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Challenges and Opportunities in Assessing Sustainable Mountain Development Using the UN Sustainable Development Goals

A REPORT COMPILED BY THE MOUNTAIN RESEARCH INITIATIVE (MRI), IN COLLABORATION WITH THE CENTRE FOR DEVELOPMENT AND ENVIRONMENT (CDE)

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Challenges and Opportunities in Assessing Sustainable Mountain Development using the UN Sustainable Development Goals

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Executive Summary

The 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs) represent a comprehensive approach to sustainable development, covering multiple dimensions of sustainability and allocating responsibility at the national level for prioritization, monitoring and reporting. Within the SDG framework, concerted efforts to acquire and globally harmonize indicator data offer opportunities to assess and track sustainable development.

As part of the Promoting Sustainable Mountain Development for Global Change (SMD4GC) programme, the Mountain Research Initiative and the Centre for Development and Environment are developing an approach to assessing sustainable mountain development (SMD) using the SDGs as framework. Such assessments can help contextualize and highlight the specific needs of and challenges for mountain communities and ecosystems in addressing SMD, backed by sound evidence. They can help inform policy and decision-making at the global, national, and subnational levels in steering SMD efforts for the benefit of people living in highlands and adjacent lowlands.

As a first step, the Mountain Research Initiative (MRI) conducted a survey of mountain researchers interested in sustainable development to identify a subset of SDG indicators that are relevant for monitoring and reporting on SMD. Next, to investigate data availability and accessibility for these indicators in countries in the SMD4GC regions, the Mountain Research Initiative performed a desktop study with selected SMD4GC partners. This working paper presents the outcomes of this study. It identifies challenges to and opportunities for reporting on the indicators that are representative for sustainable mountain social-ecological systems, and offers recommendations for further work. The following conclusions are outlined in this report:

- Disaggregating the SDGs to subnational levels and applying subsets of SDG indicators to monitor their status are two emerging considerations in reporting on SMD, and can meaningfully guide global, national, and subnational efforts to achieve the SDGs in mountains. The general need for disaggregated data to achieve the 2030 Agenda has been recognized by a wide range of actors and institutions. Nonetheless, little guidance exists on methodology for disaggregation of SDG data that takes mountain-specific challenges into account. For example, for more than half of the indicators selected for this study, no internationally established methodology or standards are available for data collection and/or data are not regularly produced. Thus, proxy data are required; but the use of proxy data can make it more challenging to compare progress between mountain regions.

- The capacity to spatially disaggregate existing SDG indicator data is relatively underdeveloped in the countries that are the focus of this paper: Ecuador, Chile, Nepal, and Bangladesh. Methodologically robust and timely subnational data are not consistently available across all four countries. However, there are many sources of proxy data that can be used to help fill gaps in SDG data. Collaboration with local partner organizations is important, as they have good knowledge of local conditions, relevant actors, and sources of data. Fostering this level of collaboration offers a key opportunity for enabling monitoring and reporting of SMD through SDGs.

- There is no commonly agreed delineation of mountain areas, since such delineations depend on the information needs of the end-user, among other factors. Often countries apply their own definitions of mountain areas, making it difficult to compare results across different countries. Efforts to monitor SDGs should thus be decentralized at the regional level using a jointly agreed approach.

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1 Introduction

The overall goal of the Swiss Agency for Development and Cooperation's (SDC) programme Promoting Sustainable Mountain Development for Global Change (SMD4GC) is "to essentially contribute to sustainable mountain development under uncertain changes in climatic, environmental and socio-economic conditions, and by focusing on poverty and risk reduction" (SDC 2014). To observe progress toward this goal, the Mountain Research Initiative (MRI), in collaboration with the Centre for Development and Environment at the University of Bern, were tasked by SDC with developing a way to assess sustainable development in mountains. MRI coordinated a number of web meetings and email exchanges following the Perth III[1] meeting in 2015 to maintain the engagement of and exchange amongst the SMD4GC partners and researchers working on sustainable mountain development (SMD). During the preparation of SMD case studies for the 2016 World Mountain Forum in Mbale, Uganda, several assessment-related issues were highlighted, in particular the difficulty in choosing meaningful indicators and obtaining the data necessary to inform them. Despite agreement that context-specific indicators are essential, the lack of a practical and political framework made the effort unfeasible. Similarly, without any overarching incentive or concrete mandate, countries were assumed to be unlikely to regularly collect standardized data to inform the indicators. However, at the 2016 World Mountain Forum, the Sustainable Development Goals (SDGs) were identified as a way to provide both a meaningful international political framework and standardized indicators that could be tailored to the assessment of SMD. Therefore, SMD4GC project partners agreed to do the following:

- Conduct a survey of SMD researchers and experts to determine if a reasonable subset of SDG indicators relevant to monitoring and reporting on SMD could be identified.
- Ascertain to what extent data for the identified indicators are already commonly available.
- Determine whether it would be possible to disaggregate the data collected for the SDGs to a resolution that would make it possible to account for mountainous areas as subregions within countries.

