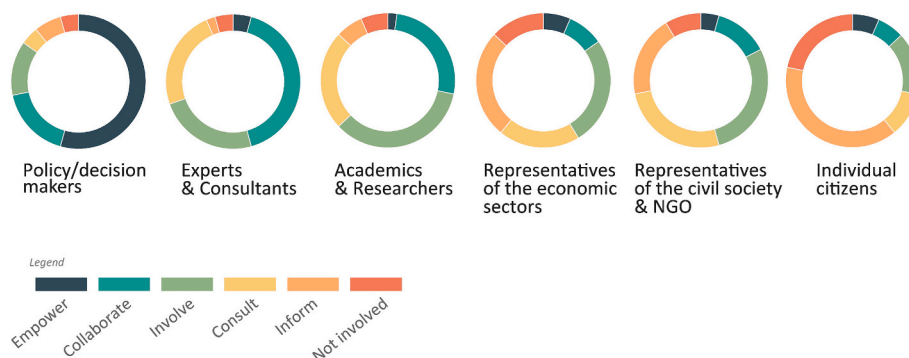

Fig. 3. Level of the governance actors' involvement in the analysed cases (based on Arnstein, 1969).

bottom-up initiatives in the long term and of scaling up from innovative demonstration projects to common practices. Furthermore, contrasting views and opinions may hinder the translation of high-level strategies into operational decisions, while the implementation of plans elaborated with the help of experts and consultants may be prevented by the lack of technical capacity. Potential improvements focus especially on enhancing cooperation/communication of different governance actors and on (better) integrating the described PIs within planning and management instruments, with both answers selected by two-thirds of the respondents (31). Many (30) also highlight the need for increased awareness of peri-urbanisation processes and their impacts on landscape sustainability.

3.2. Combinations of PIs to address the challenges of PULs

In the majority of the cases of PULs governance collected through the survey (33) there is a combination of PIs with an average of 3 instruments per case. A single PI, almost always belonging to the LRG category, is mentioned in only 14 cases. Some PIs combinations appear

more frequently than others (Fig. 4). A recurring combination concerns the association of two instruments of the LRG category, the most common being *Planning and zoning* and *Strategies and actions plans* (13), followed by *Planning and zoning* and *Binding legal and regulatory instruments* (10). Looking at the combinations of PIs belonging to different categories, there is not a predominant one. Combinations of three PI categories include LRG with RBC and SCI (4), and LRG with EFI and SCI (4). Five cases are a mix of LRG and EFI, while three combine LRG with RBC. Lastly, PIs belonging to the LRG and SCI categories were applied in one case, while there is no case that combines LRG, RBC and EFI (Fig. 4).

Considering the categories of sustainability challenges, *Planning and zoning* and *Strategies and action plans* are the two typologies of PIs mostly considered for addressing the totality of challenges categories, with different intensity gradients. *Strategies and action plans* are adopted to cope especially with *Biodiversity* (19), *Climate change* (18) and *Governance* (16); while *Planning and zoning* is frequently applied to address challenges related to *Built environment* (16), *Water management* (15) and *Biodiversity* (14). Despite the overall lower frequency in the cases, other PIs have been applied to address a wide variety of challenges. For

Fig. 4. Matrix plot showing the frequency of the combinations of policy instrument typologies in the analysed cases. The size of the circles corresponds to the number of cases. Circles in light purple on the diagonal indicate cases where a single PI was applied (no combination). The numbers in square brackets express the frequency of PIs in the total sample. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

example, PIs belonging to the SCI category, including *Public information*; *Participation, social pressure, worshipping*; and *Self regulation*, all are associated with 17 out of the 18 categories of sustainability challenges. *Voluntary agreements and incentive schemes* (in the EFI category) and *Targets* (in the LRG category) also stand out for the high number of challenge categories addressed (16) compared to their low frequency. On the contrary, *Permits and quotas* (LRG) and *Tradable permits or development rights* (EFI), besides being quite uncommon, are also associated with a low number of challenges.

Regarding the challenge categories, some of them are tackled by a wider range of PIs than others. This is the case of: *Demographic dynamics*, *Governance*, *Public participation*, and *Water management*, each linked to 18 PI typologies. *Biodiversity*, *Built environment*, and *Climate change* have also been addressed through a wide variety of instruments typologies

(17). Other categories of challenges are linked to a lower number of PIs typologies, such as *Expenditure* (tackled only by 7 PIs) and *Digital connectivity* (addressed only by 4 PIs). However, these are also the challenge categories least addressed overall (Fig. 5).

These results reveal how the analysed cases of PULs governance combined a plurality of PIs to address different categories of sustainability challenges. Combining the information on the number and typology of instruments adopted, we identified some recurring aspects and grouped the cases into 4 different clusters (Fig. 6). First, considering the number of PIs, cases (14) which adopted a single instrument (clusters 3 and 4) were distinguished from those (clusters 1 and 2) that applied a combination of PIs, in a number that varies from 2 to 9 (33). Second, based on the categories of PIs, we detected a group of cases (28) that only used LRG instruments (clusters 2 and 3), while the remaining cases
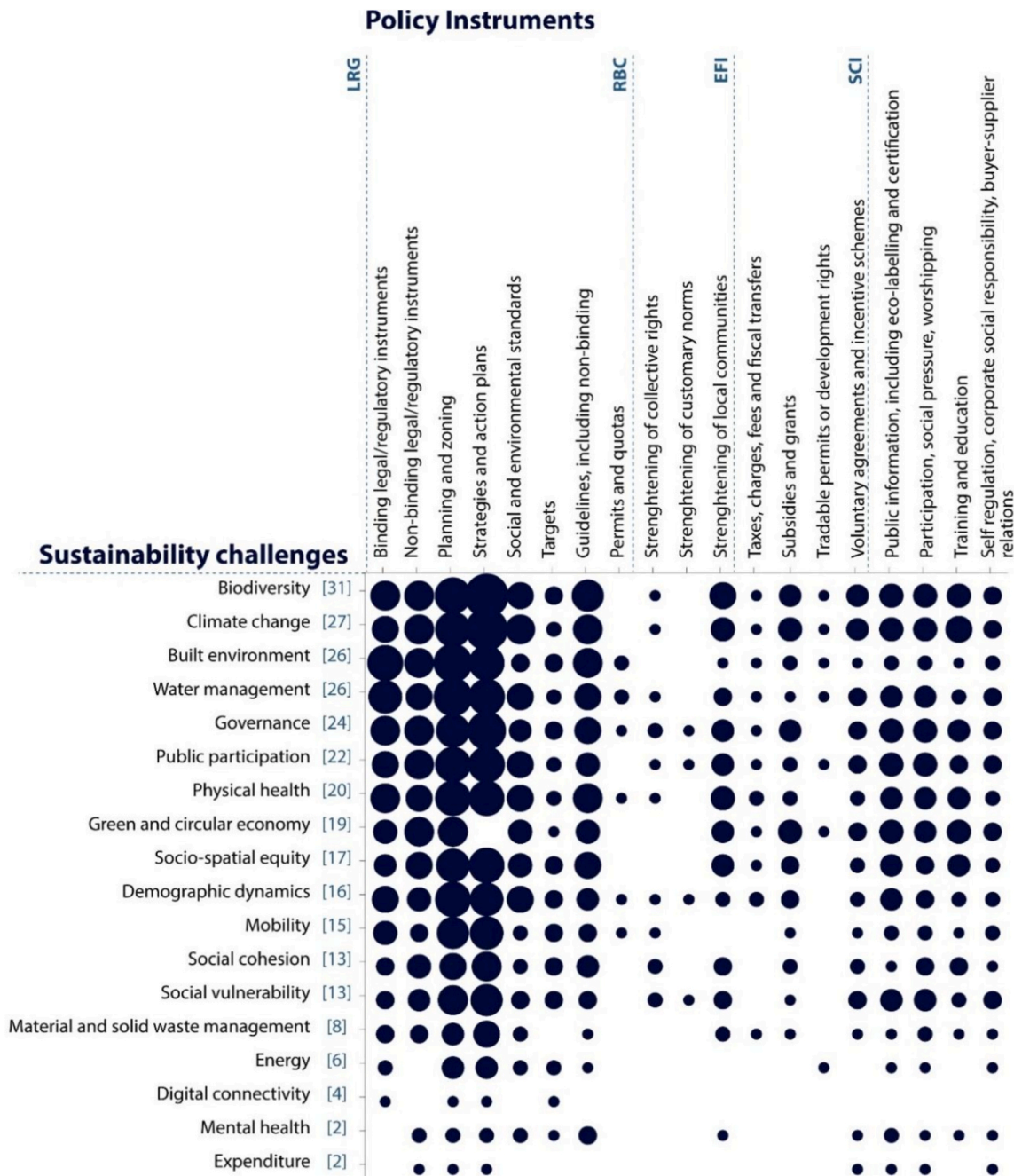

