APPENDIX 2. TABLE 2 RATIONALE FOR INDICATORS AND PERFORMANCE METRICS

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Objective of table: Provide additional definitions and justification for each indicator and metric so LandScale assessors can understand the reasons for their inclusion, composition, and value for their assessment.

Pillar 1: Ecosystems

Goal 1.1 Protect and restore natural ecosystems[1]		
Indicator/metric	**Applicability**	**Definition & Justification**
1.1.1 Natural ecosystem protection	Core	Definition: Degree to which natural ecosystems are protected through legal or other effective means. Justification: Protecting natural ecosystems from new or intensified threats is the most secure way to maintain ecological sustainability through their representation in formally protected and effectively managed areas and reduce or eliminate their conversion and degradation. The value of protected areas increases with their appropriate location relative to the distribution of natural ecosystems and biodiversity in the landscape and degree of effective management maintained within them.[2] This indicator is core because protection of natural ecosystems is essential for sustaining the array of values that they provide for biodiversity, carbon storage, and a variety of locally and regionally important ecosystem services, such as water supply, flood control, etc. Whether or not there are existing protected areas, it is important to characterize the degree of natural ecosystem protection (even if zero).

[1] LandScale uses the term "natural ecosystems" to include both natural and semi-natural types where the latter has undergone human modification but retains many elements of composition, structure, and function of the original natural ecosystem type.

[2] See the IUCN resources on protected areas: Biodiversity and protected areas. (2020). IUCN. https://www.iucn.org/commissions/world-commission-protected-areas/our-work/biodiversity-and-protected areas.

1.1.1.1 Total area (ha) and percentage (%) of the landscape that is designated and managed for long-term protection, disaggregated by ecosystem type and protected area (PA) category (national designation and corresponding IUCN PA category)	Required	Key measurement of the indicator.[3]

[3] Protected areas include those listed in the World Database on Protected Areas and their corresponding IUCN management categories as well as other areas that are protected and managed on a long-term basis to maintain ecosystem composition, structure, and function. The latter may include lands managed by indigenous peoples with long-term protection objectives, privately-owned conservation areas, and natural ecosystems within certified production or forest management units, among others.

1.1.1.2 Total area (ha) and percentage (%) of each natural ecosystem type under protection (i.e. within protected areas), disaggregated by ecosystem type and the protected area category (national designation and corresponding IUCN PA category)	Required	This metric complements the one above by providing information on the degree that each ecosystem type in the landscape is represented in protected areas. This informs whether an ecosystem type may be secure into the future (with respect to direct human threats but not extrinsic threats of climate change and intense fire for example). This metric therefore provides a gap analysis of each ecosystem type's representation in PAs.
1.1.1.3 Percentage (%) of area of protected areas with effective management[4], disaggregated by IUCN PA category	Recommended	Many PAs lack effective management, making them vulnerable to a variety of threats such as poaching, encroachment, logging, human-caused wildfires, etc. which reduces their value for maintaining ecosystems and biodiversity. Effective management of a PA considers capacity (personnel, funding, equipment, etc.) to ensure that the ecological values can be maintained.

[4] Effective management should be assessed on the basis of clear criteria for protected area management effectiveness, such as those in the IUCN Green List Standard https://www.iucn.org/theme/protected-areas/our-work/iucn-green-list-protected-and-conserved-areas.

1.1.2 Natural ecosystem conversion	Core	Definition: Conversion of natural ecosystems to other land uses. Justification: Converting natural ecosystems typically results in a permanent loss of the ecosystem type and associated services and biodiversity. It is extremely difficult ecologically, socially, and economically to substantially restore a natural ecosystem once converted.[5] This metric is core because any landscape relevant for LandScale assessment (e.g., contains natural resource-dependent production) will have past and/or ongoing conversion of natural ecosystems as well as risk of future conversion.
1.1.2.1 Total area (ha) and percentage (%) of area of natural ecosystems in the landscape that has been recently converted, disaggregated by ecosystem type	Required	Key measurement of the indicator.

[5] For example: The Ecosystem Approach: Learning from Experience. (2008). https://www.cbd.int/doc/external/iucn/iucn-ecosystem-approach-en.pdf

1.1.2.2 Natural ecosystem conversion rate (average area [ha] and percentage (%) conversion per yr), disaggregated by ecosystem type	Required	This metric adds information to the above metrics by understanding how fast conversion has been happening in recent years. Rapid rates, for example, may signal the need for more immediate intervention than very slow rates and more frequent monitoring.
1.1.3 Natural ecosystem degradation	Core	Definition: Degradation[6] of natural ecosystems. Justification: Degrading natural ecosystems removes part or all of one or more components of ecosystem composition, structure, and function thus rendering the ecosystem less biodiverse, structurally intact, and functional for providing for the needs of species and services to people.[7] This metric is core because degradation is a nearly universal dynamic in inhabited landscapes with natural resource-based economic activity.

[6] "Degraded" means ecosystems that have reached a threshold of degradation or detection of degradation according to a credible method or dataset (see assessment guidelines for suggested methods, data, and tools).

[7] The IPBES assessment report on land degradation and restoration. (2018). https://ipbes.net/assessment-reports/ldr
UNCCD (2020). Countries with Voluntary LDN Targets. https://knowledge.unccd.int/home/country-information/countries-with-voluntary-ldn-targets
IUCN. Land Degradation Neutrality: implications and opportunities for conservation, Technical Brief 2nd Edition, (2015). https://www.iucn.org/sites/dev/files/content/documents/tech_brief_land_degradation_neutrality_revised_2017_3.pdf
IUCN (2020). Connectivity Conservation. https://www.iucn.org/commissions/world-commission-protected-areas/our-work/connectivity-conservation#:~:text=The%20IUCN%20WCPA%20Connectivity%20Conservation,increasing%20resilience%20to%20climate%20change.
Finish Restoration Working Group (2020). Countries with Voluntary LDN Targets. https://knowledge.unccd.int/home/country-information/countries-with-voluntary-ldn-targets

1.1.3.1 Total area (ha) and percentage (%) of natural ecosystems in the landscape that is currently degraded, disaggregated by ecosystem type	Required	Key measurement of the indicator.
1.1.3.2 Natural ecosystem degradation rate, disaggregated by ecosystem type	Required	The rate of degradation informs whether impacts are happening quickly and if specific ecosystem types are more affected. This metric requires a baseline year and annual measurements over the assessment timeframe.
1.1.4 Ecosystem restoration	Landscape-dependent	Definition: Restoration of converted and degraded ecosystems. Justification: Many areas of natural ecosystems have been converted, degraded, and fragmented. Restoration actions can, to a degree, reverse these impacts and improve composition, structure, and function.[8] Restoration can also improve the economic, social, and cultural values of ecosystems upon which local people depend. This metric is landscape-dependent because restoration may not have been or currently be occurring in the landscape. If restoration actions are anticipated to begin within the timeframe of the assessment, then it should be included.

[8] See the following resources:
-United Nations (2020). Decade on Ecosystem Restoration. https://www.decadeonrestoration.org/
-Gann et al., (2019) International Principles & Standards for the Practice of Ecological Restoration, 2nd Edition. https://www.ser.org/page/SERStandards

1.1.4.1 Total area (ha) under restoration[9], disaggregated by ecosystem type & restoration type	Required	Key measurement for the indicator.
1.1.4.2 Rate of increase (ha/yr) in total area under restoration, disaggregated by restoration and ecosystem type	Recommended	Rate of restoration informs whether the pace of restoration is sufficient relative to rates of conversion and degradation.

-Hansen et al. (2015) The restoration diagnostic. Version 1.0. World Resources Institute and IUCN: https://www.wri.org/publication/restoration-diagnostic
-Five-Star system: McDonald T, Gann GD, Jonson J, and Dixon KW (2016) International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington, D.C. https://cdn.ymaws.com/sites/www.ser.org/resource/resmgr/docs/SER_International_Standards.pdf
-Zamora et al. (2017) Sustainability index for landscape restoration. A tool for monitoring the biophysical and socioeconomic impacts of landscape restoration. World Resources Institute.https://www.wri.org/publication/sustainability-index-landscape-restoration

[9] "Area under restoration" is defined as either: a) land where restoration has been successfully completed in general accordance with a restoration plan; or b) restoration is currently being implemented through specific on-the-ground actions and/or passive restoration management in accordance with a restoration plan.

