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Land take and the effectiveness of project screening in Environmental Impact Assessment: Findings from an empirical study

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ABSTRACT

Land take is emerging as a global environmental concern, and is particularly critical in intensively developed and land-scarce regions. This paper seeks to understand the effectiveness of the screening stage of Environmental Impact Assessment (EIA) in addressing land take. Screening is the stage where a decision is made as to whether an EIA is required for a project. In many jurisdictions, screening results in three pathways: full EIA directly, preliminary EIA only, or preliminary EIA followed by full EIA. We compared the land take of 217 projects triggering the different pathways in a study region in Italy over a 15-year time interval. Land take was quantified by overlaying the footprint of the projects with a land cover map.

The results show that while more attention was given to projects with larger land take impacts overall, the cumulative land take from smaller projects not triggering full EIA was considerable (40% of overall land take). The case-by-case examination conducted through the preliminary EIA was found to work better for some project types (ski areas and small urban development), than for others (quarries). Our findings lead us to advocate improvements in current screening procedures to ensure that the land take impacts are quantified and made explicit in preliminary EIA reports. Our evidence-based approach to determining land take in EIA provides a compelling basis for understanding ways to improve EIA policies, guidance and practice.

1. Introduction

Land take is the loss of agricultural, forest and other semi-natural and natural land to urban and other artificial land development (EEA, 2006). Land take has emerged as a global environmental concern, particularly critical in land-scarce regions of the world (Foley et al., 2005). For example, in Europe land take has grown in recent decades at more than twice the rate of population increase, and about 1000 km^2 of agricultural and natural land are lost every year to urban, infrastructure and industrial development (EEA, 2016; EEA, 2015). Land take affects habitats and ecosystems, both directly by reducing their area, and indirectly through fragmentation and degradation (Madadi et al., 2017; Haddad et al., 2015; Karlson and Mörtberg, 2015). This in turn affects the delivery of important ecosystem services, such as water and climate regulation, soil conservation, and recreation (Lawler et al., 2014; Geneletti, 2016, 2013). Hence, land take represents, often permanently, erosion of natural capital, with potential flow on consequences for population wellbeing and quality of life (Elmqvist et al., 2013; Wu, 2013; Nelson et al., 2009).

Policies and regulations to prevent or reduce land take have emerged somewhat later than initiatives addressing other environmental issues, such as air pollution, water conservation and noise. For example, at European level there are still no binding measures on land conservation, even though in 2011 the European Commission introduced the “no net land take by 2050” target (EC, 2011a). Several countries and regions have experimented with a variety of regulations to reduce land take, mostly within their urban planning and spatial development policies (Barbosa et al., 2016; Decoville and Schneider, 2016). As recorded in EC (2011b), some of these regulations are based on quantitative thresholds identifying overall acceptable land take (e.g., in Austria, Wallonia) or rates of land take (e.g., in France). Others specify the share of new development that must take place within brownfield sites, so as to avoid or minimise land take (e.g., in the United Kingdom and Flanders). Finally, some regulations outlay management strategies - such as off-set mechanisms- to compensate for land take (e.g., in Germany). Elsewhere approaches based on economic incentives and constraints are used to promote infill development and prevent inefficient use of land and urban sprawl. Examples include smart growth policies in the USA (Bengston et al., 2004) and Australia (Gurran et al., 2015).

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With urban expansion being one of the key causes of land take worldwide (Seto et al., 2011), it comes as no surprise that most initiatives to halt or regulate it are implemented through urban and spatial plans and policies, and many studies have been conducted within those fields (e.g., Colantoni et al., 2016; Sallustio et al. 2015). However, land take is also caused by individual projects located beyond urban and developed areas, or which are assessed and approved using other policy and legislative instruments. These projects include, for example, tourism infrastructure such as ski areas (Geneletti, 2008) and golf courses (Choi et al., 2016), mines and quarries (Ghosh, 2016), landfill sites (Gorsevski et al., 2012; Geneletti, 2010), as well as powerlines and other linear infrastructure development (Bagli et al., 2011). In most countries, these kinds of projects are subject to some form of Environmental Impact Assessment (EIA) prior to approval (Glasson et al., 2012). In theory then, EIA should play an important role in determining if the land take of these projects (among other impacts) is acceptable, as well as in identifying ways for mitigating and monitoring impacts of land take.