This report documents that work and offers an evidence-informed preliminary assessment of a subset of SDG indicators tailored to an SMD context, data availability for those indicators, and the possibility of disaggregating those data to meaningful spatial contexts.

[1] Perth III stands for the "Mountains of Our Future Earth" conference, which took place in Perth, Scotland, from 4 to 8 October 2015.

2 Significance of the SDG framework for SMD

Since early 2016, the United Nations' 2030 Agenda for Sustainable Development and the associated SDGs has become the new imperative in global efforts to promote sustainable development. Comprising 17 goals with 169 associated targets and 232 indicators, the SDG framework defines an agenda for sustainable development to be achieved by 2030 by all UN member states (UN-GA 2015). To fulfil the pledge that "no one will be left behind" (UN-GA 2015), the implementation of the 2030 Agenda will require not only tremendous effort and the participation of a broad range of actors at multiple spatial levels from local to global, but also adequate assessment methodologies to support evidence-based decision-making (UN-ECOSOC 2017a). While there is an emerging consensus that the focus of SDG monitoring will be at the national level with complementary monitoring at regional and global levels (UN-SDSN 2015a), it is increasingly understood that data produced within the SDG framework must not only be methodologically clear and continuously measured but also sufficiently disaggregated to address specific challenges for vulnerable population groups and subnational units such as cities (UN-ECOSOC 2017a; Bizikova 2017). To adequately address such issues with an often immanent spatial component, a call for the localization of the SDG framework has emerged (UNDP et al. 2015; Global Taskforce of Local and Regional Governments 2016).

The need for localized assessments of sustainable development applies equally to mountain regions. Although they cover one fourth of the global land surface (Mountain Partnership 2014), mountains provide a broad range of ecosystem services to more than half of the world's population (Veith 2011), serving as key biodiversity hotspots as well as spaces of cultural heritage (Drexler et al. 2016). However, they do not receive appropriate consideration in national and global development agendas (Wymann von Dach et al. 2016). A focus on mountain areas is important, since challenges and priorities for sustainable development in mountain areas may differ from those in lower-lying areas or at the national level. Furthermore, measures should be implemented at local levels, and knowledge of local conditions, opportunities, and challenges are therefore crucial for evidence-informed decision-making. Consequently, mountains were explicitly addressed by the UN General Assembly when the foundation for the SDGs was laid. The UN clearly stated that they "recognize that the benefits derived from mountain regions are essential for sustainable development" and therefore "encourage States to adopt a long-term vision and holistic approaches, including by incorporating mountain-specific policies into national sustainable development strategies". Moreover, the UN "call for international support for sustainable mountain development in developing countries" (UN-GA 2012).

While three SDG targets directly refer to mountains,[2] all SDGs should be considered for SMD: The SDG framework takes an integrative approach (UN-GA 2015; UN-SDSN 2015b), and assessments of SMD should do the same. However, given the scope, complexity, interdependence, and time frame of the 2030 Agenda for Sustainable Development, there is great interest in the development of subsets of indicators to enable more timely and specific tracking of sustainable development (UN-SDSN 2015a). Such indicators should be "limited in number; simple, intuitive, and policy-relevant; consensus-based, in line with international standards; relevant to all countries and all people; and able to be disaggregated to track progress for all relevant groups" (UN-SDSN 2015a). Although there is still much work to do with regard to each of these requirements, there is a consensus that the application of the SDG framework should not be delayed until full methodological clarity is achieved and all data are at hand (UN-SDSN 2015a; Sachs et al. 2016).

The aim of this paper is therefore to report on the assessment of these two emerging issues for sustainable development – localizing SDGs, and developing subsets of indicators that can effectively assess local progress towards achieving them – by identifying challenges to and opportunities for developing a context-specific subset of SDG indicators and providing recommendations for further work. Such indicators should be practical to use, applicable to different mountain regions worldwide for comparative reasons, and relevant to SMD. With this objective, this paper is situated at the interface of two current methodological issues related to the SDG framework: first, how to harness the large amounts of data that will be compiled both within and outside the SDG framework and translate them into a meaningful tool to assess SMD; and second, how to meet the need for spatially disaggregated data when assessing sustainable development at

[2] The mountain-related SDG targets are:
- Target 6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.
- Target 15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.
- Target 15.4: By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits which are essential for sustainable development.

subnational levels, or indeed in transboundary spaces, both of which apply to mountain areas. To this end, this report will first provide a general overview of the SDG framework, with a critical consideration of the methodology related to the development of indicator subsets and data disaggregation. Subsequently, availability, quality, and applicability of SDG data are assessed for case study regions. This part aims to provide a feasibility and gap study by identifying opportunities, weaknesses, and possible challenges when using the SDG framework to assess SMD.

