

TEXTE

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Final report

International Standards and Strategies for the Reduction of Land Con- sumption (SURFACE)

Targets, Indicators and Monitoring Concepts

by:

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Elisabeth Marquard, Eva-Maria Schatz, Jana Bovet
Helmholtz-Centre for Environmental Research – UFZ, Leipzig

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On behalf of the German Environment Agency

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Preliminary remark

This report is based on an analysis of data from 2021. It does not take into account any subsequent developments in the areas of soil protection and soil and land use policy that have taken place since then at EU level, in EU Member States or in other countries documented in this report.

Abstract: International Standards and Strategies for the Reduction of Land Consumption (SURFACE)

The aim of the SURFACE project was to assess and analyse the status of political strategies and administrative routines to reduce land take for settlements and transport infrastructure in selected countries. Against the background of emerging international discussions on land take, the European Commissions “no net land take” target until 2050, the United Nations Sustainable Development Goals (SDGs) 11 (“Make cities and human settlements inclusive, safe, resilient and sustainable”) and 15 (“Protect, restore and promote the sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, halt and reverse land degradation, and halt the loss of biodiversity”), the project investigated the extent to which national targets and instruments for reducing land take exist, what level of implementation has been achieved and what obstacles exist to effectively reduce land take. The results of the project presented here are based on two comprehensive written expert surveys and supplementary literature research. Based on this, recommendations for a concretisation of the term “land take” in European strategies and frameworks as well as in national legislation and instrument design were developed. A conceptual clarification of the term “land take” is also a prerequisite for deriving internationally harmonised indicators for monitoring land take associated with settlement development. A second focus of the study was the analysis of the implementation of Directive 2014/52/EU in selected European member states. Against the background of the EU target of “no net land take by 2050”, this directive stipulates the inclusion of land as an environmental asset to be considered in environmental impact assessments (EIAs). The results of our study indicate that the actual impact of this directive has so far remained limited. Therefore, persistent challenges of a land saving policy were identified and options for action to mitigate obstacles were reflected.

Kurzbeschreibung: Internationale Maßstäbe und Strategien für die Reduzierung des Flächenverbrauchs (SURFACE)

Ziel des SURFACE-Vorhabens war es, den Stand fachlicher und politischer Strategien zur Reduzierung der Flächenneuanspruchnahme für Siedlungs- und Verkehrszwecke (Flächenverbrauch) in ausgewählten Ländern zu erfassen und zu analysieren. Vor dem Hintergrund der zunehmend auch international diskutierten Flächenverbrauchsproblematik, der „no net land take“-Zielsetzung für 2050 der Europäischen Kommission, der flächenpolitischen Ziele der Bundesregierung in der Deutschen Nachhaltigkeitsstrategie (30 Hektar minus X Ziel), der Nachhaltigkeitsziele der Vereinten Nationen (SDGs 11 „Städte und Siedlungen inklusiv, sicher, widerstandsfähig und nachhaltig gestalten“ und SDG 15 „Landökosysteme schützen, wiederherstellen und ihre nachhaltige Nutzung fördern, Wälder nachhaltig bewirtschaften, Wüstenbildung bekämpfen, Bodendegradation beenden und umkehren und dem Verlust der Biodiversität ein Ende setzen“) wurde untersucht, inwieweit in anderen Ländern nationale Ziele und Instrumente zur Reduzierung des Flächenverbrauchs bestehen, welcher Umsetzungsstand erreicht ist und welche Hindernisse für eine effektive Flächensparpolitik bestehen. Die hier vorgelegten Ergebnisse des Vorhabens beruhen auf zwei umfassenden schriftlichen Expert*innenbefragungen und ergänzenden Literaturrecherchen. Mithilfe der empirischen Erhebungen wurden zum einen Empfehlungen für eine Konkretisierung des Begriffs „Flächenverbrauch“ in europäischen Strategien und Rahmenwerken sowie der nationalen Gesetzgebung und Instrumentenausgestaltung erarbeitet. Eine konzeptionelle Klärung des Begriffs „Flächenverbrauch“ ist auch Voraussetzung für die Ableitung international harmonisierter Indikatoren für ein Monitoring der mit der Siedlungsentwicklung einhergehenden Flächeninanspruchnahme. Ein zweiter Untersuchungsschwerpunkt war die Analyse der Umsetzung und Anwendung der Richtlinie 2014/52/EU in ausgewählten europäischen Mitgliedstaaten. Vor dem Hintergrund des EU-Ziels „kein Netto-Flächenverbrauch bis 2050“ legt diese Richtlinie fest, den Faktor Fläche als Schutzgut in Umweltverträglichkeitsprüfungen (UVPs) einzubeziehen. Die Untersuchungsergebnisse deuten darauf hin, dass die tatsächlichen Auswirkungen dieser Richtlinie bisher begrenzt geblieben sind. Daher wurden anhaltende Herausforderungen einer Flächensparpolitik identifiziert und Handlungsoptionen zur Abschwächung von Hindernissen reflektiert.

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List of abbreviations

CLC	Corine Land Cover
EC	European Commission
EEA	European Environment Agency
EIA	Environmental Impact Assessment
ESDAC	European Soil Data Centre
ESPON	European Spatial Planning Observation Network
EU	European Union
EUROSTAT	European Statistical Office
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
ha	hectares
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCR	Land Consumption Rate
LUCAS	Land Use/Cover Area frame Survey
MMU	Minimum Mapping Unit
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
TFEU	Treaty on the Functioning of the European Union
UN	United Nations
UNEP	United Nations Environment Programme

Summary

In Germany, the term land take refers to the conversion of agricultural land or land used as forest into "settlement and transport land". In addition to degradation processes such as erosion, salinization, desertification or contamination, land take is the cause of soil damage and the loss of soil-related ecosystem services. Other negative impacts of land take are soil sealing and landscape fragmentation, but also economic and social consequences. Settlement density influences the efficiency of technical and social supply and disposal services and increases the per-capita costs of infrastructure for municipalities and users. At the same time, socio-spatial disaggregation is exacerbated when economically efficient households move out of existing settlement cores into the surrounding areas. The growth of cities and municipalities on the outskirts of settlements also makes it more difficult to reach recreational destinations close to settlements. The German Advisory Council on the Environment (Sachverständigenrat für Umweltfragen) therefore considers land take to be one of the so-called persistent environmental problems, which, due to its gradual development and complex causes, has only limited acceptance for environmental policy measures. According to the goals of the German Sustainability Strategy, the German government aims to reduce land take to an average of less than 30 hectares per day by the year 2030, and by the year 2050 no additional land should be used for settlement and transport purposes through the transition to a circular land economy.

Against this background, the SURFACE project (International Standards and Strategies for Land Use Reduction) analysed public policies to avoid the negative consequences of land take in an international context. In particular, it investigated which targets and instruments for reducing land take exist in selected European and Non-European countries and which indicators and monitoring concepts are suitable for recording and evaluating land take. The results of SURFACE are intended to stimulate mutual exchange and promote efforts to reduce land take in Germany and in Europe.

At the core of the SURFACE research were two expert surveys that compiled international and national strategies for reducing land take and monitoring land use. These expert interviews were complemented by literature research. In addition, several workshops were held with national and international experts.

The first expert survey of the SURFACE project was dedicated to the investigation of goals, strategies and policies for reducing land take at the international, EU and national levels in more than twenty countries in Europe (and the world). In particular, relevant strategies at the European level and in the national policies of European countries were considered.

Quantified land saving targets exist in Germany, Belgium (Flanders) and France, although the targets in Germany and Belgium are not legally binding but merely political in nature. In other countries there are mostly only qualitative targets for the protection of soils and open spaces. In some cases, certain land uses are protected by law or the conversion of agricultural land for the implementation of certain projects is only permitted under certain conditions.

With regard to environmental policy instruments for reducing land take, a high variability between the countries surveyed became apparent. The experts interviewed named a variety of legal and planning instruments that are used. The approach of tradable land development rights, which exist for example on a regional scale in Belgium and France, appears promising, but would have to be adapted for application at national or European level. In Austria and Germany, this instrument is being discussed at least in scientific circles.

Planning instruments have the advantage of taking into account different site-specific qualities, since a land take with the same quantitative dimensions can have very different qualitative envi-

ronmental consequences. However, the experts interviewed pointed out a number of challenges and implementation weaknesses that reduce the quantitative control power of planning approaches in particular. Therefore, quantitative control approaches should be (further) developed in order to achieve the goal of "no net land take".

In the course of analysing the survey results and evaluating relevant policy documents, terminological differences and demarcation difficulties between different, often synonymously used terms for land take also became apparent. This is a challenge both for comparative studies of different national policies and for their harmonisation as well as the operationalisation and implementation of international frameworks. The EU's simultaneous commitment to "lead the way in implementing the 2030 Agenda and the SDGs" (EC, 2016) and to strive for "no net land take" (EC, 2011) requires linking the conceptual clarification of the land take terms used and further defining their scope. The majority of the experts interviewed at least agreed that the term 'land take' is primarily associated with quantitative objectives, while 'soil protection' addresses more qualitative aspects.

However, this distinction is not clear-cut. In general, it can be said that the discussion about land take and its operationalisation is complicated by the linguistic diversity in Europe. In some cases, different terms are used for the corresponding terms in the different languages, so that it seems insufficient for a harmonisation of national policies or the implementation of European frameworks to merely demand the inclusion or exclusion of the words "area" and/or "soil" in the respective national provisions.

Building on the analyses of the SURFACE inventory, it is proposed to work towards a common understanding of terms on the one hand, and to apply these terms and delimitations consistently in monitoring and reporting on the other. The following recommendations are made:

- ▶ For the EU context, it is proposed to prioritise the term "land take" and prefer it to "land consumption". This should improve conceptual clarity, which is a prerequisite for harmonised implementation of directives and decisions and for comparable reporting.
- ▶ For the determination and reporting of land take at international, national and EU level, measures for the redensification of existing settlement areas or the return of brownfields to use as settlement and transport areas should not be taken into account.
- ▶ Where possible, measurements of land take should be assigned to a reference figure (e.g. total area of the reference area, population size) in order to increase comparability.
- ▶ The limits of the terms used must be taken into account and communicated. For example, the terms frequently used so far convey qualitative impacts of land use changes, e.g. on various ecosystem services. Alternative concepts, e.g. hemeroby, soil degradation or the term anthropogenic overprinting ("artificialization"), which is established in French-speaking countries, could prove to be more meaningful in this respect.

The second analysis in the SURFACE project was dedicated to assessing the impact of a concrete political steering impulse: the reform of the EU EIA Directive. In 2014, 'land' was added to the list of environmental assets to be considered in the course of environmental impact assessments (EIAs) (Directive 2014/52/EU, Art. 3). The term land take has been mentioned in recital 9 as an example of an impact that may affect the protected good 'land'. EIAs identify, estimate and assess the environmental impacts of existing and planned projects in order to mitigate the relevant negative impacts before decisions and commitments are made.

All EU Member States had to transpose Directive 2014/52/EU into national law by 2017, which in many countries has also affected the procedures for assessing the environmental impacts of

public plans and programmes in the course of a strategic environmental assessment (SEA). The inclusion of the land factor in the Directive was widely welcomed in the legal literature and described as a necessary clarification and emphasis on the issue of land take. On the whole, however, the changes included were assessed rather cautiously in the literature and judged to be little more than a minimum consensus between the Member States. It is to be expected that the effects of Directive 2014/52/EU will strongly depend on the respective national transposition and implementation in the Member States.

Against this background, a second expert survey was conducted in the SURFACE project. The aim was to find out how the amended EIA Directive has been implemented in selected EU countries and whether the inclusion of the surface area factor is perceived as positive for planning practice by the relevant experts. The results of this survey show that the amended EIA Directive 2014/52/EU has been transposed and implemented in all countries surveyed. Most countries amended their national EIA regulations to include the area factor in the list of factors to be taken into account in EIA (if it was not already listed). However, the wording used in these national regulations is not always identical to the official EU language version of the EIA Directive due to the transposition into national law and the conception of land take that is applied in each case.

The majority of the participating experts are reserved in their assessment of the steering impulse for a more effective handling of land take resulting from the EIA Directive 2014/52/EU. On the one hand, this is attributed to delays in the implementation of the Directive by the Member States; that is, further effects of the Directive could still unfold in the future. On the other hand, there is also criticism of the way the factor land is operationalised within national EIA-legislation. In particular, there is a lack of a precise definition of the term land in the EU guidelines as well as a complete breakdown of the quantitative targets for land take down to the regional and local level. With regard to operationalisation, the inclusion of qualitative indicators to assess the environmental impacts of land take is recommended, as is already done in some countries. Without a clear reference to land take targets and a suitable operationalisation, the land factor cannot develop its full potential within EIA.

Furthermore, the implementation process of the Directive seems detached from policies and objectives regarding land take reduction. Neither the EU nor any of the countries that have set quantified land take targets (such as Germany or Switzerland) link these targets and strategies to 'land' as a factor within EIA.

The results of the SURFACE survey also showed that the focus of the distinction between the assets "land" and "soil" is predominantly on the differentiation between quantitative (area) and qualitative (soil) indicators and that there are considerable conceptual ambiguities that make a common understanding of the phenomenon of land take difficult. An interesting aspect for related research would be an investigation of the extent to which linguistic differences regarding land and soil shape political narratives and practical approaches around the issue of land take and how this influences the ways discussed by countries to address the related ecological, economic and social challenges.

In summary, the findings of the SURFACE project show that the need to reduce land take was recognised internationally and nationally even before the UN Sustainable Development Goals, the European sustainability strategies and in particular the goal of "no net land take by 2050" and the sustainability goals set at national level. However, the conceptual vagueness of the terms "land take" and "land consumption" is problematic for a comparability of the chosen management approaches to achieve these goals. This vagueness is not only evident when comparing different national strategies, monitoring approaches and management instruments, but also complicates the transposition of European frameworks into national law, as illustrated by the

case of the EU's EIA Directive, which is being examined in more detail in the SURFACE project. The conceptual clarification of the term "land take" as well as its concretisation with indicators for monitoring and evaluating different forms of settlement land growth are therefore essential prerequisites for a more effective limitation of land take.

Zusammenfassung

Der Begriff Flächenverbrauch bezieht sich in Deutschland auf die Umwandlung von landwirtschaftlichen oder als Wald genutzten Flächen in „Siedlungs- und Verkehrsfläche“. Diese Flächenneuanspruchnahme ist neben Degradationsprozessen wie Erosion, Versalzung, Desertifikation oder Kontamination z. B. Ursache für Bodenschäden und den Verlust bodenbezogener Ökosystemleistungen. Weitere negative Auswirkungen der Flächenneuanspruchnahme sind Bodenversiegelung und Landschaftszerschneidung- aber auch ökonomische und soziale Folgen. So beeinflusst die Siedlungsdichte die Effizienz technischer und sozialer Ver- und Entsorgungsleistungen und erhöht die Pro-Kopf-Kosten von Infrastrukturen für Kommunen und Nutzer*innen. Gleichzeitig wird eine sozialräumliche Disaggregation unterstützt, wenn wirtschaftlich leistungsfähige Haushalte aus bestehenden Siedlungskernen ins Umland abwandern. Auch die Erreichbarkeit siedlungsnaher Erholungsziele wird durch das Wachstum von Städten und Gemeinden am Siedlungsrand erschwert. Der Sachverständigenrat für Umweltfragen der Deutschen Bundesregierung zählt daher den Flächenverbrauch zu den sog. persistenten Umweltproblemen, bei dem aufgrund seiner schleichenden Entwicklung und den komplexen Ursachen nur eine begrenzte Akzeptanz für umweltpolitische Maßnahmen gegeben ist. Nach den Zielen der Deutschen Nachhaltigkeitsstrategie strebt die Bundesregierung an, den Flächenverbrauch bis zum Jahr 2030 auf durchschnittlich unter 30 Hektar pro Tag zu reduzieren und bis zum Jahr 2050 sollen durch den Übergang zu einer Flächenkreislaufwirtschaft netto keine weiteren Flächen für Siedlungs- und Verkehrszwecke beansprucht werden.

Vor diesem Hintergrund analysierte das Projekt SURFACE (Internationale Standards und Strategien zur Reduktion des Flächenverbrauchs) öffentliche Politiken zur Vermeidung der negativen Folgen der Flächenneuanspruchnahme im internationalen Kontext. Insbesondere wurde untersucht, welche Ziele und Instrumente zur Reduzierung des Flächenverbrauchs in ausgewählten europäischen und außereuropäischen Ländern existieren und welche Indikatoren und Monitoring-Konzepte geeignet sind, um Flächenneuanspruchnahme zu erfassen und zu bewerten. Die Ergebnisse von SURFACE sollen den gegenseitigen Austausch anregen und die Anstrengungen zur Reduzierung des Flächenverbrauchs in Deutschland und in Europa fördern.

Kernstück der Untersuchung in SURFACE bildeten zwei Expert*innen-Befragungen, die internationale und nationale Strategien zur Reduzierung der Flächenneuanspruchnahme und zum Monitoring der Landnutzung zusammentrugen. Diese Expert*innen-Befragungen wurden durch Literaturrecherchen ergänzt. Darüber hinaus wurden mehrere Fachworkshops mit nationalen und internationalen Expert*innen durchgeführt.

Die erste Befragung des SURFACE-Vorhabens widmete sich der Untersuchung von Zielen, Strategien und Politikmaßnahmen zur Reduzierung des Flächenverbrauchs auf internationaler, EU- und nationaler Ebene in mehr als zwanzig Ländern in Europa (und der Welt). Insbesondere wurden dabei relevante Strategien auf europäischer Ebene und in den nationalen Politiken europäischer Länder berücksichtigt. Im Zuge dieser Bestandsaufnahme wurden erfolgsversprechende rechtliche, planerische und ökonomische Politikinstrumente zur Reduzierung der Flächenneuanspruchnahme identifiziert und zusammengetragen.

Quantifizierte Flächensparziele gibt es in Deutschland, Belgien (Flandern) und in Frankreich, wobei die Zielsetzungen in Deutschland und Belgien nicht rechtlich verbindlich, sondern lediglich politischer Natur sind. In anderen Ländern bestehen hingegen meist nur qualitative Ziel für den Schutz der Böden und Freiflächen. Teilweise sind Flächen bestimmter Nutzungen gesetzlich geschützt oder ist die Umwandlung von Agrarflächen zur Umsetzung bestimmter Vorhaben nur unter gewissen Bedingungen gestattet.

Hinsichtlich umweltpolitischer Instrumente zur Reduzierung des Flächenverbrauchs wurde eine hohe Variabilität zwischen den untersuchten Ländern erkennbar. Die befragten Expert*innen benannten eine Vielzahl rechtlicher und planerischer Instrumente, die zum Einsatz kommen. Vielsprechend erscheint der Ansatz handelbarer Flächenausweisungsrechte, die z.B. in Belgien und Frankreich in regionalem Kontext existieren aber für eine Anwendung auf nationaler oder europäischer Ebene angepasst werden müssten. In Österreich und Deutschland wird dieses Instrument zumindest in Wissenschaftskreisen diskutiert.

Planerische Instrumente haben den Vorteil, unterschiedliche Qualitäten möglicher Flächen zu berücksichtigen, da eine Flächeninanspruchnahme mit gleichen quantitativen Dimensionen sehr unterschiedliche qualitative Umweltfolgen haben kann. Allerdings wiesen die befragten Expert*innen auf eine Reihe von Herausforderungen und Umsetzungsschwächen hin, die insb. die quantitative Steuerungskraft planerische Ansätze reduzieren. Daher sollten quantitative Steuerungsansätze (weiter-)entwickelt werden, um zum Ziel „keine Netto-Flächenneuanspruchnahme“ zu gelangen.

Im Zuge der Analyse der Befragungsergebnisse und der Auswertung von relevanten Politikdokumenten wurden zudem erhebliche terminologische Unterschiede und Abgrenzungsschwierigkeiten zwischen verschiedenen, oft synonym verwendeten Begriffen für Flächenverbrauch (englisch land take) deutlich. Dies ist eine Herausforderung sowohl für vergleichende Untersuchungen verschiedener nationaler Maßnahmen als auch für ihre Harmonisierung sowie die Operationalisierung und Umsetzung internationaler Rahmensetzungen. Die gleichzeitige Verpflichtung der EU, „Vorreiter bei der Umsetzung der Agenda 2030 und der SDGs zu sein“ (EK, 2016) und sich um „keine Netto-Flächenneuanspruchnahme“ (EK, 2011) zu bemühen, erfordert die Verknüpfung der konzeptionellen Klärung der verwendeten Begrifflichkeiten zum Flächenverbrauch und die nähere Bestimmung ihres Anwendungsbereichs. Bei der Mehrheit der befragten Expert*innen herrschte zumindest Einigkeit darüber, dass der Begriff „Flächenverbrauch“ vor allem mit quantitativen Zielvorstellungen verbunden ist, während 'Bodenschutz' eher qualitative Aspekte adressiert.

Allerdings ist diese Unterscheidung nicht eindeutig. Generell lässt sich feststellen, dass die Diskussion um Flächenneuanspruchnahme und ihre Operationalisierung durch die sprachliche Vielfalt in Europa erschwert wird. Teilweise werden die entsprechenden Termini in den verschiedenen Sprachen mit unterschiedlichen Begriffen belegt, so dass es für eine Harmonisierung nationaler Politiken oder die Umsetzung europäischer Rahmensetzung unzureichend erscheint, lediglich die Aufnahme oder den Ausschluss der Wörter "Fläche" und/oder "Boden" in den jeweiligen nationalen Bestimmungen zu fordern.

Aufbauend auf den Analysen der SURFACE-Bestandsaufnahme wird daher vorgeschlagen, einerseits auf ein gemeinsames Begriffsverständnis hinzuarbeiten und andererseits diese Begriffe und Abgrenzung konsequent bei Monitoring und Berichterstattung anzuwenden. Im Einzelnen werden folgende Empfehlungen ausgesprochen:

- Für den EU-Kontext wird vorgeschlagen, das Begriffspaar „Flächenneuanspruchnahme/land take“ zu priorisieren und dem Begriffspaar „Flächenverbrauch/land consumption“ vorzuziehen. Damit soll die konzeptionelle Klarheit verbessert werden, was Voraussetzung für eine harmonisierte Umsetzung von Richtlinien und Entscheidungen und für eine vergleichbare Berichterstattung ist.
- Für die Ermittlung und Berichterstattung der Flächenneuanspruchnahme auf internationaler und nationaler sowie der EU-Ebene sollten Maßnahmen zur Nachverdichtung der beste-

henden Siedlungsfläche oder die Rückführung von Brachflächen in eine Nutzung als Siedlungs- und Verkehrsfläche nicht als Flächenneuanspruchnahme erfasst werden.

- ▶ Messungen der Flächenneuanspruchnahme sollten wenn möglich einer Referenzzahl (z.B. Gesamtfläche des Bezugsraums, Bevölkerungsgröße) zugeordnet werden, um die Vergleichbarkeit zu erhöhen.
- ▶ Die Grenzen der verwendeten Begrifflichkeiten müssen berücksichtigt und kommuniziert werden. So transportieren die bislang häufig verwendeten Termini qualitative Auswirkungen von Flächennutzungsänderungen, z.B. auf verschiedene Ökosystemleistungen. Alternative Konzepte, z.B. Hemerobie, Bodendegradation oder der im französischen Sprachraum etablierte Begriff der anthropogenen Überprägung („artificialization“) könnten sich in dieser Hinsicht als sinnvoller erweisen.

Die zweite Befragung im SURFACE-Vorhaben widmete sich der Abschätzung der Wirkung eines konkreten politischen Steuerungsimpulses: der Reform der UVP-Richtlinie der EU. Im Jahr 2014 wurde „Fläche“ in die Liste der Umweltgüter aufgenommen, die im Zuge von Umweltverträglichkeitsprüfungen (UVPs) zu berücksichtigen sind (Richtlinie 2014/52/EU, Art. 3). Der Begriff Flächenneuanspruchnahme (land take) wurde in Erwägungsgrund 9 als Beispiel für eine Auswirkung genannt, die das Schutzgut Fläche beeinträchtigen kann. UVPs identifizieren, schätzen und bewerten die Umweltauswirkungen bestehender und geplanter Projekte, um die relevanten negativen Auswirkungen zu mindern, bevor Entscheidungen und Verpflichtungen getroffen werden.

Alle EU-Mitgliedstaaten mussten die Richtlinie 2014/52/EU bis 2017 in nationales Recht überführen, was sich in vielen Ländern auch auf die Verfahren zur Prüfung der Umweltauswirkungen von öffentlichen Plänen und Programmen im Zuge einer strategischen Umweltprüfungen (SUP) ausgewirkt hat. Die Aufnahme des Faktors Fläche in die Richtlinie wurde in der juristischen Fachliteratur weitgehend begrüßt und als notwendige Klarstellung und Betonung der Problematik des Flächenverbrauchs beschrieben. Insgesamt wurden die aufgenommenen Änderungen in der Literatur jedoch eher zurückhaltend bewertet und als kaum mehr als ein Minimalkonsens zwischen den Mitgliedstaaten beurteilt. Es sei zu erwarten, dass die Auswirkungen der Richtlinie 2014/52/EU stark von der jeweiligen nationalen Umsetzung und Implementierung in den Mitgliedstaaten abhängen.