The aim of this research is to understand how land take is addressed in EIA practice. In particular, the research focuses on the role of EIA screening. Screening is the stage where a decision is made as to whether an EIA is required for a project, on the basis of the expected significance of the likely environmental impacts (Weston, 2000). Where land take becomes the trigger for EIA, this issue would subsequently become a key focus for the assessment process that follows (i.e. from scoping stage through to detailed assessment and approval decision-making). Thus the screening step represents a key entry point for understanding how EIA addresses land take.

Several approaches to screening exist, most of which involve the use of predefined lists of projects and thresholds (e.g., based on project size), case-by-case examinations, or a combination of the two (Glasson et al., 2012). The use of thresholds offers advantages in terms of simplicity, rapidity and consistency. A disadvantage of this approach however is that it treats similar projects in the same way, irrespective of the sensitivity of the receiving environmental and socio-economic context. For this reason, screening procedures that involve some form of case-by-case examination have grown popular, particularly in conjunction with the use of thresholds (Weston, 2011).

In Europe, the most common screening approach involves the use of thresholds to exclude (i.e. determining when EIA is never required), to include (i.e. development projects for which EIA is always required), as well as for case-by-case examination after which an EIA might be required (Pinho et al., 2010). Hence, projects that enter the EIA system have three possible pathways and their corresponding procedures: full EIA, preliminary EIA only, or preliminary EIA followed by full EIA. Similar approaches that involve the generation of a preliminary EIA (in some context called also initial environmental assessment or simplified EIA) can be found in other regions of the world, such as for example in Brasil, USA, Canada and Australia (Rocha and Fonseca, 2017; Noble, 2015; Canter and Canty, 1993). The way in which the preliminary EIA is conducted varies according to specific legislative requirements, but it generally involves a simplified EIA procedure (e.g., quicker and with limited consultation and public participation) and less detailed impact analysis. This is consistent with the idea that an effective EIA screening should ensure that the size of the solution is adjusted to the size of the problem, i.e. the level of EIA effort is proportional to the significance of expected impacts (Pinho et al., 2010; Wood and Becker, 2005).

This paper presents an empirical investigation to quantify the land take caused by different types of projects that trigger different EIA pathways, and to assess the effectiveness of the screening stage in addressing land take. Specifically, our research questions are:

i) What is the land take caused by different types of projects?
ii) How effective is the case-by-case examination in identifying projects that cause higher land take?
iii) What is the land take caused by projects assessed with full EIA versus projects assessed with preliminary EIA only?

The investigation was conducted by analysing all of the projects that entered the EIA system of a study region within Europe over a 15-year time interval.

2. Methods

2.1. Study context and EIA sample

Our research used the Trentino region, in northern Italy, as a case study. Trentino is a largely mountainous region, hosting about 538,000 inhabitants and covering 6207 km^2. As with many other countries, Italy has a dual EIA system, where major projects are addressed by a national-level procedure, and remaining projects are addressed at regional level. This research focuses on the regional-level EIA system of Trentino. This provides for a screening stage that produces the three pathways described in Section 1. Projects are screened based on a set of thresholds to determine whether they are subject to full EIA, subject to preliminary EIA, or exempt from EIA. If a project is subject to preliminary EIA, a case-by-case examination is undertaken to determine whether a full EIA is required.

The case-by-case examination consists of a relatively short procedure (the responsible authority must decide within 45 days). It is based on a report that describes the main project characteristics (e.g., size, use of resources, production of waste), the sensitivity of the receiving environment (e.g., land use, quality of natural resources, carrying capacity) and the expected impacts in terms of magnitude, area, probability, complexity and frequency. The report largely draws on existing data, such as GIS databases and environmental monitoring reports maintained by public agencies. Although some quantification of impacts might be performed, detailed analyses and modelling are rarely undertaken, particularly if they require original surveys and data collection. The public is informed about the procedure and its outcome, but there are no formal provisions for public participation.

This approach to EIA screening has been in force in Trentino since 2001, offering the opportunity to conduct a longitudinal study of its implications. We reviewed all project types subject to EIA, and selected those characterised by important land take and for which at least 10 similar kinds of project entered the EIA system of Trentino in the 2001–2015 period. This resulted in the following four project types:

- Quarries - sand, gravel and stone excavations roads, and small urban developments;
- Road developments - including secondary roads in extra-urban areas;
- Ski areas - comprising ski-lifts/cable cars and ski pistes (and their redesign or expansion); and
- Small urban developments - including shopping centres, tourism and health facilities, and parking lots.