Fig. 5. Matrix plot showing the frequency of the correlation among challenges categories (y-axis) and policy instrument typologies (x-axis). The numbers in square brackets express the frequency of sustainability challenges in the total sample (47 cases).
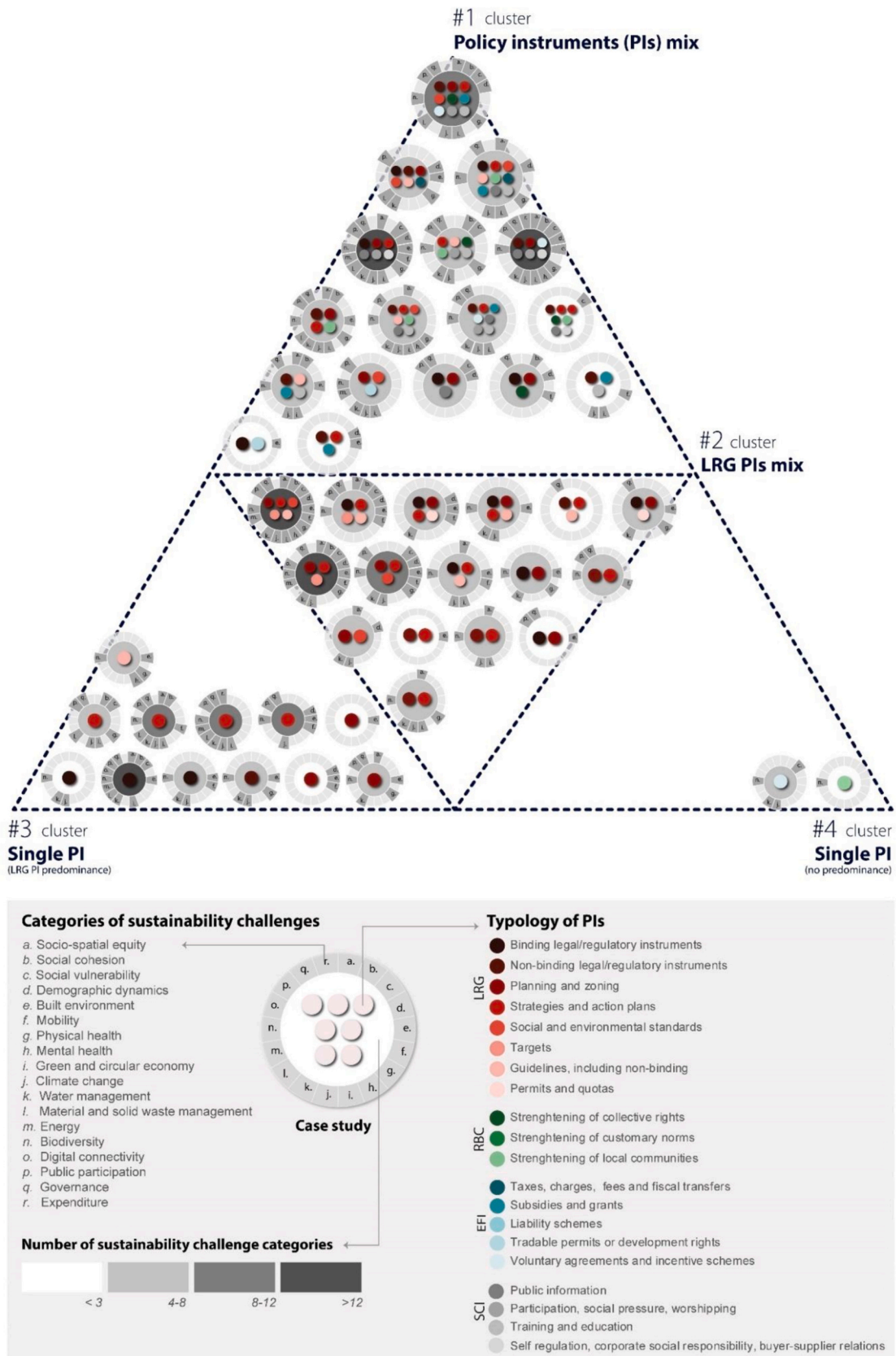
Fig. 6. Clusters of cases of PULs governance organised according to the number and typology of adopted PIs, including information on the categories of sustainability challenges addressed.

(19) show a typological mix of instruments, with no predominance of a PI category (clusters 1 and 4).

The details and the main characters of the clusters are summarised in the following table showing similarities and differences among the 4 different clusters that characterise different policy mixes (Table 1).

4. Discussion

4.1. Features and shortcomings of existing PIs for PULs

While to date evidence on policy mixes implemented in PULs has been scattered and focused on specific contexts, processes, or challenges, the results of the survey reveal some commonalities across different cases of PULs governance across the world. Our results confirm the hypothesis that a plurality of PIs is needed to address existing sustainability challenges of PULs. In most of the analysed cases of PULs governance, the respondents considered a combination of different PIs, i.e., a policy mix, as the most obvious answer to the survey request of describing a PI for the governance of PULs. Moreover, considering the challenges classified by Babí Almenar et al. (2021), the analysis reveals a complementarity of the different PIs in addressing different challenge categories.

Most of the PIs mentioned in the survey belong to the LGR category. Although not all of them are binding instruments (e.g., guidelines), many of the analysed instruments fall into the typology of *Planning and zoning*, frequently used in combination with *Binding legal and regulatory instruments*. Moreover, many cases included policy mixes composed only of LGR instruments. A cluster of cases adopting a single instrument falling into the LGR category was also discovered (Fig. 6, Table 1). Results show that binding LGR PIs are frequently used to address significant sustainability challenges of PULs, such as biodiversity and climate

change issues. Such coercive PIs show the best usefulness in governance contexts characterised by a strong rule of law (Pacheco-Vega, 2020).

Nevertheless, previous studies also show that in environmental policies it is important to mix coercive approaches with less binding ones to increase policymaking effectiveness and flexibility (Gunningham & Sinclair, 1999). For example, using a broader palette of PIs than just LGR showed a better effectiveness in addressing challenges related to forests than implementing only traditional binding PIs (Van Gossum et al., 2012). The results of the survey included some policy mixes between LRG, RBC and SCI and between LRG, EFI and SCI. These mixes are in line with the overall concept of governance as being more flexible and adaptive compared to top-down government (Termeer et al., 2010). Such flexibility is especially important in PULs as it allows addressing their transitioning characters in a more adaptive way.