Vor diesem Hintergrund wurde eine zweite Expert*innen-Befragung im SURFACE-Vorhaben durchgeführt. Dabei sollte herausgestellt werden, wie die novellierte UVP-Richtlinie in ausgewählten EU-Ländern umgesetzt wurde und ob die Aufnahme des Faktors Fläche von den einschlägigen Expert*innen als positiv für die Planungspraxis wahrgenommen wird. Die Ergebnisse dieser Befragung zeigen, dass die geänderte UVP-Richtlinie 2014/52/EU in allen untersuchten Ländern umgesetzt und implementiert wurde. Die meisten Länder änderten ihre nationalen Vorschriften zur UVP, um den Faktor Fläche in die Liste der bei der UVP zu berücksichtigenden Faktoren aufzunehmen (sofern er nicht bereits aufgeführt war). Der in diesen nationalen Vorschriften verwendete Wortlaut ist jedoch durch die Überführung in nationales Recht und die jeweils zur Anwendung gelangende Konzeption des Begriffs Flächenneuanspruchnahme nicht immer identisch mit der offiziellen EU-Sprachfassung der UVP-Richtlinie.

Die Mehrheit der teilnehmenden Expert*innen schätzt den aus der UVP-Richtlinie 2014/52/EU resultierenden Steuerungsimpuls für einen effektiveren Umgang mit Flächenverbrauch zurückhaltend ein. Einerseits wird dies auf Verzögerungen bei der Umsetzung der Richtlinie durch die Mitgliedstaaten zurückgeführt; das heißt, weitere Auswirkungen der Richtlinie könnten sich in Zukunft noch entfalten. Andererseits gibt es auch Kritik an der Operationalisierung und Kontext-

tualisierung des Faktors Fläche als Aspekt der UVP. Insbesondere fehle eine präzise Definition des Begriffs Fläche in den EU-Leitfäden sowie eine vollständige Aufschlüsselung der quantitativen Ziele für die Flächenneuanspruchnahme bis auf die regionale und lokale Ebene. Im Hinblick auf die Operationalisierung wird die Aufnahme qualitativer Indikatoren zur Bewertung der Umweltauswirkungen der Flächenneuanspruchnahme empfohlen (Binder et al., 2021), wie es in einigen Ländern bereits geschieht. Ohne einen klaren Bezug zu den Zielen der Flächenneuanspruchnahme und eine geeignete Operationalisierung kann der Faktor Fläche sein volles Potenzial innerhalb der UVP nicht entfalten.

Darüber hinaus scheint der Umsetzungsprozess der geänderten Umweltverträglichkeitsprüfung-Richtlinie (UVP-Richtlinie) losgelöst von politischen Strategien und Zielen hinsichtlich der Eindämmung des Flächenverbrauchs. Weder die Europäische Union (EU) noch eines der Länder, die sich quantifizierte Ziele zur zusätzlichen Flächenanspruchnahme gesetzt haben (wie Deutschland oder die Schweiz), verbinden diese Ziele und Strategien mit der Operationalisierung des Faktors Boden innerhalb der UVP.

Die Ergebnisse der Befragung haben außerdem gezeigt, dass der Schwerpunkt bei der Unterscheidung zwischen den Schutzgütern "Fläche" und "Boden" überwiegend auf der Differenzierung zwischen quantitativen (Fläche) und qualitativen (Boden) Indikatoren liegt und erhebliche begriffliche Unklarheiten bestehen, die ein gemeinsames Verständnis des Phänomens Flächenneuanspruchnahme erschweren. Ein interessanter Aspekt für anknüpfende Forschung wäre eine Untersuchung, inwiefern sprachliche Unterschiede bezüglich Fläche und Boden politische Narrative und praktische Ansätze rund um das Thema Flächenanspruchnahme prägen und wie dies die von den Ländern diskutierten Wege zur Bewältigung der damit verbundenen ökologischen, ökonomischen und sozialen Herausforderungen beeinflusst.

Zusammenfassend kann konstatiert werden, dass die Notwendigkeit einer Reduzierung der Flächenneuanspruchnahme vor den Nachhaltigkeitszielen der UN, den europäischen Strategien zur Nachhaltigkeit und insb. zum "no net land take until 2050" und den auf nationaler Ebene gesetzten Nachhaltigkeitszielen international und national anerkannt ist. Problematisch für eine Vergleichbarkeit der gewählten Steuerungsansätze zur Erreichung dieser Ziele ist jedoch die konzeptionelle Unschärfe der Begriffe "Flächenanspruchnahme" und "Flächenverbrauch". Diese Unschärfe wird nicht nur beim Vergleich verschiedener nationaler Strategien, Monitoring-Ansätze und Steuerungsinstrumente offensichtlich, sondern erschwert auch die Umsetzung europäischer Rahmensetzungen in nationales Recht, wie der im SURFACE-Vorhaben näher betrachtete Fall der UVP-Richtlinie der EU zeigt. Daher sind die konzeptionelle Klärung des Begriffs "Flächenneuanspruchnahme" sowie seine Untersetzung mit Indikatoren für das Monitoring und die Bewertung verschiedener Formen des Siedlungsflächenwachstums wesentliche Voraussetzungen für eine effektivere Begrenzung des Flächenverbrauchs.

1 Introduction

1.1 Background

Land and soil are non-renewable resources that are under enormous and increasing pressure worldwide. The conversion of natural and semi-natural land into urban and other anthropogenically influenced (artificial) land is referred to by the European Environment Agency as land take (EEA, 2019b). In German usage, the term land take stands for 'Flächenneuinanspruchnahme' or, more abbreviated, 'Flächeninanspruchnahme'. The term land take is used in the following, denoting the increase in settlement and transport land (see Chapter 3). Overall, it is expected that the global land consumption for settlements will at least double by 2050 and that the share of settlement areas will increase from currently two to four or even five percent of the total earth's surface (UNEP, 2014). As this will have social and economic effects as well as negative impacts on many important ecological functions and ecosystem services, including global food security, biodiversity and climate protection (IPCC, 2012), land take is receiving increasing attention in discourses on sustainable development. In Germany, the federal government already formulated the goal of reducing land take to 30 hectares per day by 2020 in the national sustainability strategy in 2002 (Bundesregierung, 2002). This goal was updated in the new edition of the sustainability strategy: It now reads: Reduction of land take to an average of less than 30 hectares per day by 2030 and transition to a circular land economy by 2050, so that no more net land is used for settlement and transport purposes (Federal Government, 2021). In 2012, at the Conference on Sustainable Development in Rio de Janeiro, the United Nations (UN) committed to halting soil degradation and restoring degraded soils by 2030. The 2030 Agenda for Sustainable Development includes further targets to reduce land take in Sustainable Development Goals (SDGs) 11 and 15, which call for sustainable and resilient human settlement and sustainable forest management, combating desertification and halting and reversing land degradation. In the current scientific debate, a global focus on several specific issues can be identified. These are, on the one hand, topics dealing with agriculture and related land use changes (Hong et al., 2020; Meyer and Früh-Müller, 2020). On the other hand, there is intensive research on the problem of ongoing urban sprawl (Pierri Daunt et al., 2021; Yuan et al., 2020), on land management (Montanarella and Panagos, 2021; Braitto et al., 2020) and on the availability, collection and use of cadastral data (Thompson and van Oosterom, 2021; Cienciała et al., 2021).

In order to curb land take in the European context, the European Commission (EC) set a target ten years ago of 'no net land take until 2050' (EC, 2011). Despite a decrease in the last decade, land take in the EU still amounted to 539 km² per year between 2012 and 2018. Moreover, the total amount of undeveloped land lost annually to settlement and infrastructure development is more than ten times the amount of land that is reclaimed (EEA, 2019a). In addition, total land take is expected to be around 150 km² per year between 2030 and 2050 (ESPON, 2014). Achieving the EU target of 'no net land take by 2050' therefore requires a further significant reduction in land consumption in EU Member States. With the inclusion of the factor "land" in Directive 2014/52/EU, the European Union (EU) is striving for further harmonisation of the previously heterogeneous EIA approaches of the Member States. The amendments are thus intended to make a significant contribution to the European strategy of curbing land take and thus also to the EU objective. Due to their binding character, all EU member states were obliged to implement the amendment. The actual effects of Directive 2014/52/EU on the problem of land use have not yet been the subject of studies. However, a close examination is necessary, on the one hand for monitoring success, and on the other hand for identifying and minimising potential obstacles by means of targeted control.

The drivers of land take are diverse and include demography, economic development, but also political and institutional factors such as planning regulations, financial incentives and fiscal relations between different levels of government (Colsaet et al., 2018; Droste et al., 2017). Land use for settlement and transport is particularly detrimental to agricultural or natural land and is a key cause of soil degradation, along with erosion, salinization, desertification or contamination. In addition to ecological consequences, such as sealing and landscape fragmentation, the effects of land take are also of an economic and social nature. Settlement density influences the efficiency of technical and social supply and disposal services and increases the per-capita costs of infrastructure for municipalities and users. At the same time, socio-spatial disaggregation is supported when economically efficient households migrate from existing settlement cores to the surrounding areas. The accessibility of recreational destinations close to settlements is also made more difficult by the growth of cities and municipalities on the outskirts of settlements. The German Advisory Council on the Environment (SRU) considers land take to be a persistent environmental problem with limited acceptance for environmental policy measures due to its gradual development and complex causes (SRU, 2016). Governance approaches to reduce land consumption include appropriate policy targets, spatial planning at federal, local or sectoral level, financial or fiscal incentives, and environmental assessments of development plans and projects. Environmental assessments, such as Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA), are legal instruments that can improve the consideration of environmental impacts resulting from plans or projects, promote the identification of more environmentally friendly alternatives and contribute to more systematic and transparent planning (EEA, 2019b; Köck et al., 2007).

A large part of land consumption in Germany takes place in smaller and rural municipalities (Bundesregierung, 2021). While there is now a trend towards land-saving densification in cities, land take per capita continues to rise in rural municipalities, although their population density is stagnating or even falling. This is mainly explained by the fact that municipalities hope for higher tax revenues when residents or companies move in. However, this calculation often does not work out, since the designation of new residential and commercial areas also results in permanent infrastructure costs for a municipality. Hence, an average of 54 ha of new land per day was still taken up for settlement and transport in Germany in the years 2017 to 2020 (DESTATIS, 2022), making it unlikely that the German Sustainability targets with regard to land take will be achieved. Nevertheless, with such a quantitative target, Germany is a pioneer in addressing the problem of land take. In addition, Germany participates in the High-Level Support Group initiated by Sweden, whose members have committed themselves to making exemplary contributions to the rapid and ambitious implementation of the SDGs at national and international level.

1.2 Objective

The aim of the report is to take stock of technical and political strategies on land take at international and national level and to provide a detailed analysis of selected countries. The focus of the study is on new land take for settlement and transport purposes, but other important and relevant factors for some countries (e.g. desertification or contamination) are also part of the analysis. The analyses are carried out against the background of the UN Sustainable Development Goals (SDGs), in particular SDG 11 ("Make cities and human settlements inclusive, safe, resilient and sustainable") and SDG 15 ("Protect, restore and promote the sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, end and reverse land degradation and halt the loss of biodiversity"). It examines how national targets and instruments for reducing land take are linked to the SDGs. Based on the empirical surveys, concrete proposals for suitable indicator sets, practicable monitoring concepts for land take and definitions of terms at European and national level will be developed.

In addition, a second part will show how Directive 2014/52/EU has been implemented at national level and examine whether the EIA regulations amended at national level actually contribute to curbing land take. Against this background, persistent challenges on the way to the European goal of "no net land take by 2050" will also be presented, reasons for the limited impact of the revised directive so far will be identified and possible solutions to minimise obstacles will be shown.

1.3 Methodological approach

The methodological core of the study in SURFACE was formed by two expert surveys, which compiled international and national strategies for reducing new land consumption and for monitoring land use. These expert interviews were supplemented by literature research. In addition, several expert workshops were held with national and international experts. The details of the project's methodological approach are presented below.

1.3.1 First expert survey to take stock of strategies and policies for reducing land take

The screening of existing strategies and policies was based on a questionnaire survey, a focus group meeting and a review of academic literature and policy-relevant documents. These three sources contributed to the investigation of how land take is conceptualised and addressed in policy and regulatory terms at the EU level and at the national level in several EU and selected non-EU countries. Taken together, these three sources of knowledge have a broad thematic scope and cover different aspects of the political and legal governance of land take, as well as the political and scientific discourse on this topic. For this report, information was selectively processed to conceptualise key terms and valuation approaches of land use and land take via indicators at international and national level. The focus was on the political context of the EU.

Recruitment of Participating Experts

For the questionnaire survey and the focus group, experts were recruited through purposive sampling. The following selection criteria were applied:

- ▶ relevant expertise on land take issues, ,
- ▶ professional affiliation and
- ▶ geographical localisation.

We sought to involve experts with scientific, administrative, legal and political knowledge and therefore approached representatives of academic and policy-related institutions. Furthermore, we strived to cover as many EU countries as possible, and, in the case of the questionnaire survey, of selected non-EU countries for comparison. Potential candidates were identified primarily via pre-established contacts and collaborations on the respective topic, and in some cases by screening the authors of relevant documents or the members of respective institutions. For the questionnaire survey, 48 persons were contacted in 30 different countries (of which 22 were EU Member States). Of those contacted, 25 experts responded, covering 20 countries. In addition, two of the researchers running the SURFACE project completed the questionnaire for Germany which resulted in a sample of 21 countries (16 EU and five non-EU countries, see section A in the appendix volume). The disciplinary background of the respondents was diverse, the majority holding degrees in law, spatial planning or geography, and their affiliations were either scientific or administrative institutions responsible for or dealing routinely with the matter at hand.

The focus group was formed by 18 experts from 13 EU countries who were joined by three members of the SURFACE team. Twelve of these experts had previously taken part in the questionnaire survey. All but two authors of this article participated in the focus group meeting.

Data Collection

The emailed questionnaire focussed on the issue of land take (this term was used by the research team; see appendix, section A.2 for details of the questionnaire design). In the questionnaire participants were asked to describe the respective situation in the country they were most knowledgeable about (usually the country of their professional workplace). The conceptualization of land take and related terms was highly significant for many of the questions posed, in particular those that dealt with indicators and monitoring systems. Anticipating the need for clarifying the terminology, the EEA-definition of the term land take was provided to the participants in the introduction of the questionnaire as a reference point (EEA, 2019) (see also definition #10 in Table 1) which ensured that the majority of them interpreted land take in the intended way. However, the answers obtained also showed marked differences in the familiarity with the land take concept across survey participants, e.g., two respondents associated it with land expropriation and one with the purchase of land by foreign investors ('land grabbing'). Additionally, many respondents pointed out that the concept was not the one they normally use, and some provided equivalent or closely related terms in their own languages.

The challenge of finding a common understanding of land consumption and land take also pervaded the discussions during the focus group meeting. This two-day event was held in April 2019 in Berlin/Germany and provided room for discussing central issues and ideas related to the content of the questionnaire survey. Five guiding questions were provided to the participants prior to the meeting, inviting them to reflect on the particular situation in their country and on their (national) perspective on the following issues in the context of land consumption and land take: problem awareness among different stakeholder groups, the course and actors of relevant political debates, relevance of SDG-11 and SDG-15, monitoring programs and indicator sets, effectiveness of policies, and ideas for improvement.

For the literature review, we considered scientific articles dealing with spatial governance or related themes, as well as documents relevant to the respective EU policy context, and some pertinent internet sources (see appendix, section B for a list of the 50 policy relevant documents considered, all released during the period 1997–2019). We extracted published definitions, interpretations, and limitations of the concepts land consumption and land take, and, less exhaustively, of the concepts 'soil sealing' and 'artificialization'.

While insights on the conceptualization and monitoring of land take could be gained through all three research components of this study (questionnaire survey, focus group, and literature review), respective information on the related concepts land consumption, soil sealing, and artificialization was mostly retrieved from the literature.

To explore how the concepts of interest have been defined and how they conceptually differ or overlap, we compared the collected definitions of key terms systematically with regard to the land use type(s) they declare either to expand or to reduce as a result of the phenomenon in question. Moreover, the definitions were screened for information suggesting a particular unit of measurement for quantifying the phenomenon to which they refer.

To assess the comparability of different land consumption and land take monitoring schemes, selected indicators were scrutinized with regard to their informative value and their methodological limits. To this end, underlying methodologies were screened and compared, with particular attention paid to the classification of land use types and land use changes. The compatibility

of the selected international monitoring schemes was further checked by a comparison of land take trends that have been reported for the period 2009–2015 in the SDG context and for the period 2000–2018 in the EU context.

Table 1: Country Studies

Country	EU	OECD	BRICS	Inventory	Data basis
Australia		✓		✓	Questionnaire, literature
Austria	✓			✓	2 Questionnaires, literature
Belgium	✓			✓	Questionnaire, literature
Brazil			✓	✓	Questionnaire, literature
Bulgaria	✓			✓	Literature
Canada		✓		✓	2 Questionnaires, literature
China			✓	✓	Questionnaire, literature
Croatia	✓				(request, no response)
Cyprus	✓			✓	Literature
Czech Republic	✓			✓	Questionnaire, literature
Denmark	✓			✓	Questionnaire, literature
Estonia	✓			✓	Questionnaire, literature
Finland	✓				(request, no response)
France	✓			✓	Questionnaire, literature
Germany	✓			✓	Questionnaire, literature
Great Britain	(✓)	✓			(request, no response)
Greece	✓			✓	Questionnaire, literature
Ireland	✓				(request, no response)

Country	EU	OECD	BRICS	Inventory	Data basis
Italy	✓			✓	Questionnaire, literature
Luxembourg	✓				(request, no response)
Netherlands	✓			✓	Questionnaire, literature
Poland	✓			✓	Questionnaire, literature
Portugal	✓			✓	Questionnaire, literature
Romania	✓			✓	Questionnaire, literature
Slovakia	✓			✓	2 Questionnaires, literature
Slovenia	✓			✓	Questionnaire, literature
Spain	✓			✓	Questionnaire, literature
Sweden	✓				(request, no response)
Switzerland		✓		✓	2 Questionnaires, literature
USA		✓			(request, no response)

1.3.2 Second expert survey on the factor land in environmental impact assessments

The second, in-depth questionnaire survey was carried out between April and September 2020. The aim was to include at least eight countries that were obliged to implement the Directive, so candidates were the European Member States and the United Kingdom. The selected countries were to be geographically spread across the EU and cover a certain variation in terms of political history (formerly East/West), size of territory, annual land take and existing land use policies. In addition, there were already existing contacts with national experts in the field of spatial planning, which facilitated the recruitment of participants with relevant knowledge. A combination of these criteria ultimately led to a shortlist of the following 14 countries: Austria, Belgium, Czech Republic, Denmark, France, Germany, Italy, Latvia, Netherlands, Poland, Portugal, Spain and Sweden.

Recruitment of experts

The experts were selected primarily through a network of scientists and practitioners who deal with land use and similar topics, according to the snowball principle. The questionnaire was first

sent to experts with whom there had been previous cooperation. They were asked to identify other experts with the relevant specific expertise in their country. The target group included experts from scientific and political institutions as well as from the private sector, whereby certain diversity in terms of disciplinary background and professional environment was aimed for. Over the entire sample period, 68 experts in 17 countries (the above plus Estonia, Finland and Norway) were contacted. They were offered a financial reward for completing the questionnaire. In order to demonstrate the expectations regarding the content and level of detail and to increase the comparability of the answers, a completed questionnaire describing the German situation was provided as an example. Such a "blueprint" questionnaire had already been used for the same purpose in a previous study (Bovet et al., 2018). In total, 22 of the 68 invited experts participated in the survey (response rate: 32%). This sample included ten EU countries (Austria, Belgium, Czech Republic, Estonia, France, Germany, Italy, Poland, Portugal, Sweden) and the UK. It is important to note that Flanders and Wallonia were included as two different entities with different legal frameworks due to the almost complete autonomy of Belgian regions in land use decisions (OECD, 2017). Furthermore, the professional affiliation and the answers of the UK experts suggest that their questionnaires only reflect the situation in England. While the other countries of the UK (Scotland, Wales and Northern Ireland) have developed a broadly similar approach to spatial planning, the legislation and public bodies responsible for the different tasks differ. Therefore, in the remainder of this report, 'England' will be used when referring to expert testimony from the UK.

One to five experts per country/region responded to the request and filled out a questionnaire. The majority of the respondents have a degree in law, spatial planning or geography and belong to scientific or administrative institutions within which they regularly deal with the topics relevant to this study.

Questionnaire set-up

The questionnaire was divided into nine thematic sections, each with one to four questions (see appendix, section E.2). In order to analyse how the countries or regions have transposed the EIA Directive 2014/52/EU into national law, questions were asked about the respective transposition laws (see 4.2.1). In order to evaluate whether this has actually led to changes in the national provisions regarding the area factor, the experts were asked to report on the specific paragraphs of the national environmental assessment laws and to indicate whether area was included in the list of factors (see 4.2.2).

Furthermore, the questionnaire asked about the distinction between land and soil (see 4.2.4). In this context, the experts were asked to provide indicators used at national level for the assessment of land use and national guidelines for the assessment of soil in EIA. The indicators mentioned can be found in section F of the appendix volume.

In order to get an overview of the general perception of land as a factor in the EIA Directive, the experts were also asked whether in their personal opinion the inclusion of land in the list of factors makes a difference (see 4.2.3). For a better understanding of the operationalisation of the area factor, the experts were also asked to give examples where it had been assessed (see 4.2.3). Some experts also pointed out persistent challenges that they consider to be barriers to reducing land take (see 4.2.5).

Guiding questions of the second survey:

- ▶ How was the amended EIA Directive transposed into national law?
- ▶ Was there sufficient implementation in the legal sense?

- ▶ Does the area factor mean a difference?
- ▶ Is there a clear distinction between surface area and soil?
- ▶ What are the ongoing challenges of land use?

Due to different interpretations of some questions by the experts interviewed, the answers received were not always comparable. Furthermore, the level of detail varied and in some cases questions were skipped altogether. Therefore, the results described in section 4.2 are based on a different number of answers.

Analysis based on scientific, legal, and policy-related literature

In preparation for the expert survey described above, we collected information on the 2014 EIA-amendment, in particular on the underlying political motivation and the reflection of this amendment in the legal discourse. We checked the 23 official language versions of the EIA Directive 2014/52/EU for possible linguistic variations with regard to the terms 'land', 'soil' and land take. Furthermore, we reviewed the scientific literature dealing with the effectiveness of the EIA Directive in containing land take.

For the interpretation of the expert statements, we consulted legislation, guidelines and documents from the legislative process. Specifically, we cross-checked and supplemented information on the national regulations referred to by the respondents. We checked the databases of the European Union for entries regarding the transposition of Directive 2014/52/EU, such as national legislation, infringement procedures and the Environmental Implementation Review. Regarding 'land' we looked into European Impact Assessment Guidelines (EC, 2017a, b, c; EEA, 2005), documentation and reports that included information on land take and the land take indicator assessment. In our review of the scientific literature we focused on publications concerning the amended directive, the effectiveness of impact assessments with regard to taming land take, and those potential challenges for the new factor the experts had identified.

1.3.3 Events held during the project

In the course of the SURFACE project, a series of events were organised to serve three purposes: Firstly, (interim) results of the questionnaire surveys were presented, validated and discussed; secondly, further research questions were identified; and thirdly, two online events served to disseminate SURFACE results to a broad professional audience and to derive further research needs for coming (research) projects.

At this point, these events will only be briefly mentioned; details on the events can be found in the appendix volume (see sections C and D as well as H and I of the appendix).

International Expert Workshop "Land Take" in April 2019

In April 2019, an international expert workshop was held in Berlin. The aim of the workshop was to present and discuss the inventories among the European stakeholders. The event served as a recursive evaluation and discussion of the results of the first questionnaire survey together with the experts interviewed. The discussions contributed to a deeper understanding of the respective political and social approaches to the problem of land take and helped to identify the ten countries for detailed studies in the course of the second round of surveys. Furthermore, the workshop offered the participants space for networking.

Expert meeting on the interface between 'land take' and 'land/soil' as a protected good in environmental assessment in December 2019

This expert meeting with German experts from science, administration and practice in Berlin served to concretise the focal points of the SURFACE project in the second survey phase. As a result, the focus was placed on investigating the impact of the further development of the instrument of environmental impact assessment. The national regulations of the EIA had to be reformed by an EU directive, in particular the factor area was newly included in the list of environmental factors to be taken into account.