1.1.5 Natural ecosystem connectivity	Optional	Definition: Connectivity and fragmentation of natural ecosystems (e.g., natural ecosystem conversion and infrastructure development) Justification: Connected ecosystems serve the needs of many species by supporting seed dispersal of plants, allowing access to different habitat types and resources for animals, and maintaining genetic diversity and resilience. Fragmentation of ecosystems reduces these functions along with other impacts such as decreasing moisture and allowing invasion by exotic species.[10] This metric is optional because connectivity may not be a key determiner of ecosystem sustainability, such as in landscapes where natural ecosystems and species are already adapted to a naturally or human-fragmented ecosystem pattern.
1.1.5.1 Assessor-defined metrics of connectivity and/or fragmentation appropriate to the types and patterns of natural ecosystems	Recommended	Connectivity is typically an important component of proper ecosystem functioning and viability for many species. Assessors should define metrics suitable to the ecosystems and species in the landscape and tractable with available data and technical capacity. Options can range from the use of simple landscape-wide connectivity/fragmentation indices to more advanced mapping/modeling of species-specific movement corridors. More than one metric may be necessary to capture different aspects of connectivity.

[10] See IUCN connectivity resources here: IUCN (2020). Connectivity Conservation. https://www.iucn.org/commissions/world-commission-protected-areas/our-work/connectivity-conservation#:~:text=The%20IUCN%20WCPA%20Connectivity%20Conservation,increasing%20resilience%20to%20climate%20change.

Goal 1.2 Protect and restore biodiversity		
Indicator/metric	**Applicability**	**Definition & Justification**
1.2.1 Threats to species	Core	Definition: Changes in threats to species. Species are inclusive of those on the IUCN Red List threatened categories and optionally other species of interest. Justification: Human activities that lead to habitat conversion and degradation or direct killing or collecting of species cause biodiversity decline and secondary ecosystem impacts such as changes in composition and structure. Stopping or reducing threats proactively is the best way to avoid impacts, reducing the need for restoration. This indicator is core because all landscapes where LandScale is intended to be applied will contain human activities that cause some threat to species.

1.2.1.1 Changes in threats to threatened species[11] using a metric that measures changes in threats of high scope and severity[12] in the IUCN Red List for threatened species in the landscape (required if IUCN Red List Threatened species are present in the landscape)	Required	This metric assesses current threat pressure and change (with repeat assessments) as a key measure of viability of Red List species. Measurement of this indicator is recommended to use the STAR metric[13] but other measures using localized data on species and threats are also acceptable.

[11] Threatened species refers to species at global risk of extinction, including those classified as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Near Threatened (NT) in the IUCN Red List of Threatened Species (www.iucnredlist.org). Changes in threats to threatened species should be assessed using the standardized approach provided by STAR (Species Threat Abatement and Recovery metric https://www.iucn.org/regions/washington-dc-office/our-work/species-threat-abatement-and-recovery-star-metric).

[12] High scope are those that affect the whole or majority of the population and high severity are those that cause very rapid to rapid declines per https://www.iucnredlist.org/resources/threat-classification-scheme

[13] The Species Threat Abatement and Recovery (STAR) Metric uses the IUCN Red List of Threatened Species data on globally assessed taxa (currently terrestrial vertebrates; trees to be added soon) to calculate a value (the STAR Score) that represents the opportunity to reduce the risk of species extinction in a particular area or landscape. Further information can be found here: https://www.iucn.org/regions/washington-dc-office/our-work/species-threat-abatement-and-recovery-star-metric.

1.2.1.2 2 Changes in threats to populations of indicator species or other species identified as important in the landscape	Required, alternate, or recommended, depending on context[14]	This metric optionally adds information about other species outside of those on the Red List that are important within the landscape. Because the STAR metric will not apply to these species, the assessor may develop their own proposed metric. Options and sources are provided in the Pillar Resources.
1.2.2 Biodiversity habitat conversion	Core	Definition: Conversion of natural ecosystems in areas identified as important for biodiversity[15] (e.g., Protected Areas [PAs], Key Biodiversity Areas [KBAs], and other areas identified as important). Justification: Conversion of habitat is a leading reason for species decline and extinction. Because these important biodiversity areas are often identified to support species that are threatened, at risk, rare, or otherwise vulnerable to extinction or local extirpation; conversion in them may have a significant impact on maintaining these species due to their already reduced population sizes and extent. This indicator is core because any landscape relevant for LandScale assessment (i.e., landscapes with natural resource-based economic activity) will have past and/or ongoing conversion of habitat, or threat of future conversion. This may be in protected areas that are insufficiently managed or in other important biodiversity areas lacking formal protection.

[14] In landscapes where there are no known or probable IUCN Red List threatened species occurring (i.e., when 1.2.1.1 is not required), this metric will be required. In landscapes where 1.2.1.1 is required, this metric is recommended.

[15] This includes Protected Areas (PAs), Key Biodiversity Areas (KBAs), and other areas identified as important by national or local designations, maps, or studies.

1.2.2.1 Area (ha) of natural ecosystem conversion within places identified as important for biodiversity and percentage (%) of such areas that this represents[16]	Required	This metric augments the ecosystem conversion metric by focusing on conversion within PAs, KBAs, and other identified areas important for biodiversity. These areas tend to harbor threatened species and therefore represent key habitat areas.
1.2.3 Biodiversity habitat degradation	Optional	Definition: Degradation of ecosystems in areas identified as important for biodiversity[17] (e.g., Protected Areas [PAs], Key Biodiversity Areas [KBAs], and other areas identified as important). Justification: As for indicator 1.2.2 above, degradation in areas identified as important for biodiversity, particularly for rare, threatened, and vulnerable species, can have a significant impact on maintaining these species. This indicator is optional because, while degradation of important habitat is likely to occur, degradation is also addressed in the ecosystem indicator 1.1.3. This indicator complements indicator 1.1.3 by adding information on degradation specific to protected areas and other identified areas of high biodiversity value.

[16] Since the baseline year established in 1.1.2.1

[17] Protected Areas (PAs), Key Biodiversity Areas (KBAs), and other areas identified as important by national or local designations, maps, or studies.

1.2.3.1 Area (ha) and percentage (%) of area of natural ecosystem degradation within places identified as important for biodiversity	Recommended	The amount of degradation within important biodiversity areas informs whether degradation is a serious threat to biodiversity conservation in these areas. With repeat assessments, trends in degradation can be measured. This metric may use the same data and methods used to measure ecosystem degradation or may draw on monitoring data within these areas which may be more accurate.
1.2.4 Biodiversity habitat restoration	Optional	Definition: Restoration of ecosystems in areas identified as important for biodiversity[18] (e.g., Protected Areas [PAs], Key Biodiversity Areas [KBAs], and other areas identified as important). Justification: Where these areas that are important for biodiversity are already impacted through conversion, degradation, and fragmentation, restoration is important for improving persistence of biodiversity and for threatened species in particular, for them to recover their viability. This indicator is optional because restoration is also addressed in the ecosystem indicator 1.1.5. This indicator complements indicator 1.1.5 by adding information on degradation specific to protected areas and other identified areas of high biodiversity value.

[18] Protected Areas (PAs), Key Biodiversity Areas (KBAs), and other areas identified as important by national or local designations, maps, or studies.