On the other hand, the cluster of cases where only non-LGR instruments were implemented is extremely small (2 cases). This reveals that LGR is a PI category compatible with a large variety of instruments and it seems to suggest that LGR instruments are a fundamental "ingredient" of any policy mix addressing PULs. The reason could be that effective governance of PULs, i.e., one having a real impact on sustainable development, needs to be grounded on a well-established and implemented local legislative framework (Spyra et al., 2020).

As shown in our study, combinations of PIs addressing PULs usually try to address more than one sustainability challenge category. The most common challenges addressed in the analysed cases are related to biodiversity, often mentioned together with climate change and water management issues. This aspect is important as biodiversity continues to decline in many PULs (Henríquez et al., 2022) that are characterised by high levels of multifunctionality (Ives & Kendal, 2013; Sylla et al., 2020) and where natural and seminatural areas perform multiple functions and provide a variety of ecosystem services (Filyushkina et al., 2022). The

Table 1
Summary of the main features of the identified policy instruments clusters.
* mentioned in more than 50 % of the cases, the frequency is reported in brackets.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Number and category of PIs	Policy mix with LRG and non-LRG PIs	Policy mix with only LRG PIs	Single LRG PI	Single non-LRG PI
Number of cases	17	16	12	2
Most common PIs	*Non-binding legal/regulatory instruments* (10), *Planning and zoning* (9), *Strategies and action plans* (9 cases)	*Planning and zoning* (13), *Strategies and action plans* (12), *Binding and legal/regulatory instruments* (6)	*Strategies and action plans* (4), *Binding legal/regulatory instruments* (3), *Planning and zoning* (3)	*Strengthening of local communities* (1), *Voluntary agreements and incentive schemes* (1)
Sustainability challenge category addressed (average and range)	6.7 (1–15)	5.9 (1–15)	6.5 (1–12)	2.5 (1–4)
Most recurrent sustainability challenges *	*Climate change* (11), *Green and circular economy* (10), *Biodiversity* (10), *Public participation* (10), *Governance* (10)	*Built environment* (11), *Biodiversity* (10), *Water management* (10), *Climate change* (8)	*Biodiversity* (9), *Built environment* (8), *Water management* (7) *Climate change* (7)	*Biodiversity* (2)
Sustainability challenges not addressed	*Digital connectivity*	*Material and solid waste management, Expenditure*	–	(many)
Most common support tools and methodologies *	*for assembling data and knowledge* (10), *for assessment and evaluation* (10)	*for assembling data and knowledge* (11), *for assessment and evaluation* (10)	–	*for assembling data and knowledge* (2); *for public discussion, involvement and participatory process* (2); *for selection and design of policy instruments* (2); *for social learning, innovation, and adaptive governance* (2)
Support tools and methodologies applied (average)	2.2	2.9	2.5	5.0
Most common resources *	A mix of public and private resources (9)	Public resources (10)	Public resources (9)	–
Most common results (achieved or expected) *	Stakeholders' engagement (12), Awareness (10), Multi-scale governance (9)	Increased provision of ES (10), Increased quality of life (10), Better policy coordination (9)	–	–
Most common barriers *	Lack of financial resources (11), Resistance to normative innovation (10), Lack of policy coordination (9)	Governance fragmentation (9)	–	–
Mentioned barriers (average)	3.9	2.7	3.2	1.5

frequency of mention of the challenges related to biodiversity, climate change, and water management could also be partly explained by the prevalence of cases from Europe, where several strategies promoted by the European Commission are in place to minimise ecosystem degradation and to contrast global warming (among the many: European Commission, 2021, 2020, 2019, 2013).

On the other hand, challenges like mental health, digital connectivity, and expenditure appeared only few times. This might suggest that those challenges, despite their relevance, are not frequently addressed in the governance of PULs. For example, digital connectivity is an important but not often discussed challenge particularly for PULs located in low and middle-income countries (Arslan et al., 2022). On the other hand, expenditure decisions are usually made at local or regional administrative levels with no specific instruments dedicated to PULs, which aligns with the identification of lack of financial resources and governance fragmentation as the main barriers that could hinder a successful implementation of the described PIs. At the same time, the results could indicate that existing policies only sometimes acknowledge their full range of impacts. This could be the case of mental health which is linked, among others, to the use and access of green infrastructure such as peri-urban forests (Uchiyama & Kohsaka, 2022) and peri-urban informal green spaces (Pedrosa et al., 2021). The many described PIs addressing biodiversity and the built environment most probably have an indirect impact on mental health, which was not explicitly acknowledged.

Cases mentioning multiple challenges may represent good practices of policies aware of their multiple interrelated impacts on the complex socio-ecological-technological systems of PULs. On the other hand, trying to address multiple objectives with a single PI is not without risks, as trade-offs can emerge between them (Hahn, 1986) and the objectives can be "played off against each other" (Helm, 2005) leading to multiple failures in the governance process.

As shown in the results, the regional level emerges as the most important in terms of both scale of cooperation and direct funding. As Allen (2003) highlighted, managing peri-urban areas requires specific methods and tools for combining the rural, urban, and regional planning dimensions where "the regional one seeks to act upon rural-urban pressures and flow". This approach perceives the territory as "a network in which planning and policy initiatives are developed for multi-sectoral, interrelated and complementary activities" (Allen, 2003; Douglass, 1998). Moreover López-Estébanez et al. (2022) argue on the crucial role of the regional level in addressing relevant issues - such as biological and landscape diversity in agro-ecosystems - that also affect PULs.

In this context, it is also important to consider who (which actors) should coordinate the implementation of a policy mix for PULs. Both this research and previous studies confirm the leading role of regional or metropolitan authorities in this matter (Spyra et al., 2021). Nevertheless, this policy arrangement could end up in a very complex situation where an entity coordinating a policy mix for PULs (let it be a regional one) is divided into many smaller powerful players (actors in the governance process) who deal with sectoral policies. Things can get even more complicated in the case of PULs located in countries where regional planning levels do not exist (Calò & Spyra, 2022) or situated in cross-boundary regions covering two or more countries (Inostroza et al., 2019). In such cases, policy mixes could be supported by cross-border land-use management strategies, but a significant limitation is their lack of legal entitlement (Spyra, 2014). Also, many of such approaches are specific to the European Union context, where multi-level governance is coordinated by a transnational bureaucratic system and supported financially with structural funds from the European Union. The extent to which such approaches could work in other, not European Union contexts is still not verified.

Lack of coordination could create barriers to PULs sustainable development. To avoid this, Hassink et al. (2021) suggest that coordination processes should not only take place among various policies and planning instruments but also cover horizontal coordination between policies and research/technology, vertical coordination between responsible stakeholders acting in a hierarchical planning structure, and temporal coordination among long-term and short-term interventions by different governance actors. Trying to answer the question of what could be 'appropriate', 'effective', or 'balanced' policy mixes, Flanagan et al. (2011) noted that coordination of PIs is very demanding or hardly impossible due to governance systems' complexity and fragmentation. Even more so in PULs, which are complex, transitioning and difficult to delimitate systems. Quitzow (2015), following Rayner and Howlett (2009), argues that policy trade-offs are an inevitable part of a policy-making process and the whole idea of designing an optimal policy mix is actually wrong. Instead, he proposes the concept of "(integrated) policy strategy", where all components are coherent and mutually supportive in working to achieve its goals.

In the largest majority of the analysed cases, representatives of the civil society and the economic sectors have been at least consulted. This is good news, as several studies have highlighted the need to work with non-governmental actors to develop more effective policy responses (Eckersley et al., 2022; Ingold et al., 2019; Klein et al., 2016). As shown by Lehmann (2012), in the case of policy mixes addressing pollution control, private governance structures are often underestimated in policy mixes, thus causing a dysfunctional operation of the whole mix. On the contrary, incorporating a broad range of governance actors is a way to design policies that are leading towards "smart regulation" (Van Gossum et al., 2012) and to comprehensive, consistent and coherent policy mixes (de Boon et al., 2021). However, the level of involvement of the civil society and the economic sectors still often does not reach the level of a proper collaboration where PIs emerge from co-creation and shared responsibility. This is reflected in a strong dependence of the analysed PIs on public funds. Diversification of funding sources is shown as an important aspect by various academics, e.g. in the context of policies for cultural heritage protection (Jelinčić & Tišma, 2021). A policy mix mostly or exclusively grounded on public funds could be seen by private actors as unstable in the long run and too much dependent on the local political situation (Wall et al., 2018).