Online conference on land take in Europe in November 2020

Due to the Covid 19 pandemic, the methodological approach of the SURFACE project had to be constantly adapted to the pandemic situation. In particular, the planned discussion event with national decision-makers from politics and administration of different European member states could not be held as planned in Brussels as a face-to-face meeting. It was therefore decided to hold a virtual conference.

On 16 November 2020, about 150 people took part in the online conference "Achieving 'no net land take' in Europe: Are we on the right track?" to discuss the results of the SURFACE project and to contribute their own experiences - both personal and institutional - on how best to deal with land take in the EU.

Symposium "Fit for 2050? Strategies for achieving the EU's 'no net land take' goal"

The second virtual event took place on 4 February 2022. It provided a platform for the presentation and discussion of the results of the SURFACE project and policy approaches in selected EU Member States, especially against the background of the EU Soil Strategy published in November 2021. In addition, a panel discussion during the event put the European goal of "no net land take by 2050" in relation to other European sustainability efforts and competing societal goals. In total, more than 140 participants from several European countries took part in the symposium.

1.4 Structure of this report

This report is divided into three main parts, following the step-by-step approach of the SURFACE project.

In Chapter 2, an overview of the current status of strategies and policies on land use is given, based on the evaluation of the first questionnaire survey. For this purpose, the experts' answers are summarised for each question.

These survey results, complemented by a focus group and a literature review, also served to identify commonalities and differences in the terminological conception and use of the terms "land take" and "land use" in different EU Member States. These are presented in Chapter 3.

Chapter 4 presents the results of the second in-depth questionnaire survey, which looked at the meaning of the reformed Directive 2014/52/EU on the consideration of land take in environmental impact assessments in ten EU Member States and the UK. Again, the results of the survey are complemented by a literature review.

Chapter 5 contains conclusions and recommendations for action that can be derived from the results of the SURFACE project.

Further details and background to this study can be found in a separately available appendix.

2 Overview of strategies and policies on land take

This chapter summarises the responses of the experts to the first survey. The questions contained in the questionnaire are preceded by a green box. The complete questionnaire and all the experts' answers can be found in the appendix, section A.

2.1 Current situation of land take

Question 1.1: Shortly describe the current situation of land take for residential, industrial, commercial and transportation purposes in your country (in particular recent statistical data about land take). What are the main drivers of land take in your country? Which economic activities/policy sectors are benefiting from land take, which are affected negatively and how?

Synopsis: Land take for settlement and transport purposes is a driver of land use change in all the countries studied, but there are differences in the extent of land use, its importance in relation to other drivers of land take change and the causes of land take (housing, commercial space, infrastructure development, etc.).

The main reasons for land consumption cited by the respondents are growing prosperity, population growth and economic growth as a whole. These developments go hand in hand with an increase in (smaller) households and a higher demand for living space per person. For the increase in transport routes, both an increase in private transport and the infrastructure development for certain industries, especially for tourism, logistics and production sites (e.g. in Austria, Belgium, Denmark, Cyprus, France, Germany) are responsible. In many countries, urbanization and suburban sprawl are observed. The latter is driven by house and apartment building (e.g. in Poland, Germany, Romania), but also by the construction of transport routes, large retail markets and other urban infrastructure facilities (e.g. in Canada, the Czech Republic, China, the Netherlands, Austria, Poland). In addition to the direct drivers mentioned above, policy failure is also partly blamed for this development (weak or missing protection for agricultural land, decentralized or weakly implemented spatial planning, long planning periods, uncoordinated policy measures or short legislative periods; e.g. in the Czech Republic, Greece, Italy).

The experts repeatedly point out the great regional differences in the respective countries. In Belgium and Spain, this phenomenon is exacerbated by the fact that these countries have independent regions with partly independent legal systems.

When asked which economic/political sectors benefit from land consumption, the experts involved name the following, among others:

- ▶ Investors and landowners
- ▶ Players in the real estate sector
- ▶ Municipalities that hope for higher tax revenues through the influx or settlement of businesses
- ▶ Companies in the following industries: Logistics/transport, retail, entertainment, sports

Negatively affected economic/political sectors, on the other hand, are agriculture and forestry as well as municipalities and landowners, who incur higher costs for infrastructure. Furthermore, the following negative impacts of land take are highlighted, among others: Landscape fragmentation, loss of high-quality soil, transport problems and high commuter volumes.

Question 1.2: Is there an acknowledged or a legally or otherwise binding definition for the term "land take in your country?"

Synopsis: A legally established definition for the term land take exists in Germany and Austria, and similarly in Switzerland. In terms of content, land take is understood as the conversion of agricultural or forestry areas into settlement and transport areas (incl. gardens), into recreational or extraction areas. In Switzerland, the terms "settlement growth" and "soil consumption" are more familiar for these processes. A similar understanding – albeit without binding force – can be found in Flanders (Belgium) ("ruimtebeslag"), France ("artificialisation") and Portugal ("artificial land use"). In Flanders (Belgium) and France, these terms also include, in addition to settlement and transport areas, non-sealed areas where the natural soil functions are severely impaired (e.g. gardens, parks, campsites). For Portugal, this remains unclear on the basis of the expert survey.

Furthermore, many countries tend to use terms (some of them legally binding) that refer directly to the growth of cities or settlements, such as "urban extension" (Brazil), "urban development/urban growth" (Denmark), "urbanization" (Spain), and "urban sprawl" (Portugal).

In Poland, (any) conversion of agricultural or forestry land is understood as land take; this is indirectly inferred from the law. In Romania, Italy, Greece, Portugal and Estonia there are no definitions. Nevertheless, awareness-raising and conceptualization are taking place there, which is probably primarily due to European activities (not certain for Estonia).

The question about a definition of the term "land take", however, was obviously partly accompanied by a linguistic misunderstanding, although the questionnaires were preceded by definitions of terms for "land use", "land take", "land consumption" and "land development".

Some experts interpreted the term more in the context of "land take"/"appropriation". One of the Canadian experts explicitly pointed out this connotation of the term in English: "Land take is not a term used in Canada. It [is] usually referred to as land use change. "Takings" in the US actually means the seizure of private property by government for public use."

The answers from Australia and China should also be understood in this sense. For Australia, reference is made to the acquisition or appropriation of land and possible compensation lines. For China, it is pointed out that with regard to the term "land take", a differentiation is made as to whether state access to land is permanent or only temporary. These answers were thus obviously based on an alternative conceptualization of "land take".

Question 1.3: What different forms of land degradation (SDG 15.3) or soil loss are relevant in your country (erosion, salinization, desertification or contamination). If available, please provide figures and data.

Synopsis: In Austria, the Czech Republic, France, Germany, Slovenia and Switzerland, land take/soil sealing/settlement growth/urban sprawl are considered to be among the greatest threats to soil functions.

In addition, the experts named the following factors that endanger soil functions:

Relatively frequent:

- ▶ Erosion by water/wind (incl. loss of organic matter/humus layer)
- ▶ Desertification, especially in the light of advancing climate change (e.g. in Spain, Greece, Italy, Portugal, Romania, China).

- ▶ Contamination, pollution, excess nutrients
- ▶ Soil compaction
- ▶ Salinization

Relatively rare:

- ▶ Loss of soil biodiversity
- ▶ Overexploitation of water reserves/groundwater

2.2 Strategies and political background for reducing land take

Question 2.1: Is land take an issue in the political debate in your country? Is it perceived as a sustainability issue in the implementation of the SDGs?

Synopsis: According to the experts' opinions, there is a relatively high level of awareness of land policy issues in many of the countries studied - although it is not always clear whether this awareness exists in political or scientific circles, or in both (Austria, Belgium, Canada, Denmark, France, Germany, Italy, Slovakia, Spain, Switzerland).

Urban sprawl, in particular, has long been the subject of political debate in many countries, including the Czech Republic, Poland and Portugal. There is great pressure in Austria and the Netherlands, where a growing population is confronted with a very limited potential of still free or even usable land. The experts interviewed stated that land policy has therefore been on the political agenda in both countries for many years. While in Austria there is a high awareness of the ecological consequences of land consumption, in the Netherlands the issue is also discussed intensively in the context of urban development, but less in connection with ecological issues:

"As one of the world's most densely populated countries, [...] land for development is scarce in the Netherlands. [...] In 1985, the Dutch parliament accepted a national memorandum on spatial planning in which urban densification is mentioned as a policy goal [...]. However, the densification was less an issue of ecological sustainability or land thrift, but driven by social problems in city centers [...]. Since then, densification policies have never left the political agenda as a major spatial strategy."

In some cases, however, the issue of urban sprawl (or the broader concept of land take) is only discussed in certain professional circles without being reflected in national policies on a larger scale (e.g. in Brazil). The experts from Romania, Slovenia and Greece consider the topic to be more limited to academic circles, although there is hope for political development under the SDGs. As the expert from Romania puts it:

"Land take it is not a permanent topic in the political debate in Romania but presents a high interest among professionals and academics. Romania is committed to implementing the Sustainable Development Goals at national level and will review the National Strategy for Sustainable Development to integrate the Sustainable Development Goals."

According to the expert interviewed, there is also little awareness of the problem in Estonia. The country is relatively sparsely populated and the prevailing view is that economic development takes precedence over nature conservation concerns and should not be heavily regulated. The situation seems to be similar in Bulgaria and China.

Question 2.2: Are there controversies among different policy sectors/departments with regard to land take and achievement of different SDGs?

Synopsis: Most of the experts interviewed stated that there are intense controversies in their countries regarding the issue of land take. Basically, the greatest conflict is between ecological and economic interests: Land conservation, soil and nature protection on the one hand and economic growth, business expansion and regional development/cohesion policy on the other.

In concrete terms, the following positions of sectors/policy areas, among others, are outlined by the experts interviewed as examples:

- ▶ Industry/manufacturing: often positions itself against greater regulation of land take out of an interest in economic expansion.
- ▶ The real estate industry (real estate developers) and land owners benefit from rising land prices and are therefore often also against stronger regulation.
- ▶ Agriculture is divided because, on the one hand, valuable agricultural land is disappearing as a result of new land take, while, on the other hand, landowners are profiting from the conversion of agricultural land into building land.
- ▶ In several countries, municipalities are rewarded for attracting residents and businesses due to the tax system (e.g. in Denmark and Germany) and are therefore on the one hand interested in a generous designation of building land. On the other hand, they are also interested in reducing land take for social and ecological reasons.
- ▶ Tax policy: Certain financial support instruments can provide incentives for increased land take, such as the commuter allowance.
- ▶ Energy industry: Conflicts arise regarding the question of whether land may be used for the expansion of renewable energies (e.g. for wind turbines).

Question 2.3: If your country is a member of the EU: Are there interconnections between land take/land development and European strategies and activities that are relevant in your country?

Synopsis: In some countries, national sustainability strategies have been adopted that place land policy issues or soil protection in the context of the SDGs (e.g. in Austria, Germany; before 2015 also in Switzerland). Overall, however, the picture is heterogeneous.

The experts involved also refer to the following strategies in their answers to question 2.3: Soil Thematic Strategy, EU Road Map of Resource Efficiency ('no land take until 2050'), Partnerships of the Urban Agenda of the EU, Habitats Directive/Natura 2000; also mentioned: Leipzig Charter on Sustainable European Cities (2007); Marseille Declaration (2008) and European Framework of Reference for Sustainable Cities; Toledo Declaration (2010) and Promotion of Integrated Urban Regeneration, Towards a future "European Urban Agenda".

2.3 Goals and monitoring

Question 3.1: Are there any targets addressing the problem of land take? If legally binding: Where (i.e. in which law) are they stated? And how do public and private decision-makers have to consider these targets in land development?

Synopsis: Quantified land saving targets exist in Germany, Flanders (Belgium) and France. These targets are not binding in Germany and Belgium, but are to be understood as a political declaration of intent:

In its National Sustainability Strategy (2016), Germany sets itself the goal of reducing new land take for settlements and transport to less than 30 ha per day by 2030 (current land take: 66 ha per day).

In the White Paper Spatial Policy Plan of Flanders, Belgium sets the target to gradually reduce land consumption to 3 ha per day by 2040 and finally to zero in 2025 (in 2016, land consumption was 6 ha per day).

In France, the law stipulates that the new use of agricultural land should be halved by 2020 and that urban sprawl should be counteracted.

"The "Grenelle II Law" (Law No. 2010-788 of 12 July 2010): reinforces the objectives of local urban planning documents against urban sprawl and (but no national target set). The Agriculture and Fisheries Modernisation Law (Law No. 2010-874 of 27 July 2010): sets a target to reduce agricultural land take by half by 2020."

Furthermore, in France, the targets of a "significant reduction" of land take by 2035 and its further reduction beyond that are enshrined in the National "Low-Carbon" Strategy. A biodiversity protection law affirms that negative environmental impacts of construction and development measures must be prevented, reduced or compensated.

In 2002, Austria had set a national target for the reduction of land take in its sustainability strategy (2.5 ha per day by 2010). The target was not achieved and an extension of the target was not pursued.

Similarly, in Switzerland, a quantified target was formulated in the National Sustainability Strategy until 2015 (max. 400 m² anthropogenically overlaid surface/inhabitant), but this was not legally binding and was not included in the current sustainability strategy.

Poland does not have a quantified land take reduction target, but has quantified targets for increasing forest and woodland areas; similar to China, where there are targets for agricultural land.

In other countries, land for certain uses is protected by law or the conversion of agricultural land for the implementation of certain projects is only permitted under certain conditions (e.g. in Portugal, Romania, Slovenia, Switzerland).

Question 3.2: Who is responsible for monitoring and assessing the attainment of land take goals?

Synopsis: The question was understood in very different ways. On the one hand, it was answered - as the German report is designed - with a view to national objectives in particular sustainability strategies. The German expert's answer was:

"Reducing land take is a goal of the National Sustainability Strategy. Assessment of goal attainment is realized via a report of the Federal Statistical Office that is being published every two years (most recently 2017 for the year 2016). Monitoring of land take is realized via a methodically coherent statistical evaluation of the land survey register by the Federal Bureau of Statistics."

In countries where (quantified) land take targets or sustainability targets exist (see question 3.1), the experts named specific institutions at national level for their countries that are responsible for or carry out the monitoring of land use (e.g. Belgium: Environment Department; Germany: Federal Statistical Office; Austria: Federal Environment Agency).

Countries that do not have explicit national targets are more likely to address this question if there are environmental assessments for plans, e.g. Denmark, Portugal and Spain. Then a diverse picture emerges with many responsibilities:

"The problem of urban sprawl is addressed within the formal planning system and along national, regional and local scales, constituting one of the main goals of spatial planning agenda in Portugal".

Question 3.3: Are there any monitoring programs which help to assess changes in land take, especially structural land use changes and their impacts on environmental objectives? Can you provide information, if and how respective data is provided to and assessed by responsible authorities?

Synopsis: Monitoring instruments for environmental observation are available in all countries, although only some of them specifically focus on land take for settlement and transport (e.g. in Austria, France, Belgium and Germany). These are also the countries that stated in question 1.2 that they have a recognized or legally binding definition of land take in their country.

An expert from the Czech Republic emphasizes the good quality of the national information system (<https://bpej.vumop.cz/>):

"This comprehensive land and soil evaluation system is unique worldwide in terms of its scale and detail. Thanks to this database, the Czech Republic ranks among the countries with the most detailed and precise information about land and soil in the world."

In other countries, land take or land use change is recorded in the course of general environmental monitoring or other relevant monitoring programs (e.g. in Denmark, Italy, Spain, Portugal and Slovenia). The data situation with regard to land use seems to be particularly incomplete in Estonia, Greece and Slovenia, among others.

Question 3.4: Based from your experience in your national context: What are suitable indicators for land take that may help to assess progress towards respective political goals?

Synopsis: The national experts mention a variety of possibly suitable indicators or indicators that they think should be collected. Indicators that measure land take (or some form of it) per inhabitant, per administrative unit, per unit of area or per unit of time are often mentioned, for example:

- ▶ Settlement area per capita/per workplace/per municipality
- ▶ Sealed area in relation to the total area of a municipality
- ▶ Land take per hectare

- ▶ New land take per day
- ▶ In addition, the experts often refer to measures of population density, e.g:
- ▶ Population density
- ▶ Number of buildings per hectare
- ▶ Household density
- ▶ Other relevant metrics mentioned include the following:
- ▶ Arrangement and distribution of the most valuable soils
- ▶ Degradation of the most valuable soils
- ▶ Size of undeveloped areas
- ▶ Average building height
- ▶ Degree of intersection of "living" and "working"
- ▶ Size of green spaces and open spaces in relation to the total area of a municipality
- ▶ Size of unsealed areas (or areas of soil regeneration) in relation to the total area of a municipality.

A more detailed evaluation and assessment of the indicators must be made considering question 1.3. There, the experts named the relevant forms of land degradation or soil loss (erosion, salinization, desertification or contamination) in their country.

2.4 Instruments for the reduction of land take

Question 4.1: Which legal, planning, economic or informational instruments to control land take are applied in your country?

Synopsis: Overall, there is a high degree of variability between the countries with regard to the existence of instrumental control approaches for reducing land consumption. The experts interviewed named a large number of building law and planning instruments and explained in some cases to which specifications these are linked (e.g. for urban development in Denmark, it is stipulated that new land may only be taken up if it is directly connected to the existing urban area. This is to counteract urban sprawl, protect agricultural land and use infrastructure facilities as efficiently as possible). In some cases, negative planning instruments are also emphasized, for example in the Czech Republic, where agricultural land is intensively protected.

While tradable zoning rights - it is unclear in what exact form - are already established in Canada, this instrument is also used in Belgium and France (there as a voluntary instrument in some mountain communities). In Austria and Germany, it is being discussed in scientific circles.

Question 4.2: Which innovative instruments are currently developed/debated in your country?

Synopsis: In the following, some examples are given which were described as innovative instruments by the experts interviewed:

- ▶ Assessment of soil functions during the planning process (Austria)
- ▶ Property tax reform (inter alia Austria, Germany)
- ▶ Tradable area designation certificates (Austria, Germany, Belgium, Canada)
- ▶ Land use plans as a steering instrument (Austria)
- ▶ Infrastructure cost calculator (e.g. NIKK in Austria)
- ▶ Agglomeration programs (Switzerland)
- ▶ Planning law (Denmark)
- ▶ (Penalty) payments for low density development ("Underdensity Payments") (France)
- ▶ Application of the principle "Avoid, Reduce, Compensate" to smaller projects (France)
- ▶ Monitoring tools (Greece)
- ▶ Distance regulations for renewable energy (Poland)
- ▶ Aligning sustainability strategies and planning with the SDGs (Portugal, Spain)

Whether the examples listed are really innovative instruments in the sense that they are novel and particularly effective cannot be judged on the basis of the questionnaires. On the one hand, there is usually no detailed description, and on the other hand, these control elements must always be seen in the context of the respective national planning and regulatory law as a whole. It may well be that certain instruments - perceived as innovative by the experts - close gaps in the national legal systems, even though this instrument would be meaningless in another country.

2.5 Overall assessment of strategies, goals, and instruments to control land take

Question 5.1: If there are strategies and instruments for controlling land take in your country: How do you assess these approaches? Are there any instruments or legal regulations you would recommend as being particularly effective or innovative? (Please make precise references to your answers in question 2 and 3.

Synopsis: Many of the experts interviewed were cautious about this question, referring to the lack of evaluations of existing instruments (e.g. Belgium, Canada).

For France, a corresponding evaluation is expected in 2019:

"There are evaluations of some land take policies, but no comprehensive ones. A full evaluation of land take policies is planned by the 2019 as part of the Plan for Biodiversity."

Among other things, quantified land saving targets (e.g. Germany), certain laws or legislative initiatives (e.g. Denmark, Italy), as well as the "traditional" planning instruments (e.g. Netherlands, Slovenia, Switzerland) are highlighted as positive by the experts.

Question 5.2: If there are no strategies and instruments for controlling land take: What are in your opinion the deciding reasons that such strategies and instruments are missing? Is there a

lack of political motivation, acceptance or awareness of the problem? Are there any constitutional boundaries that form an obstacle?

Synopsis: With regard to the answers as to what causes sustainable land policy to fail, a distinction can be made between two basic answers.

Italy, for example, attributes this to a fundamental policy failure due to short government terms. Greece sees the main problem as an inability to implement land use strategies and a lack of effective land use control. In Poland, there is a lack of an overarching strategy to reduce land take.

In the other countries, the causes were seen more in the planning system and in previous planning practice. Belgium, for example, points out that there are large reserves of land in old - still legally valid - plans. The Netherlands, on the other hand, point to the actual development that there is a high demand for new buildings due to population growth and the already existing dense settlement. Slovakia and Estonia, on the other hand, point to their small cities and sparse population, respectively, so that there is a lack of awareness of the problem.

Question 5.3: Please give a short appraisal of current or prospective national policy trends regarding the control of land take and related activities to contribute to SDGs 11 and 15.

Synopsis: The responses to the question about the political approach to reducing land take and the associated activities to achieve SDGs 11 and 15 are very diverse. It is possible that some of the experts were not able to give an assessment.

In Germany, the 2016 Sustainability Strategy is seen as the central strategic framework for the implementation of the SDGs and there is a certain amount of consolidation in it.

The assessment from Austria is different, where there seems to be no real link between the sustainability strategy (ÖSTRAT) and the UN and EU SDGs, as the strategy is still based on the previous EU SDG strategy; however, the approach of the Austrian Conference on Spatial Planning (ÖROK), which has taken up SDGs 11, is seen positively.

The three Eastern European countries Bulgaria, Romania and Slovakia - all countries in which the topic of land take reduction seems to receive little attention - hope that the SDGs will provide an impulse for sustainability strategies to be developed. This also applies to Portugal, which is already increasingly addressing the issue.

2.6 Conclusions for different governance levels

2.6.1 EU Level

With regard to the EU level, the experts emphasized the important role of the common framework, especially the goal formulated in 2011 of "reducing net land take to zero by 2050". Some countries – for example Germany and France – have already integrated and transferred this goal into national strategies. However, deficits are identified in the lack of harmonization of the terms used. Details of these findings and recommendations for action are presented in Chapter 3 of this report. Furthermore, it is questioned to what extent statistical data on land use are actually reliable and comparable. Methodological differences between the collection methods at the European level and the Member States or between different Member States lead to problems of comparability and pose a challenge for policy formulation and the monitoring of regulatory success. Another criticism is that the focus on the quantitative reduction of land use ignores qualitative aspects of soil and land protection. With the EU Soil Strategy presented in November 2020, a

further framework is now available, which, however, was not yet the subject of the present study.

With regard to the policy instruments influenced by the European framework for reducing land take, reference is made to the environmental impact assessment. By including the factor land in the list of environmental goods to be taken into account, the EU has given an impulse to reform the corresponding national legislation. Details on the impact were examined in the further course of the SURFACE project and are presented in Chapter 4 of this report.

2.6.2 EU Member State level

Flanders (Belgium) and Germany can be titled as pioneers in terms of setting quantified targets to reduce land take. In Austria, France and Switzerland, land take is also intensively discussed and administratively addressed, but without quantified national reduction targets. In all these five countries, there seems to be quite a high awareness of the problem, comprehensive planning procedures are in place and quite detailed monitoring data are available. Nevertheless, it cannot be concluded that these are the five countries with the lowest levels of urban sprawl and land take, as land policies have not necessarily been consistent in the past. In fact, current policies are partly a reaction to high levels of land consumption, e.g. in Flanders and Germany. According to the most recent data from the European Environment Agency (EEA) for the period 2012-2018, annual land take in relation to national area during this period was actually higher than the EEA 39 average ($150 \text{ m}^2/\text{km}^2$) in Belgium ($195 \text{ m}^2/\text{km}^2$) and Germany ($158 \text{ m}^2/\text{km}^2$), slightly lower than the average in France ($144 \text{ m}^2/\text{km}^2$) and Austria ($135 \text{ m}^2/\text{km}^2$), and comparatively low in Switzerland ($50 \text{ m}^2/\text{km}^2$). However, these figures should be interpreted with great caution, e.g. they have to be considered in relation to the size of the areas that are suitable for e.g. agriculture, housing or other purposes. Furthermore, they cannot necessarily indicate whether recently introduced measures to limit land take are successful or not, as more time may need to pass before these measures have a significant impact (e.g. the quantified target in Flanders).

Furthermore, the problem of land consumption is discussed relatively dynamically in Italy, the Netherlands, Poland, Portugal, Slovenia and Spain, but embedded in very different national contexts. In countries that were heavily affected by the financial crisis in 2008 and/or underwent profound economic and social changes during the post-communist era, the reduction of land take seems to be seen mainly as a conflict with economic growth. In the Netherlands, high population pressure and a correspondingly tight real estate market seem to be additional factors hindering a more restrictive spatial planning policy.