Overall, 217 projects were examined in this study. Of these, 89 triggered full EIA directly, and 128 triggered the case-by-case examination, of which 18 eventually were subject to full EIA. Table 1 details the distribution of projects in the different types and the EIA pathways.

Before presenting the key results corresponding to the three research questions, some clarification on quantification of land take is warranted.

2.2. Quantifying land take

Land take can be defined and measured in many different ways, depending on what is considered as the land being “taken”, e.g. land being sealed (and therefore having all natural values removed) versus land more generally being converted into more artificial conditions

Table 1
Sample of projects considered in this study broken down by types and EIA pathway.

	No. projects	Full EIA directly	Full EIA after case-by-case examination	Preliminary EIA only
Quarries	78	38	4	36
Roads	28	14	1	13
Ski areas	63	26	7	30
Small urban developments	48	11	6	31
TOTAL	217	89	18	110

relative to the former land use. For this study, we adopted the European Environmental Agency definition, according to which land take represents the:

"change in the amount of agriculture, forest and other semi-natural and natural land taken by urban and other artificial land development. It includes areas sealed by construction and urban infrastructure, as well as urban green areas, and sport and leisure facilities" (EEA, 2017).

We focused on direct land take, i.e. land take resulting only from the space occupation of a project, or footprint. This includes the area directly occupied by the project, by virtue of its location and dimension. We acknowledge that the footprint underestimates the total land take that might result, as it overlooks areas that might be needed for constructing the project or for its functioning. While not presenting the complete picture of land take for a given project, the measure of direct land take, offers the advantage of being straightforward to compute and to enable comparison across the suite of projects and project types investigated.

We estimated land take by spatially overlaying in a Geographical Information System (GIS) the footprint of the projects with a land cover map compiled in the year 2000 (scale: 1:10,000) using the legend of the CORINE Land Cover inventory (Bossard et al., 2000). The footprint of the 217 projects was provided as GIS layers by the EIA office of Trentino administration. Land take was computed separately for two land cover classes: agricultural areas (including arable lands, permanent crops, pastures and heterogeneous agricultural land) and natural/seminatural areas (including forests, shrubs, herbaceous vegetation and open spaces with little vegetation). The results of the overlay between project footprint and land cover were then aggregated by project type to answer our first research question, and by EIA pathway to answer our second and third research questions. More specifically, to answer the first research question, we quantified the overall and average land take by project type. For the second question, we compared the land take of projects that triggered full EIA after case-by-case examination, with that of the projects that did not. For the third question, we compared the land take of projects that underwent preliminary EIA only with that of projects that underwent full EIA, either directly or following the case-by-case examination process.

3. Results

The results of our empirical analysis are presented in Table 2, which shows the overall and average land take caused by the projects, broken down by project type and EIA pathway. The data set has been analysed in different ways to answer the three research questions, as described below.

3.1. What is the land take caused by different types of projects?

The overall land take of the considered projects is 2086 ha, about 65% of which occurred on natural/semi-natural areas and 35% on agricultural areas. Fig. 1 shows the overall land take broken down by project type. Ski areas are responsible for 41% of the overall land take (a total of 860 ha) and for 53% of the land take on natural/seminatural areas (722 ha). Quarries contribute to 38% of the overall land take (790 ha), and to 38% of the loss of natural/seminatural areas. Roads and small urban developments are responsible for 6 and 3% of the land take on natural/seminatural areas respectively, but contribute to 23 and 20% of the loss of agricultural areas (533 ha).

When looking at the average land take per project, ski areas cause the highest loss (13.0 ha), followed by quarries (10.1 ha), roads (8.7 ha) and small urban developments (3.9 ha). Ski areas were also found to have the highest ratio between project footprint and land take; i.e. 0.99 as shown in Fig. 2. This means that almost the entire footprint of ski areas produce land take, and this is mainly on natural/seminatural areas. This comes as no surprise, considering that ski areas largely occur in non-developed and natural environments and on steeply sloping land. At the other extreme are quarries, which have a ratio of 0.51. Roads and small urban developments have ratios of 0.87 and 0.76, respectively, mostly due to their interference with agricultural land.