1.2.4.1 Area (ha) & percentage (%) of land under restoration[19] within areas identified as important for biodiversity	Recommended	Many places identified as important for biodiversity conservation, including protected areas, suffer from past conversion or ongoing degradation. Understanding the amount of restoration in these places is useful for gauging how well they may be retaining their biodiversity. Optionally this metric can be disaggregated by restoration type.
1.2.5 Biodiversity habitat protection	Optional	Definition: Protection of areas identified as important for biodiversity[20] (e.g., Protected Areas [PAs], Key Biodiversity Areas [KBAs], and other areas identified as important). Justification: In landscapes that contain areas identified as important for biodiversity conservation, it is useful to understand the proportion of the area of these places that are currently protected in designated areas. It is not recommended to include this metric where important biodiversity areas have not been rigorously and systematically identified, otherwise this metric may be misleading, i.e., suggesting that because only designated PAs have been identified and are protected, therefore, all important biodiversity areas are protected. This indicator is optional because protection is also addressed in the ecosystem indicator 1.1.1. This indicator complements indicator 1.1.1 by adding information on protection specific to areas of high biodiversity value.

[19] "Area under restoration" is defined as either: a) land where restoration has been successfully completed in general accordance with a restoration plan; or b) restoration is currently being implemented through specific on-the-ground actions and/or passive restoration management in accordance with a restoration plan.

[20] Protected Areas (PAs), Key Biodiversity Areas (KBAs), and other areas identified as important by national or local designations, maps, or studies.

1.2.5.1 Area (ha) and percentage (%) of areas identified as important for biodiversity that are designated and managed for long-term protection[21]	Recommended	Because the areas included in the 1.2 goal include those not already formally protected, it is useful to understand progress in achieving protection for all areas identified as important for biodiversity. This metric will be most informative if systematic planning has been conducted to identify all such places otherwise it could provide misleading information on the status of conserving biodiversity (i.e., if only a few of the important areas have been identified).
Goal 1.3 Maintain and enhance ecosystem services		
Indicator/metric	**Applicability**	**Definition & Justification**
1.3.1. Water quantity	Landscape-dependent	Definition: Provisioning capacity of water resources for human and agricultural consumption and for ecosystem function. Justification: Water shortages increasingly threaten human livelihoods and natural values such as ecosystem processes and biodiversity. Conserving and restoring natural areas can help maintain and enhance groundwater recharge and water flows. Ensuring water provision and resource management and understanding to what extent landscape activities depend on water is key to achieve sustainability at landscape scale. This indicator is landscape-dependent since not all landscapes are facing water stress.

[21] See footnote 2 for a definition of areas designated and managed for long-term protection.

1.3.1.1 Seasonal water quantity or flow rate of key water bodies (e.g. total volume, depth, volume flow /time)	Required	This metric can help track improvement of seasonal water flows/stocks derived from improved water management or watershed conservation and restoration measures. Changes in impounded lake and reservoir levels, groundwater abstraction,[22] and streamflows are appropriate means to identify risk and progress related to water scarcity at the landscape scale. Depending on whether groundwater and / or surface water are the main water resource for the landscape, the assessor might choose to monitor water levels, abstraction, and / or streamflow. It is strongly recommended to obtain records of water gauges and rainfall for at least five years to better understand the relationship between hydrology, land cover, and interannual precipitation hydroclimatic variability though longer timeframes may be necessary.
1.3.1.2 Water withdrawals (for production or processing) from surface or groundwater versus recharge (ratio)	Required	The ratio expresses the degree to which land-use activities exploit renewable water resources. It complements the first metric by indicating whether the demand for water exceeds aquifer recharge, which can explain declining levels of water bodies (1.3.1.1). Where possible and based on existing hydrological studies, the water recharge of the landscape should take into consideration water inflow/outflow from surrounding watersheds.
1.3.1.3 Frequency of interruption or shortage in water supply for agriculture, domestic & industrial sectors (average number of days per year with interruption or shortage of water availability)	Recommended	This metric indicates to what extent households and businesses suffer from water shortage at the landscape level.

[22] Removal of water from groundwater sources, typically for human use.

1.3.2. Water quality	Landscape dependent	Definition: Quality of water resources for human and agricultural consumption and for ecosystem function. Justification: Inadequately managed and treated industrial and agricultural wastes and nutrient run-off are among the most important pollution sources that are associated with land-use activities. Poor water quality increases the risk of adverse consequences for human health while harming aquatic life and potentially negatively impacting agriculture and other economic activities. Even though water quality is an important aspect of sustainability in every landscape, this indicator is landscape-dependent because water quality threats associated with land use are significant issues in only a subset of landscapes.
1.3.2.1 Total suspended solids in key water bodies (load/volume)	Required	Sediment load found in stream flows depends on soil erosion and sediment retention capacity of land, therefore it captures the efficacy of landscape management, conservation, and restoration efforts in reducing soil erosion. Total suspended solids also impacts treatment costs of drinking water, thus, this metric might help set incentives for water users to pay land-users for improved upper watershed management.
1.3.2.2 Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) (mg/l) or nutrients (nitrogen and phosphorus) (load/volume)	Required	BOD and COD inform on the capacity of stream flows to sustain aquatic life and aesthetic quality for human use. Oxygen demand reflects how much oxygen is needed for bacteria to decompose waterborne organic matter and toxic compounds. Excess application of fertilizers, discharges of agricultural wastes, and untreated domestic and industrial effluent are among the most important human induced pressures. See WHO recommendations for water quality sampling and monitoring here (p22).

1.3.2.3 Diversity of aquatic macroinvertebrates (Biological Monitoring Working Party or other index when appropriate)	Recommended	Biological monitoring is commonly used to assess environmental conditions of water resources. Macroinvertebrates are sensitive to both physical and chemical conditions of water streams and critical to aquatic food chains. This metric is recommended to add information to the above water quality metrics as a measure of the water body biological response.
1.3.2.4 Concentration of metals or other toxins (load/volume) in key water bodies	Recommended	While some metals may be naturally occurring in water bodies, the addition of these from human activities can disrupt aquatic ecosystems by creating toxic conditions for organisms and health-hazards for human use. This metric is recommended to add information to the water quality indicator about concentration of contaminants that may impact aquatic ecosystems, biodiversity, human well-being, and value for use in production.
1.3.3 Agriculture, forestry & other land use (AFOLU) sector GHG sources and sinks	Optional	Definition: Greenhouse gas (GHG) emissions (sources) and sequestration (sinks), restricted to the AFOLU sector. Justification: Emissions from and potential for sequestration within the AFOLU sectors are most relevant to LandScale production sectors. AFOLU sectors represent a quarter of global GHG emissions and an important sequestration potential resides in soil and biomass managed by these sectors. This indicator can help identify the degree that AFOLU sectors and changes are affecting emissions and the degree sequestration is occurring to compensate for emissions. This indicator is optional because the AFOLU sectors may not be a significant source of GHG emissions within a particular landscape.

1.3.3.1 Rate of net GHG emissions from land use change ($tCO2e$[23]/yr) in recent years	Recommended	This metric captures the climate impacts of land-use change (indicator 1.1.2, 1.1.3 and 1.1.5), which account for both GHG emissions and carbon removals related to deforestation, afforestation, and reforestation. This metric requires a baseline year with annual measurements. The baseline should be set, when data allow, to include a recent time of significant land use change.
1.3.3.2. Rate terrestrial (above- and below-ground) C sequestration in plants & soil within agricultural, forestry & other production land uses & lands under restoration ($tCO2e$/yr)	Recommended	Understanding ecosystems' capacity to absorb $CO2$ and store it in soil and biomass is important to fully account for the landscape carbon balance over time (complementary with the metric above).
1.3.3.3 GHG emissions rate from agricultural production & primary processing[24] ($tCO2e$/yr)	Recommended	This metric informs GHG emissions generated by processes (fertilization, machinery) associated with the landscape agricultural production (Pillar 4).

[23] $tCO2e$ stands for: tonnes (t) of carbon dioxide ($CO2$) equivalent (e).

[24] Includes emissions from agricultural operations in the landscape (e.g., fertilizer use, energy consumption, and livestock methane emissions) but not from agricultural land-use change or from the emissions "footprint" of livestock feed produced outside of the landscape.