In Denmark, regulatory instruments and monitoring programs are largely lacking at the national level. However, the goal of reducing land take seems to have been implemented relatively successfully at the municipal level for several decades. Furthermore, the issue of reducing land take seems to be increasingly entering national policy via climate change issues (e.g. related to hail insurance, coastal protection).

The Czech Republic and Slovakia stand out for their monitoring systems, which create very detailed databases on agricultural soils. Both countries have laws prohibiting the conversion of high value agricultural land and a corresponding economic instrument, but in practice exceptions are made in favor of economic or other social interests.

Low awareness and few political activities were found for Estonia, Greece, Bulgaria and Romania. The respective experts expressed the hope to change this situation, especially with regard to the implementation of the SDGs.

2.6.3 Results from countries outside the EU included in the study

In Australia, there are few compulsory land take policies, but there are several land take oversight bodies, such as the Land Monitor in the state Victoria. The Land Monitor provides the government with assurance of accountability, impartiality, transparency and integrity in land transactions. It analyses each transaction to ensure that it is legal, in the public interest and delivers the desired outcome for the government. Planning regulations in Victoria also allow for rezoning. This allows land to be rezoned so that a government agency can acquire private land for a public purpose.

In China, too, no legal targets are formulated for land take. There are only similar requirements for minimum sizes of agricultural land and maximum sizes of construction projects. However, China does have an annual structural land use change survey and a number of laws to reduce land take. Currently, several national strategies and policies on land use, especially on the protection of agricultural land, are being discussed with regard to their form of implementation in practice.

In Canada, the issue of land take is the subject of political and professional debate. While there are no specific targets, the amount of agricultural land converted to non-agricultural uses is monitored and documented. In the province of British Columbia, the government has also created reserves of agricultural land. These reserves are monitored by a commission. Similar measures also limit the expansion of peri-urban settlements. However, there are no concrete national monitoring programmes, and most legal instruments concerning land take are developed at the provincial level.

In Brazil, there are neither legally binding targets for land take nor objectives. However, monitoring is carried out at the national level by the Brazilian Institute of Geography and Statistics. The most important legal instrument for reducing land consumption is the "municipal master plan", which is regulated by a federal law. This contains a non-exhaustive list of planning and economic instruments that can be used to control land consumption and urban expansion.

3 Conceptions of the terms "land take" and "land consumption" in the European context

3.1 Background and research question

The conversion of undeveloped land into built-up urban areas, or to industrial sites and transport infrastructure is an underrated, yet increasing problem worldwide (van Vliet et al., 2017; Gerten et al., 2019). Termed land consumption or land take, it results in the loss of multi-functional, fertile soils and in the deterioration of biodiversity and ecosystem services (Seto et al., 2012; Yuan et al., 2019; d'Amour et al., 2017). Moreover, the exceeding growth of the built environment poses further challenges, e.g., related to health, housing, transport, or energy provision and related carbon emissions (EEA and Swiss Federal Office for the Environment (FOEN), 2016), as well as to public services provision (Hortas-Rico and Sole-Olle, 2010). Steering cities toward well-balanced compactness is, therefore, an important strategy to level their environmental footprint, to support culturally and aesthetically attractive downtown areas, and to secure adequate public infrastructure at viable costs (Cortinovis et al., 2019; Muñiz and Dominguez, 2020; Guastella et al., 2019). UN Sustainable Development Goal 11 (SDG-11), calling for inclusive, safe, resilient, and sustainable cities, covers the spatial aspect of urbanization by its indicator of land consumption (SDG indicator 11.3.1: 'Ratio of land consumption rate to population growth rate'). The indicator postulates that where rates of land conversions due to urban development are disproportionately high compared to population dynamics, such a 'growth turns out to violate every premise of sustainability that an urban area could be judged by' (UN Habitat).

In the European Union (EU), almost three quarters of the population live in cities, towns, and suburbs, and further urbanization is expected (Kompil et al., 2015). The EU promotes land recycling, e.g., via brownfield redevelopment (EC, 2012), but such re-use of land accounts only for a small fraction of urban development so far. During the period 2000–2018, 11 times more land was newly developed than re-cultivated within the EU (EEA, 2019b). Built-up areas have expanded predominantly at the expense of agricultural land with mostly high-quality soils (van Vliet et al., 2017; EEA, 2019b) and, during the past decades, expansion has not corresponded with urban population dynamics (EEA, 2006). In fact, between 1990 and 2015, Europe was the world region with the least efficient use of urban land: while the population increased in these years by 2.4%, the built-up areas expanded by more than 30% (Schiavina et al., 2019). Acknowledging that this trend is unsustainable and that it risks fostering inexpedient urban sprawl with all its negative side-effects, the EU introduced the soil sealing guidelines (EC, 2012) and declared the goal of 'no net land take' within the EU by 2050 (European Parliament and the Council, 2013; EC, 2011). This objective thus relates very closely to the SDG-11 indicator of land consumption. Both imply that the conversion of undeveloped into developed land should be minimized. However, besides this obvious overlap with regard to content, there is a striking difference in terminology, prompting the questions of what land consumption and land take exactly entail, whether both terms are synonymous, and how they relate to other important concepts such as soil sealing and artificialization.

A clear conceptualization of the terms land consumption and land take is not only of academic interest but of high practical and political relevance. It is essential for effectively exchanging knowledge on spatial governance nationally and internationally, and also for compatible monitoring and reporting, which in turn impacts the credibility of quantitative policy targets (Decoville and Schneider, 2016; Desrousseaux et al., 2019). A need for clarification and guidance has been highlighted repeatedly (see, e.g., Decoville and Schneider, 2016; Desrousseaux et al., 2019;

Nicolau et al., 2019). In particular for the EU policy context, it has been pointed out that ‘to date, there is a lack of harmonised terminologies across [EU] M[ember] S[tates] to describe issues related to the development of artificial areas as well as a lack of consensus regarding how to assess their environmental and socio-economic impacts and how to define compensation’ (Desrousseaux et al., 2019). The following paragraphs outline the two internationally agreed indicators used in this context.

The SDG-11 indicator of land consumption was adopted by the UN General Assembly in 2017 as part of the SDG framework. This framework is used for producing comparable information on how countries perform with respect to fundamental individual and societal human needs and is meant to be complemented by national indicators decided upon autonomously by the UN Member States. Every SDG is underpinned with several SDG targets to which the indicators are assigned.

In the case of SDG-11, target 11.3 reads:

“By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries and one of its indicators is the ratio of land consumption rate to population growth rate.” If the indicator value is < 1 , the increase in built-up area is slower than the increase in the number of inhabitants, and it can be explained by the demographic trend; if, instead, the indicator value is > 1 , land consumption is disproportionately high, i.e., decoupled from population growth.

The EU-wide land take indicator was established around 2004 by the European Environment Agency (EEA, 2017). It is regularly monitored and reported by the EEA (EEA, 2005; EEA, 2019; Joint Research Centre, 2012), and this has significantly increased the political relevance of the term land take in the EU. Specifically, its inclusion as a key concept in several strategic EU documents (e.g., European Parliament and the Council, 2013; EC, 2011) anchored it in the political discourse on spatial development in Europe (Barbosa et al., 2017). At the same time, land consumption continues to be used as a key concept in policy- or science-policy documents related to land governance and with relevance to the EU (e.g., EEA, 2016; OECD, 2017; Corbane et al., 2017; Urban Development Ministers, 2010).

With this study, we aim to further scrutinize the terms land consumption and land take from an EU-centred perspective, seeking to show how they are interrelated. We argue that the formation of a common understanding of these terms and their relationship (also with other concepts), as well as the testing of their practical application, lags behind their increasing use and relevance in policy-settings. With an analytical emphasis on the land take concept, we present 30 published definitions of relevant terms and reflect on major definition-related ambiguities and practical impediments. By providing this overview, we aspire to contribute to the discourse on sustainable land governance, particularly within the EU.

3.2 Definitions of land consumption, land take, and related concepts

From the studied scientific and policy relevant literature, as well as some internet sources, we extracted 30 definitions of the concepts of interest. Among those were eight definitions of land consumption, 13 definitions of land take, five definitions of soil sealing, and four definitions of artificialization (or of derivations of these terms, respectively). One of the definitions explicitly equates land consumption and land take (#1; this and all subsequent numbers marked with # refer to Table 2). Another definition conceives land take as one of ‘three forms of land consumption’ (#7).

Regarding the land use types they refer to, the extracted definitions range from broad to narrow (e.g., #1 vs. #2 for land consumption, or #16 vs. #9 for land take). Furthermore, the definitions vary in the degree to which they frame land take as being driven by urbanization or the growth of rural settlements (e.g., #2, #11), or by other specific developments like the building of infrastructures (e.g., #9 which was taken from a source dealing solely with the impacts of expanding transport networks). Many of the definitions of land consumption, land take, and soil sealing use the word ‘artificial’ to specify the types of land, areas, or purposes under consideration (#5, #6, #8, #10, #12–#16, #20, #25, #26).

From the total set of collected definitions, one for land consumption (#1) encompasses the widest spectrum of land conversions and affected land types, including area used for (over-intensive) agriculture or forestry. In fact, according to this general definition of UN Habitat and the EEA, the term land consumption may be used to describe the spatial effects on land of any economic activity. In contrast, none of the collected land take definitions explicitly includes land conversions for the purpose of expanding agriculture or forestry. Rather, land take is described to convert (e.g., #10, #12) and diminish (#17) areas used for agriculture or forestry. Thus, if land consumption is conceived according to definition #1, all land take belongs to the category of land consumption, but not vice versa.

However, many of the reviewed sources conceive land consumption more narrowly than expressed in definition #1, i.e., as resulting primarily from urban developments (#2, #3, #5), and as referring only to processes that increase the area of ‘developed’ or ‘artificial’ land (#3–#6, #8). In these cases, the conceptual scopes of land consumption and land take are close, and possibly congruent; sometimes both concepts are used as synonyms (#11). In SDG indicator 11.3.1 (#3), the land consumption rate only refers to urban development (Nicolau et al., 2019).

Land take is described by several of the collected definitions as a process that converts, and thereby diminishes, natural, semi-natural, forest, or agricultural land (#10, #12, #17–#19). Additionally, two land take definitions explicitly include inner-rural development and densification (#11, #16). In contrast, the densification of existing settlements, including the redevelopment of brownfields, is excluded from the definition of land consumption and land take according to the SDG indicator 11.3.1 (#3) and the EU indicator of land take (#10).

With regard to soil sealing and artificialization, the collected definitions suggest that both concepts are less equivocal than land consumption and land take. All five definitions collected for soil sealing describe this phenomenon as involving the covering of land, and four out of five mention that impermeable/impervious materials are used for this purpose (#22, #24–#26). One of the definitions for soil sealing (#22) include processes by which soils are not necessarily covered but changed in such a way that they lose the ability to absorb water (e.g., due to compaction).

The four definitions collected for artificial or artificialized areas/land surfaces (#27–#30) characterize the land they refer to as being in use for a range of different human activities; the exact set of activities varies among the definitions. The most encompassing definition of artificialized land refers to all human activities other than agriculture and forestry (#29).

Beside the differences in land use types to which the definitions refer, variation was observed with respect to the units of measurements the definitions suggest for the phenomenon in question. Applying this criterion, the following types of definitions emerge: (i) definitions from which an appropriate unit of measurement cannot be inferred, e.g., because they attribute the term in question to a process or activity rather than to its result (e.g., #18, #22–#25); (ii) definitions suggesting that the phenomenon in question should be expressed in absolute terms, i.e., as the total amount of area affected (e.g., #12, #27–#30); (iii) definitions suggesting that the phenome-

non in question should be expressed in relative terms, i.e., as a percentage (affected area compared to a reference area, e.g., #3, #5), a rate (change in affected area over time, e.g., #11, #20), or in relation to the human population (e.g., change in affected area per capita, e.g., #4, #6). Measures of land use change that refer to the human population have been termed land use intensity (Kompil et al., 2015) or land use efficiency (Corbane et al., 2017).

Table 2: Definitions of (a) land consumption, (b) land take, and (c) related terms, in chronological order of cited references (if publication dates were apparent); accentuations added.

#	Definition	Reference
(a) Land Consumption:		
1	Land consumption includes: (a) The expansion of built-up area which can be directly measured; (b) the absolute extent of land that is subject to exploitation by agriculture, forestry, or other economic activities; and (c) the over-intensive exploitation of land that is used for agriculture and forestry.	(UN Habitat) similar in EEA Glossary ¹
2	Land consumption rate: the annual rate at which cities uptake land for urbanized uses (both built-up and open space demands)	(Mwaniki, 2018)
3	[...], the percentage of current total urban land that was newly developed (consumed) will be used as a measure of the land consumption rate . The fully developed area is also sometimes referred to as built up area.	(UN Habitat)
4	[...] the developed area per capita, [which] we refer to as ‘per capita land consumption .’	(McDonald et al., 2010)
5	The ‘ land consumption ’ (percentage) is measured as the percentage share of urban (artificial) land to the total land area. It indicates the level of urbanisation for a given area.	(Siedentop and Fina, 2012)
6	The [LUISA ²] land use intensity indicator measures the land consumption or the size of actual artificial areas per inhabitant, expressed in square meters per inhabitant.	(Kompil et al., 2015)
7	The seven sources of information compared in this paper refer to the three forms of land consumption evoked earlier: land take , soil sealing, and building plots.	(Decoville and Schneider, 2016)
8	In a more general sense, land consumption can be considered the change from a non-artificial land cover to an artificial land cover of the ground [...].	(Strollo et al., 2020)
(b) Land Take:		

¹ https://www.eea.europa.eu/help/glossary#c4=10&c0=all&b_start=0

² LUISA stands for the ‘Land-Use-Based Integrated Sustainability Assessment’ modelling platform, see <https://ec.europa.eu/jrc/en/luisa>

#	Definition	Reference
9	Land take: The area of land that is ‘taken’ by infrastructure itself and other facilities that necessarily go along with the infrastructure, such as filling stations on roads and railway stations.	EEA Glossary ¹
10	The land take indicator addresses the change in the area of agricultural, forest, and other semi-natural and natural land taken for urban and other artificial land development. Land take includes areas sealed by construction and urban infrastructure, as well as urban green areas, and sport and leisure facilities.	(EEA, 2019b), similar in (EEA, 2004, 2017)
11	Land take , also referred to as land consumption , describes an increase of settlement areas over time. This process includes the development of scattered settlements in rural areas, the expansion of urban areas around an urban nucleus (including urban sprawl), and the conversion of land within an urban area (densification).	(EC, 2012), similar in (Smith et al., 2016; FAO and Intergovernmental Technical Panel on Soils (ITPS), 2015) ³
12	[...], land take is defined as the amount of agriculture, forest, and semi-natural land taken by artificial land [...].	(Lavalley et al., 2013)
13	[...] the ‘ net land take ’ concept could be subject to different interpretations. It can be defined ‘arithmetically’ as ‘changes of non-artificial areas into artificial areas, which are not compensated by the restoration of the same amount of artificial areas into non-artificial areas’ or in a more ‘ecological’ manner depending on the balance between the land functions lost and restored.	(BIO by Deloitte, 2014)
14	Gross land take [is] defined as the growth of artificial areas irrespective of re-naturalisation.	(BIO by Deloitte, 2014)
15	One measure of urban development is the land take (i.e., the amount of land converted into artificial or built-up areas) [...].	(Kompil et al., 2015)
16	The concept of land take covers all forms of conversion for the purpose of settlement, including: the development of scattered settlements in rural areas; the expansion of urban areas around an urban nucleus; the conversion of land within an urban area (densification); and the expansion of transport infrastructure such as roads, highways, and railways. Broadly, this discussion considers as land take any conversion of agricultural, natural, or semi-natural land cover to an ‘artificial’ (e.g., human-made) area.	(FAO and Intergovernmental Technical Panel on Soils (ITPS))
17	Land take , by its definition, is the subtraction of an area from a previous agricultural, natural or semi-natural land use.	(FAO and Intergovernmental Technical Panel on Soils (ITPS))

³ This definition was taken up by a workshop of the European Committee for Standardization (CEN Workshop 74), i.e., it became part of an early stage standardisation activity; the draft is available at ftp://ftp.cencenelec.eu/CEN/Sectors/List/Environment/HOMBRE/DraftCWA74_20140528_.pdf

#	Definition	Reference
18	Land take: Converting agricultural or forestland or natural habitats to residential, industrial, commercial, or infrastructure areas.	(Tobias et al., 2018)
19	Land take is the process in which urban areas and sealed surfaces occupy agricultural, forest, or other semi-natural and natural areas.	(EEA, 2019a)
20	Average annual land take (the increase of artificial land)	(Eurostat, 2019)
21	Settlement area per capita: This indicator captures the amount of settlement area due to land take such as for buildings, industrial and commercial areas, infrastructure, sport grounds, etc., and includes both sealed and non-sealed surfaces.	(Eurostat)
	(c) Related Concepts:	
22	Soil sealing refers to changing the nature of the soil such that it behaves as an impermeable medium (for example, compaction by agricultural machinery). Soil sealing is also used to describe the covering or sealing of the soil surface by impervious materials by, for example, concrete, metal, glass, tarmac, and plastic.	EEA Glossary ¹
23	Soil sealing is the loss of soil resources due to the covering of land for housing, roads, or other construction work.	(European Soil Bureau Network and EC, 2005)
24	The covering of the soil surface with impervious materials as a result of urban development and infrastructure is known as soil sealing .	(European Soil Bureau Network and EC, 2005)
25	Soil sealing means the permanent covering of an area of land and its soil by impermeable artificial material (e.g., asphalt and concrete), for example through buildings and roads.	(EC, 2012)
26	Sealing of land areas indicates the amount of area covered with impervious materials due to urban development, increases in traffic infrastructure and construction (for example, buildings, constructions, and laying of completely or partially impermeable artificial material, such as asphalt, metal, glass, plastic, or concrete).	(Eurostat, 2019)
27	[...] artificial areas are defined as urban fabric, industrial/commercial land uses and infrastructures/transport networks.	(Lavalle et al., 2013)
28	Artificial land is defined as the total of artificial non-built up areas (such as parking lots, playgrounds, farms, cemeteries, roads, railways, and bridges) as well as built-up areas (for example, buildings and greenhouses).	(Eurostat, 2018)
29	Artificialised land is the variety of land use supporting all human activities other than agriculture and forestry	(Desrousseaux et al., 2019)
30	Artificial surfaces = land that is assigned to one of the following classes: urban fabric (continuous and discontinuous); industrial, commercial, and transport units; mine, dump, and construction sites; artificial, non-agricultural vegetated areas (green urban	(Copernicus Land Monitoring Service a)

#	Definition	Reference
	areas, sport, and leisure facilities).	

3.3 Indicators for monitoring land consumption and land take

As mentioned in the introduction, the SDG indicator 11.3.1 is composed of the quotient of the land consumption rate (LCR) and the population growth rate (also referred to as the land use efficiency (Schiavina et al., 2016; Melchiorri et al. 2019). LCR is defined as ‘the percentage of current total urban land that was newly developed’ (UN Habitat) and calculated as (ibid.):

$$LCR = \frac{\ln(Urb_{t+n}/Urb_t)}{(y)}$$

where Urb_t = total areal extent of the urban agglomeration in km² for past/initial year, Urb_{t+n} = total areal extent of the urban agglomeration in km² for current year, and y = the number of years between the two measurement periods.

The methodology for computing the land consumption rate for the SDG indicator 11.3.1 is subject to a scientific debate (Nicolau et al., 2019). Promising advances have been made in using new global datasets, tools, and maps, specifically those subsumed under the header ‘Global Human Settlement Layer, GHSL’ (Gerten et al., 2019; Schiavina et al., 2019; Corbane et al., 2017; Melchiorri, 2019). However, there is no consensus yet on how to define the exact geographic boundaries of urban land and this poses a major challenge for assessing LCR (Nicolau et al., 2019; Fleischmann et al., 2020).

The land take indicator has been defined by the EEA to address ‘the change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development. Land take includes areas sealed by construction and urban infrastructure, as well as urban green areas, and sport and leisure facilities’ (EEA, 2019) see also definition #10 in Table 2). It captures all transitions of ‘agricultural areas,’ ‘forest areas,’ ‘wetlands,’ or ‘water bodies’ into one of the following classes: ‘continuous urban fabric,’ ‘discontinuous urban fabric,’ ‘industrial or commercial units and public facilities,’ ‘road and rail networks and associated land,’ ‘port areas,’ ‘airports,’ ‘mineral extraction sites,’ ‘dump sites,’ ‘construction sites,’ or ‘sport and leisure facilities. (EEA, 2019).

According to this EEA methodology, land take may occur at any place where land classifies as natural, semi-natural, forest, or agricultural land, and these land type categories are almost exclusively assigned to land outside existing settlements. Urban green is seen as part of the settlement structure, and the respective land is regarded as ‘taken.’ It follows that developments within the boundaries of a settlement are not counted as land take, even if they affect vegetated plots (e.g., brownfields, gardens). Inner-urban areas affected by densification thus change from a less intensely developed state to more intensely developed state, but as the area has already been counted as ‘urban,’ the change has no effect on the land take statistics.

In contrast, successful land take compensation measures have an effect on the land take statistics because they change the status of areas from ‘taken’ to ‘non-taken’. Such a ‘land return to non-artificial land categories’ (EEA, 2019) is also called re-cultivation, and can be achieved by unsealing or other conservation measures. By subtracting the re-cultivated area from the total area affected by land take, one arrives at the EEA indicator of *net land take* (see definitions #13 and #14 in Table 2). In the EU policy context, the concept of ‘net land take’ plays a prominent role because it is the basis of the ‘no net land take until 2050’ target. It is important to note that

according to the EEA scheme, a distinction is made between ‘greening of urban areas’ (which does not translate into a reduction of land take, because the area remains in the category ‘urban’) vs. ‘re-naturalisation of artificial areas’ (which is a compensation measure and does reduce land take) (EEA, 2019).

The EEA land take indicator is currently calculated using the CORINE Land Cover (CLC) Accounting Layers for the years 2000, 2006, 2012, and 2018. A serious limitation of CLC data is that small-scale developments cannot be detected in the Geographic Information System (GIS) vector dataset, as the Minimum Mapping Unit (MMU) for areal phenomena is 25 ha and the minimum width for linear phenomena is 100 m (Copernicus Land Monitoring Service b). This leads to the exclusion of most linear transport infrastructures from the EU land take assessment (EEA, 2019) and may result not only in an underestimation of the total land take but also in flawed (counterfactual) judgements if, e.g., scattered sprawl (many smaller developments across the landscape) scores much better than coordinated, large developments. Due to its low resolution, CORINE based measures have proven inadequate for detecting relevant developments on a small scale (Diaz-Pacheco and Gutiérrez, 2014).

Furthermore, the CLC based method is not the only one by which land use is analysed across all EU Member States. The European Statistical Office (EUROSTAT), in close cooperation with the Directorate General for Agriculture and supported by the Joint Research Centre (JRC), samples the topsoil at more than 250,000 locations throughout the EU, approximately every three years. This survey is abbreviated LUCAS (which stands for Land Use/Cover Area frame statistical Survey) (JRC/European Soil Data Centre (ESDAC)), and the obtained data are used, inter alia, for monitoring the progress towards the SDG targets, because this is under the responsibility of EUROSTAT.

The differences in the methodologies between CLC based (obtained from remote sensing) and LUCAS based estimates of land use changes (obtained from in-situ sampling) have resulted in divergent conclusions about recent trends in land consumption/land take: While the EEA detected a reduction of land take in the last decade (from over 1000 km²/year between 2000–2006 to 539 km²/year between 2012–2018) (EEA, 2019), EUROSTAT concluded that ‘the rate of land take has accelerated’ between 2009–2015 (Eurostat, 2018).

In addition to the two international schemes described above, several different national classifications and monitoring systems exist to assess and monitor land consumption and land take. These have their own specificities and are not necessarily harmonized and aligned to the international reporting schemes. The national approaches listed in Table 3 demonstrate how the conceptualization of land take differs between EU countries. For example, gardens are judged as being neutral to land take in Czechia but regarded as part of the settlement area in Austria, Belgium (Flanders), and Germany, thus contributing to land take. Areas for which building plans exist but that are not (yet) actually used for purposes related to settlements, infrastructure, or service provision do not count as being taken in Belgium (Flanders), but contribute statistically to land take in Germany.