The involvement of individual citizens rarely goes beyond information, and one out of five cases did not address this group of governance actors at all. This is a main critical point, since accepting PIs in a policy mix context is essential for their success, for example, in the case of the larger energy transition (Ingold et al., 2019). A policy mix can become a key driver to create public understanding along with behavioural change and effective implementation (Ingold et al., 2019). Hence, the lack of effective involvement of all relevant actors, including individual citizens, in all stages of a policy cycle appears as an important shortcoming of existing policy mixes in peri-urban contexts, also considering their unsustainable characters.

4.2. Outlook: from policy mixes to governance mixes for PULs

The clustering of the cases revealed specific aspects that characterise policy mixes applied to PULs. Policy mixes combining PIs from different categories (cluster 1 in Fig. 6) address, on average, more challenge categories compared to those combining only LRG instruments, which suggests that they adopt a more holistic perspective. They also tackle more frequently key sustainability issues of PULs such as those related to *Climate change*, *Green and circular economy*, and *Public participation*. At the same time, cases in cluster 1 often combine public and private resources, an evidence of the successful involvement of a multiplicity of actors. While all these are desirable features of a policy mix, which can be expected to improve its effectiveness, policy mixes combining PIs from different categories also suffer from specific shortcomings and are expected to encounter more obstacles than policy mixes based on more traditional combinations of LRG instruments. Part of the reason for this might be that they make less use of support tools and methodologies, probably because they are included in less structured processes.

This analysis suggests that moving from the described policy mixes towards a "governance mix" approach could be a possible way forward for PULs. The term "governance mix" is not so frequent in the scientific literature and its meaning is still vague. Existing uses of the term are related to specific cases, with slightly different meanings. For example, in the context of the European Union, "governance mix" was used to describe local policy processes (Börzel, 2012), social policy arrangements (Hartlapp, 2007), or impacts of supranational investment policies (Mertens & Thiemann, 2022). In a study related to Seoul (South Korea) researchers analysed the mixing of governance modes like hierarchy, market, and network (Yoo & Kim, 2012). The way in which the notion of governance mix has been so far used suggests that this term is still more useful for specific economic arrangements like public-private partnerships (Maurya & Srivastava, 2020), or to describe general processes related to governance mechanisms.

Like policy mixes, a governance mix for PULs does not refer to a particular type of a PI but builds upon multi-level and multi-actor settings. Two main groups of components form a governance mix: (1) a mix of PIs from different categories, which also includes context-specific top-down planning and zoning instruments created and implemented under local law (Nadin et al., 2018), which set the basis and the legal framework for the local spatial planning; and (2) a set of policy support tools and methodologies. The difference between policy mix and governance mix lies in the fact that the latter includes a broader set of PIs, as well as complementary support tools and methodologies, that are not usually considered in a policy mix, such as education, awareness raising, training and capacity building activities. Such a combination would allow a more efficient targeting of individual decisions and a better coordination and cooperation between local-level strategies promoted by local actors, what is written and implemented at the policy level, and what is described in statutory planning instruments. Ultimately, this would also limit the domination of top-down instruments that we detected in the analysed policy mixes. In this sense, the "ingredients" of a governance mix may have different forms and be implemented by various actors at multiple levels of governance (Keskitalo et al., 2016; Mees et al., 2014).

We argue that, to address some of the shortcomings identified in the analysed policy mixes, a governance mix for PULs should have some key features.

First, a governance mix should be equipped with an active, scientifically based landscape monitoring component. This component would dynamically gather sociological, economic, and ecological data characterising a landscape, thus supporting continuous identification and monitoring of existing and emerging challenges related to PULs. In line with a policy cycle approach, the constant evaluation of the level of achievement of policy and planning objectives through defined indicators would highlight the necessary adjustments in the applied PIs, hence contribute to a more flexible and less static governance as required by many researchers (Karpouzoglou et al., 2016). A scientific component integrated into such monitoring activities would help to translate advanced scientific methods and evidence emerging from research results into governance practices.

Second, we see a need to integrate various land-use planning actors, who are an "active force in enabling changes", with actors involved in other policymaking processes, who are often a different group (Albrechts, 2003). Specifically, we would like to stress the need to better integrate representatives of civil society and individual citizens, who should not only be informed but also actively engaged in policy and planning activities via different participatory arrangements. A higher degree of active participation could reduce conflicts in PULs by supporting more equity and reducing lobbyism (Erman & Eken, 2004). Crucially, it could also be a step forward to diversify sources of funds needed to implement a governance mix. To this aim, there is a need to go beyond traditional communication activities and include innovative approaches using art and design to communicate about scientific evidence, to raise citizens' awareness about peri-urban challenges, and to imagine possible sustainable solutions for PULs.

Third, a well-established, transparent and multi-level coordination among all governance activities and involved actors should be in place to provide a remedy for governance fragmentation. Such a role could be played by regional authorities (as suggested by our results), or by metropolitan authorities, which are currently in the process of defining their responsibilities in many European regions. The coordinator should have a "proactive" approach, regularly engaging with governance actors in policy and land-use planning processes, thus responding more accurately, comprehensively, and dynamically than existing policy and planning approaches to constantly and quickly emerging challenges. This could be at least a partial remedy for the "slowness" of existing approaches, which can be attributed to the "stiffness" of existing planning legislation resulting in unstable or too time demanding environmental policy processes, poor understanding of the threats posed by peri-urbanisation to the sustainable development of cities and regions, and lack of coherency among policy goals and thus difficulties with the consistency of the components of a policy mix (Rayner & Howlett, 2009).

Moving from a policy mix to a governance mix for PULs is not without difficulties and would require a demanding and time-consuming trial-and-error process. This can be discouraging for the governance actors who should be involved in it, or who should lead such an experimentation process. Nevertheless, further advancements in the development of governance mixes for PULs cannot disregard the need for testing various prototypes of governance mixes and assessing their level of balance and effectiveness. Therefore, new research can be developed starting from our results and assumptions. Design thinking, an approach commonly used in business settings to test the performance of new products, could be a helpful approach to perform such experimental governance and enable design of adaptable governance mixes (Clarke & Craft, 2019) for example through urban living labs (Trei et al., 2021).

4.3. Limitations of the study and further research directions

To correctly interpret the results, some key limitations of the study must be acknowledged. The first limitation relates to the amount of analysed cases of PULs governance. Our study addressed PIs designed or implemented in 47 case study PULs, which is relatively a small number in the panorama of existing PULs. Moreover, cases have not been selected systematically a-priori, but gathered bottom-up, making their geographical distribution uneven. This led to a certain over-representation of the European context. However, our aim was not to achieve a quantitative representativeness of all PULs conditions across the world, but rather to capture their diversity and to investigate potential common patterns. The large geographical coverage of the cases, which is not common in similar studies, and the fact that no significant differences emerged in the analysed aspects among cases located in different areas (e.g., between Global North and Global South contexts), suggest that the results are -to some extent- generalisable. This does not mean that the forms of PULs governance should be the same everywhere. As noted by Singh and Narain (2020), peri-urbanisation is different in Global North and Global South regions and this fact influences the way in which PULs are governed. There is no one-size-fit-all approach that can be used across various peri-urban contexts. Instead, the definition of appropriate governance mixes for PULs should be based on a careful examination of local peculiarities, indigenous knowledge, and socio-ecological variables, among others.