3.2. How effective is the case-by-case examination in identifying projects that cause higher land take?

To answer this question we compared the average land take of projects that triggered full EIA after the case-by-case examination with that of projects that did not (Fig. 3). As can be seen, ski areas and small urban developments that underwent full EIA cause an amount of land take that is respectively 6.1 and 3.9 times higher than that of projects that underwent preliminary EIA only. Despite this overall finding, for quarries the opposite was found to be the case. Quarry projects that did not trigger full EIA cause 3.5 times more land take that those that did trigger it. Similar results were obtained for roads. However, only one road project triggered full EIA after the case-by-case examination. When breaking down the land take by agricultural and natural/seminatural areas, the overall picture was found to be the same: ski areas and small urban development that triggered full EIA caused much higher land take on both land cover types, than those that did not trigger it, whereas the opposite was true for quarries and small urban developments (Fig. 3). Hence the answer to our question is mixed. Overall, it was apparent that the case-by-case examination approach has been effective in that most development proposals with greater land take did trigger full EIA. However, there is some variability between development types in this regard. Giving specific attention to the issue of land take during the EIA screening step would theoretically resolve such inconsistencies in future practice.

3.3. What is the land take caused by projects assessed with full EIA versus projects assessed with preliminary EIA only?

When comparing the average land take of individual projects, the results are in line with what might be expected. The projects that triggered full EIA, either directly or after case-by-case examination were found on average to represent a higher land take for all four project types (Fig. 4). The difference in land take ranged from about 25% (for quarries) to just over 400% (for ski pistes). That is, the average land take by ski areas that undergo full EIA is about four times larger than that of ski areas that undergo preliminary EIA only. Also in this case, the results were similar when the land take was broken down by agricultural and natural/semi-natural areas.

Despite this connection between full EIA and greater land take, when looking at the total set of projects, the analysis shows that 40.8% of land take was caused by projects that underwent preliminary EIA only (Fig. 5). The share was almost identical for both agricultural land and natural/seminatural land. The share was also found to be very similar across project types, with the exception of ski areas, for which the land take determined by projects that underwent preliminary EIA only was around 18%.

Table 2
Land take (ha) of the sample of projects, broken down by type and EIA pathway.

Project type	EIA pathway[a]	Total footprint	Avg project footprint	Total land take agriculture	Avg project land take agriculture	Total land take nat./seminat.	Avg project land take nat/seminat.
Quarries	Pathway 1	996.84	26.23	153.88	4.05	305.88	8.05
	Pathway 2	21.75	5.44	0.93	0.23	9.06	2.26
	Pathway 3	543.02	15.08	113.47	3.15	207.05	5.75
Roads	Pathway 1	172.28	12.31	109.56	7.83	36.23	2.59
	Pathway 2	2.40	2.40	1.60	1.60	1.00	1.00
	Pathway 3	108.68	8.36	54.65	4.20	42.37	3.26
Ski areas	Pathway 1	477.76	18.38	49.08	1.89	427.33	16.44
	Pathway 2	180.20	25.74	72.41	10.34	153.74	21.96
	Pathway 3	204.13	6.80	16.27	0.54	140.95	4.70
Small urban dev.	Pathway 1	53.80	4.89	33.66	3.06	13.51	1.23
	Pathway 2	62.79	10.47	46.95	7.83	15.39	2.56
	Pathway 3	133.64	4.31	66.94	2.16	14.06	0.45

[a] Pathway 1: Full EIA directly; Pathway 2: Full EIA after case-by-case examination; Pathway 3: Preliminary EIA only.

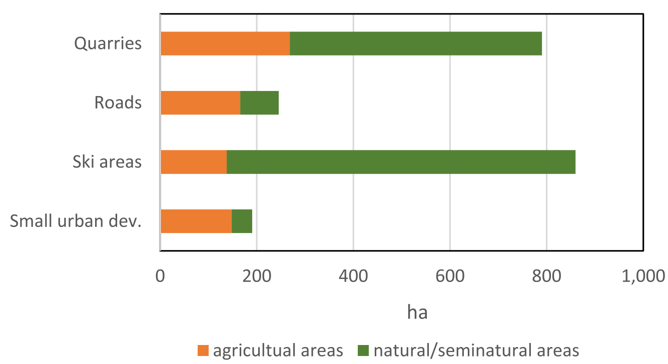

Fig. 1. Overall land take by project types.