Table 3: Four approaches for assessing land take on the national scale: examples from of Austria, Belgium (Flanders), Czech Republic, and Germany⁴

Country	land-Take Equivalent in National Language	English Translation (by the Authors)	Definition	Further Specifications
Austria	Bodenverbrauch und Flächeninanspruchnahme	soil consumption and land take	Both interchangeable terms mean '...permanent loss of biologically productive soil for settlement and transport purposes, but also for intensive recreational uses, landfills, quarries, power plants and similar intensive uses.' ⁵	The exchangeable use of Bodenverbrauch and Flächeninanspruchnahme derives from changing terminologies in the past years—leading to a use of both terms, even within one authority (like the Austrian Environment Agency). A distinction is made to soil sealing ('Versiegelung'), which describes the actual coverage of soil through asphalt or other building material, making it impermeable for water.
Belgium/Flanders	ruimtebeslag	settlement area	Areas affected by ruimtebeslag are the '[...] part of the space in which the biophysical function is not the most important. In other words, the space that is taken up by human activity (i.e., the space we use for housing, industrial, and commercial purposes, transport infrastructure, and recreational purposes). Parks and gardens, ecoducts across infrastructures, and some shoulders and banks along (road) infrastructures are also part of the settlement area.' ⁶	'This [ruimtebeslag] includes all plots of land with buildings (for residential use as well as for industrial and commercial use and for services), all land associated with road infrastructure, and all land used mainly for recreation. [...]. The built-up area within the military domains is included, but the exercise areas are not, because these often perform a (semi)natural function. 'Land take,' as understood in the Flemish definition, refers to the surface actually occupied by the mentioned use-categories.'
Czechia	záběr půdy	land take, land occupation	'Change in the area and structure of individual categories of agricultural land. The share of built-up and other areas in the total area.' This is one of the indicators of sustainable development within the	The Czech statistical approach focuses on the amount of land with sealed surfaces which comprises two statistical categories: (i) built-up areas and (ii) other areas (mainly artificial

⁴ The displayed information was either obtained from the SURFACE questionnaire study or extracted from the referenced sources

⁵ <https://www.umweltbundesamt.at/umweltthemen/boden/flaecheninanspruchnahme>

⁶ <https://www.statistiekvlaanderen.be/en/settlement-area-0>

Country	land-Take Equivalent in National Language	English Translation (by the Authors)	Definition	Further Specifications
			Czech Republic (European Soil Bureau Network and EC, 2005). It implicitly assumes effective forest protection which holds in reality (the area of forest land increases in time).	land including transport infrastructure, land-fills, or mining). Therefore, data on built-up areas within urban land are combined with those of outside urban land. Gardens (also within the boundaries of a city) are classified as a type of agricultural land and therefore are not considered as land taken by development within Czech Act No. 334/1992 Coll. On the protection of agricultural land (Copernicus Land Monitoring Service a).
Germany	Flächenneu-inanspruchnahme (für Siedlungs- und Verkehrszwecke)	extra/new land utilization (for settlements and transport purposes)	Land take in Germany is understood as the conversion of agricultural, forest, and other semi-natural and natural land into land for settlement and traffic. Land for settlement and traffic includes building areas and urban infrastructure as well as urban green areas and sport and leisure facilities and cemeteries (but excluding excavation areas).	In Germany, an area is statistically classified as a 'settlement and traffic area' if it has been designated as a buildable area by a binding municipal land use plan, regardless of whether the area is actually used for this purpose (legal dedication determines the statistical classification). Thus, land take, as understood in the German definition, refers to the surface potentially occupied by the mentioned use-categories, resulting in a situation where land take happens when planning allows the creation of buildings or infrastructure (Melchiorri et al., 2019).

3.4 Identified challenges and need for action

Over the past decade, a growing number of studies have addressed the operationalization of the concepts of land consumption and land take and related analytical questions (Schiavina et al., 2019; Decoville and Schneider, 2016; BIO by Deloitte, 2014; Nicolau, et al., 2019; Lavalle et al., 2013). This increased interest has been spurred by the fact that both concepts are components of internationally agreed sustainability indicators and are thus of high political relevance. Included in the analyses were inter alia, the factors driving the development of previously undeveloped land (Barbosa et al., 2017; Colsaet et al., 2018; Ustaoglu and Williams, 2017), the socio-economic context and spatial pattern of such conversions (Salvati et al., 2018), and their potential consequences, e.g., for food production (van Vliet, 2017; Gardi et al., 2015; Aksoy et al., 2017) and climate change adaptation (Thorne et al., 2017). However, as we discuss below, several theoretical and practical questions relevant for monitoring and curtailing land consumption and land take have not yet been fully explored.

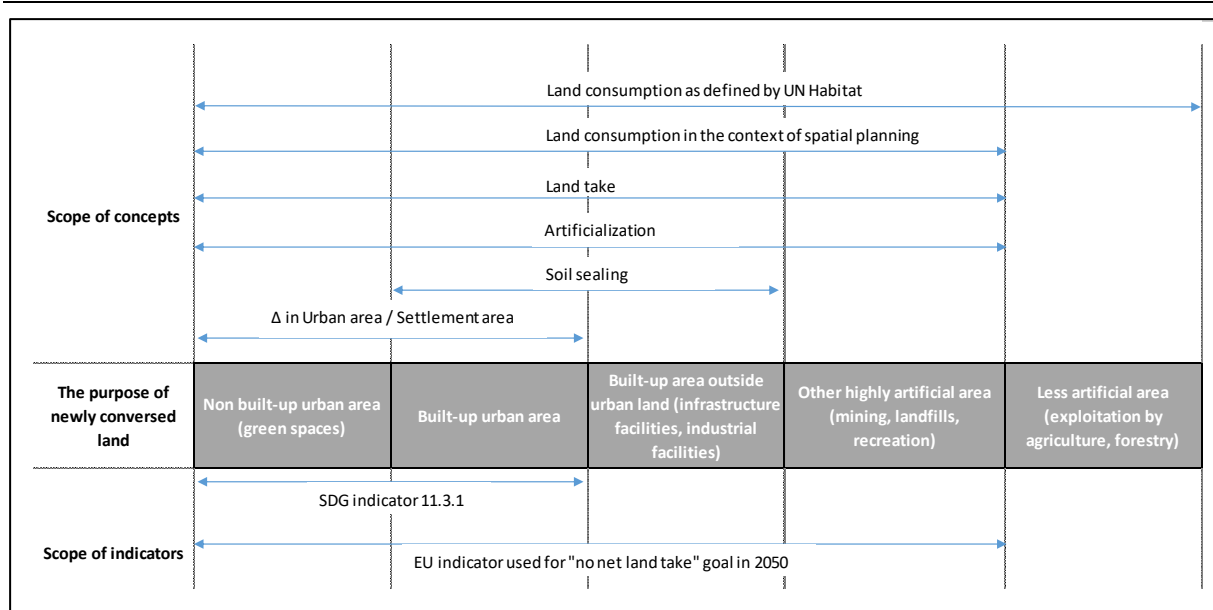
Major conceptual ambiguities arise from the fact that different definitions are in use for the terms land consumption and land take (see Section 2.3.1). This partly confounds the relationship of the concepts with each other, and with related concepts, respectively. Notably, the inclusion of land conversions resulting from the expansion of (intensive) agriculture and forestry or from urban densification measures, within the meaning of land consumption and land take is controversial, whereas the contrast of naturalness vs. artificiality seems to be a key element of conceptualizing and operationalizing both concepts (Table 1).

3.4.1 Sharpening the conceptualization of land consumption and land take

In the context of urbanization and spatial planning, land consumption and land take are frequently used (sometimes interchangeably) to describe the expansion of settlements, industries, and infrastructures at the expense of agricultural land, forests, or (other) semi-natural or natural areas (e.g., Colsaet et al., 2018; Salvati, 2014) (see also Table 2). Thus, land consumption and land take often have the same meaning. The same is true for artificialization, a term that is used as an equivalent in some EU Member States (Desrousseaux, 2019, Table 2). Equating land consumption and land take seems legitimate and adequate in situations when exact and comparable quantifications for the respective phenomena are not the matter of discussion and an overall conceptual understanding is sufficient. For example, alternative planning objectives can be discussed in this way at a general level, such as avoiding settlement enlargement vs. creating new residential or commercial areas in the periphery. However, a change in the thematic focus may imply that land consumption is conceived differently and more broadly (see Section 2.3.1). If, e.g., deforestation for agricultural purposes is discussed, land consumption could be an appropriate term, but not land take.

Figure 1 synthesizes our understanding of the scopes of the discussed concepts and indicators in relation to different land use/land cover categories. In our view, land consumption and land take (along with artificialization) are conceptually broadly equivalent in the context of urbanization and spatial planning (see also, e.g., Decoville and Schneider, 2016), even though the exact spectrum of land conversions that are considered to contribute to these phenomena may vary. The ultimate categorization of a specific case contributing to, being neutral to, or compensating for the phenomenon in question depends on the exact definitions and methodologies applied, and is subject to national specificities (Table 2).

Figure 1: Scopes of the discussed concepts and indicators in relation to different land use/land cover categories



However, some general statements can be made. Both concepts, land consumption and land take, emphasize that land conversions go along with the expansion or shrinkage of areas occupied by particular land use or land cover types. The binary classification both concepts rest upon is coarse and largely neglects that two areas falling into the same broad use-category can perform very different ecological, economic, or social functions. In other words, land consumption and land take stress the quantitative rather than the qualitative aspects of land use changes. Both concepts are much more encompassing than soil sealing, which refers only to areas covered by impervious surfaces.

It is important to note that the developments that are of most interest here usually occur outside of (and thus between) existing settlements, often within the so-called peri-urban area and, in these cases, directly related to urban sprawl phenomena. We support the view that inner-urban development should not be conceived as contributing to land take and land consumption, as the affected areas are usually under strong anthropogenic influence and their soils compacted or otherwise significantly altered compared to their natural state. In fact, in the related policy discourse, densification (including brownfield redevelopment) is regarded as a measure for curtailing sprawl and urban expansion, and thus land consumption and land take (OECD, 2017; EEA, 2016; Bartke, 2013).

One may argue that, compared to land consumption and land take, the term 'artificialization' may be more intuitively understood and better suitable for conceiving land conversions as gradual processes. The latter would be compatible with the gradual conceptualisation of naturalness (as the counterpart of artificiality) that underlies the hemeroby concept about the degree of human impact on a natural environment (Wrbka et al., 2004; Walz and Stein, 2014). However, determining the degree of artificialization or naturalness is inherently difficult, and certainly not reliably possible with remote sensing tools (Decoville and Schneider, 2016). Furthermore, the discrimination of naturalness vs. artificiality carries a strong normative connotation. While this may also be true, to a lesser extent, for consumed vs. non-consumed, the distinction between taken vs. non-taken seems to be comparatively neutral.

3.4.2 Monitoring land consumption and land take

As the debatable case of urban densification shows, the evaluation of land use changes may depend on whether they occur inside or outside a particular area. The geographic and administrative localization of land use changes is furthermore critical for a clear attribution of responsibilities. Monitoring land use changes precisely is, therefore, a prerequisite for taking informed decisions and for post-hoc assessments of policy impacts. Respective indicators and monitoring tools need to be available and they are expected to deliver reliable and comparable data. As mentioned above, both concepts, land consumption and land take, are used in international reporting systems, but several methodological issues are still under debate (Schiavina et al., 2019; Decoville and Schneider, 2016; Nicolau et al., 2019; Corbane et al., 2017). In this context, it is critical to acknowledge that there is a great variety in land cover classification systems worldwide (Yang et al., 2017), and to specify which system has been applied in the case at hand. Furthermore, attention needs to be paid to the type of data that is used (information on land cover, land use, or administrative categories), and to the tools that are applied to obtain the data (remote sensing, field surveys, or cadastres). These factors considerably complicate the interpretation of respective indicators and potentially lower their comparability (Decoville and Schneider, 2016; Strollo et al., 2020). Thus, when the exact demarcation of an area that is consumed/taken is the subject of discussion, it is advisable not to use land consumption and land take synonymously, as this entails the risk of comparing two measures that have been estimated by diverging methodologies (see Section 2.3.2). In the context of SDG 11, land consumption has a specific meaning, as the land consumption rate is one of the components of SDG indicator 11.3.1. Here, '[...] the land type addressed [by the indicator] is urban land' (Decoville and Schneider, 2016), i.e., the indicator's scope is restricted to urbanization processes.

The discrepancy reported here between two examples of EU land take trends (assessed by EEA and EUROSTAT) further illustrated that a detailed methodological understanding of monitoring schemes is needed for interpreting quantitative measures and statements accurately as well as for disentangling related incongruences. This was further corroborated by our comparison of selected national approaches for land take monitoring (Table 2) which illustrated that, in the absence of a uniformly shared definition, the understanding of land take varies between EU countries. Striking differences were observed with regard to the classification of gardens (that may or may not be part of the settlement area) and of areas that have been designated for development but not actually used (they may or may not contribute to land take). The Austrian/German example showed that conceptual differences between terms go beyond national language issues (both countries use almost the same wording) and are indeed a matter of national policy definitions.

Methodological sophistry also complicates the question of whether a conservation measure counts as a compensation for land take (and thereby reduces the net land take statistics, see Section 2.3.2). Compensation has become an essential instrument in spatial governance and is incorporated in the principles of sustainable land use for mitigating impacts: 'avoid, reduce, compensate' (EC, 2012). While these principles are generally agreed upon, controversies arise as to whether damage caused to the living environment, specifically to ecosystems and biodiversity, can actually be counterbalanced. One may dispute which areas may count as equivalent to each other and whether a quality improvement of an area in one location can compensate for the loss of an ecosystem elsewhere. Moreover, when an area is taken, it is challenging to define what exactly needs to be compensated for (e.g., impacts to the scenery, the soils, biodiversity, or all of these?), and which relevant characteristics or components need to be considered (e.g., landscape elements, soil features, or species). Several other aspects are also far from certain, such as where compensation should take place (i.e., whether an area in close proximity should be prioritized

over one farther away), how to deal with knowledge gaps regarding the damage caused, who decides about the equivalence of lost and gained components, or when to conclude that the loss is incommensurable and what consequences this has. These and related questions are at the centre of an intense debate around 'biodiversity offsetting,' which is discussed elsewhere (Darbi, 2020; Santos et al., 2015). Ultimately, these questions need to be negotiated and decided in a well-informed political arena or in a participatory planning setting; they are not primarily a matter of definitions and exact quantifications.

3.4.3 Operating with the land take concept – potentials and limits of its applicability

For the sake of clarity and because our focus is on the EU policy context, we favour the term land take over the terms land consumption and artificialization in this subsection.

Land take is often associated with urbanization, but also the result of human activities and projects that may occur at great distances from cities and settlements. Examples include cross-country roads and industrial extraction or disposal sites (e.g., for the excavation of resources by open pit mining). These activities are all land based and, therefore, land take is usually considered to affect terrestrial systems applied as such, e.g., by van Vliet et al., 2017. However, according to the methodology for calculating the EU land take indicator, this includes wetlands, and the conversion of waterbodies to urban area is also counted as land take (see Section 2.3.2). While only a small fraction of the total land take affects wetlands and waterbodies in Europe (with exceptions in some countries, e.g., in Iceland or The Netherlands) (EEA, 2019), urbanization has a huge impact on waterbodies in some other parts of the world (examples include the expansion of some of the Asian megacities) (Brinkmann et al., 2020). The land take concept thus bears potential for wetlands as well. Moreover, and highly relevant to the EU context, infrastructures are increasingly built offshore. Examples include power lines, oil, and gas platforms and pipelines, mobile transmission towers, and communication cables. To assess their impact on the environment, it seems plausible to extend the applicability of the land take concept also to marine systems. It has already been used to calculate the spatial impact of offshore wind turbines (Cheng and Hammond, 2017).

Further complexity is added when environmental effects of above or below ground installations (such as storage tanks or solar panels) or on the surroundings of a project are considered. The latter has been referred to as indirect land take (Geneletti et al., 2017) and discussed, e.g., in the context of traffic routes causing the fragmentation of habitats (Madadi et al., 2017). We suggest that these are special cases to be decided upon according to the prevalent (national) classification system, and that non-binary categorizations might be most suitable for discussing them, as they have been introduced, e.g., for assessing the degree of hemeroby (as the opposite of naturalness) (Wrbka et al., 2004; Walz und Stein, 2014).

3.5 Conclusion

The EU's simultaneous commitment to "lead the implementation of the 2030 Agenda and the SDGs" (EC, 2016a) and to aim for "no net land take" (EC, 2011) requires relating the two terms land use and land take and clarifying their scope. Based on the above considerations, it is proposed to work towards a common general understanding of what is meant by land use and land take (in a broader sense) on the one hand, and towards a consistent interpretation and implementation of these concepts for monitoring and reporting purposes on the other hand. This differentiation would facilitate communication on land use (if specified) and should therefore be popularised and continuously applied in practical, political and scientific contexts. Furthermore,

it is equally important to use and refer to existing definitions more consistently and clearly, especially in the SDG and EU context. Whenever precise quantification of trends is required, it is advisable not to use land use and land take as synonyms and to understand the respective phenomena as changes over time, i.e. to state them consistently as a rate (e.g. as ha/day or km²/year). Relating measurements to a reference value (e.g. total area, number of inhabitants) usually increases their comparability and should therefore be encouraged. Urban densification measures should be excluded from the definition of land use (in the context of urbanisation and spatial planning) and land take. In the EU context, the concept of land take should be preferred to land use wherever appropriate. Exemptions can refer e.g. to the international SDG framework.

Furthermore, the limitations of the concepts of land use and land take need to be considered - especially their dichotomy, which neglects that the impacts of different uses on e.g. ecosystem services are very different. Alternative concepts, e.g. hemeroby, soil degradation and possibly also artificialization could prove more useful in this respect, as they can be perceived as gradual processes.

In addition to these primarily conceptual issues, it is important to raise awareness of the scarcity of land in general and of land with different qualities in particular. This should lead the general public to question the processes by which space is allocated to different purposes and to reflect on the social and environmental impacts that result from these patterns.

4 The factor land in environmental impact assessments

This chapter presents the results of the second questionnaire survey, in which experts from ten EU Member States and the United Kingdom assessed progress towards the EU's "zero net land take" target in their respective countries. The survey focused in particular on how Directive 2014/52/EU has been implemented at national level. The results have also been published in Schatz et al. (2021).

Drivers of land take are manifold, including demography, economic development but also policies and institutions, such as planning regulations, financial incentives and fiscal relations between different governmental levels (Colsaet et al., 2018; Droste et al., 2017). Governance approaches for reducing land take include respective policy targets, spatial planning on federal, local or sectoral levels, financial or fiscal incentives and environmental assessments of development plans and projects. Environmental assessments, such as the Strategic Environmental Assessment (SEA) and the EIA are legal instruments that can improve the consideration of environmental impacts that result from plans or projects, promote the identification of more environmentally friendly alternatives and contribute to more systematic and transparent planning (EEA, 2019b; Köck et al., 2007).

Sustainable land take governance requires four key elements (Bovet et al., 2018):

- ▶ Implementation of sustainability goals;
- ▶ Application of coordinated and integrated policy instruments including legal regulation;
- ▶ Continuous integration of new knowledge;
- ▶ Participation of stakeholders and the public.

The SEA can be an especially useful tool in the context of urban expansion, since it evaluates potential environmental impacts of urban development planning at a larger scale (Shepherd and Ortolano, 1996; Rega et al., 2018). The EIA can target land take for projects outside of settlement areas, e.g. quarries, road developments, ski areas or small urban development, such as shopping centres or health facilities (Geneletti, 2017). Due to their placement in natural surroundings the land take associated with these projects can have ecological impacts far beyond the areas that are actually converted into developed land, e.g. by fragmenting habitats and triggering cascades of disturbances that endanger natural ecosystems and biodiversity (Madadi et al., 2017; Haddad et al., 2015; Karlson and Mörtberg, 2015).

For the European Union, EIA and SEA are important tools to influence the approach to land take in European Member States, since the general competence to regulate land and urban planning lies with regional and national governments (EEA, 2019b). In order to utilize the potential of Environment Assessments to protect land and soil, the EC placed a stronger focus on resource efficiency in the revision of the European EIA Directive (Directive 2014/52/EU, recital 6; EC, 2011). For this reason, and as an element of the European strategy to curb land take (EEA, 2019b; EC, 2011), 'land' was included in the list of environmental assets that need to be considered in EIAs in 2014 ('list of factors', Directive 2014/52/EU, Art. 3). In the revised EIA Directive, land take is explicitly mentioned as an example of a relevant impact on 'land' (ibid., recital 9).

In the scientific literature, the implications of the revised EIA Directive in different EU countries has received some attention (Mustow, 2017; Fischer et al., 2016; Mayer, 2016; Mercier et al., 2016; Balla and Peters, 2015), but its practical implementation has rarely been in focus (for an exception, see Pölönen et al., 2019). While the explicit recognition of 'land' and the emphasis on

land take as a major environmental threat was welcomed in the German legal literature (Karrenstein, 2019; Alsleben, 2015; Paluch and Werk, 2014; Sangenstedt, 2014) and its potential conceptualisation and operationalisation was analysed (Binder et al., 2021; Karrenstein, 2019), it has been merely mentioned in the European legal discourse so far (Fischer et al., 2016).

Three years after its transposition to national law, we set out to evaluate the impact of the amended EIA Directive with regard to the consideration of 'land' in environmental assessments. We examined by which regulations selected EU countries have transposed and implemented the Directive into domestic law, and asked national experts how they judge the amendment with regard to its potential to reduce land take in practice. Specifically, we investigated whether the factor 'land' has been included in national legislations and to what extent its definition and operationalization differs from the factor 'soil'. Our main hypothesis was that the implementation of the EIA Directive leads to increased attention for land take in planning processes and project approvals across the EU. The survey, in turn, suggested that the legislative changes have – so far – not substantially affected land take-related decisions. We discuss our results in light of the persisting challenges that impede existing approaches to confine further land take in the EU.

4.1 The policy context of the EIA-Directive of the European Union

4.1.1 EU regulation on Environmental Impact Assessment and Strategic Environmental Assessment

Environmental assessments identify, estimate, and evaluate the environmental impacts of existing and proposed projects, to mitigate the relevant negative effects prior to making decisions and commitments (Balaman, 2019). An EIA is carried out at project level, e.g. for an infrastructure development such as constructing a road, that needs public approval. In order to prevent environmental damage, an EIA requires the clarification of the rationale and purpose of a project, the identification of potential significant impacts and the consideration of alternatives and mitigation measures (Glasson et al., 2005). It further necessitates public consultation and participation, systematic review and post-decision monitoring (Glasson et al., 2005). Today almost every country has EIA systems and legislation in place (UNEP, 2018).

EU Directive (85/337/EC) to harmonize national EIA approaches across European Member States has been in force since 1985 and applies to a wide range of public and private projects, which are defined in the annexes of the directive. The EIA Directive and its three amendments were codified by Directive 2011/92/EU in 2011. A further amendment followed in 2014 by Directive 2014/52/EU, which is in focus here. The amended Directive 2014/52/EU came into force on 15 May 2014, and the EU Member States had to transpose it into their national law by 16 May 2017.

Three of the changes made in 2014 that affected Article 3 of the EIA Directive (see Table 4) relate to the scope of the assessment: The new version of Article 3 lists 'land' as an additional environmental factor next to 'soil', it highlights the species and habitats of the European Natura 2000 network as being particularly relevant for biodiversity, and it explicitly calls 'expected effects deriving from the vulnerability of the project to risks of major accidents and/or disasters' into consideration. Further changes in Art. 3 para. 1 EIA Directive were rather editorial: The term 'human beings' was replaced by 'population and human health', and the term 'fauna and flora' by 'biodiversity', which corresponds to the wording of the SEA Directive 2001/42/EC.

Table 4: Changes in Article 3 of the EIA Directive

Article 3 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment	Article 3 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, as adapted by Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014
The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case and in accordance with Articles 4 to 12, the direct and indirect effects of a project on the following factors: (a) human beings, fauna and flora; (b) soil, water, air, climate and the landscape; (c) material assets and the cultural heritage; (d) the interaction between the factors referred to in points (a), (b) and (c).	1. The environmental impact assessment shall identify, describe and assess in an appropriate manner, in the light of each individual case, the direct and indirect significant effects of a project on the following factors: (a) population and human health; (b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC and Directive 2009/147/EC; (c) land, soil, water, air and climate; (d) material assets, cultural heritage and the landscape; (e) the interaction between the factors referred to in points (a) to (d). 2. The effects referred to in paragraph 1 on the factors set out therein shall include the expected effects deriving from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project concerned.

Additional to Art. 3 para. 1 of the Directive, recital 9 contains the terms 'land' and 'land take'; it reads (italics added by the authors):

'The Commission Communication of 22 September 2006 entitled 'Thematic Strategy for Soil Protection' and the Roadmap to a Resource-Efficient Europe underline the importance of the sustainable use of soil and the need to address the unsustainable increase of settlement areas over time (*land take*). Furthermore, the final document of the United Nations Conference on Sustainable Development held in Rio de Janeiro on 20-22 June 2012 recognises the economic and social significance of good land management, including soil, and the need for urgent action to reverse land degradation. Public and private projects should therefore consider and limit their impact on *land*, particularly as regards *land take*, and on soil, including as regards organic matter, erosion, compaction and sealing; appropriate land use plans and policies at national, regional and local level are also relevant in this regard.'