A second limitation concerns the possibility of a (positive) bias in the results. Since the respondents are mostly scientists and researchers, one might expect that they described good practices or experiences related to research projects, not fully representative of the PIs commonly applied in other PULs. Moreover, the analysis is based on observations, opinions, and assessments made by the respondents, whose level of involvement in the policy process is not known. Thus, for example,

perceived barriers might not correspond to the real ones, or be different from the ones observed by other stakeholders. However, the fact that many issues and barriers have been identified suggests that respondents had a good knowledge of the reported cases and assumed towards them a quite critical perspective.

The third and last limitation is linked to the restricted knowledge of the local contexts that we could draw from the survey, mostly composed of closed-ended questions. This prevented a more in-depth understanding of the cases, especially those where a mix of PIs was described. While our study offers an overview of the panorama that emerged, future context specific insights on policy mixes addressing PULs can be developed using a more qualitative approach, to verify how some specific typologies of PIs - belonging to different categories - made it possible to achieve specific goals. This could allow formulating specific recommendations related to different levels of governance. A follow-up survey or an interview could be administered to the respondents of cases where we found a policy mix, giving them the opportunity to articulate what was the contribution of the individual PIs in addressing context-related sustainability challenges and what relationships exist among the PIs.

5. Conclusions

The findings of this research provide valuable insights for the governance of PULs. The study characterised the PIs implemented in 47 cases of PULs governance and their combinations, moving from the hypothesis that a policy mix is needed to address the complex sustainability challenges associated with peri-urbanisation. The analysis revealed prevalent features and common shortcomings of PIs adopted in PULs, including the prevalence of top-down regulatory approaches, a high dependency on public funds, and a still low level of involvement of citizens in policy-making processes.

In most cases, a policy mix was described. Their clustering revealed how different combinations of PIs are adopted to address different categories of challenges. Policy mixes overcoming the traditional focus on LRG instruments and combining PIs from different categories demonstrate a more holistic approach to PULs sustainability and mobilize both public and private resources through a successful involvement of different actors. However, they make less use of support tools and methodologies and are at risk of encountering more obstacles in the implementation stage.

Based on these findings, the article discussed the possibility to expand existing policy mixes into the broader concept of governance mixes for PULs. It was argued that such governance mixes should be composed of combinations of different PIs and policy support tools and methodologies, and have specific features to overcome the limitations of existing policy mixes: i) be equipped with a strong monitoring component, ii) integrate a broad set of governance actors including citizens, and iii) emerge from an effective and transparent multi-level coordination.

Moving from a policy- to a governance mix for PULs would require experimenting with various prototypes of governance mixes and assessing their level of balance and effectiveness. Besides tackling the sustainability challenges of PULs in innovative ways, this complex trial and error process would open new avenues for comparative and applied research.

CRediT authorship contribution statement

Marcin Spyra: Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Chiara Cortinovis:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Silvia Ronchi:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cities.2024.105508.

Data availability

Data will be made available on request.

References

Albert, C., & Von Haaren, C. (2017). Implications of applying the green infrastructure concept in landscape planning for ecosystem services in peri-urban areas: An expert survey and case study. *Planning Practice and Research, 32*(3), 227–242. https://doi.org/10.1080/02697459.2014.973683

Albrechts, L. (2003). Reconstructing decision-making: Planning versus politics. *Planning Theory, 2*(3), 249–268. https://doi.org/10.1177/147309520323007

Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and Urbanization, 15*(1), 135–148. www.ucl.ac.uk/dpu/pui.

Allen, A., Dávila, J. D., & Hofmann, P. (2006). The peri-urban water poor: Citizens or consumers? *Environment and Urbanization, 18*(2), 333–351. https://doi.org/10.1177/0956247806069608

Amirinejad, G., Donohue, P., & Baker, D. (2018). Ambiguity at the peri-urban interface in Australia. *Land Use Policy, 78*, 472–480. https://doi.org/10.1016/J.LANDUSEPOL.2018.07.022

Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners, 35*(4), 216–224. https://doi.org/10.1080/01944366908977225

Arslan, A., Cavatassi, R., & Hossain, M. (2022). Food systems and structural and rural transformation: A quantitative synthesis for low and middle-income countries. *Food Security, 14*(1), 293–320. https://doi.org/10.1007/s12571-021-01223-2

Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, ecosystem services and urban challenges. *Land Use Policy, 100*. https://doi.org/10.1016/j.landusepol.2020.104898

Börzel, T. (2012). The Oxford handbook of governance. In D. Levi-Faur (Ed.), *The Oxford handbook of governance* (pp. 613–627). https://doi.org/10.1093/oxfordhb/9780199560530.013.0043

Boynton, P. M. (2004). Administering, analysing, and reporting your questionnaire. *BMJ, 328*(7452), 1372–1375. https://doi.org/10.1136/BMJ.328.7452.1372

Boynton, P. M., & Greenhalgh, T. (2004). Selecting, designing, and developing your questionnaire. *BMJ, 328*(7451), 1312–1315. https://doi.org/10.1136/BMJ.328.7451.1312

Calò, N., & Spyra, M. (2022). Implementing green infrastructures concept to protect peri-urban open spaces. Example from Gorenjska region, Slovenia. In H. Gölz (Ed.), *International expert workshop on economic aspects of nature restoration* (pp. 61–73). Federal Agency for Nature Conservation (BfN). https://doi.org/10.19217/skr637.

Caro-Borrero, A., Carmona-Jiménez, J., Temis-García, L., & Martínez-Moreno, M. F. (2024). "The springs are untouchable": Amid community management and government neglect, the last springs in peri-urban areas of Mexico City. *Urban Ecosystems, 27*(2). https://doi.org/10.1007/s11252-023-01453-6

Cattivelli, V. (2020). The urban gardens in South Tyrol (IT): Spatial distribution and some considerations about their role on mitigating the effects of ageing and urbanization. *Regional Studies, Regional Science, 7*(1), 206–209. https://doi.org/10.1080/21681376.2020.1770121

Clarke, A., & Craft, J. (2019). The twin faces of public sector design. *Governance, 32*(1), 5–21. https://doi.org/10.1111/gove.12342

Crossman, N. D., Bryan, B. A., & Collins, S. (2007). Systematic landscape restoration in the rural-urban fringe: Meeting conservation planning and policy goals. *Biodiversity and Conservation, 16*, 3781–3802. https://doi.org/10.1007/s10531-007-9180-8

de Boon, A., Sandström, C., Arbieu, U., Hansen, I., Lehnen, L., Marino, A., … Rønningen, K. (2021). Governing dual objectives within single policy mixes: An empirical analysis of large carnivore policies in six European countries. *Journal of Environmental Policy and Planning, 23*(4), 399–413. https://doi.org/10.1080/1523908X.2020.1841614

Douglass, M. (1998). A regional network strategy for reciprocal rural-urban linkages: An agenda for policy research with reference to Indonesia. In C. Tacoli (Ed.), *Vol. 20.*

Third world planning review (pp. 124–154). https://doi.org/10.3828/twpr.20.1. f2827602h503k5j6. Issue 1.

Eckersley, P., Harrison, O., & Poberezhskaya, M. (2022). A new framework to understand the drivers of policy mixes in multilevel contexts: The case of urban air pollution. *Environmental Policy and Governance.*. https://doi.org/10.1002/EET.2010

Erman, T., & Eken, A. (2004). The "other of the other" and "unregulated territories" in the urban periphery: Gecekondu violence in the 2000s with a focus on the Esenler case, Istanbul. *Cities, 21*(1), 57–68.