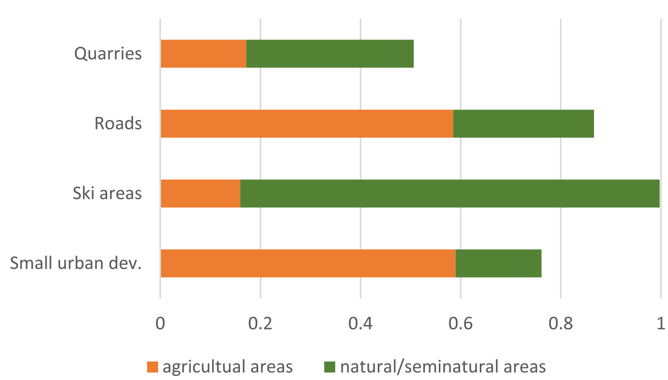

Fig. 2. Ratio between project footprint and land take.

4. Discussion

We discuss our key findings in two ways; firstly the implications of the empirical results and secondly some reflections on our research methods for understanding screening pathways and the quantification of land take.

4.1. About the findings

Perhaps the most interesting and surprising finding was that 40% of land take caused by projects that enter the EIA system "fly under the radar" of full EIA. The combination of the results presented in Figs. 4 and 5 clearly show the cumulative nature of land take associated with projects that do not undertake a full EIA: these projects cause a relatively small impact individually, but, in aggregation, contribute to an important share of the overall land take. The issue of cumulative effects emerged as particularly evident for three project types: roads, small urban developments and quarries.

Despite being required by most EIA systems (Therivel and Ross, 2007), the treatment of cumulative effects constantly rank high among the limitations of impact assessment practice (Wärnbäck and Hilding-Rydevik, 2009; Bragagnolo et al., 2012). Previous research on cumulative effects reviewed the state of practice (Cooper and Sheate, 2002) and proposed new methods and tools, as well as procedural improvements (Canter and Ross, 2010; Duinker and Greig, 2006). This is one of the few studies that empirically demonstrated the nature and extent of cumulative impacts in EIA, for a geographical region and for a long temporal interval. Our results confirm that project-level land take is largely a cumulative issue, potentially subject to the "tyranny of small decisions" (Odum, 1982), i.e. to decisions based on limited information and on a reductionist perspective. It is important to emphasise that the impact assessment conducted during preliminary EIA is highly simplified and largely descriptive, based on limited (often non-existing) surveys and collection of new environmental data. In addition, the public

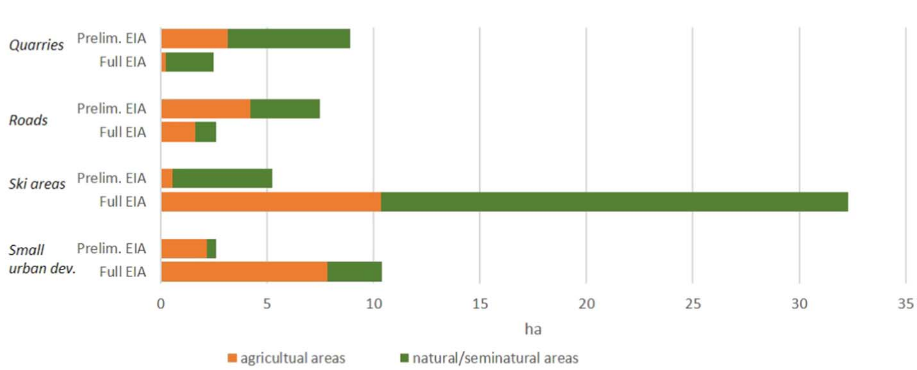

Fig. 3. Average land take by projects that underwent preliminary EIA only versus projects that triggered full EIA after case-by-case examination.

Fig. 4. Average land take by projects that triggered preliminary EIA only versus full EIA, either directly or after case-by-case examination.