The terms 'land' and 'land take' are further mentioned quite prominently in Annex IV of Directive 2014/52 (Information for the Environmental Impact Assessment report).

4.1.2 Multilingualism in the EU as a regulatory challenge

One of the founding principles of EU is multilingualism, and it becomes a growing challenge for policy implementation with now 24 official EU languages (Šarčević, 2001). Clear definitions and guidelines for interpretation are therefore indispensable to ensure a joint understanding of cen-

tral terms across the different countries. This holds true, e.g., for ‘soil’, ‘land’ and land take, key terms in the context of the EU EIA Directive assessed here.

‘Soil’ is defined in the EU Thematic Strategy of Soil Protection as ‘the top layer of the earth’s crust, formed by mineral particles, organic matter, water, air and living organisms. It is the interface between earth, air and water and hosts most of the biosphere.’ (EC, 2006). Directive 2014/52/EU refers to this strategy and recites parts of the definition in recital 9. In contrast, the term ‘land’ remains unspecified in context of Directive 2014/52/EU, although respective definitions exist on the European level. For example, the General Multilingual Environmental Thesaurus, maintained by the EEA provides such a definition. It states that ‘land’ is ‘a specified geographical tract of the Earth’s surface including all its attributes, comprising its geology, superficial deposits, topography, hydrology, soils, flora and fauna, together with the results of past and present human activity, to the extent that these attributes exert a significant influence on the present and future land utilization.’ (EEA, 2001). A different definition is used in the ‘Future brief: No net land take by 2050?’, a policy brief published by the Science Communications Unit of the EC (EC, 2016b). It refers to Art. 1e of the United Nations Convention to Combat Desertification, that defines ‘land’ as ‘the terrestrial bio-productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system’ (UNEP, 1994). Both definitions are rarely referenced in the scientific and legal literature on the factor ‘land’ (see Alsleben, 2015 for an exception) and not used in further European Guidance documents (EC, 2017a, b, c, 2012a, b; EEA, 2005). Recital 9 of Directive 2014/52/EU nevertheless gives an indication of how to interpret ‘land’ in the EIA by setting it in context to land take.

EU legislation is translated and published in all official languages (except Irish), and all these versions are equally binding. Thus, Directive 2014/52/EU exists in 23 versions and different connotations of terms used in national languages as equivalents to ‘soil’, ‘land’ and land take may influence how ‘land’ is understood and separated from other environmental assets in the respective domestic or European context. These 23 versions of Directive 2014/52/EU had to be transposed into the national law of the respective countries. According to Art. 288 Treaty on the Functioning of the European Union (TFEU), directives as a type of European secondary legal acts, bind the countries regarding the results to be achieved, but leave the national authorities the choice of form and methods. Regarding ‘land’, this enables the countries to choose a term in their national language that may diverge from the official literal translation if they regard it as best suited to grasp the concept of ‘land’.

The way from the drafting of a directive to the final wording in the national legislation in the EU countries thus includes various steps, where difficulties in communication could arise. Prior SURFACE research examined other potential miscommunications in regard to land take, namely in its relation to ‘land consumption’ (Marquard et al., 2020; see also Chapter 3 of this report). Within the context of this study, we examined the distinction between ‘land’ and ‘soil’ and the linguistic variations of ‘land’ and land take in the different stages of the legal process.

4.2 Results

4.2.1 How was the EIA Directive 2014/52/EU transposed into domestic law?

Merely three out of the 11 countries included in our study France, Italy and Poland - managed to meet the May 2017 deadline for the transposition of Directive 2014/52/EU (EC, 2019c, page 41; 2019d, page 37; 2019e, page 34). Some of the other countries in our survey, e.g. Austria and Germany, have implemented with delays (see Table 5). The EC launched 21 infringement cases for late transposition across the EU Member States (EC, 2018, 30). Further infringement cases concerned shortcomings in the amended legislation. These calls to improve domestic rules –

addressed to Austria, Germany, Italy, Sweden and Portugal, among others – were not related to the newly included factor ‘land’, but rather to national requirements on screening, shortcomings in public consultation rules and transboundary Environmental Impact Assessment procedures (EC, 2020a, b, 2019a, b).

By 2020, however, all countries considered in our study had transposed Directive 2014/52/EU into national law. The legislative decisions for the transposal of the Directive 2014/52/EU are listed in Table 5. In the following sections, we discuss how the specific implementation of the newly introduced factor ‘land’ took place in the respective national/regional laws.

Table 5: Legislative Transposition of Directive 2014/52 in the European Member States

Country	Transposition of Directive 2014/52	Transposition of Directive 2014/52
Austria	Beschluss des Nationalrates vom 25. Oktober 2018 betreffend ein Bundesgesetz, mit dem das Umweltverträglichkeitsprüfungsgesetz 2000 geändert wird	https://www.parlament.gv.at/PAKT/VHG/XXVI/BNR/BNR_00098/fname_717012.pdf
Czech Republic	Zákon kterým se mění zákon č. 100/2001 Sb., o posuzování vlivů na životní prostředí a o změně některých souvisejících zákonů (zákon o posuzování vlivů na životní prostředí), ve znění pozdějších předpisů 326/2017	https://www.zakonyprolidi.cz/cs/2017-326
England (UK)	The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (2017) & The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017	http://www.legislation.gov.uk/ukxi/2017/571/contents/made https://www.legislation.gov.uk/ukxi/2017/572/contents/made
Estonia	Keskkonnamõju hindamise ja kesk-konnajuhtimissüsteemi seaduse muutmise ning sellega seoses teiste seaduste muut-mise seadus (2015)	https://www.riigiteataja.ee/akt/123032015006
Flanders (Belgium)	Besluit van de Vlaamse Regering van 17 februari 2017 betreffende het geïntegreerde planningsproces voor ruimtelijke uitvoeringsplannen, planmilieueffectrapportage, ruimtelijke veiligheidsrapportage en andere effectbeoordelingen	https://navigator.emis.vito.be/mijn-navigator?wold=75128
France	Ordonnance n° 2016-1058 du 3 août 2016 relative à la modification des règles applicables à l'évaluation environnementale des projets, plans et programmes	https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032966723&categorieLien=id
Germany	Gesetz zur Modernisierung des Rechts der Umweltverträglichkeitsprüfung vom 20. Juli 2017	http://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl117s2808.pdf

Country	Transposition of Directive 2014/52	Transposition of Directive 2014/52
Italy	Decreto Legislativo 16 giugno 2017, n. 104	https://www.gazzettaufficiale.it/atto/stampa/serie_generale/originario
Poland	Ustawa z dnia 9 października 2015 r. o zmianie ustawy o udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziaływania na środowisko oraz niektórych innych ustaw (Dz.U. 2015 poz. 1936) & Ustawa z dnia 19 lipca 2019 r. o zmianie ustawy o udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziaływania na środowisko oraz niektórych innych ustaw (Dz.U. 2019 poz. 1712)	http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20150001936/T/D20151936L.pdf http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20190001712/O/D20191712.pdf
Portugal	Decreto-Lei n.º 152-B/2017, de 11 de dezembro (2017)	https://dre.pt/pesquisa/-/search/114337013/details/maximized
Sweden	Miljöbedömningsförordning (2017:966)	http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/miljobedomningsforordning-2017966_sfs-2017-966
Wallonia (Belgium)	Projet de décret transposant la directive 2014/52/UE du Parlement européen et du Conseil du 16 avril 2014 modifiant la directive 2011/92/UE concernant l'évaluation des incidences de certains projets publics et privés sur l'environnement et modifiant le décret du 11 mars 1999 relatif au permis d'environnement en ce qui concerne la dématérialisation et la simplification administrative et diverses dispositions (2018)	https://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=fr&la=F&cn=2018052414&table_name=loi

4.2.2 Was there a sufficient transposition in a legal sense?

According to the answers of the survey participants, the factor 'land' has been integrated into domestic laws of nearly all countries/regions examined here. Only the Czech Republic and Sweden did not extend their list of factors (see below for details). In all other countries the national (or in the case of Belgium: regional) law has been changed to also include the factor 'land' (Austria, England, Estonia, Flanders, France, Germany, Italy, Poland, Portugal, Wallonia).

Most of the countries that amended their national laws to account for the new factor 'land', did so by using terms identical to those used in the official language version of the EIA Directive 2014/52/EU. However, four countries selected a wording that slightly differs from the official EU translation as shown in Table 6.

Table 6: Comparison of wording between official EU language versions and national law

Country	Official EU translation of 'land, soil' in Art. 1 Nr. 3)	Terms in national law
Countries with divergent wording		
Estonia	maa, muld	maa, pinnas <i>land, soil</i>
Poland	grunty , gleby	gleby, powierzchni ziemi <i>soil, earth's surface</i>
Portugal	terra , solo	o território , o solo <i>land, soil</i>
Countries with consistent wording		
Austria	Fläche , Boden	die in Anspruch genommenen Flächen , der Boden <i>land take (pl.), soil</i>
Czech Republic	půdu	půdu
England (UK)	land, soil	land, soil
Flanders (Belgium)	het land, de bodem	het land, de bodem
France	les terres, le sol	Les terres, le sol
Germany	Fläche, Boden	Fläche, Boden
Italy	territorio, suolo	territorio, suolo
Sweden	mark, jord	mark, jord
Wallonia (Belgium)	les terres, le sol	les terres, le sol

As indicated above, in the Czech Republic, the national assessments laws were not changed with regard to the factor 'land'. The Czech experts explained that the meaning of the factor 'land' had been already covered by the Czech Environmental Assessment Act since its adoption in 2002,

because the Czech word 'půda' used in the Czech act can be translated as 'soil' as well as 'land'. They reported further that, in Czech EIA practice, it has been common to assess the impact a project has on soil as well as the quantities of land take, thus 'půda' has long been interpreted also in the sense of 'land'. This was said to be true since the early 1990s, and also for assessments that need to be carried out independently of whether a project is subject to EIA or not (as specified in legislation to ensure the protection of agricultural land and forests). This explains why the official translation of the five factors listed in Art. 3 I (c) 2014/52/EU 'land, soil, water, air and climate' in Czech reads 'půdu, vodu, ovzduší a klima' and contains only four terms (see appendix, sections E 3.2 and E 3.3). Thus, the Czech Republic has not failed to include 'land' in the list of factors, since its meaning was already covered by the previous wording of Czech law.

Similarly, for Sweden, the consulted expert reported that 'land and soil' were already listed as factors in the Swedish Environmental Code before the EIA Directive was amended in 2014 (Miljöbalk 1998:808; Chapt. 6, Section 2, Nr. 3). Therefore, 'land' was not introduced in course of the transposition of the amended directive. However, since 2017, and as a consequence of the EIA Directive 2014/52/EU, the Swedish law additionally requests to assess effects on the 'management of land' ('hushållningen med mark') which could cover changes due to land take.

Thus, all countries that participated in the survey transposed Directive 2014/52/EU and feature the factor 'land' in their national legislation.

4.2.3 Are effects of the inclusion of the factor 'land' (already) visible?

'Land' is only one of 11 factors that have to be taken into account in the EIA according to Art. 3 (1) of the EIA Directive (others are, for example, human health, biodiversity, climate). In order to find out how the area factor is assessed in the different Member States and to what extent it is taken into account in decisions, the survey asked for EIA assessments carried out after the national transposition of Directive 2014/52/EU that take the area factor into account. The experts were asked to give 1-3 practical examples and describe how the area factor was considered (question 6a). In addition, they were asked whether the inclusion of 'land' as a protected good in the EIA makes a difference in their personal opinion (question 7a).

Our experts provided examples from various countries/regions (Austria, Flanders, Czech Republic, England, France, Portugal), including cases from transport and energy infrastructure projects, urban development projects, and shopping or leisure facilities. Among the cases mentioned by the experts, EuropaCity (a shopping and leisure complex in the north of Paris) was the only example for which the expert noted that the project was ultimately rejected due to land take related concerns. It is important to emphasize, however, that the decision for the project rejection did not directly follow the EIA findings. The expert noted, however, that a central argument of the public resistance which eventually led to the project's cancellation was the imminent conversion of 80 ha of fertile agricultural land (280 ha of land for the entire project). In a reported example from the Czech Republic, the uptake of 1.7 ha land for a shopping center was judged only as 'slightly negative' in the assessment, partially because the soil at the site had been already deposited and compacted two years before. Similarly, in Flanders (Belgium), the expected land take of 6 ha of a business park in was also rated as 'slightly negative' and did not have any impact on the consideration of alternatives, since they all would have had the same effect on land. An expert from the Czech Republic reported on a road construction project that was expected to have 'very negative' impact on valuable (agricultural and forest) land. However, due to already approved municipal land use planning, the location and the extent of the affected area were seen as being without alternative. Furthermore, the public interest in the project was rated high and the impact on the land was therefore evaluated as acceptable. In summary, the specific

EIA cases listed by the experts showed exemplarily that projects affecting undeveloped land are not necessarily rejected or modified – even if an EIA concludes that their impact on land will be negative.

When asked about their personal judgements on ‘land’ being an additional EIA factor, experts mostly stated that it has hardly had any practical impact so far. In this context, also experts from countries other than Czech Republic and Sweden explained that ‘land’ had already been assessed in EIAs before the amendment of the national law – even though it had not been explicitly listed as a factor (e.g., experts from Estonia, Germany, Portugal, for the situation in the Czech Republic and Sweden see 4.2.).

The Estonian expert stated that prior to the amendment of the EIA directive, ‘land’ had been generally considered under ‘landscape, valuable agricultural land, green corridors etc.’ and that in his eyes, this had already been sufficient. Quite similar was the argumentation from the Portuguese expert who pointed out that the factor ‘solo’ had already been present in the first Portuguese legislation on EIA (1990). Since the word ‘solo’ can be translated with ‘soil’, ‘land’ and ‘territory’ the changes based on the amendment of EIA Directive 2014/52/EU were regarded as merely of cosmetic nature and were not expected to have further consequences in terms of legislation.

In Wallonia (Belgium), the word ‘terres’ was introduced into the Environmental Code to account for the new factor ‘land’ when Directive 2014/52/EU was transposed. According to our Belgian expert, the practical implications of this modification still await further clarification, as has been pointed out by the regional advisory committee for spatial planning (committee régionale d’aménagement du territoire, CRAT) in 2016.

Overall, there seems to be a consensus that the inclusion of the factor ‘land’ had not yet made a real difference. Nevertheless, ten experts (out of 12 who responded to the respective question) stated, that it could potentially make a difference in the future, especially by raising awareness.

4.2.4 Is there a clear distinction between ‘land’ and ‘soil’?

As answers to the previous question already showed, several experts were of the opinion that the concepts ‘land’ and ‘soil’ are not clearly distinguished in the EIA context (e.g. experts from Austria, Wallonia, Czech Republic, Germany, Italy and Portugal). Furthermore, experts asserted that in practice, ‘land’ is not treated as a separate factor (e.g. experts from Flanders, Estonia and UK). For the Czech Republic, the reported conflation of the two concepts can likely be explained by the linguistic specificity of ‘land’ and ‘soil’ being covered by the same Czech word (see 4.2). Noteworthy, also in other languages, terms that translate to the English word ‘soil’ often also comprise the concept of ‘ground’ or ‘floor’ and may therefore also be used in equivalence to ‘land’. For example, this is the case for the Portuguese word ‘solo’ (see 4.3). Moreover, the phenomenon that has been coined as ‘land take’ by the EEA is discussed as ‘consumo di suolo’ (‘consumption of soil/ground’) in Italy (see also Munafò, 2020). In Wallonia (Belgium), soil sealing and land take merge under the term ‘artificialisation’, for example in the Spatial Development Scheme (Schéma de Développement du Territoire Wallonie, SPW Territoire, 2019). The Wallonian expert stated, that he/she considers ‘consommation’ for land take and ‘imperméabilisation’ for ‘soil sealing’ as better suited to grasp the two concepts. In France there seems to be a similar situation, with ‘artificialisation’ or ‘artificialisation des sols’ used interchangeably, but in the same vain as ‘artificialisation’ in Wallonia.

In an effort to clarify the concepts and their distinction, some participants defined ‘land’ and ‘soil’ in their own words, but none of the experts referenced the definitions existing at the Euro-

pean level. Overall, 'soil' was linked predominantly to qualitative aspects, which include e.g. characteristics of the sediment, the soil structure and profile and the presence of (rare) soil types. The ecological functions of the soil, e.g. with respect to filtering, erosion control and groundwater control, were further mentioned as being relevant for assessing effects on 'soil'. The factor 'land' was, in contrast, characterized predominantly by a quantitative perspective. The latter often included a component of human activity in some form (e.g. land use, conversion of the land, uptake for construction, soil sealing). In line with this differentiation, three of the experts (from Austria, Germany and Flanders) explicitly asserted that the factor 'soil' refers rather to qualitative and the factor 'land' rather to quantitative aspects of the area that is affected by the project. As mentioned above, the distinction between quantitative and qualitative impacts on land/soil was also reported from the Czech Republic. However, the experts did not seem to conceive this differentiation as clear-cut and mixed approaches are applied in some countries. One example is an economic instrument in the Czech system, i.e. the so-called charge for agricultural land loss (as discussed, e.g., in Vejchodská & Palucha, 2019). As one of the Czech experts explained, this system is based on a detailed classification of land according to its value for agricultural or silvicultural purposes. If land is converted, the charge that is due for an approval of a project depends on the quantity of land but also on its quality according to the category assigned to the respective land.

4.2.5 How is the factor 'land' operationalised in EIAs?

A specific weakness identified by many of the experts interviewed concerns the lack of operationalisation of the factor 'land', i.e. there is uncertainty about how impacts on land should be measured and reported. At the national level, EIA guidance documents have been published in most of the countries surveyed, e.g. in Austria (Federal Ministry for Sustainability and Tourism, 2019), the UK (Natural England and Department for Environment, Food and Rural Affairs, 2020) and Portugal (Agência Portuguesa do Ambiente, 2013). These guides support the implementation of EIAs, but they contain only few statements on the factor land, on the possible impacts of land take and on relevant measures and assessment scales for such impacts in the EIA context. According to the experts, this reduces the impact of including the factor 'land'. Even in cases where compensation requirements are set, the experts say that these are sometimes imprecise and cannot be adequately controlled in their implementation.

4.3 Discussion

In 2021, the year of this study, ten years had passed since the declaration of the "no net land take" target and the EIA Directive was revised in 2014. It is clear that all practical implications of Directive 2014/52/EU depend on its careful transposition and implementation by Member States: As national EIA systems differ and the interpretation of the Directive is flexible (Pölönen et al., 2019), delays and limitations of impacts should not be surprising. In the following, possible reasons for the so far negligible influence of the area factor on EIA in general and on project rejections in particular are discussed. Against this background, possible solutions are also discussed.

4.3.1 The potential of the EIA to influence land take

In the global and European political context, there are hopes in the EIA as an instrument that can help with resource protection and the realization of sustainability goals (EEA, 2019b; UNEP, 2018; EC, 2011). However, the EIA is a decision-making and information tool and not per se a protection instrument and depends on other political and legal strategies to maximize its potential impact in that regard (Roßnagel and Hentschel, 2017; Kuhlmann et al., 2014). If and to what

extent impact assessments can fulfil their aims in practice, is a question of substantive effectiveness (Chanchitpricha and Bond, 2013). A substantially effective environmental assessment ideally incorporates environmental issues in decision-making and increases awareness of environmental issues (Lyhne et al., 2017; Arts et al., 2012; Runhaar and Driessen, 2007). In fact, many participants of our study expressed the general hope that the problem of land take will draw heightened attention in the future. Ideally, including 'land' in environmental assessments would ensure this environmental concern to be more prominently taken in account by developers and decision-makers, especially on a regional and local level. However, the effectiveness of an EIA depends on various factors as the regulatory framework, the context of decision-making, the participation of the public and stakeholders and the quality, accuracy and accessibility of the impact assessment report (Chanchitpricha and Bond, 2013). These factors can vary on a case to case basis as well as in different (European) countries.

According to Hugé et al. (2011), the four central functions an impact assessment can fulfil in the decision-making process are: 1) to generate information, 2) serve as a forum for debate and deliberation, 3) help to foster attitude shifts and 4) structure complex situations. Direct influences of the environmental assessment in the decision-making process can be project modification, the selection of the most environmentally friendly alternative, mitigation measures or the abandonment of the project (Runhaar et al., 2019; Lyhne et al., 2017; Arts et al., 2012). In practice, EIAs usually do not entail the rejection of the entire project under assessment, but rather lead to incremental changes or modifications of the project – only in rare cases this also includes the consideration of a different location (Runhaar et al., 2019). However, our questionnaire data suggests that even in cases where the impact on land was taken into account, this did not necessarily influence the decision whether or not to choose an alternative development option.

Further indirect effects of environmental assessments can occur when the planning authority anticipates the mandatory assessment and may adapt the project from the outset (Runhaar and Driessen, 2007). Such effects are discussed in Germany, for example, under the term 'Vorwirkung' (pre-effect) of EIA (Führ et al., 2009).

4.3.2 Interpreting the so-far limited effects of the factor 'land' and ways forward

As we can see from our experts' opinions and the examples we collected, the impact of the factor 'land' in the EIA on singular decisions seems to be minimal so far. Based on the survey results and the scoping of the relevant literature, we can identify several reasons for this limited impact.

First, the time that has elapsed since the amendments of the relevant national provisions and our survey could have been too short for any substantial changes in common EIA practice. The deadline of the transposition of Directive 2014/52/EU ended in May 2017 but by then the factor 'land' had not yet been included into the national legislation of all the participating countries. Since we sent out the questionnaires in spring/summer 2020, there were merely three years between the transposition deadline and the survey. As some of the involved experts pointed out, the effects of the amended Directive could take some more time to really find entry into practice. This seems particularly reasonable in the light that most countries were late in implementing the directive (see 3.4.1). Given these circumstances of our survey, it seems reasonable to assess the substantive effectiveness of the EIA in regard to the factor 'land' (for example by using the framework by Runhaar and Driessen, 2007) after a considerable amount of time has passed (e.g. another ten years).

Secondly, prior to the amendment of the EIA Directive, 'land' was already included and assessed within the context of the factor 'soil' in some of the countries in our sample. As case summaries and opinions provided by the experts have shown, this practice continues to be the case today,

so 'land' is not yet universally recognized as a separate factor. In combination with the diffuse distinction between the two factors also in regard to their operationalization, this could explain why 'land' was not emphasized by the respondents as making a real difference. The European Union offers several guidance documents on the application and effectiveness of the EIA Directive (EC, 2017a, b, c; EEA, 2005). Overall, however, these sources provide scant information about definitions and indicators of 'land', as well as its differentiation from the other factors like 'soil' or 'landscape'. A clear definition of 'land' in the EIA context at the European level could be beneficial for communication and awareness-raising of the issue.

Thirdly, the lack of a proper operationalization of the factor 'land' in EIAs, including a set of indicators and a frame of reference seems to constitute a further, related challenge. The German Federal Environment Agency (UBA) is conducting a research project entitled "Area as a Protected Good under the Environmental Impact Assessment Act - Development of Practical Recommendations" (FKZ 3719 13 1020, duration 2019-2022) to investigate in more detail how the protected good of area can be operationalised in environmental assessments.

Binder et al. (2021) provide a proposal for the operationalizing the factor 'land' delimitating it from 'soil'. They argue that instead of distinguishing between soil as a qualitative concept and land as a quantitative concept, operationalisation could benefit from recognising that certain land use changes degrade the ecological functions of an area and restrict future use options more than others and that this should also be taken into account. Therefore Binder et al. propose six indicators to assess land take in EIA, namely:

- ▶ land-use change,
- ▶ land take,
- ▶ durability,
- ▶ limited usability of adjacent areas,
- ▶ discharge effect and,
- ▶ land demand.

The inclusion of the indicator 'limited usability of adjacent areas' would open up the possibility of also taking the effects of indirect land take into account, e.g. habitat fragmentation caused by settlement development or noise pollution of areas adjacent to traffic lanes that are not taken up directly by the traffic route.

Fourthly, in addition to missing information on indicators, the EU guidance documents include no link to the 'no net land take by 2050' target of the EU. In the same vein the operationalization of the factor 'land' in the reported EIA case summaries occurred without reference to land take goals, even in those Member States where this could have potentially been done (for an overview over quantitative land take targets in selected European countries, see Bovet and Marquard, 2021). In the examples given by the experts, it often seemed unclear how permissible land take was to be differentiated from non-permissible land-take. For determining respective thresholds, quantified national targets broken down to targets at the regional and municipal level could provide a useful frame of reference and thereby allow a more efficient use of the factor 'land' on a regional planning and project level.