European Commission. (2012). *Guidelines on best practice to limit, mitigate or compensate soil sealing*. Publications Office of the European Union. https://doi.org/10.2779/75498

European Commission. (2019). *The European green Deal - COM(2019) 640 final*. https://doi.org/10.1017/CBO9781107415324.004

European Commission. (2020). *EU biodiversity strategy for 2030: Bringing nature back into our lives*. COM(2020) 380 Final.

European Commission. (2021). *EU soil strategy for 2030 reaping the benefits of healthy soils for people, food, nature and climate {SWD(2021) 323 final}*.

European Commission - Directorate-General for Environment. (2013). *Building a green infrastructure for Europe*. Publications Office of the European Union. https://doi.org/10.2779/54125

European Environment Agency. (2006). Urban sprawl in Europe - The ignored challenge. In *, Vol. 10. EEA report*. Luxembourg: Publications Office of the European Union. https://doi.org/10.1080/02697451003740312. Issue 10.

Evans, J. R., & Mathur, A. (2018). The value of online surveys: A look back and a look ahead. *Internet Research, 28*(4), 854–887. https://doi.org/10.1108/IntR-03-2018-0089

Faysse, N., Errahj, M., Imache, A., Kemmoun, H., & Labbaci, T. (2014). Paving the way for social learning when governance is weak: Supporting dialogue between stakeholders to face a groundwater crisis in Morocco. *Society and Natural Resources, 27*(3), 249–264. https://doi.org/10.1080/08941920.2013.847998

Filyushkina, A., Komossa, F., Metzger, M. J., & Verburg, P. H. (2022). Multifunctionality of a peri-urban landscape: Exploring the diversity of residents' perceptions and preferences. *Ecosystems and People, 18*(1), 583–597. https://doi.org/10.1080/26395916.2022.2131911

Flanagan, K., Uyarra, E., & Laranja, M. (2011). Reconceptualising the 'policy mix' for innovation. *Research Policy, 40*(5), 702–713. https://doi.org/10.1016/J.RESPOL.2011.02.005

Follmann, A. (2022). Geographies of peri-urbanization in the global south. *Geography. Compass, 16*(7). https://doi.org/10.1111/GEC3.12650

Frank, S., Spyra, M., & Fürst, C. (2017). Requirements for cross-border spatial planning technologies in the European context. *Change and Adaptation in Socio-Ecological Systems, 3*(1), 39–46. https://doi.org/10.1515/CASS-2017-0004

Gardi, C., Panagos, P., Van Liedekerke, M., Bosco, C., & De Brogniez, D. (2015). Land take and food security: Assessment of land take on the agricultural production in Europe. *Journal of Environmental Planning and Management, 58*(5), 898–912. https://doi.org/10.1080/09640568.2014.899490

Gawel, E. (1992). Mixed-instrument strategy in environmental policy economic considerations on a new policy approach. *Jahrbuch fur sozialwissenschaft. Jahrbuch Sozialwissenschaft, 43*(2), 267–286.

Gonçalves, J., Gomes, M. C., Ezequiel, S., Moreira, F., & Loupa-Ramos, I. (2017). Differentiating peri-urban areas: A transdisciplinary approach towards a typology. *Land Use Policy, 63*, 331–341. https://doi.org/10.1016/J.LANDUSEPOL.2017.01.041

Gunningham, N., & Sinclair, D. (1999). Regulatory pluralism: Designing policy mixes for environ- mental protection. *Law & Policy, 21*(1), 49–76. https://doi.org/10.1111/1467-9930.00065

Hahn, R. W. (1986). Trade-offs in designing markets with multiple objectives. *Journal of Environmental Economics and Management, 13*(1), 1–12. https://doi.org/10.1016/0095-0696(86)90012-4

Hamiduddin, I. (2018). Journey to work travel outcomes from 'city of short distances' compact city planning in Tübingen, Germany. *Planning Practice and Research, 33*(4), 372–391. https://doi.org/10.1080/02697459.2017.1378980

Hartlapp, M. (2007). EU social policy: The governance mix in implementation politics. In *HSI DP 2007-04. Discussion Paper Series Hugo Sinzheimer*. Institute, University of Amsterdam: Amsterdam.

Hassink, R., Gong, H., Fröhlich, K., & Herr, A. (2021). Exploring the scope of regions in challenge-oriented innovation policy: The case of Schleswig-Holstein, Germany. *30*(11), 2293–2311. https://doi.org/10.1080/09654313.2021.2017857

Hayashi, K., Abdoulaye, T., Wakatsuki, T., Hayashi, K., Abdoulaye, T., & Wakatsuki, T. (2010). Evaluation of the utilization of heated sewage sludge for peri-urban horticulture production in the Sahel of West Africa. *Agricultural Systems, 103*(1), 36–40. https://econpapers.repec.org/RePEc:eee:agisys:v:103:y:2010:i:1:p:36-40.

Hedblom, M., Andersson, E., & Borgström, S. (2017). Flexible land-use and undefined governance: From threats to potentials in peri-urban landscape planning. *Land Use Policy, 63*, 523–527. https://doi.org/10.1016/j.landusepol.2017.02.022

Helm, D. (2005). Economic instruments and environmental policy. *The Economic and Social Review, 36*(3), 205–228.

Henríquez, C., Morales, M., Qüense, J., & Hidalgo, R. (2022). Future land use conflicts: Comparing spatial scenarios for urban-regional planning. *Environment and Planning B: Urban Analytics and City Science, 50*(2). https://doi.org/10.1177/2399808322111404

Hutchison, R. (2010). *Encyclopedia of urban studies*. SAGE Publications, Inc.. https://doi.org/10.4135/9781412971973

Ingold, K., Stadelmann-Steffen, I., & Kammermann, L. (2019). The acceptance of instruments in instrument mix situations: Citizens' perspective on Swiss energy

transition. *Research Policy, 48*(10), Article 103694. https://doi.org/10.1016/J.RESPOL.2018.10.018

Inostroza, L., Hamstead, Z., Spyra, M., & Qhreshi, S. (2019). Beyond urban–rural dichotomies: Measuring urbanisation degrees in central European landscapes using the technomass as an explicit indicator. *Ecological Indicators, 96*, 466–476. https://doi.org/10.1016/j.ecolind.2018.09.028

IPBES - The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2023). Policy instruments. https://www.ipbes.net/policy-instruments.

Ives, C. D., & Kendal, D. (2013). Values and attitudes of the urban public towards peri-urban agricultural land. *Land Use Policy, 34*, 80–90. https://doi.org/10.1016/J.LANDUSEPOL.2013.02.003

Jabareen, Y. R. (2006). Sustainable urban forms: Their typologies, models, and concepts. *Journal of Planning Education and Research, 26*(1), 38–52. https://doi.org/10.1177/0739456X05285119

Jelinčić, D. A., & Tišma, S. (2021). Ensuring sustainability of cultural heritage through effective public policies. *Urbani Izziv, 31*(2), 78–87. https://doi.org/10.5379/urbani-izziv-en-2020-31-02-002

Karpouzoglou, T., Dewulf, A., & Clark, J. (2016). Advancing adaptive governance of social-ecological systems through theoretical multiplicity. *Environmental Science & Policy, 57*, 1–9. https://doi.org/10.1016/J.ENVSCI.2015.11.011

Keskitalo, E. C. H., Juhola, S., Baron, N., Fyhn, H., & Klein, J. (2016). Implementing local climate change adaptation and mitigation actions: The role of various policy instruments in a multi-level governance context. *Climate, 4*(1), 7. https://doi.org/10.3390/CLI4010007

Kleemann, J., Struve, B., & Spyra, M. (2023). Conflicts in urban peripheries in Europe. *Land Use Policy, 133*, Article 106849. https://doi.org/10.1016/j.landusepol.2023.106849