1.3.4 Soil health	Optional	Definition: Status of soil health including fertility, erosion, and soil organic carbon (SOC). Justification: Soil composition and conservation are fundamental to maintain land productivity and therefore the provision of food, water and climate regulation. Soil is a fundamental basis for the productivity of land, which is important in virtually all landscapes with natural resource based economic activity. While soil fertility and conservation are challenges that will be relevant in most landscapes, lack of primary data on soil erosion rates and soil analysis are also very likely to hinder accurate assessments of the state and progress on soil fertility.
1.3.4.1 Average soil erosion rate[25] (t/ha/yr)	Recommended	Soil is a critical resource to maintain agricultural productivity and ecosystems while sediment export impacts infrastructure and water quality downstream.
1.3.4.2. Average % SOC at a representative sample of production sites across the landscape	Recommended	Soil Organic Carbon is a common proxy of soil fertility since it is highly correlated with soil organic nitrogen and other nutrients' availability and cycling.

[25] This may be calculated for the landscape overall or for specific land-use types of interest, such as agriculture.

1.3.5 Other ecosystem services	Optional	Definition: Status of other ecosystem services of interest to the LandScale assessor or landscape actors. Justification: The most commonly relevant ecosystem services are covered by indicators 1.3.1 through 1.3.4. This indicator affords LandScale users the opportunity to measure additional ecosystem services of interest to the user or landscape stakeholders, such as provisioning services (e.g., ecosystems' provisioning of fisheries, firewood, or other raw materials), regulating services (e.g. pollination or flood control) or cultural services (e.g., mental and physical health, recreation, or nature tourism).
1.3.5.1 Assessor-defined metrics	Recommended	A number of other ecosystem services may be important in the landscape such as pollination of crops by native pollinators. Document relevance to assessment objectives.

Pillar 2: Human Well-Being

Goal 2.1 Improve standard of living, especially for vulnerable and/or marginalized Groups		
Indicator-Metric	**Applicability**	**Definition & Justification**
2.1.1 Household income and assets	Core	Definition: Rate of monetary poverty (relative to national poverty line) and household assets. Justification: This indicator is core because monetary poverty is a critical dimension of human livelihoods that complements other multidimensional poverty measurements covered by indicators 2.1.2 through 2.1.6.

2.1.1.1 Percentage (%) of population living below the local poverty line (or, if this is not specified, earning <$1.90/day)		Adequate income is an essential component of an individual's ability to reach a decent standard of living. The local poverty line should be used if possible, to reflect the local costs for a specified standard of living.
2.1.1.2 Percentage (%) of households owning or lacking context-appropriate asset(s). Examples include radio, TV, telephone, computer, animal cart, bicycle, motorbike, refrigerator, car, or truck	Recommended	Lack of ownership of these assets, which are related to a household's ability to communicate, be mobile, and have access to safe food, are an indication of poverty, as supported by a body of literature[26]. Data on ownership of these assets is collected through a number of global household surveys, as well as censuses, and this metric is included in UNDP & OPHI's Global Multidimensional Poverty Index (MPI).
2.1.2 Health and nutrition	Core	Definition: Proportion of the population lacking adequate health and nutrition. Justification: Ensuring health and nutrition for all adults, children, and other vulnerable groups is critical to reduce poverty. This indicator is core because adequate health and nutrition are critical components of a decent standard of living in any context.

[26] Alkire, S. and Santos, M.E. (2010). "Acute Multidimensional Poverty: A New Index for Developing Countries." OPHI Working Papers 38, University of Oxford.

2.1.2.1 Percentage of children that are undernourished	Required	Undernourishment indicates a lack of adequate nutrition, a fundamental need for human health. Undernourishment in children can have effects on cognitive and physical development, while undernourishment at any age can increase susceptibility to other health disorders or diseases. Adults age 19-70 are considered undernourished if their Body Mass Index is below 18.5 kg/m².[27] Those ages 5-19 are considered undernourished if their age-specific BMI values are below minus two standard deviations from the median of the reference population[28]. Children under 5 years are considered undernourished if their z-score for either height-for-age (stunting) or weight-for-age (underweight) is below minus two standard deviations from the median of the reference population[29].
2.1.2.2 Percentage of population without access to health services	Required	Access to health services is essential for human well-being and to ensure that those who are ill receive the care they need.
2.1.2.3 Mortality rate of children under 18 years (averaged over the past five years)	Required	Child death is often due to preventable causes. Child mortality is thus indicative of a lack of an adequate health system.

[27] United Nations Development Programme: Human Development Reports & Oxford Poverty and Human Development Initiative at the University of Oxford. (2020). *The 2020 Global Multidimensional Poverty Index (MPI)*. UNDP & OPHI. http://hdr.undp.org/en/2020-MPI

[28] World Health Organization. (2020). Growth reference data for 5-19 years. WHO. https://www.who.int/growthref/en/

[29] World Health Organization. (2020). Growth reference data for 5-19 years. WHO. https://www.who.int/growthref/en/

2.1.3 Education	Core	Definition: Educational status of the population. Justification: Literacy rates in terms of reading and writing skills, are a fundamental dimension that impact the level of poverty. Increasing and improving school attendance in landscapes is central to reducing poverty rates. This indicator is core because education is a critical component of a decent standard of living in any context.
2.1.3.1 Percentage (%) of school-aged children that are not attending school	Required	This metric provides information on the percentage of children that are not able to access education, a human right that is critical to provide individuals enhanced opportunities for higher-quality jobs, decent incomes, and an improved standard of living. Although school attendance does not capture the quality of education, data are widely available for most countries.
2.1.3.2 Percentage (%) of adults that have not completed primary education	Required	Similar to above, this metric provides information on the percentage of adults that were not able to complete their primary education. Completion of primary education is a proxy for the attainment of fundamental skills, including literacy and numeracy.
2.1.4 Water, sanitation, and hygiene	Core	Definition: Proportion of the population lacking safe drinking water and sanitation. Justification: Billions of people throughout the world still lack access to safely managed water and sanitation services, as well as basic hand washing facilities at home. Deficient sanitation is known to contribute to the transmission of diseases such as cholera, diarrhoea, dysentery, hepatitis A, typhoid, and polio, and to the exacerbation of stunting. The lack of safe drinking water likewise undermines human well-being and social and economic development. This indicator is core because improved drinking water and sanitation are critical components of a decent standard of living in any context.

2.1.4.1 Percentage (%) of households without access to safe drinking water within a 15-minute walk from home	Required	Safe drinking water is critical for human health and hygiene. This metric provides information on the percentage of households that are not able to meet this fundamental need, utilizing a standard metric that is widely used in household surveys and censuses around the world. Improved drinking water sources are those that have the potential to deliver safe water.[30] A household is considered to have access to improved drinking water if the water source includes piped water, public tap, borehole or pump, protected well, or protected rain or spring water, within a 30-minute walk from home (round trip).[31]
2.1.4.2 Percentage (%) of households without a safely managed sanitation facility exclusive to the household	Required	Access to basic sanitation facilities is a fundamental need for human health and disease prevention. This metric provides information on the percentage of households that are not able to meet this fundamental need, utilizing a standard metric that is widely used in household surveys and censuses around the world. An improved sanitation facility is one that separates excreta from human contact. A household is considered to have access to improved sanitation if it has flush or pour-flush toilets or latrines, or a ventilated improved pit or composting toilet. Sanitation facilities are not considered improved if they are shared with other households or open to public use[32].