Lastly, there are other reasons for the limited impact of 'land' of a more systemic nature: general weaknesses in EIA systems, path dependencies and interest constellations at the regional and

municipal level. For example in Flanders and Wallonia in Belgium the spatial planning regulations that still apply today were established in the 1970s, when large areas were declared as land to be developed. Today, these areas cannot be re-zoned without compensating the owners, which in turn would lead to immense costs for municipalities and local governments (Crabbé and Coppens, 2019). However, such compensations of land owners find little public support; so re-zoning stalls. Another example for path dependencies was reported from Italy, where historic building rights, as for example the so-called ground rent, seem to be an obstacle towards reducing land take on the local level (Pileri, 2013).

What is more, the current economic incentives work against reducing land take, since municipalities profit financially from turning open space into developed land but are not routinely compensated for measures to curb land take (Colseal et al., 2018; Nuijsl and Schröter-Schlaack, 2009). The spatial planning procedures at regional or municipal levels often result in legislative fragmentation (Moscarelli and Pileri, 2020; Salata et al., 2019). And while each institution on various governance levels may act according to its best intentions when balancing various interests, cumulative effects of individual decisions on land take are not sufficiently considered (Köck et al., 2007). In other words, the effective implementation of land use reduction strategies down to the local level remains a challenge that cannot be solved by amending the Impact Assessment Regulation alone.

A broader awareness of the land take issue and a financial incentive structure that does not generally subordinate environmental concerns to economic development are crucial: institutional path dependencies that make re-zoning of land a financial liability would have to be overcome. This suggests that the broader institutional and politico-economic context within which EIAs are conducted also plays an important role in determining the future impact of the factor 'land' in EIAs.

4.3.3 Limitations of our study in regard to different kinds of land take

In regard to the qualification of the factor 'land' and land take, our study has limitations, which arise from the boundaries of the EIA systems. Since the questionnaire focused on the factor 'land' as it is currently measured in EIA systems, it can miss aspects of the concept, which might be discussed in the scientific or legal literature, but are not (yet) included in the practical field. Examples of this are indirect land take and cumulative land take. As mentioned above, indirect land take arises from habitat fragmentation, degradation of adjacent areas or displacement of e.g. agricultural land uses to more natural sites (e.g. forest) due to the expansion of settlement and transport areas (Madadi et al., 2017; Haddad et al., 2015; Karlson and Mörtberg, 2015). Additionally, cumulative land take describes the combined impact on land by multiple projects in an area or country. It is an important factor to keep in mind, as small projects, that might not even trigger an EIA in some countries can have a considerable impact on the land overall (Genelletti et al., 2017). Depending on the weighting of factors such as indirect land use in the operationalisation of the factor 'land' in the EIA, projects could potentially be assessed differently in future (Binder et al., 2021).

At the same time, however, the scope of EIA needs to be limited to keep the instrument practicable and other instruments seem to be more suited to account for indirect and cumulative effects. For example, life cycle assessments (LCAs) are a common research tool to estimate environmental impacts comprehensively across all life stages of a product, including e.g. effects caused by the extraction of resources drawn on. Some scholars propose using LCA for assessing the impact of urban development at neighbourhood scale (Lotteau et al., 2015), others propose to combine LCA with models on urban metabolism in order to provide a powerful tool for policy makers in

developing and monitoring urban development policies (Goldstein et al., 2013). With regard to cumulative effects, a Strategic Environmental Assessment (SEA) is also likely to be a more appropriate tool than EIA, as it takes into account the effects of spatial and urban plans on a larger area. Therefore, it can be a powerful option to control cumulative effects of land use decisions. In Germany, EIA and SEA are regulated together in the Environmental Impact Assessment Act (§ 1 (1) UVPG). The amended wording of § 2 para. 1 no. 3 UVPG (area, soil, water, climate and landscape) therefore also refers to SEA. In the coming years, it will be necessary to observe how the protected resource of land is operationalised in the context of the assessment of plans and programmes and how the earlier and larger-scale consideration of land take made possible by SEA affects decision-making and the protection of land.

4.3.4 Avenues for further research

There are other components of the Directive 2014/52/EU that could be helpful in increasing the attention to land take beyond the factor ‘land’ assessed at the level of singular projects. Since the EIA report now has to include descriptions of the impact on land, there is an increase in data collection on the topic. Art. 6 para. 5 Directive 2014/52/EU requires the Member States to ensure access for the public to the relevant information through at least a central webportal. Although some of them existed prior to the revised EIA directive, such webportals are available for example in Austria (UBA, UVP-Dokumentation), Germany (UBA, federal UVP-Portal but also UVP-Portals of German Länder), Czech Republic (CENIA, Informační systém EIA) and Portugal (Agência Portuguesa do Ambiente, SIAIA). This collection of data could be useful for further research on the topic, for example regarding the operationalization of the factor ‘land’, the consideration of alternatives and or mitigation measures.

The results from the questionnaires of our study showed, that the current emphasis in the distinction between ‘land’ and ‘soil’ is on the differentiation between quantitative and qualitative indicators but that considerable conceptual ambiguities exist that partly hamper a common understanding of the land take phenomenon (see also Marquard et al. 2020). How linguistic differences with regard to land and soil shape political narratives and practical approaches around land take, and how this might influence the trajectories countries debate for tackling related ecological, economic and social challenges could be an interesting aspect of future research.

Moreover, we share the opinion of Binder et al. that the factor ‘land’ could profit from including qualitative components in the operationalization (see as well Alsleben, 2015). This could enable a more differentiated examination of contextualized land take impacts and the possibility to better protect land that is in a more natural state (van Vliet, 2019). One example where qualitative indicators are used in the operationalization of the factor ‘land’ is the Czech Republic. There, a levy is imposed on land take depending on the quality of the agricultural land in question, i.e. the conversion of ecologically more valuable areas is subject to a higher levy than ecologically less important areas. Paradoxically, while this policy has been designed to protect precious agricultural land from excessive development, it could also become a driving force of the loss of precious land due to the dual role of municipalities – as levy gain receivers and as decision makers concerning future usage of land within their jurisdiction (Vejchodska and Pelucha, 2019). The effective incorporation of qualitative aspects in the practice of land take therefore needs to be further explored. Moreover, evaluating the potential of LCAs for feeding insights into EIA assessments could be another promising avenue of future EIA research (Karlsson et al., 2017).

5 Conclusions and recommendations for action

The growing land take for settlement and transport purposes is gaining attention worldwide as an environmental burden, especially against the background of the UN Sustainable Development Goals (SDGs) 11 and 15. For the EU and its Member States, the limitation of land take is additionally relevant in view of the EU target "No net land take until 2050". The aim of the SURFACE project was therefore to assess and analyze the status quo and the development of political goals and strategies on the topic of "land consumption" as well as implemented control instruments to reduce land take in selected countries.

The methodological core of the project consisted of two questionnaire-based expert surveys, which were complemented by literature research and expert workshops. The first survey was conducted in 2018 and examined the status quo of land consumption in 21 countries in Europe and selected countries worldwide. The second survey of the project in 2020 analyzed the implementation of Directive 2014/52/EU on the extension of the environmental impact assessment (EIA) to include land. Twenty-two experts from 11 European Member States participated in this survey.

In the following, the recommendations for action developed on the basis of the project results are summarized both for the EU level and at the level of the Member States.

Clearly conceptualize and prioritize the term land take

In the course of the empirical survey, the ambiguity of the terms land consumption from the SDG 11 indicator and land take from the EU 'No net land take' target became clear. This has implications for the conception and interpretation of key terms both in various EU strategies, directives and monitoring approaches, as well as in the implementation and translation of these frameworks into Member State practice. In the project, the experts involved in a focus group, in conjunction with a literature review, developed concrete approaches to eliminate existing ambiguities. Thus, a uniform, context-dependent clarification of the term definition is pleaded for and it is suggested to prioritize the term land take in the EU context. Standardizing the use of the term could facilitate communication on the dynamics of land use for settlement and infrastructure purposes within and between EU Member States and support the exchange of experiences in monitoring and mitigating settlement growth, land degradation and natural habitat loss. It would also enable harmonization and more efficient use of nationally and internationally collected data on land take. This would be particularly necessary with a view to consistent monitoring of target achievement and thus for evaluating and comparing the performance of the various country-specific spatial planning systems and management instruments.

Monitor land take on an ongoing basis and report in a comprehensible manner

The monitoring of land take changes is a basic prerequisite for planning procedures and the evaluation of the effectiveness of political steering instruments. Appropriate indicators and monitoring tools must therefore be available and provide reliable and comparable data. In this context, it is important to recognize the wide variety of land use classification systems and the different data sources (remote sensing, field surveys or cadaster) and to take them into account when reporting land take data. It is recommended that land take be understood as a change over time and consistently reported as a trend (e.g., as ha/day or km²/year). Relating measurements to a reference value (e.g. total area, number of inhabitants) increases comparability and should therefore be preferred. Urban densification measures should be excluded from the definition of land consumption (in the context of urbanization and spatial planning) and land take.

Add innovative policy instruments to spatial governance

The spatial governance structures in the Member States set different priorities and, in some cases, use different instruments. Comparing their effectiveness in reducing negative environmental, economic, and social impacts of land take holds great potential for mutual learning from best practices in a variety of different political, geographic, and cultural contexts and thus for more efficient spatial, national, and global governance.

One example of an instrument innovation is tradable development rights for effective quantitative control, in combination with spatial planning instruments for more spatially differentiated assessment and control of land take. For example, land take in the vicinity of a public transport line could be given preference over land take along car-dominated transport lines or land take in poorly developed peripheral locations. In addition, the type of settlement in question should be taken into account; in the case of land take, spatial planning instruments should aim for high efficiency and a high settlement density. Complementary to the goal of "no net land take", spatial planning practice should thus attempt to achieve qualitatively appropriate land take where necessary.

Further strengthen 'land' as a factor in environmental assessment.

The impact of including land as a factor in EIAs is considered by international experts to be limited so far. While this is partly due to delays in the implementation of the Directive by Member States (i.e. further impacts could unfold in the future), there are also still obstacles regarding the operationalization and contextualization of land as an aspect of EIAs. In particular, there is a lack of a precise definition of the term "land" or "land take" in the EU guidance documents, as well as a complete breakdown of quantitative targets for land take down to the regional and local levels. In terms of operationalization, the inclusion of qualitative indicators to assess the environmental impact of land take is recommended, as is already done in some countries. Without a clear reference to land use objectives and a suitable operationalization, the factor land cannot develop its full potential within the EIA. Moreover, the level of EIA, i.e., the individual development project, seems too small-scale to contribute noticeably to the reduction of land take. A standard consideration of the factor land is also recommended in the Strategic Environmental Assessment (SEA), which deals with plans and entire development programs, and could therefore better monitor and control cumulative effects of individual EIA-requiring projects.

6 References

- Agência Portuguesa do Ambiente (2013): Guias para a atuação das Entidades Acreditadas (EA) no Domínio do Ambiente –2. Guia AIA (in Portuguese).
https://www.apambiente.pt/_zdata/Divulgacao/Documentos%20Referencia/2%20GUIA%20AIA.pdf (Last accessed on January 14, 2021)
- Agência Portuguesa do Ambiente: Sistema de Informação sobre Avaliação de Impacte Ambiental.
<https://siaia.apambiente.pt/> (Last accessed on February 26, 2021)
- Aksoy, E.; Gregor, M.; Schroder, C.; Lohnertz, M.; Louwagie, G. (2017): Assessing and analysing the impact of land take pressures on arable land. In: *Solid Earth*, 8, p. 683–695
- Alsleben, C. (2015): "Fläche" als neues (altes) Schutzgut der UVP: Konturen des Schutzgutes Fläche unter der neuen UVP-Richtlinie. In: Hanke, R.; Schmidt, C.; Tschirner, M.-L. [ed.]: *Dresdner Planergespräche*. TU Dresden, p. 27–36
- Artmann, M.; Inostroza, L.; Fan, P. (2019): Urban sprawl, compact urban development and green cities. How much do we know, how much do we agree? In: *Ecological Indicators*, 96, p. 3-9
- Arts, J.; Runhaar, H.; Fischer, T.; Jha-Thakur, U.; van Laerhoven, F.; Driessen, P.; Onyango, V. (2012): The effectiveness of EIA as an instrument for environmental governance: Reflecting on 25 years of EIA practice in the Netherlands and the UK. *Journal of Environmental Assessment Policy and Management*, 14, article ID 1250025
- Balaman, Ş.Y. (2019): Chapter 4 – Sustainability Issues in Biomass-Based Production Chains. In: Balaman, Ş.Y. [ed.]: *Decision-Making for Biomass-Based Production Chains*. Academic Press, p. 77–112
- Balla, S.; Peters, H.-J. (2015): Die novellierte UVP-Richtlinie und ihre Umsetzung. In: *Natur und Recht*, 37, p. 297–305
- Barbosa, A.; Vallecillo, S.; Baranzelli, C.; Jacobs-Crisioni, C.; Silva, F. B. E.; Perpina-Castillo, C.; Lavalle, C.; Maes, J. (2017): Modelling built-up land take in Europe to 2020: an assessment of the Resource Efficiency Roadmap measure on land. In: *Journal of Environmental Planning and Management*, 60, 8, p. 1439–463
- Bartke, S. (2013): Editorial: Improving brownfield regeneration - a sustainable land take solution. In: European Commission's DG Environment [ed.]: *Science for Environment Policy: Brownfield Regeneration*. Thematic Issue 39, Bristol, p. 3–4
- Binder, C.; Krüger, G.; Rudner, M. (2021): Das Schutzgut "Fläche" in der Umweltverträglichkeitsprüfung. Eine neue Methode in Fachgutachten zu Straßenbauvorhaben. In: *UVP-Report*, 35, 1, 26-33
- BIO by Deloitte (2014): Study supporting potential land and soil targets under the 2015 Land Communication. Publications Office of the European Union, Luxembourg. <https://op.europa.eu/en/publication-detail/-/publication/fdbdf00a-87ac-4c85-8eab-ef60118963c5> (Last accessed on January 14, 2021)
- Bovet, J.; Marquard, E. (2021): Quantitative targets, tradable planning permits & infrastructure cost calculators: Examples of instruments addressing land take in Europe. In: Ginzky, H.; Dooley, E.; Heuser, I.L.; Kasimbazi, E.; Kibugi, R.; Markus, T.; Qin, T.; Ruppel, O. [ed.]: *International Yearbook of Soil Law and Policy*. Springer, Cham
- Bovet, J.; Reese, M.; Köck, W. (2018): Taming expansive land use dynamics - Sustainable land use regulation and urban sprawl in a comparative perspective, *Land Use Policy*, 77, p. 837–845
- Braitto, M.; Leonhardt, H.; Penker, M.; Schauppenlehner-Kloyber, E.; Thaler, G.; Flint, C. G. (2020): The plurality of farmers' views on soil management calls for a policy mix. In: *Land Use Policy*, 99, article ID 104876
- Brinkmann, K.; Hoffmann, E.; Buerkert, A. (2020): Spatial and Temporal Dynamics of Urban Wetlands in an Indian Megacity over the Past 50 Years. In: *Remote Sensing*, 12, p. 662

- Bryman, A. (2016): Social Research Methods; Oxford University Press: New York, USA, 2016
- Bundesministerium für Nachhaltigkeit und Tourismus (2019): UVE-Leitfaden: Eine Information zur Umweltverträglichkeitserklärung, Wien.
https://www.bmk.gv.at/themen/klima_umwelt/betrieblich_umweltschutz/uvp/uve.html (Last accessed on January 14, 2021)
- CENIA – Informační systém EIA (in Czech and English). https://portal.cenia.cz/eiasea/view/eia100_cr?lang=cs (Last accessed on February 26, 2021)
- Chanchitpricha, C.; Bond, A. (2013): Environmental Impact Assessment Review, 43, p. 63–72
- Cheng, V. K. M.; Hammond, G. P. (2017): Life-cycle energy densities and land-take requirements of various power generators: A UK perspective. In: Journal of the Energy Institute, 90, p. 201–213
- Cienciata, A.; Sobolewska-Mikulska, K.; Sobura, S. (2021): Credibility of the cadastral data on land use and the methodology for their verification and update. In: Land Use Policy, 102, article ID 105204
- Codified EIA Directive – Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification). In: Official Journal of the European Union, L 26, p. 1-21
- Colsaet, A.; Laurans, Y.; Levrel, H. (2018): What drives land take and urban land expansion? A systematic review. In: Land Use Policy, 79, p. 339–349
- Consolidated Version of the Treaty on the Functioning of the European Union. In: Official Journal of the European Union, C 326, p. 47-390
- Copernicus Land Monitoring Service a: CORINE Land Cover nomenclature conversion to Land Cover Classification system. https://land.copernicus.eu/eagle/files/eagle-related-projects/pt_clc-conversion-to-fao-lccs3_dec2010 (Last accessed on January 14, 2021)
- Copernicus Land Monitoring Service b: CORINE Land Cover. <https://land.copernicus.eu/pan-european/corine-land-cover> (Last accessed on October 5, 2020)
- Corbane, C.; Politis, P.; Siragusa, A.; Kemper, T.; Pesaresi, M. (2017): LUE User Guide: A tool to calculate the Land Use Efficiency and the SDG 11.3 indicator with the Global Human Settlement Layer. In: JRC Scientific Information Systems and Databases, edited by the European Commission/JRC, 33. Publications Office of the European Union, Luxembourg
- Cortinovis, C.; Haase, D.; Zanon, B.; Geneletti, D. (2019): Is urban spatial development on the right track? Comparing strategies and trends in the European Union. In: Landscape and Urban Planning, 181, p. 22–37
- Crabbé, A.; Coppens, T. (2019): Swapping Development Rights in Swampy Land: Strategic Instruments to Prevent Floodplain Development in Flanders. In: Hartmann, T., Slavíková, L., McCarthy, S. [ed.]: Nature-Based Flood Risk Management on Private Land: Disciplinary Perspectives on a Multidisciplinary Challenge. Springer International Publishing, Cham, p. 85–97
- d'Amour, C. B.; Reitsma, F.; Baiocchi, G.; Barthel, S.; Guneralp, B.; Erb, K. H.; Haberl, H.; Creutzig, F.; Seto, K. C. (2017): Future urban land expansion and implications for global croplands. In: Proceedings of the National Academy of Sciences of the United States of America, 114, 34, p. 8939–8944
- Darbi, M. (2020): Biodiversity offsets between regulation and voluntary commitment. Springer Nature, Cham.
- Decoville, A.; Schneider, M. (2016): Can the 2050 zero land take objective of the EU be reliably monitored? A comparative study. In: Journal of Land Use Science, 11, p. 331–349
- Desrousseaux, M.; Schmitt, B.; Billet, P.; Béchet, B.; Le Bissonnais, Y.; Ruas, A. (2019): Artificialised land and land take: What policies will limit its expansion and/or reduce its impacts? In: Ginzky, H.; Dooley, E.; Heuser, I.

L.; Kasimbazi, E.; Markus, T.; Qin, T. [ed.]: International Yearbook of Soil Law and Policy 2018. Springer Nature, Cham

Diaz-Pacheco, J.; Gutiérrez, J. (2014): Exploring the limitations of CORINE Land Cover for monitoring urban land-use dynamics in metropolitan areas. In: Journal of Land Use Science, 9, p. 243–259

Droste, N.; Ring, I.; Schröter-Schlaack, C.; Lenk, T. (2017): Integrating Ecological Indicators into Federal-State Fiscal Relations: A policy design study for Germany. In: Environmental Policy and Governance, 27, p. 484–499

EC – European Commission (2006): Thematic Strategy for Soil Protection (COM/2006/231 final). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Brussels. <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0231:FIN:EN:PDF> (Last accessed on January 14, 2021)

EC – European Commission (2011): Roadmap to a Resource Efficient Europe. (COM/2011/571 final). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571> (Last accessed on January 14, 2021)

EC – European Commission (2012): Guidelines on best practice to limit, mitigate or compensate soil sealing; Commission Staff Working Document, SWD 101 final, Publications Office of the European Union, Brussels. https://ec.europa.eu/environment/soil/pdf/guidelines/pub/soil_en.pdf (Last accessed on January 14, 2021)

EC – European Commission (2012a): Assessment of resource efficiency indicators and targets. Final report prepared by the BIO Intelligence Service, Institute for Social Ecology and Sustainable Europe Research Institute for the European Commission, DG Environment. https://ec.europa.eu/environment/enveco/resource_efficiency/pdf/studies/report.pdf (Last accessed on January 14, 2021)

EC – European Commission (2012b): Life cycle indicators framework: development of life cycle based macro-level monitoring indicators for resources, products and waste for the EU-27 (EUR 25466 EN). European Commission, Joint Research Centre, Institute for Environment and Sustainability, Luxembourg. <https://publications.jrc.ec.europa.eu/repository/bitstream/JRC73336/lbna25466enn.pdf> (Last accessed: January 14, 2021)

EC – European Commission (2016a): Next Steps for a Sustainable European Future – Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2016) 739 final; Strasbourg. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2016%3A739%3AFIN> (Last accessed: January 14, 2021)

EC – European Commission (2016b): Science for Environment Policy: No net land take by 2050?, Future Brief 14. Produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol. https://ec.europa.eu/environment/integration/research/newsalert/pdf/no_net_land_take_by_2050_FB14_en.pdf (Last accessed: January 14, 2021)

EC – European Commission (2017a): Environmental Impact Assessment of Projects. Guidance on Scoping (Directive 2011/92/EU as amended by 2014/52/EU). Publications Office of the European Union, Luxembourg. https://ec.europa.eu/environment/eia/pdf/EIA_guidance_Scoping_final.pdf (Last accessed on January 14, 2021)

EC – European Commission (2017b): Environmental Impact Assessment of Projects. Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU). Publication Office of the European Commission, Luxembourg

EC – European Commission (2017c): Environmental Impact Assessment of Projects. Guidance on Screening (Directive 2011/92/EU as amended by 2014/52/EU). Luxembourg.

https://ec.europa.eu/environment/eia/pdf/EIA_guidance_Screening_final.pdf (Last accessed on January 14, 2021)

EC – European Commission (2018): Monitoring the application of European Union Law 2017 Annual Report - Part II: Policy Areas (SWD/2018/378). Publication Office of the European Commission, Brussels. <https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:52018SC0378> (Last accessed on January 14, 2021)

EC – European Commission (2019a): Environmental impact assessment: Commission calls on Denmark, Sweden, Greece, Austria, Luxembourg, Portugal, Slovenia, Slovakia and Croatia to improve domestic rules (INF/19/5950). Publication Office of the European Commission, Brussels. https://ec.europa.eu/commission/presscorner/detail/en/INF_19_5950 (Last accessed on January 14, 2021)

EC – European Commission (2019b): Environmental impact assessment: Commission calls on Germany to take steps to ensure that the environmental impact of certain projects is adequately assessed (INF/19/6304). Publication Office of the European Commission, Brussels. https://ec.europa.eu/commission/presscorner/detail/en/INF_19_6304 (Last accessed on January 14, 2021)

EC – European Commission (2019c): The EU Environmental Implementation Review 2019. Country Report – Italy (SWD/2019/123 final). Publications Office of the European Union, Brussels. https://ec.europa.eu/environment/eir/pdf/report_it_en.pdf (Last accessed on January 14, 2021)

EC – European Commission (2019d): The EU Environmental Implementation Review 2019. Country Report – France (SWD/2019/120 final). European Commission, Brussels. https://ec.europa.eu/environment/eir/pdf/report_fr_en.pdf (Last accessed on January 14, 2021)

EC – European Commission (2019e): The EU Environmental Implementation Review 2019. Country Report – Poland (SWD/2019/128 final). European Commission, Brussels. https://ec.europa.eu/environment/eir/pdf/report_pl_en.pdf (Last accessed on January 14, 2021)

EC – European Commission (2020a): Environmental impact assessments: Commission calls on Italy to correct its domestic rules (INF/20/202). European Commission, Brussels. https://ec.europa.eu/commission/presscorner/detail/en/inf_20_202 (Last accessed on January 14, 2021)

EC – European Commission (2020b): Impact Assessment: Commission urges Czechia and Cyprus to correct their systems of environmental impact assessment (INF/20/859). European Commission, Brussels. https://ec.europa.eu/commission/presscorner/detail/EN/INF_20_859 (Last accessed on January 14, 2021)

EC – European Environment Agency (2001): General Multilingual Environmental Thesaurus: Land. European Environment Information and Observation Network. <https://www.eionet.europa.eu/gemet/en/concept/4599> (Last accessed on January 14, 2021)

EEA – European Environment Agency (2004): Land take - Indicator specification, <https://www.eea.europa.eu/data-and-maps/indicators/land-take> (Last accessed on October 19, 2021)

EEA – European Environment Agency (2005): Land cover accounts (LEAC) Methodological guidebook. Data processing of land cover flows. European Topic Centre Terrestrial Environment, European Environment Agency, Barcelona. <https://www.eea.europa.eu/data-and-maps/data/land-cover-accounts-leac-based-on-corine-land-cover-changes-database-1990-2000> (Last accessed on January 14, 2021)