Klein, J., Juhola, S., & Landauer, M. (2016). Local authorities and the engagement of private actors in climate change adaptation. *Environment and Planning C: Politics and Space, 35*(6), 1055–1074. https://doi.org/10.1177/0263774X16680819

Lehmann, P. (2012). Justifying a policy mix for pollution control: A review of economic literature. *Journal of Economic Surveys, 26*(1), 71–97. https://doi.org/10.1111/j.1467-6419.2010.00628.x

Li, L., Taeihagh, A., & Tan, S. Y. (2022). What factors drive policy transfer in smart city development? Insights from a Delphi study. *Sustainable Cities and Society, 84*, Article 104008. https://doi.org/10.1016/J.SCS.2022.104008

Lin, T., Guo, X., Zhao, Y., Pan, L., & Xiao, L. (2010). A study of residents' environmental awareness among communities in a peri-urban area of Xiamen. *International Journal of Sustainable Development and World Ecology, 17*(4), 285–291. https://doi.org/10.1080/13504509.2010.487995

Llausàs, A., Buxton, M., & Beilin, R. (2015). Spatial planning and changing landscapes: A failure of policy in peri-urban Victoria, Australia. *Journal of Environmental Planning and Management, 59*(7), 1304–1322. https://doi.org/10.1080/09640568.2015.1074888

Lombard, M. (2016). Land conflict in peri-urban areas: Exploring the effects of land reform on informal settlement in Mexico. *Urban Studies, 53*(13), 2700–2720. https://doi.org/10.1177/0042098015603569

López-Estébanez, N., Yacamán-Ochoa, C., & Mata-Olmo, R. (2022). The multifunctionality and territoriality of peri-urban agri-food systems: The metropolitan region of Madrid, Spain. *Land, 11*(4), 588. https://doi.org/10.3390/LAND11040588

Marino, D., Mazzocchi, G., Pellegrino, D., & Barucci, V. (2022). Integrated multi-level assessment of ecosystem services (ES): The case of the Casal del Marmo Agricultural Park Area in Rome (Italy). *Land, 11*(11), 2055. https://doi.org/10.3390/LAND11112055

Maurya, D., & Srivastava, A. K. (2020). Controlling opportunism in partnerships: A process view. *International Journal of Public Sector Management, 33*(6–7), 751–769. https://doi.org/10.1108/IJPSM-02-2020-0062

Mees, H. L. P., Dijk, J., van Soest, D., Driessen, P. P. J., van Rijswick, M. H. F. M. W., & Runhaar, H. (2014). A method for the deliberate and deliberative selection of policy instrument mixes for climate change adaptation. *Ecology and Society, 19*(2). https://doi.org/10.5751/ES-06639-190258

Mertens, D., & Thiemann, M. (2022). Investing in the single market? Core-periphery dynamics and the hybrid governance of supranational investment policies. *Journal of European Integration, 44*(1), 81–97. https://doi.org/10.1080/07036337.2021.2011261

Mortoja, M. G., Yigitcanlar, T., & Mayere, S. (2020). What is the most suitable methodological approach to demarcate peri-urban areas? A systematic review of the literature. *Land Use Policy, 95*, Article 104601. https://doi.org/10.1016/J.LANDUSEPOL.2020.104601

Nadin, V., Fernández Maldonado, A. M., Zonneveld, W., Stead, D., Dąbrowski, M., Piskorek, K., ... Degórska, B., et al. (2018). *COMPASS - comparative analysis of territorial governance and spatial planning systems in Europe*.

Nigam, R., Tripathi, G., Priya, T., Luis, A. J., Vaz, E., Kumar, S., ... Kotha, M. (2022). Did Covid-19 lockdown positively affect the urban environment and UN - Sustainable Development Goals? *PLoS One, 17*(9), Article e0274621. https://doi.org/10.1371/JOURNAL.PONE.0274621

OECD. (2017). Land-use planning systems in the OECD. In *Country fact sheets (OECD Regio)*. OECD Publishing. https://doi.org/10.1787/9789264268579-en.

Pacheco-Vega, R. (2020). Environmental regulation, governance, and policy instruments, 20 years after the stick, carrot, and sermon typology. *Journal of Environmental Policy & Planning, 22*(5), 620–635. https://doi.org/10.1080/1523908X.2020.1792862

Patti, D. (2017). Metropolitan governance in the peri-urban landscape: The tower of babel? The case of the Vienna-Bratislava Metropolitan Region. *Planning Practice & Research, 32*(1), 29–39. https://doi.org/10.1080/02697459.2016.1146431

Pedrosa, E. L. J., Okyere, S. A., Frimpong, L. K., Diko, S. K., Commodore, T. S., & Kita, M. (2021). Planning for informal urban green spaces in African cities: Children's perception and use in peri-urban areas of Luanda, Angola. *Urban Science, 5*(3), 50. https://doi.org/10.3390/urbansci5030050

Phulkerd, S., Sacks, G., Vandevijvere, S., Worsley, A., & Lawrence, M. (2017). Barriers and potential facilitators to the implementation of government policies on front-of-pack food labeling and restriction of unhealthy food advertising in Thailand. *Food Policy, 71*(August), 101–110. https://doi.org/10.1016/j.foodpol.2017.07.014

Piorr, A., Ravetz, J., & Tosics, I. (2011). Peri-urbanisation in Europe: towards European policies to sustain urban-rural futures. In *Synthesis report*.

Plieninger, T., Draux, H., Fagerholm, N., Bieling, C., Bürgi, M., Kizos, T., … Verburg, P. H. (2016). The driving forces of landscape change in Europe: A systematic review of the evidence. *Land Use Policy, 57*, 204–214. https://doi.org/10.1016/J.LANDUSEPOL.2016.04.040

Prokop, G., Jobstmann, H., & Schönbauer, A. (2011). *Report on best practices for limiting soil sealing and mitigating its effects.* Technical Report - 2011 - 050. https://doi.org/10.2779/15146.

Quitzow, R. (2015). Assessing policy strategies for the promotion of environmental technologies: A review of India's National Solar Mission. *Research Policy, 44*(1), 233–243. https://doi.org/10.1016/J.RESPOL.2014.09.003

R Core Team. (2018). *R: A language and Environment for statistical computing.* R Foundation for Statistical Computing.

Rayner, J., & Howlett, M. (2009). Introduction: Understanding integrated policy strategies and their evolution. *Policy and Society, 28*(2), 99–109. https://doi.org/10.1016/j.polsoc.2009.05.001

Ring, I., & Schröter-Schlaack, C. (2011). Towards a framework for assessing instruments in policy mixes for biodiversity and ecosystem governance. In I. Ring, & C. Schröter-Schlaack (Eds.), *Instrument mixes for biodiversity policies.* Helmholtz Centre for Environmental Research – UFZ. POLICYMIX Report.

Rogge, K. S. (2018). Designing complex policy mixes: Elements, processes and characteristics. In M. Howlett, & I. Mukherjee (Eds.), *Routledge handbook of policy design* (pp. 34–58). Taylor and Francis.

Rogge, K. S., & Reichardt, K. (2013). Towards a more comprehensive policy mix conceptualization for environmental technological change: A literature synthesis. *Working Papers "Sustainability and Innovation"*, 1–62. https://ideas.repec.org/p/zbw/fisisi/s32013.html.