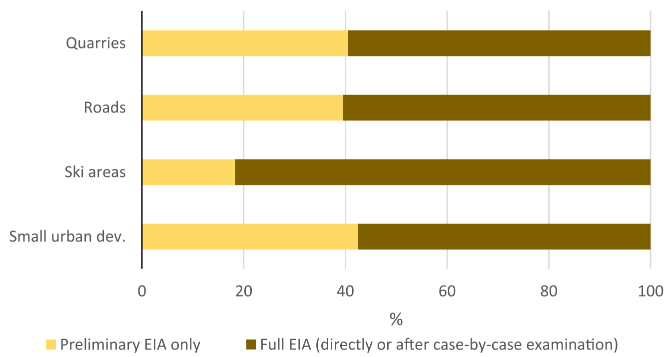

Fig. 5. Land take caused by projects that triggered preliminary EIA versus full EIA (either directly or after case-by-case examination), measured as a percentage of the overall land take by project type.

is not formally consulted and the decision-making process is fast-tracked with respect to full EIA. The notion that such cumulative impacts are occurring in the absence of the kind of rigour and transparency expected from best practice EIA (e.g., IAIA, 2009) is a troubling realisation.

A second key finding of this research concerns the effectiveness of EIA screening. Our results have borne out the logic of having a flexible approach to EIA screening. By looking at the land take effects of projects subject to preliminary versus full EIA (Fig. 4), we can conclude that projects having greater impact were associated with higher levels of EIA attention overall. Hence, the principle of the proportionality of the solution is respected: the depth of the EIA (in terms of temporal, financial and technical resources) is adjusted to the likely significance of the impacts (Pinho et al., 2010).

When zooming in on the effectiveness of the case-by-case examination, though, a more complex picture emerges. Our third key finding is that for ski areas and small urban developments the case-by-case examination works, i.e., it allows regulators to identify the projects having a greater land take impact, which are then sent to full EIA. However, this is not the case for quarries and for roads. Considering roads, only one project triggered full EIA after the case-by-case examination, hence we cannot formulate robust conclusions based on this sample. Considering quarries, we can conclude that the case-by-case examination did not produce a satisfactory outcome in terms of identifying projects with greater land take. In saying this, we must acknowledge that there may be other explanations for this outcome. For example, it is possible that impacts on health or water represented the driving factor for triggering full EIA for quarries rather than the impact of land take. However, our findings do signal a need to improve the current way of conducting preliminary EIA, particularly for this type of project.

Taken together, our three findings above lead us to make the following recommendation for enhancing EIA practice in Trentino and which may have relevance to practitioners elsewhere also. We advocate improvements in current screening procedures to ensure that the land take impacts are quantified and made explicit in preliminary EIA reports, so that regulators have clear evidence of the expected land take issues for projects when making approval decisions.

This research, as well as previous studies (Sallustio et al., 2015; Salvati, 2014), showed that quantitative land take estimates can be produced with largely available data sets and relatively modest analytical efforts. The quantification of the expected land take is also instrumental to produce the empirical data needed by authorities to monitor progress towards land take reduction targets, which are becoming increasingly common at different administrative levels, especially in Europe (Barbosa et al., 2016). Recent research has questioned the capability to reliably monitor the achievement of land take targets (Decoville and Schneider, 2016). In order to improve the reliability of monitoring efforts, an improved preliminary EIA should be directed at producing a systematic and comparable analysis of land take, so as to produce data that can be entered in broader database (e.g., at national or sub-national level).

Our research revealed that in the study region over 2000 ha of land would be taken by the considered projects. This area is about three time larger than the growth of urban areas that occurred roughly in the same time period.[1] This is, at least in part, due to the rather extensive definition of land take that was adopted, which include for example areas converted to ski pistes. However, this finding suggests that the land take by projects that enter the EIA system cannot be disregarded by policy measures aimed at reducing or capping land take within a region.

Finally, most research and policy on land take focuses on urban growth, and on spatial and urban plans as the main instruments to halt it (EC, 2011b). Hence, Strategic Environmental Assessment (SEA) of these plans would be considered as the key impact assessment type to address land take. Based on our findings though, we suggest that developments other than urban growth should be carefully examined for their effects on land take, and that impact assessment types other than SEA should play a role in addressing land take. Importantly, EIA is instrumental in properly understanding the land take associated with individual development proposals, which are not necessarily included in other strategic-level decisions. In the study region, SEA was introduced in 2004. Therefore, in principle, our sample of projects could be divided into a pre- and a post-SEA set, in order to study the role of SEA. However, it is not always easy to link the proposal of a given project to a specific planning instrument. Plans are subject to revisions; projects might be included in plans but not be implemented, or vice-versa. Hence, our sample of projects alone cannot be used to infer about the role and effectiveness of SEA in limiting land take. However, the

[1] Urban growth was estimated by comparing the land cover map that was used in the study with a 2014 update

results presented draw attention to a key issue that, even when an SEA system is in place, the proper consideration of cumulative effects is not guaranteed.