[30] World Health Organization & United Nations International Children's Emergency Fund. (2018). *Drinking water | JMP*. WHO UNICEF. https://washdata.org/monitoring/drinking-water

[31] UNDP & OPHI

[32] World Health Organization & United Nations International Children's Emergency Fund. (2018). *Drinking water | JMP*. WHO UNICEF. https://washdata.org/monitoring/drinking-water | United Nations Development Programme: Human Development Reports & Oxford Poverty and Human Development Initiative at the University of Oxford. (2020). *The 2020 Global Multidimensional Poverty Index (MPI)*. UNDP & OPHI. http://hdr.undp.org/en/2020-MPI

2.1.5 Basic infrastructure	Core	Definition: Proportion of the population lacking electricity, adequate housing, or adequate cooking fuel. Justification: People across landscapes still suffer from a lack of adequate housing. This indicator is core because access to electricity, adequate housing material, and adequate cooking fuel are critical components of a decent standard of living in any context.
2.1.5.1 Percentage (%) of households without electricity[33]	Required	Electricity is important for a range of household needs, including lighting and use of appliances, and is an indication of quality of housing. Lack of electricity inhibits households from improving their standard of living.
2.1.5.2 Percentage (%) of households where the roof, walls and/or floor are composed predominantly of rudimentary materials[34]	Required	This metric provides an indication of quality of housing and its ability to provide adequate shelter and withstand extreme weather. This metric is included in UNDP & OPHI's Global MPI and nearly all existing National MPIs. Natural materials for flooring include mud/clay/earth, sand or dung; natural and rudimentary materials for roofing and walls include cane, palm/trunks, sod/mud, dirt, grass/reeds, thatch, bamboo, sticks, carton, plastic/polythene sheeting, bamboo/stone with mud, loosely packed stones, uncovered adobe, raw/reused wood, plywood, cardboard, unburnt brick or canvas/tent.[35]

[33] Access to electricity may be provided by a state/national grid or by local, distributed, or household-level systems powered by solar or other energy sources.

[34] This includes dirt floor as well as natural roofing or wall material lacking long-term durability.

[35] United Nations Development Programme: Human Development Reports & Oxford Poverty and Human Development Initiative at the University of Oxford. (2020). *The 2020 Global Multidimensional Poverty Index (MPI)*. UNDP & OPHI. http://hdr.undp.org/en/2020-MPI

2.1.5.3 Percentage (%) of households that use dung, wood, charcoal or coal as fuel for cooking or heating	Required	Use of solid fuels for cooking, including wood, charcoal, dung, or coal, can lead to respiratory diseases, heart problems, and premature death. This disproportionately affects women and children, who are often exposed to household air pollution at higher levels.
2.1.6 Vulnerability	Optional	Definition: Proportion of the population that has recently experienced a severe shock or crime. Justification: Hurricanes, wildfires, floods, earthquakes, and other natural disasters exacerbate poverty in all dimensions. Crime also exacerbates poverty and increases household vulnerability. The occurrence or threat of such disruptive events has also been shown to worsen other dimensions of human well-being.[36] This indicator is optional because information on this indicator might not be readily available for all landscapes.

[36] L. Guarcello, F. Mealli, and F.C. Rosati, Household vulnerability and child labour: the effect of shocks, credit rationing, and insurance, J Popul Econ, 2010, 23: 169, https://doi.org/10.1007/s00148-008-0233-4. 45 & K. Beegle, R. H. Dehejia and R. Gatti, 2003. Child labor, income shocks, and access to credit, World Bank Policy Research Working Paper No. 3075 (Washington, DC)

2.1.6.1 Percentage (%) of households that have experienced a severe shock (i.e., a significant loss of income or property) in the past 12 months due to a natural disaster or human-caused events[37]	Recommended	This metric provides information on the extent to which household-wellbeing is affected by natural disasters beyond temporary losses. Vulnerability to such disasters can threaten the livelihood of landscape residents. This metric has been used by the World Bank to measure multidimensional poverty; metrics on exposure to environmental hazards have also been used in some existing National MPIs.
2.1.6.2 Percentage (%) of households that have been subject to crime in the previous 12 months	Recommended	The ability to live free from the threat of exposure to crime and violence is essential to human wellbeing. This metric has been used by the World Bank to measure multidimensional poverty; metrics on safety and crime have also been used in some existing National MPIs.

[37] This includes shocks due to natural disasters (e.g., drought, flooding, or earthquakes) as well as those due to human-caused events whose source is outside the affected household or community (e.g., civil unrest, armed conflict, and war). The assessor may define a context-appropriate threshold for what constitutes a "severe" shock, for instance an income loss or a livestock herd loss of 40% or more due to drought-induced crop failure.

Goal 2.2 Respect, protect, and fulfill human rights		
Indicator-Metric	**Applicability**	**Definition & Justification**
2.2.1 Child labor[38]	Landscape-dependent	Definition: Incidence of child labor relevant to the production activities of interest. Justification: Child labor is among the worst forms of human exploitation. The effective abolition of child labor is a fundamental principle of international human rights law. This indicator is landscape-dependent because there is not significant incidence or risk of child labor in all landscapes.

[38] Child labor: Work that deprives children of their childhood, their potential, and their dignity, and that is harmful to physical and mental development. Whether or not work performed by children is defined as child labour depends on the child's age, the hours and type of work and the conditions in which the work is performed. (Adapted from ILO)
LandScale focuses on Worst Forms of Child Labour:

- All forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including recruitment of children for use in armed conflict.
- The use, procurement or offering of a child for prostitution, for the production of pornography or for pornographic performances.
- The use, procurement or offering of a child for unlawful activities, in particular for the production and trafficking of drugs as defined in the relevant international treaties.
- Work which, by its nature or the environment where it takes place, is likely to harm the health, safety or morals of children (referred to as hazardous child labour). (Adapted from ILO)

2.2.1.1 Assessor-defined metrics based on identified enabling conditions - see Annexes 3 & 4	Required	Recent studies have highlighted four main areas — education, social protection, labor markets, legal standards, and regulation — as essential pillars of a policy response to child labor. However, despite consensus around priority areas, current policy initiatives worldwide show that there is no one-size-fits-all policy approach to ending child labor but rather a set of multidimensional methods adapted to a given context.[39] There is also an ongoing need for information about the impact of policies and interventions on child labor. Except for cash transfers, there is not enough evidence about the effectiveness of interventions in policy areas of relevance to child labor. In light of this, LandScale has designed a qualitative assessment for human rights metrics that is based on local enabling conditions (available in Annex 4) and complemented where possible with quantitative metrics. Given that child labor in global supply chains concerns a diverse range of stakeholders - from government, multinational companies, industries, international buyers, employers' and workers' organizations, and civil society - it is essential that the selected enabling conditions drive collective action rather than point to individual responsibilities.

[39] International Labour Organization. (2018). *Ending child labour by 2025: A review of policies and programmes*. ILO. https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---ipec/documents/publication/wcms_653987.pdf

2.2.1.2 Estimated number of child laborers in economic activities of interest	Recommended	Of the estimated 152 million children globally, that are engaged in child labor Despite substantial advancement in making global estimates, many gaps remain in reliable and recent child labor data and statistics. More recently, however, the number of countries with available data sets on child labor in one form or another have significantly increased, and missing countries are now a minority.[40] Data collection on child labor is usually conducted through surveys that contain sample questionnaires for the various types of working environments. While surveys contribute towards comprehensive statistical data on multiple aspects of working children, because they are based on samples, they do not provide great depth concerning the context in which these issues occur. Therefore, to have a fuller understanding of child labor, LandScale encourages the collection of both quantitative and qualitative information.
2.2.2 Forced labor[41]	Landscape-dependent	Definition: Incidence of forced labor relevant to the economic activities of interest. Justification: Freedom from slavery and freedom from forced and compulsory labor are universal human rights that should be respected and protected in every landscape. Forced labor is among the worst forms of human exploitation. The elimination of all forms of forced or compulsory labor is a fundamental principle of international human rights law. This indicator is landscape-dependent because there is not significant incidence or risk of forced labor in all landscapes.