Ronchi, S., Pontarollo, N., & Serpieri, C. (2021). Clustering the built form at LAU2 level for addressing sustainable policies: Insights from the Belgium case study. *Land Use Policy, 109*, Article 105642. https://doi.org/10.1016/J.LANDUSEPOL.2021.105642

Ronchi, S., Salata, S., Arcidiacono, A., Piroli, E., & Montanarella, L. (2019). Policy instruments for soil protection among the EU member states: A comparative analysis. *Land Use Policy, 82*, 763–780. https://doi.org/10.1016/J.LANDUSEPOL.2019.01.017

Roth, A. T., Kleemann, J., & Spyra, M. (2024). Policy-making for peri-urban landscapes as arenas of human-wildlife interactions. *Urban Ecosystems.*. https://doi.org/10.1007/s11252-024-01548-8

Roth, D., Khan, M. S. A., Jahan, I., Rahman, R., Narain, V., Singh, A. K., … Yakami, S. (2019). Climates of urbanization: Local experiences of water security, conflict and cooperation in peri-urban South-Asia. *Climate Policy, 19*(sup1). https://doi.org/10.1080/14693062.2018.1530967

Rozas-Vásquez, D., Spyra, M., Jorquera, F., Molina, S., & Caló, N. C. (2022). Ecosystem services supply from peri-urban landscapes and their contribution to the sustainable development goals: A global perspective. *Land, 11*(11). https://doi.org/10.3390/land11112006

Schindler, S. (2015). Governing the twenty-first century metropolis and transforming territory. *Territory, Politics, Governance, 3*(1), 7–26. https://doi.org/10.1080/21622671.2014.937453

Schneider, A., & Woodcock, C. E. (2008). Compact, dispersed, fragmented, extensive? A comparison of urban growth in twenty-five global cities using remotely sensed data, pattern metrics and census information. *Urban Studies, 45*(3), 659–692. https://doi.org/10.1177/0042098007087340

Shaw, B. J., van Vliet, J., & Verburg, P. H. (2020). The peri-urbanization of Europe: A systematic review of a multifaceted process. *Landscape and Urban Planning, 196*. https://doi.org/10.1016/J.LANDURBPLAN.2019.103733

Simon, D., McGregor, D., & Thompson, D. (2005). Contemporary perspectives on the peri-urban zones of cities in developing countries. In D. Simon, D. McGregor, & D. Thompson (Eds.), *The peri-urban interface. Approaches to sustainable natural and human resource use* (pp. 26–40). Routledge. https://doi.org/10.4324/9781849775878-9.

Singh, K. A., & Narain, V. (2020). Lost in transition: Perspectives, processes and transformations in periurbanizing India. *Cities, 97*, Article 102494. https://doi.org/10.1016/j.cities.2019.102494

Spyra, M. (2014). The feasibility of implementing cross-border land-use management strategies: A report from three Upper Silesian Euroregions. *IForest, 7*, 396–402. https://doi.org/10.3832/ifor1248-007

Spyra, M., Kleemann, J., Calò, N. C., Schürmann, A., & Fürst, C. (2021). Protection of peri-urban open spaces at the level of regional policy-making: Examples from six European regions. *Land Use Policy, 107*. https://doi.org/10.1016/J.LANDUSEPOL.2021.105480

Spyra, M., Kleemann, J., Cetin, N. I. N. I., Vázquez Navarrete, C. J. C. J., Albert, C., Palacios-Agundez, I., … Fürst, C. (2019). The ecosystem services concept: A new Esperanto to facilitate participatory planning processes? *Landscape Ecology, 34*(7), 1715–1735. https://doi.org/10.1007/s10980-018-0745-6

Spyra, M., La Rosa, D., Zasada, I., Sylla, M., & Shkaruba, A. (2020). Governance of ecosystem services trade-offs in peri-urban landscapes. *Land Use Policy, 95*. https://doi.org/10.1016/J.LANDUSEPOL.2020.104617

Sylla, M., Hagemann, N., & Szewrański, S. (2020). Mapping trade-offs and synergies among peri-urban ecosystem services to address spatial policy. *Environmental Science & Policy, 112*, 79–90. https://doi.org/10.1016/J.ENVSCI.2020.06.002

Termeer, C. J. A. M., Dewulf, A., & van Lieshout, M. (2010). Disentangling scale approaches in governance research: Comparing monocentric, multilevel, and adaptive governance. *Ecology and Society, 15*(4). https://doi.org/10.5751/ES-03798-150429

Trei, D. T., Hornung, J., Rychlik, J., & Bandelow, N. C. (2021). From political motivation to scientific knowledge: Classifying policy labs in the science-policy nexus. *European Planning Studies, 29*(12), 2340–2356. https://doi.org/10.1080/09654313.2021.1941785

Uchiyama, Y., & Kohsaka, R. (2022). Visiting peri-urban forestlands and mountains during the COVID-19 pandemic: Empirical analysis on effects of land use and awareness of visitors. *Land, 11*(8). https://doi.org/10.3390/land11081194

Van Gossum, P., Arts, B., & Verheyen, K. (2012). "Smart regulation": Can policy instrument design solve forest policy aims of expansion and sustainability in Flanders and the Netherlands? *Forest Policy and Economics, 16*, 23–34. https://doi.org/10.1016/J.FORPOL.2009.08.010

van Vliet, J., Verburg, P. H., Grădinaru, S. R., & Hersperger, A. M. (2019). Beyond the urban-rural dichotomy: Towards a more nuanced analysis of changes in built-up land. *Computers, Environment and Urban Systems, 74*, 41–49. https://doi.org/10.1016/J.COMPENVURBSYS.2018.12.002

Von Der Dunk, A., Grêt-Regamey, A., Dalang, T., & Hersperger, A. M. (2011). Defining a typology of peri-urban land-use conflicts – A case study from Switzerland. *Landscape and Urban Planning, 101*(2), 149–156. https://doi.org/10.1016/J.LANDURBPLAN.2011.02.007

Wall, R., Grafakos, S., Gianoli, A., & Stavropoulos, S. (2018). Which policy instruments attract foreign direct investments in renewable energy? *Climate Policy, 19*(1), 59–72. https://doi.org/10.1080/14693062.2018.1467826

Wickham, H. (2007). Reshaping data with the reshape package. *Journal of Statistical Software, 21*(12), 1–20. https://doi.org/10.18637/JSS.V021.I12

Wilts, H., & O'Brien, M. (2019). A policy mix for resource efficiency in the EU: Key instruments, challenges and research needs. *Ecological Economics, 155*(May 2018), 59–69. https://doi.org/10.1016/j.ecolecon.2018.05.004

Winter, A. K., & Karvonen, A. (2022). Climate governance at the fringes: Peri-urban flooding drivers and responses. *Land Use Policy, 117*, Article 106124. https://doi.org/10.1016/j.landusepol.2022.106124

Yiran, G. A. B., Ablo, A. D., & Asem, F. E. (2020). Urbanisation and domestic energy trends: Analysis of household energy consumption patterns in relation to land-use change in peri-urban Accra, Ghana. *Land Use Policy, 99*, Article 105047. https://doi.org/10.1016/J.LANDUSEPOL.2020.105047

Yoo, J. W., & Kim, S. E. (2012). Understanding the mixture of governance modes in Korean local governments: An empirical analysis. *Public Administration, 90*, 816–828.

Zasada, I. (2011). Multifunctional peri-urban agriculture—A review of societal demands and the provision of goods and services by farming. *Land Use Policy, 28*(4), 639–648. https://doi.org/10.1016/j.landusepol.2011.01.008

Zasada, I., Fertner, C., Piorr, A., & Nielsen, T. S. (2011). Peri-urbanisation and multifunctional adaptation of agriculture around Copenhagen. *Geografisk Tidsskrift-Danish Journal of Geography, 111*(1), 59–72. https://doi.org/10.1080/00167223.2011.10669522

Zhao, P. (2013). Too complex to be managed? New trends in peri-urbanisation and its planning in Beijing. *Cities, 30*(1), 68–76. https://doi.org/10.1016/J.CITIES.2011.12.008

Žlender, V. (2021). Characterisation of peri-urban landscape based on the views and attitudes of different actors. *Land Use Policy, 101*, Article 105181. https://doi.org/10.1016/J.LANDUSEPOL.2020.105181