EEA – European Environment Agency (2006): Urban Sprawl in Europe – The ignored challenge. Office for Official Publications of the European Communities, Copenhagen. Office for Official Publications of the European Communities (Last accessed on January 14, 2021)

EEA – European Environment Agency (2016): Land Recycling in Europe – Approaches to measuring extent and impacts. Publications Office of the European Union, Luxembourg. <https://www.eea.europa.eu/publications/land-recycling-in-europe> (Last accessed on January 14, 2021)

- EEA – European Environment Agency (2019): Land take - Indicator Assessment. Data and maps. <https://www.eea.europa.eu/data-and-maps/indicators/land-take-2/assessment-1> (Last accessed on January 14, 2021)
- EEA – European Environment Agency (2019a): The European environment - State and outlook 2020. Knowledge for transition to a sustainable Europe. Publications Office of the European Union, Luxembourg. <https://www.eea.europa.eu/publications/soer-2020> (Last accessed on October 19, 2021)
- EEA – European Environment Agency (2019b): Land take in Europe - Indicator Assessment. <https://www.eea.europa.eu/data-and-maps/indicators/land-take-3/assessment> (Last accessed on January 14, 2021)
- EEA – European Environment Agency and the Swiss Federal Office for the Environment (FOEN) (2016): Urban sprawl in Europe. Publication Office of the European Union, Luxembourg. <https://www.eea.europa.eu/publications/urban-sprawl-in-europe> (Last accessed on January 14, 2021)
- EIA Directive – Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. In: Official Journal of the European Communities, L 175, p. 40-48
- ESPON – European Observation Network for Territorial Development and Cohesion (2014): ET2050 Territorial Scenarios and Visions for Europe, Volume 5: Land-use Trends and Scenarios. https://www.espon.eu/sites/default/files/attachments/ET2050_FR-03_Volume_5_-_Land-use_Trends_and_Scenarios.pdf (Last accessed on January 14, 2021)
- European Parliament and the Council (2013): Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 Living well, within the limits of our planet. In: Official Journal of the European Union, p. 171-200
- European Soil Bureau Network, and European Commission (2005): Soil Atlas of Europe. Office for Official Publications of the European Community, Luxembourg. <https://esdac.jrc.ec.europa.eu/content/soil-atlas-europe> (Last accessed on January 14, 2021)
- Eurostat (2018): Sustainable development in the European Union. Monitoring report on progress towards the SDGs in an EU context. 2018 edition; Publications Office of the European Union: Luxembourg. <https://ec.europa.eu/eurostat/documents/3217494/9237449/KS-01-18-656-EN-N.pdf/2b2a096b-3bd6-4939-8ef3-11cfc14b9329?t=1547214788000> (Last accessed on January 14, 2021)
- Eurostat (2019): Sustainable development in the European Union. Monitoring report on progress towards the SDGs in an EU context. 2019 edition; Publications Office of the European Union, Luxembourg. <https://ec.europa.eu/eurostat/documents/3217494/9940483/KS-02-19-165-EN-N.pdf/1965d8f5-4532-49f9-98ca-5334b0652820?t=1573202053000> (Last accessed on January 14, 2021)
- Eurostat: Settlement area per capita (sdg_11_31). https://ec.europa.eu/eurostat/cache/metadata/en/sdg_11_31_esmsip2.htm (Last accessed on January 14, 2021)
- FAO; Intergovernmental Technical Panel on Soils (ITPS) (2015): Status of the World's Soil Resources (SWSR) - Main Report. Rome. <http://www.fao.org/3/i5199e/i5199e.pdf> (Last accessed on January 14, 2021)
- Fischer, T. B.; Théritel, R.; Bond, A.; Fothergill, J.; Marshall, R. (2016): The revised EIA Directive – possible implications for practice in England. In: UVP-report 30, p. 106–12
- Fleischmann, M.; Romice, O.; Porta, S. (2020): Measuring urban form: Overcoming terminological inconsistencies for a quantitative and comprehensive morphologic analysis of cities. In: Environment and Planning B: Urban Analytics and City Science, online first

- 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. In: *Journal of Environmental Planning and Management*, 58, p. 898–912
- Geneletti, D.; Biasioli, A.; Morrison-Saunders, A. (2017): Land take and the effectiveness of project screening in Environmental Impact Assessment: Findings from an empirical study. In: *Environmental Impact Assessment Review*, 67, p. 117–123
- Gerten, C.; Fina, S.; K. Rusche (2019): The Sprawling Planet: Simplifying the Measurement of Global Urbanization Trends. In: *Frontiers in Environmental Science*, 7, p. 140
- Glasson, J.; Therivel, R.; Chadwick, A. (2005): *Introduction to Environmental Impact Assessment*. 3th Edition, Routledge, Oxon
- Goldstein, B.; Birkved, M.; Quitzau, M.-B.; Hauschild, M. (2013): Quantification of urban metabolism through coupling with the life cycle assessment framework: concept development and case study. In: *Environmental Research Letters*, 8, article-ID 035024
- Gorsevski, P.V.; Donevska, K.R.; Mitrovski, C.D.; Frizado, J.P. (2012): Integrating multicriteria evaluation techniques with geographic information systems for landfill site selection: a case study using ordered weighted average. In: *Waste Management*, 32, 2, p. 287–296
- Guastella, G.; Oueslati, W.; Pareglio, S. (2019): Patterns of Urban Spatial Expansion in European Cities. In: *Sustainability*, 11, p. 2247
- Haddad, N. M.; Brudvig, L. A.; Clobert, J.; Davies, K. F.; Gonzalez, A.; Holt, R. D.; Lovejoy, T. E.; Sexton, J. O.; Austin, M. P.; Collins, C. D.; Cook, W. M.; Damschen, E. I.; Ewers, R. M.; Foster, B. L.; Jenkins, C. N.; King, A. J.; Laurance, W. F.; Levey, D. J.; Margules, C. R.; Melbourne, B. A.; Nicholls, A. O.; Orrock, J. L.; Song, D.-X.; Townsend, J. R. (2015): Habitat fragmentation and its lasting impact on Earth's ecosystems. In: *Science Advances* 1, 2, article ID e1500052
- Hartmann, T.; Spit, T. (2015): Dilemmas of involvement in land management – Comparing an active (Dutch) and a passive (German) approach. In: *Land Use Policy*, 42, p. 729–737
- Henger, R.; Bizer, K. (2010): Tradable planning permits for land-use control in Germany. In: *Land Use Policy*, 27, p. 843–52
- Hong, Y.; Heerink, N.; van der Werf, W. (2020): Farm size and smallholders' use of intercropping in Northwest China. In: *Land Use Policy*, 99, article ID 105004
- Hortas-Rico, M.; Sole-Olle, A. (2010): Does Urban Sprawl Increase the Costs of Providing Local Public Services? Evidence from Spanish Municipalities, *Urban Studies*, 47, p. 1513–1540
- Hugé, J.; Waas, T.; Eggermont, G.; Verbruggen, A. (2011): Impact assessment for a sustainable energy future – Reflections and practical experiences. In: *Energy Policy*, 39, p. 6243–6253
- Humer, A.; Sedlitzky, R.; Brunner, D. (2019): When does population growth pay off? A case study of suburban land consumption to assess the Lower Austrian infrastructural cost calculator. In: *Journal of Housing and the Built Environment*, 34, p. 331–44
- IPCC (2012): *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Field, C. B.; Barros, V.; Stocker, T. F.; Qin, D.; Dokken, D. J.; Ebi, K. L.; Mastrandrea, M. D.; Mach, K. J.; Plattner, G.-K.; Allen, S. K.; Tignor, M.; Midgley, P. M. [ed.]. Cambridge University Press, Cambridge, S. 582
- Jehling, M.; Hecht, R.; Herold, H. (2018): Assessing Urban Containment Policies within a Suburban Context—An Approach to Enable a Regional Perspective. In: *Land Use Policy*, 77, p. 846–58

- Joint Research Centre (2012): The State of Soil in Europe – A contribution of the JRC to the European Environment Agency's Environment State and Outlook Report - SOER 2010. Publications Office of the European Union, Luxembourg. https://esdac.jrc.ec.europa.eu/ESDB_Archive/eusoils_docs/other/EUR25186.pdf (Last accessed on February 14, 2021)
- JRC/European Soil Data Centre (ESDAC): LUCAS Land Use and Coverage Area frame Survey. <https://esdac.jrc.ec.europa.eu/projects/lucas> (Last accessed on 5 October, 2020)
- Karlson, M.; Mörtberg, U. (2015): A spatial ecological assessment of fragmentation and disturbance effects of the Swedish road network. In: *Landscape and Urban Planning*, 134, p. 53–65
- Karlsson, J.; Miliutenko, S.; Björklund, A.; Mörtberg, U.; Olofsson, B.; Toller, S. (2017): Life cycle assessment in road infrastructure planning using spatial geological data. In: *The International Journal of Life Cycle Assessment*, 22, p. 1302–1317
- Karrenstein, F. (2019): Das neue Schutzgut Fläche in der Umweltverträglichkeitsprüfung. In: *Natur und Recht*, 41, p. 98–104
- Köck, W.; Bovet, J.; Gawron, T.; Hofmann, E. (2007): Activating spatial planning law: options for the reduction of land consumption. In: *Journal for European Environmental & Planning Law*, 4, p. 2–16
- Kompil, M.; Aurambout J. P.; Ribeiro Barranco, R.; Barbosa, A.; Jacobs, C.; Pisoni, E.; Zulian, G; Vandecasteele, I.; Trombetti, M.; Vizcaino, M. P.; Vallecillo Rodriguez, S.; Batista E Silva, F.; Baranzelli, C.; Mari Rivero, I.; Perpiña Castillo, C.; Polce, C.; Maes, J.; Lavalle C. (2015): European cities: Territorial analysis of characteristics and trends - An application of the LUISA Modelling Platform (EU Reference Scenario 2013 - Updated Configuration 2014). Publications Office of the European Union, Luxembourg
- Kuhlmann, M.; Lintzmeyer, F.; Wilts, H. (2014): Umweltverträglichkeitsprüfung und Strategische Umweltprüfung als Instrumente des Ressourcenschutzes. In: *UVP-Report 28 (3+4)*, p. 186–194
- Lavalle, C.; Barbosa, A. L.; Mubareka, S.; Jacobs-Crisioni, C.; Baranzelli, C.; Perpina Castillo, C. (2013): Land use related indicators for resource efficiency. Part I Land Take Assessment. Publications Office of the European Union, Luxembourg
- Lotteau, M.; Loubet, P.; Pousse, M.; Dufrasnes, E.; Sonnemann, G. (2015): Critical review of life cycle assessment (LCA) for the built environment at the neighborhood scale. In: *Building and Environment*, 93, p. 165–178
- Lyhne, I.; van Learhoven, F.; Cashmore, M.; Runhaar, H. (2017): Theorising EIA effectiveness: A contribution based on the Danish system. In: *Environmental Impact Assessment Review*, 62, p. 240–249
- Madadi, H.; Moradi, H.; Soffianian, A.; Salmanmahiny A.; Senn, J.; Geneletti, D. (2017): Degradation of natural habitats by roads: Comparing land-take and noise effect zone. In: *Environmental Impact Assessment Review* 65, p. 147–155
- Marquard, E.; Bartke, S.; Font, J.G.I.; Humer, A.; Jonkman, A.; Jurgenson, E.; Marot, N.; Poelmans, L.; Repe, B.; Rybski, R.; Schröter-Schlaack, C.; Sobocka, J.; Sorensen, M.T.; Vejchodska, E.; Yiannakou, A.; Bovet, J. (2020): Land Consumption and Land Take: Enhancing Conceptual Clarity for Evaluating Spatial Governance in the EU Context. In: *Sustainability* 12, 19, article ID 8269
- Mayer, C. (2016): Directive 2014/52/EU: Big step forward or merely minimum consensus? - An attempt to evaluate the new EU-Regulations on the assessment of the effects of certain public and private projects on the environment. In: *Law Review I*, p. 97–108
- McDonald, R. I.; Forman, R. T. T.; Kareiva, P. (2010): Open Space Loss and Land Inequality in United States Cities, 1990–2000. In: *PLoS One*, 5, article ID e9509

- Melchiorri, M.; Pesaresi, M.; Florczyk, A. J.; Corbane, C.; Kemper, T. (2019): Principles and Applications of the Global Human Settlement Layer as Baseline for the Land Use Efficiency Indicator-DSDG 11.3.1. In: *Isprs International Journal of Geo-Information*, 8, p. 96
- Mercier, J.-R.; Mercier, C.-E.; Boutot, L.F.; Thibaut Baule, A. (2016): Transposing the revised EIA Directive in France: an opportunity for a genuine systemic approach or just more formalities? In: *UVP-report*, 30, 3, 133–142
- Meyer, M.A.; Früh-Müller, A. (2020): Patterns and drivers of recent agricultural land-use change in Southern Germany. In: *Land Use Policy*, 99, article ID 104959
- Montanarella, L.; Panagos, P. (2021): The relevance of sustainable soil management within the European Green Deal. In: *Land Use Policy*, 100, article ID 104950
- Moscarelli, R.; Pileri, P. (2020): The Effectiveness of SEA in Evaluating the Land Consumption. An Analysis on 100 SEAs in Lombardy, Italy. In: Campeol, G. [ed.]: *Strategic Environmental Assessment and Urban Planning*. Springer International Publishing, Basel, p. 85–98
- Munafò, M. (a cura di) (2020): Consumo di suolo, dina-miche territoriali e servizi ecosistemici. Edizione 2020. Report SNPA 15/20. https://www.snpambiente.it/wp-content/uploads/2020/07/Rapporto_consumo_di_suolo_2020_31luglio.pdf (Last accessed on January 14, 2021)
- Muñiz, I.; Dominguez, A. (2020): The Impact of Urban Form and Spatial Structure on per Capita Carbon Footprint in US Larger Metropolitan Areas. In: *Sustainability*, 12, p. 389
- Mustow, S.E. (2017): The new EIA Directive (2014/52/EU) and UK water impact assessment practice. *Impact Assessment and Project Appraisal*, 35, p. 240–247
- Mwaniki, D. (2018): Regional Training Workshop on Human Settlement Indicators. Module 3: Indicator 11.3.1 Land Consumption Rate to Population Growth Rate (Last accessed on 5 October, 2020) https://www.unescap.org/sites/default/files/Module%203_Land%20Consumption%20Rate%20to%20Population%20Growth%20Rate%20for%20indicator%2011.3.pdf
- Natural England and Department for Environment, Food and Rural Affairs (2020): Guidance - EIA (Agriculture) regulations: apply to make changes to rural land. <https://www.gov.uk/guidance/eia-agriculture-regulations-apply-to-make-changes-to-rural-land> (Last accessed on January 14 2021)
- Nicolau, R.; David, J.; Caetano, M.; Pereira, J. M. C. (2019): Ratio of Land Consumption Rate to Population Growth Rate-Analysis of Different Formulations Applied to Mainland Portugal. In: *Isprs International Journal of Geo-Information*, 8, S. 10
- Nuissl, H.; Schröter-Schlaack, C. (2009): On the economic approach to the containment of land consumption. In: *Environmental Science & Policy*, 12, p. 270–280
- OECD – Organisation für wirtschaftliche Zusammenarbeit und Entwicklung (2017): The governance of land use in OECD countries: Policy analysis and recommendations. OECD Publishing, Paris
- Paluch, D.; Werk, K. (2014): Zum aktuellen Sachstand und zur Bewertung der europäischen Beschlüsse zur Änderung der UVP-Richtlinie. In: *Natur und Recht*, 36, p. 400–405
- Pierri Daunt, A.B.; Sanna Freire Silva, T.; Bürgi, M.; Hersperger, A.M. (2021): Urban expansion and forest reserves: Drivers of change and persistence on the coast of São Paulo State (Brazil). In: *Land Use Policy*, 101, article ID 105189
- Pileri, P. (2013): 1963-2013: Fifty years as hostage to ground rent and land consumption. Isn't it time to change course? In: *Plurimondi VI*, p. 54–68

Pölönen, I.; Mikkonen, E.; Jalava, K. (2019): Great differences in the ways of implementing the new EIA Directive – the offerings of the EIALAW 2018 conference. In: *Impact Assessment and Project Appraisal*, 37, p. 88–91

Rega, C.; Singer, J. P.; Geneletti, D. (2018): Investigating the substantive effectiveness of Strategic Environmental Assessment of urban planning: Evidence from Italy and Spain. In: *Environmental Impact Assessment Review*, 73, p. 60–69

Revised EIA Directive – Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. In: *Official Journal of the European Union*, L 124, p. 1–18

Roßnagel, A.; Hentschel, A. (2017): Rechtliche Instrumente des allgemeinen Ressourcenschutzes. Umweltbundesamt Texte 23/2017. <https://www.umweltbundesamt.de/publikationen/rechtliche-instrumente-des-allgemeinen>

Runhaar, H.; Driessen, P. (2007): What makes strategic environmental assessment successful environmental assessment? The role of context in the contribution of SEA to decision-making. In: *Impact Assessment and Project Appraisal*, 25, 1, p. 2–14

Runhaar, H.; Gommers, A.; Verhaegen, K.; Cooman, K.; Corens, P. (2019): The effectiveness of environmental assessment in Flanders: An analysis of practitioner perspectives. In: *Environmental Impact Assessment Review*, 76, p. 113–119

Salata, S.; Peccol, E.; Borsato, O. (2019): A Framework to Evaluate Land Take Control Policy Efficiency in Friuli Venezia Giulia, Italy. In: *Sustainability*, 11, 22, p. 6406

Salvati, L. (2014): Land availability vs conversion by use type: A new approach for land take monitoring. In: *Ecological Indicators*, 36, p. 221–223

Salvati, L.; Zambon, I.; Chelli, F. M.; Serra, P. (2018): Do spatial patterns of urbanization and land consumption reflect different socioeconomic contexts in Europe? In: *Science of the Total Environment*, 625, p. 722–730

Sangenstedt, C. (2014): Die Reform der UVP-Richtlinie 2014: Herausforderungen für das deutsche Recht. In: *Zeitschrift für Umweltrecht*, 25, p. 526

Santos, R.; Schröter-Schlaack, C.; Antunes, P.; Ring, I.; Clemente, P. (2015): Reviewing the role of habitat banking and tradable development rights in the conservation policy mix. In: *Environmental Conservation*, 42, p. 294–305

Šarčević, S. (2001): Multilingualism - the challenge of enlargement. In: *Perspectives*, 9, p. 313–324

Schiavina, M.; Melchiorri, M.; Corbane, C.; Florczyk, A. J.; Freire, S.; Pesaresi, M.; Kemper, T. (2019): Multi-Scale Estimation of Land Use Efficiency (SDG 11.3.1) across 25 Years Using Global Open and Free Data. In: *Sustainability*, 11, p. 25

SEA Directive – Directive 2001/42/EC of the European Parliament and of the Council of 27 June on the assessment of the effects of certain plans and programmes on the environment. In: *Official Journal of the European Union*, L 197, p. 30

Seto, K. C.; Güneralp, B.; Hutyrá, L. R. (2012): Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. In: *Proceedings of the National Academy of Sciences*, 109, p. 16083–16088

Shepherd, A.; Ortolano, L. (1996): Strategic environmental assessment for sustainable urban development. In: *Environmental Impact Assessment Review*, 16, p. 321–335

Siedentop, S.; Fina, S. (2012): Who sprawls most? Exploring the patterns of urban growth across 26 European countries. In: *Environment and Planning A: Economy and Space*, 44, p. 2765–2784

Smith, P.; House, J. I.; Bustamante, M.; Sobocká, J.; Harper, R.; Pan, G.; West, P. C.; Clark, J. M.; Adhya, T.; Rumpel, C.; Paustian, K.; Kuikman, P.; Cotrufo, M. F.; Elliott, J.A.; McDowell, R.; Griffiths, R. I.; Asakawa, S.; Bondeau, A.; Jain, A. K.; Meersmans, J.; Pugh, T. A. M. (2016): Global change pressures on soils from land use and management, *Global Change Biology*, 22, p. 1008–1028

Solly, A.; Berisha, E.; Cotella, G.; Rivolin, U. J. (2020): How Sustainable Are Land Use Tools? A Europe-Wide Typological Investigation. In: *Sustainability*, 12, p. 1257

Strollo, A.; Smiraglia, D.; Bruno, R.; Assennato, F.; Congedo, L.; De Fioravante, P.; Giuliani, C.; Marinosci, I.; Rittano, N.; Munafo, M. (2020): Land consumption in Italy. In: *Journal of Maps*, 16, p. 113–123

Thompson, R.; van Oosterom, P. (2021): Bi-temporal foundation for LADM v2: Fusing event and state based modelling of Land administration data 2D and 3D. In: *Land Use Policy*, 102, article ID 105246

Thorne, J. H.; Santos, M. J.; Bjorkman, J.; Soong, O.; Ikegami, M.; Seo, C.; Hannah, L. (2017): Does infill outperform climate-adaptive growth policies in meeting sustainable urbanization goals? A scenario-based study in California, USA. In: *Landscape and Urban Planning*, 157, p. 483–492

Tobias, S.; Conen, F.; Duss, A.; Wenzel, L. M.; Buser, C.; Alewell, C. (2018): Soil sealing and unsealing: State of the art and examples. In: *Land Degradation & Development*, 29, p. 2015–2024

Umweltbundesamt (Austria): UVP Genehmigungsdatenbank.

<https://www.umweltbundesamt.at/umweltthemen/uvpsup/uvpoesterreich1/uvp-dokumentation> (Last accessed on February 26, 2021)

Umweltbundesamt (Germany): UVP-Portal des Bundes. <https://www.uvp-portal.de/> (Last accessed on February 26, 2021)

UN Habitat: Metadata sheet on SDG indicator 11.3.1. <https://unstats.un.org/sdgs/metadata/files/Metadata-11-03-01.pdf> (Last accessed on February 14, 2021)

UNEP – United Nations Environment Program (1994): United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought, Particularly in Africa. UNEP, Geneva, Switzerland.

https://treaties.un.org/doc/Treaties/1996/12/19961226%2001-46%20PM/Ch_XXVII_10p.pdf (Last accessed on January 14, 2021)

UNEP – United Nations Environment Program (2014): Assessing Global Land Use: Balancing Consumption with Sustainable Supply. A Report of the Working Group on Land and Soils of the International Resource Panel.

https://www.resourcepanel.org/sites/default/files/documents/document/media/assessing_global_land_use_summary_english.pdf (Last accessed on June 14, 2021)

UNEP – United Nations Environment Program (2018): Assessing Environmental Impacts - A Global Review of Legislation, Nairobi, Kenya. <https://wedocs.unep.org/handle/20.500.11822/22691> (Last accessed on June 14, 2021)

Urban Development Ministers (2010): Toledo Declaration. Informal Ministerial Meeting on Urban Development. The Spanish Presidency of the European Union, Toledo.

http://ec.europa.eu/regional_policy/archive/newsroom/pdf/201006_toledo_declaration_en.pdf (Last accessed on June 14, 2021)

Ustaoglu, E.; Williams, B. (2017): Determinants of Urban Expansion and Agricultural Land Conversion in 25 EU Countries. In: *Environmental Management*, 60, 4, p. 717–746

van Vliet, J.; Eitelberg, D. A.; Verburg, P. H. (2017): A global analysis of land take in cropland areas and production displacement from urbanization. In: *Global Environmental Change*, 43, p. 107–115

Vejchodska, E. (2016): Tradable planning permits versus auctioned tradable development rights: different trading agents, different policy outcomes. In: *Journal of Environmental Planning and Management*, 59, p. 1418–1437

Wallonia SPW Territoire (2019): Schéma de Développement du Territoire.
http://lampspw.wallonie.be/dgo4/site_aménagement/aménagement/sdt (Last accessed on February 14, 2021)

Walz, U.; Stein, C. (2014): Indicators of hemeroby for the monitoring of landscapes in Germany. In: *Journal for Nature Conservation*, 22, p. 279–289

Wrbka, T.; Erb, K. H.; Schulz, N. B.; Peterseil, J.; Hahn, C.; Haberl, H. (2004): Linking pattern and process in cultural landscapes. An empirical study based on spatially explicit indicators. In: *Land Use Policy*, 21, p. 289–306

Yang, H.; Li, S.; Chen, J.; Zhang, X.; Xu, S. (2017): The Standardization and Harmonization of Land Cover Classification Systems towards Harmonized Datasets: A Review. In: *Isprs International Journal of Geo-Information*, 6, p. 154

Yuan, D.; Yau, Y.; Bao, H.; Lin, W. (2020): A Framework for Understanding the Institutional Arrangements of Urban Village Redevelopment Projects in China. In: *Land Use Policy*, 99, article ID 104998

Yuan, Y.; Chen, D.; Wu, S.; Mo, L.; Tong, G.; Yan, D. (2019): Urban sprawl decreases the value of ecosystem services and intensifies the supply scarcity of ecosystem services in China. In: *Science of the Total Environment*, 697, article ID 134170