[40] International Labour Office ILO. (2017). *Global Estimates of Child Labour: Results and Trends, 2012-2016*. 8.7 SDG Alliance. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_575499.pdf

[41] Forced labour refers to situations in which persons are coerced to work through the use of violence or intimidation, or by more subtle means such as accumulated debt, retention of identity papers or threats of denunciation to immigration authorities. (Adapted from ILO)

2.2.2.1 Assessor-defined metrics based on identified enabling conditions - see Annexes 3 & 4	Required	Since forced labor is universally condemned and illegal, it is usually difficult to detect, and few places have reliable statistical data on incidence of forced labor. Forced labor is a rare and isolated phenomenon with a prevalence rate measured in units of one per thousand persons and a relatively high concentration in particular areas of countries. The rarity and unevenness of the phenomenon make data collection on forced labor a complicated task. Forced labor, in most cases, is inherently hidden, and hence invisible in official data sources and survey efforts. Establishing contact with people in forced labor is typically challenging, and even where possible, they often fear retaliation and avoid giving accurate responses in surveys. In light of this, LandScale has designed a qualitative assessment for human rights metrics that is based on local enabling conditions (available in Annex 4) and complemented where possible with quantitative metrics. Given that forced labor in global supply chains concerns a diverse range of stakeholders - from government, multinational companies, industries, international buyers, employers' and workers' organizations, and civil society - it is essential that the selected enabling conditions drive collective action rather than point to individual responsibilities.
2.2.2.2 Estimated number of forced laborers in economic activities of interest	Recommended	There are several ways to collect data on persons in forced labor: at the place of residence, at the workplace (i.e., farm), or through other sites such as at the service provider where they go (e.g. agricultural contractor), the street where they work or live, the national border where they cross, or the news or document where they are reported. The primary sources of data include three general categories: household surveys, establishment surveys, and official records. Statistics of forced labor may also be compiled on a combination of these sources.[42]

[42] International Labour Office ILO. (2018). *Measurement of forced labour*. 20th International Conference of Labour Statisticians. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/meetingdocument/wcms_636050.pdf

2.2.3 Workers' rights[43]	Landscape-dependent	Definition: Respect for other workers' rights including freedom of association, working hour restrictions, protection from discrimination, and provision of safe working environments. Justification: The right to form and to join trade unions, to strike, to a safe working environment, and freedom from discrimination are universal human rights that should be respected and protected in every landscape. The elimination of discrimination in respect to employment and occupation, as well as freedom of association and the right to collective bargaining are fundamental principles of international human rights law. This indicator is landscape-dependent because the degree to which these workers' rights are violated or at risk of violation varies by landscape. In some contexts, strong policies, law enforcement, and/or industry norms and practices result in a generally high degree of protection of these workers' rights.

[43] Workers' rights: The fundamental principles and rights at work, which include access to freedom of association and collective bargaining, working hour restrictions, protection from discrimination, and safe working environments. (Adapted from ILO)

2.2.3.1 Assessor-defined metrics based on identified enabling conditions - see Annexes 3 & 4 (required)	Required	Workers on farms and in factories are among the most vulnerable people in global trade. As agricultural workers often lack access to land and are unable to make a living from it, they have fewer opportunities for a decent livelihood. Furthermore, they often lack formal contracts, freedom of association, basic health and safety insurances, and adequate wages, among other deprivations.[44] Freedom of association, the effective recognition of the right to collective bargaining, and the elimination of discrimination in respect of employment and occupation, are universal human rights that should be respected and protected across industries. Issues related to these human rights might vary across landscapes depending on whether people are smallholders or plantation workers. In light of this, LandScale has designed a qualitative assessment for human rights metrics that is based on local enabling conditions (available in Annex 4) and complemented where possible with quantitative metrics. Given that workers' rights in global supply chains concern a diverse range of stakeholders - from government, multinational companies, industries, international buyers, employers' and workers' organizations, and civil society - it is essential that the selected enabling conditions drive collective action rather than point to individual responsibilities.
2.2.4 Other human rights	Landscape-dependent	Definition: Status of other human rights potentially impacted by production activities. While indicators 2.2.1 through 2.2.3 identify some of the most widely relevant human rights in the context of natural resource-based sectors, by no means do they include an exhaustive list of human rights. This landscape-dependent indicator is therefore included to ensure that other human rights that are particularly salient in the landscape are also addressed in the LandScale assessment.

[44] Flinterman, W., & FairTrade International. (2020). *Workers' rights*. Fairtrade International. https://www.fairtrade.net/issue/workers-rights

2.2.4.1 Assessor-defined metrics based on identified enabling conditions of other human rights - see Annexes 3 & 4 (required)	Required	Similar to performance metrics 2.2.1.1, 2.2.2.1 & 2.2.3.1, LandScale requires incorporating other human rights issues (e.g. sexual/gender-based violence) that may be prevalent in the landscape. The assessment of these additional metrics can also be both quantitative and qualitative. For the latter, the assessor is encouraged to follow the same enabling conditions process available for the other performance metrics.

Pillar 3: Governance

Goal 3.1 Recognize and Protect Rights to Land and Resources, and Reduce Related Conflicts		
Indicator/Metric	**Applicability**	**Definition & Justification**
3.1.1 Land tenure	Core	Definition: Land for which rights to own, access, use, and manage land and resources are clear and secure through formal recognition by statutory or customary norms, are not overlapping, and are protected through legal or other means. Justification: There is a global recognition that clear tenure rights are essential to accomplish social and economic development. Securing tenure rights is also a crucial component of nature-based solutions and climate change mitigation that contributes to reducing financial and social risk. Land and resource tenure security is central to achieving sustainable livelihoods across landscapes. This indicator is core because land and resource tenure security is a critical factor in both governance and sustainability in all landscapes.
3.1.1.1 Percentage (%) of the landscape with formalized land tenure rights	Required	Land tenure security is essential to ensure the social identity, personal protection, and cultural survival of local communities, indigenous peoples, and ethnic minorities. Additionally, it plays a significant role in defining who benefits or loses in the management of economic goods and environmental services. There are two broad categories of ownership: public and private. These

		categories are further divided into four: ● **(1) Public lands administered by national or local authorities** typically include all forests in the legal forest estate owned and administered exclusively by the state or local governments and not designated for use by communities or indigenous peoples (e.g. protected areas, mining/forest/agricultural concessions). ● **(2) Public lands designated for use by communities and indigenous peoples** are areas set aside on a semi-permanent but conditional basis. Although the distribution of rights between government and community in this category is different in almost every country, governments invariably retain persuasive authority to extract and manage forest resources. ● **(3) Private lands owned by communities or indigenous peoples** refers to forest lands where rights cannot be unilaterally terminated by a government "without due process and compensation." In theory, private landowners typically "have rights to access, sell or otherwise alienate, manage, withdraw resources, and exclude outsiders." ● **(4) Private lands owned by individuals or firms** are those where a government cannot unilaterally terminate the rights without due process or compensation. They legally hold the full bundle of rights (access, withdrawal, management, exclusion, and due process and compensation) for an unlimited duration and the right to sell their land/forestland. Tenure systems define who owns and who can use what resources for how long, and under what conditions. Customary tenure systems are determined at the local level and are often based on oral agreements, whereas statutory tenure systems are applied by governments and are codified in state law. Across the world, governments are increasingly recognizing customary rights and are awarding new forms of statutory rights to indigenous peoples, communities, individuals, and firms. Yet, communities under customary tenure are still often compelled to seek a legal mantle to survive and prosper. Furthermore, hundreds of millions of people live on forest lands, and a large but undetermined number have no or weak land and resource tenure security. The

		causes for this insecurity are diverse.[45] According to international human rights law, all indigenous peoples have rights to their customary territories and their cultural heritage, but these rights too are often denied. Customary claims, in particular, are often disregarded or not fully recognized by central governments. Indigenous forest peoples are often the targets of ethnic and racial discrimination. Women often suffer from tenure and rights deprivation within their societies.[46] [47] In this context, we define "formalization" as the recognition and enforcement of specific tenure regimes (including customary arrangements) at the level of the state. Our definition characterizes formalization in terms of goals to improve tenure security. In discussing "best practices" for formal recognition of customary rights, the nature and degree of formalization should primarily be determined by how reforms address the causes of tenure security.[48]
3.1.1.2 Assessor-defined metric(s) for gender dimension of land tenure rights	Recommended	LandScale recommends the incorporation of assessor-defined metrics that address gender components and issues related to land tenure, which may vary depending on the landscape context.