4.2. About the methods

Previous studies addressing EIA screening and its effectiveness adopted a variety of methods, including: collection of experts' opinion through questionnaires and interviews (Weston, 2011; Pinho et al., 2010), review of screening decisions (Macintosh and Waugh, 2014), combination of these two (Wood and Becker, 2005; Weston, 2000), and comparison of screening outcomes across jurisdictions (Rocha and Fonseca, 2017). To the best of our knowledge, this is the first research that analysed EIA screening by independently computing the actual impacts of a sample of projects. Albeit limited to impacts in terms of land take, the results demonstrate how valuable insights can be gathered from a relatively simple approach, utilising existing data sets.

The study relied on a large and representative sample, including more than 200 projects, which resulted from a systematic analysis of all projects that enter the EIA system of a study region over a 15-year interval. However, for one project type (roads) under one EIA pathway (full EIA after case-by-case examination) the sample was too limited, preventing a meaningful statistical analysis.

The approach that was used to quantify land take relied solely on project footprint. As noted previously, this is likely to underestimate the overall land take, given that it disregards the additional space required for constructing and operating the projects, as well as indirect forms of land take, such as land fragmentation (Geneletti, 2004). These forms of additional land take are hard to predict, as they depend strongly upon local biophysical conditions (Haddad et al., 2015). Prediction is particularly complex for linear infrastructures that cut across different landscapes and habitats, as shown by studies in road ecology (Forman et al., 2003). However, even though the use of the project footprint only produces a conservative estimate and is a potential limitation with respect to understanding absolute land take, this approach nevertheless does enable a meaningful comparison of projects and for each of the EIA screening pathways.

Finally, this study considered land take without distinguishing between the relative qualities or values affected beyond our two broad categories for agricultural and natural/semi-natural areas. While this is consistent with the concept of land take, which does focus on the magnitude of land loss, it ignores other factors that may need to be considered to determine the significance of impacts. Examples here might include the biophysical characteristics of the land (e.g. in terms of fertility and habitat suitability), its capability to provide important ecosystem services (e.g., water purification and regulation), and its importance for communities and beneficiaries (e.g. in terms of location and accessibility). Ideally, a comprehensive assessment of the significance of land take impacts should occur in all assessments, including for preliminary EIA.

5. Conclusions

In this study we sought to understand the effectiveness of EIA screening in a study region with respect to land take impacts, as well as on the overall land take of projects that undergo different EIA pathways. Land take represents the loss of important habitats or sterilisation of land from former land uses. Land take has emerged as a priority environmental concern, leading some administrations to set land take reduction targets.

Specifically, it is important to make sure that land take by projects that undergo EIA (but that are not necessarily included in other planning instruments) is properly accounted for. Compared to other impacts for which pre-set quality standards or thresholds might apply (e.g. noise), land take is inherently a cumulative issue. It is essential that EIA screening is capable of accounting for the potential cumulative effects on land take in a given region. Our study found that while more attention was given to projects with larger land take impacts overall, the cumulative land take from smaller projects not triggering full EIA was considerable and seemingly is not being considered in approval decision making. We bring attention to this issue as we suspect it may have relevance for EIA practitioners elsewhere.

While our study did find the screening pathway approach to work as generally intended (i.e., by initiating preliminary EIA in uncertain cases and escalating some assessments to a full EIA), there was inconsistency in its application between project types. It was clear that the land take implications vary between project types and this apparently was not being accounted for adequately in the screening process. Hence, we advocate that more detailed land take analysis is warranted during EIA screening, and in particular when a preliminary EIA is conducted.

This study presented an approach to understanding the effectiveness of an aspect of EIA practice based on an empirical ex post study. The analysis was based upon project data itself drawn from the public record. This contrasts with other studies of the effectiveness of EIA based upon practitioner perspectives or report quality review. Our evidence-based approach provides a compelling basis for understanding ways to improve EIA policies, guidance and practice. Overall our study has enabled valuable insights for understanding land take and the effectiveness of EIA screening using this empirical approach.

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