[45] For instance, Local people might enjoy rights under both customary and statutory tenure arrangements but cannot oppose the claims made on land and resources by outsiders. In some cases, the customary provisions may be clear and well-accepted at the local level, but statutory arrangements contradict or nullify them. And in other cases, customary tenure arrangements —for whatever reasons—are unable to serve their function.

[46] It is also the case that many statutory community forestry arrangements are not sufficient to assure improved livelihoods because the tenure rights they establish are weak. Weak tenure arrangements frequently include restrictive management plans and conditional performance reviews, prohibiting the sale and restricting proceeds from forest products. In some instances, these weak arrangements fail to recognize customary forms of land ownership and management. (RRI, 2008)

[47] The previous content has been adapted from: Sunderlin, W. D., Hatcher, J., & Liddle, M. (2008). From Exclusion to Ownership? Challenges and Opportunities in Advancing Forest Tenure Reform. *Rights and Resources Initiative (RRI)*, 1–24. https://rightsandresources.org/wp-content/exported-pdf/fromexclusionfinal.pdf

[48] Fitzpatrick, D. (2005). "Best Practice" Options for the Legal Recognition of Customary Tenure. *Development and Change*, *36*(3), 449–475. https://doi.org/10.1111/j.0012-155x.2005.00419.x

3.1.2 Land conflicts	Core	Definition: Incidence of unresolved conflicts related to land and resource rights. Justification: Land and resource conflicts are commonly associated with human rights violations, negative social impacts, and poor environmental stewardship. This indicator is core because it is important to assess land and resource conflicts in all landscapes given their important influence on other dimensions of social and environmental sustainability.
3.1.2.1 Number of unresolved land and resource conflicts or grievances, and the area of land (ha) subject to such conflicts	Required	Land and resource disputes can negatively impact human well-being and environmental management. These disputes can range from land grabs, communities' displacements, genocides, boundaries settlement, and resource management exclusion, among others.
3.1.2.2 Number of people (e.g., environmental and human rights defenders) subject to violence or receiving threats of violence as a result of conflicts over land and resources	Required	Historically, land and environmental defenders have been the first line of protection and resistance against ecological devastation. The year 2019 had the highest number of killings of land and environmental defenders, a total of 212 murders, and an average of more than four people a week.[49] Environmental and human rights advocates continue to be victims of violence and threats. This metric tracks the number of cases of this nature.

[49] Global Witness. (2020). *Defending Tomorrow: The climate crisis and threats against land and environmental defenders*. https://www.globalwitness.org/en/campaigns/environmental-activists/defending-tomorrow/

3.1.3 Resource tenure	Optional	LandScale provides the opportunity to track the status and trends of specific resources' tenure, these may be the rights to carbon (capture), trees, water, among many others.
3.1.3.1 Assessor-defined metric(s) on access and use rights for key natural resources in the landscape	Recommended	LandScale provides flexibility to assess resources' tenure given that the circumstances and nature of the topic(s) may vary by landscape.
Goal 3.2 Promote transparency, participation, inclusion, and coordination in land use policy, planning, and management		
Indicator/metric	**Applicability**	**Definition & Justification**
3.2.1 Land-use plan adoption and enforcement	Core	Definition: Status of land-use or zoning plan, with respect to agreement by stakeholders, formal adoption, and enforcement. Justification: Effective land-use planning is an important foundation for rationally allocating the use of land to achieve social and environmental objectives. This indicator is core because the adoption and enforcement of land-use plans is a key element of landscape governance and determinant of sustainability outcomes in all landscapes.

3.2.1.1 Quality and status of land-use and/or zoning plans (based on Sustainable Landscapes Rating Tool (SLRT) indicators 1.1.1, 1.1.2 and 1.1.3)[50]	Required	Land-use plans are the result of planning and zoning to accommodate present and future types of development activities and their locations (i.e., farming, grazing, forestry, wildlife, tourism, urban development, among others). Assessing the quality of land-use plan(s) adoption and enforcement consists of determining whether it is formally adopted, if it covers the entire landscape, and if it was developed through a participatory process. LandScale encourages the use of the Sustainable Landscapes Rating Tool (SLRT)[51] to qualitatively assess this performance metric. For example, the existence of a land use plan, would be rated on whether the plan has been formally adopted, covers the entire jurisdiction, and has been developed through a participatory process.
3.2.1.2 Percentage (%) of landscape covered by land-use or zoning plans that are formally adopted and enforceable	Required	This quantitative metric complements the qualitative assessment under metric 3.2.1.1. Calculating the percentage of the landscape covered by land-use or zoning plans informs the degree by which the landscape is either at risk or protected from unplanned and unregulated land use change.

[50] The Sustainable Landscapes Rating Tool (SLRT) is available here.

[51] The SLRT consists of criteria for key enabling conditions structured under the following themes: land use planning and management, land and resource tenure, biodiversity and other ecosystem services, stakeholder coordination and participation, and commodity production systems. Each criterion, or enabling condition, is rated based on individual ratings of a series of elements of quality, or indicators. The Tool provides detailed guidance to rate each indicator as A (high, full, clear), B (medium, partial), C (low, not addressed), or ID (insufficient data) where insufficient information is available.

3.2.1.3 Amount (ha) & percentage (%) of the landscape that is subject to overlapping and competing land-use plans	Recommended	In cases where land-use planning has not been done according to best practices -- such as consulting local communities -- the process can yield conflicting results like overlap or competition of different land uses (e.g., state concessions overlapping with local peoples' farmlands, pastures, community forests etc.). As part of assessing the adoption and enforcement of land-use planning, it is important to determine the percentage of land-use overlap. Where overlap is a recognized aspect of the plan, such as special overlay zones that are clear in which uses or rules take precedence, such overlaps may be disregarded from this calculation.
3.2.1.4 Amount (ha) and percentage (%) of the landscape with recent[52] land-use change that is inconsistent with land use plan(s)	Recommended	This metric aims to identify those landscape areas where land-use change is not taking place in accordance with land-use plan(s). The assessor will first need to identify these types of instances in available sources and then calculate the percentage of the landscape that these areas occupy.

[52] This should be assessed for a recent time period that ends at the present time (or within a year of it). The time period may be the same as that used for indicator 1.1.2.1, or the assessor may choose a different time period provided that the reason for doing this is clearly stated.

3.2.2 Coordination of government agencies in land-use policy, planning, and management	Core	Definition: Status of intergovernmental coordination of land-use policy, planning and management across relevant government sectors including water, agriculture, forests, environment, mining, energy, transport, planning, and/or interior. Justification: Integration of government policy and programs across different levels of government (national, state, and local) and different ministries or agencies is critical to achieving synergies and reducing conflicts between social, economic, and environmental goals. It is also important for creating more coherent management of land and resources used for and affected by different sectors including agriculture, forestry, mining, tourism, and others. This indicator is core because coordination of government agencies in land use policy, planning, and management is a key element of governance in all landscapes.
3.2.2.1 Quality and status of government coordination on land-use policies, planning and management across sectors (based on SLRT indicators 4.1.1, 4.1.2 and 4.1.3)	Required	Government coordination is key to successful land-use planning and management. This metric assesses key conditions of government coordination (at all levels from national to jurisdictional) by assigning a qualitative category to indicate its progress toward full coordination in the landscape. LandScale encourages the use of the Sustainable Landscapes Rating Tool (SLRT) to qualitatively assess this performance metric.

3.2.3 Stakeholder participation and inclusion in land-use policy, planning, and management	Core	Definition: Status of participation and inclusion in landscape-level land-use planning and management for those stakeholders involved in or affected by production activities. Justification: Participatory land use planning has been gaining international recognition as an important foundation of sustainable resource management. A participatory approach with inclusive representation can result in more effective land use planning that incorporates relevant stakeholder perspectives and creates greater commitment to implement plans across different sectors. This indicator is core because stakeholder participation and inclusion are key elements of effective landscape governance in every landscape.
3.2.3.1 Quality and status of stakeholder participation and inclusion in land-use policy, planning, and management (based on SLRT indicators 4.3.1, 4.3.2, 4.3.3, 4.3.4 and 4.3.5)	Required	Stakeholder participation is a crucial component of successful land use planning. This is a qualitative metric that assesses the progress of this component in the landscape by evaluating how key stakeholder groups are being represented and included in this decision-making process, as well as how their inclusion is influencing land use planning. LandScale encourages the use of the Sustainable Landscapes Rating Tool (SLRT) to qualitatively assess this performance metric.
3.2.4 Illegality and corruption related to land and resources	Landscape-dependent	Definition: Levels of illegality and corruption in the allocation of rights, management, and use of land and resources. Justification: Illegality and corruption in land and resources are often signs of weak governance. Reducing the incidence of both issues can contribute greatly to the development and implementation of effective land-use plans and policies, and to positive sustainability outcomes. This indicator is landscape-dependent because not every landscape may experience significant ongoing or pervasive illegality and corruption.

3.2.4.1 Perceived level of corruption related to land and resource allocation and use	Required	Corruption in land and resource allocation is an ongoing challenge that many landscapes face. Many forms of land-related corruption affect people across landscapes. These include bribe payments during land administration processes, extorsions in exchange for land titles, violations of land rights to women and young people, community exclusion from land deals between private investors and local authorities, communities' eviction from their land and unfair compensation for their losses, among many others.[53] Since corruption is a criminal offense done by a person or organization in a position of authority, the issue is by nature often hidden and undocumented, complicating the assessment of the problem.
3.2.4.2 Incidence of illegality related to land and resource use and management	Required	Whether it is related to timber, mining, wildlife, or agriculture; illegality in land and resource use is a significant challenge in landscape management and a huge obstacle to sustainability by removing resources and depriving citizens and rights holders of income and legal access to those resources. The illegal uses may also cause long-term harm, reducing the productivity of the environment. Illegality can usually be assessed through official records and statistics published by local authorities.

[53] Transparency International. (2020, March 18). *Land corruption - Our priorities*. Transparency.Org. https://www.transparency.org/en/our-priorities/land-corruption#

Pillar 4: Production

Goal 4.1 Promote regenerative agricultural, agroforestry, and tree production systems		
Indicator	**Applicability**	**Definition & Justification**
4.1.1 Agricultural, agroforestry, and tree plantation productivity	Landscape - dependent	Definition: Productivity of agricultural (crop and livestock), agroforestry, and tree production systems for major production systems in the landscape. Justification: Measures of productivity are important indicators of the land use efficiency of agricultural systems and have important ramifications for the effects of agriculture on other dimensions of sustainability, such as those addressed in the ecosystems and human well-being pillars. This indicator is landscape-dependent because agricultural production is not a major component of land use or of the economy in every landscape. In landscapes where agriculture is a significant land use and component of the economy, this metric is important to include.
4.1.1.1 Average crop productivity (yield/ha) disaggregated by crop	Required	Crop productivity provides an indication of the efficiency in use of land and return on investment for producers. Yield should be enumerated in units typical for each commodity.
4.1.1.2 Average productivity of pasture-raised animals (livestock units/ha or meat or dairy production/ha) disaggregated by animal type	Required	Livestock productivity provides an indication of the relative efficiency of animal production.
4.1.1.3 Average	Required	Forest plantation productivity indicates the relative efficiency of wood product

forest plantation productivity (timber volume/ha) disaggregated by plantation type		production.
4.1.2 Input use efficiency in agricultural, agroforestry, and tree production systems	Landscape-dependent	Definition: Efficiency of input use in agricultural, agroforestry, and tree production systems. Justification: Similar to the prior indicator, agricultural input use efficiency has important ramifications for the effects of agriculture on other dimensions of sustainability. It can also indicate the resilience of farming systems to natural variability or shocks such as droughts and pest outbreaks. This indicator is landscape-dependent because agricultural production is not a major component of land use or of the economy in every landscape. Where it is, this metric is important to include.
4.1.2.1 Fertilizer use efficiency (quantity of product produced per unit of nitrogen, phosphorus, and / or potassium [NPK] use) disaggregated by product	Required	Fertilizer efficiency is important from an economic standpoint of return on investment and potential for environmental harm from overuse. Landscapes, on average, applying more fertilizer per unit of production than equally productive areas may be applying more than is needed and can be used by crops.
4.1.2.2 Water use efficiency (quantity of product produced per unit of water use) disaggregated by product	Required	Water efficiency in crop production (e.g. for irrigation) is very important because agriculture is often the top user of water in many landscapes and often with resulting impacts on the environment and people. Use of larger amounts of water per unit of production relative to equally productive areas can signal the overuse of water.

4.1.3 Adoption of sustainable land management practices	Optional	Definition: Adoption of sustainable land management (SLM) practices in agricultural and forest plantation operations. Justification: This indicator supplements indicators 4.1.1 and 4.1.2 to provide additional information on the rate of adoption of practices that may contribute to more sustainable performance of cropping and livestock systems. Because LandScale is primarily focused on sustainability outcomes (rather than practices), this indicator is optional. However, it may be of particular interest to users who want to monitor a leading indicator of the extent to which agricultural systems are being managed to achieve sustainability outcomes of interest.
4.1.3.1 Land area (ha) under major crop, livestock and or plantation forestry production that utilize Integrated Pest Management (IPM) and percentage (%) of total production area that this represents	Recommended	Use of IPM is an important indication of agricultural sustainability because it tends to generate fewer impacts to the environment and people.

4.1.3.2 Land area (ha) under other specific SLM practices appropriate to the crop, livestock, and or plantation forestry systems[54] in the landscape, disaggregated by practice and production system and percentage (%) of total production area that this represents	Recommended	SLM refers to a broad set of integrated practices that can have a number of benefits across production and other LandScale pillars. Reporting by practice is preferred if data is available; practices can be categorized for example by FAO's system.[55]
4.1.3.3 Assessor-defined metric on environmental and health risk from pesticide use	Recommended	Use of pesticides has implications for ecosystem and human health. Therefore, calculating risk from pesticide use and how that risk may change (e.g., decrease through use of IPM and SLM) is a useful measure of sustainability. LandScale recommends use of the Environmental Impact Quotient (EIQ) https://nysipm.cornell.edu/eiq/ to calculate this metric but other measures may be appropriate. If the EIQ is used, LandScale recommends using a dose measurement based on purchase/sale data of pesticides within the landscape. In that case, the EIQ-FUR would be: EIQ-FUR (landscape) = EIQ x % active ingredient in product x volume or mass of pesticide sold/purchased per unit area

[54] Examples include conservation agriculture, diversified agroforestry systems, holistic grazing management, and others.

[55] FAO SLM resources: http://www.fao.org/land-water/land/sustainable-land-management/slm-practices/en/

4.1.3.4 Extent and percentage of fire in natural ecosystems resulting from agricultural land management (ha and % of the landscape burned/yr)	Recommended	Fires caused by agricultural practices (e.g., burning off crop residue or setting fires to convert natural ecosystems to cropland) are a key source of wildfires that threaten ecosystems, biodiversity, and human populations and development. This metric provides an indication of the degree that agriculture is the origin of wildfires.
4.1.4 Adoption of sustainable waste management practices	Optional	Definition: Adoption of sustainable waste management practices for agricultural solid waste and wastewater. Justification: Impacts on the environment and human health from improper agricultural waste management can be significant. Commodity-appropriate handling of wastes can improve or maintain sustainability across multiple ecosystem and human wellbeing indicators. This indicator is optional because agricultural waste is not a significant sustainability issue in all landscapes.
4.1.4.1 Assessor-defined metrics on adoption of sustainable waste management practices for agricultural solid waste and wastewater	Recommended	This metric will provide additional information about the sustainability of production, particularly how it impacts other pillars' indicators. Specification of the metric(s) should take into account the waste-generating types of agricultural production and processing.