3 The SDG framework: A closer look

3.1 Brief outline of the SDG framework

Following the Rio+20 conference, the UN General Assembly adopted Resolution 66/288, 'The Future We Want', on 27 July 2012, laying the foundation for the 2030 Agenda for Sustainable Development (UN-GA 2012). The adoption of the 2030 Agenda by the UN General Assembly followed on 25 September 2015 (UN-GA 2015). The SDGs have been in effect since 1 January 2016, and all UN member states are expected to refer to them in policymaking and to achieve the 169 targets by 2030 (UN-SDSN 2015b). Until then, regular voluntary national reviews (VNRs) are conducted by all UN member states "to facilitate the sharing of experiences, including successes, challenges, and lessons learned, with a view to accelerating the implementation of the 2030 Agenda" (UN-DSDG 2017b). All VNRs are reported to the High-Level Political Forum on Sustainable Development and made publicly available (UN-DESA 2018). Common challenges, gaps, achievements, and lessons learned are subsequently reported in synthesis reports by the UN Economic and Social Council and the Division for Sustainable Development Goals (UN-DSDG 2017a).

The 17 SDGs are intended to stimulate action in the key areas of people, planet, prosperity, peace, and partnerships, and thereby address the three dimensions – economic, social, and ecological – of sustainable development. Although they are not legally binding, all UN member states are expected to take ownership of them and to contribute to their achievement (UN 2017). However, the UN also recognizes each country's "specific challenges to achieve sustainable development, and […] the special challenges facing the most vulnerable countries" (UN-GA 2015). These guiding principles of the SDGs are summarized by the UN as follows:

> *The Sustainable Development Goals and targets are integrated and indivisible, global in nature and universally applicable, taking into account different national realities, capacities and levels of development and respecting national policies and priorities. Targets are defined as aspirational and global, with each Government setting its own national targets guided by the global level of ambition but taking into account national circumstances. Each Government will also decide how these aspirational and global targets should be incorporated into national planning processes, policies and strategies.* (UN-GA 2015)

3.2 SDG indicators

The currently 232 indicators are considered preliminary and are expected to be continuously refined (Sachs et al. 2016). The IAEG-SDGs (2018) defined three tiers describing the level of methodological development and the availability of data (Table 1).

Table 1: SDG indicator tiers.

Tier	Definition
I	Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.
II	Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.
III	No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.

The tier classification is based on methodological development status and data availability on the global level and may not align with the national level (IAEG-SDGs 2018). The methodology and the compilation of data for an indicator are the responsibility of custodian agencies (usually an international organization like the Food and Agriculture Organization or the World Bank). The IAEG-SDGs regularly reviews indicators' tier assignments, and these may be reclassified when methodologies are developed or data become available (IAEG-SDGs 2018). As of 11 May 2018, 93 indicators were classified as Tier I (~40% of all indicators), 72 as Tier II (~31%), and 62 as Tier III (~27%); 5 indicators (~2%) had components in more than one tier (IAEG-SDGs 2018).

3.3 Localization of SDGs

Within the SDG framework it is increasingly understood that, since most responsibilities for achieving the SDGs lie at the local level, regional governments and subnational contexts must be more strongly taken into account – a process referred to as localization of the SDGs (UNDP et al. 2015; Global Taskforce of Local and Regional Governments 2016; UCLG 2017). Based on consultations with over 5,000 stakeholders from over 80 countries, the Global Task Force of Local and Regional Governments, United Nations Development Programme, and UN-Habitat conclude that integrated multi-level and multi-stakeholder approaches including local, regional, and national governments as well as stakeholders are needed for the implementation of the SDGs at the local level to ensure ownership and commitment and to promote transformative agendas (Global Taskforce of Local and Regional Governments 2016). To this end, the initiative Localizing the SDGs made five recommendations (Global Taskforce of Local and Regional Governments 2016):

1. Develop a set of localized indicators, specific to each territory.
2. Ensure that the information gathered by the local and regional governments is used in national monitoring and reporting.
3. Enable the participation of local and regional governments and stakeholders in the review of national plans.
4. Use SDG indicators to monitor and assess local or regional plans.
5. Ensure that local achievements are recognized and part of the national SDG progress reports.

Although current efforts mainly aim at awareness-raising, advocacy, implementation and monitoring with a focus on SDG 11 (sustainable cities and communities), these efforts are also indicative for future applications and implementations of the SDG framework with a sharpened awareness of the spatial dimension of sustainable development. Therefore, insights gained in analyzing how SDG targets and indicators can be localized also provide valuable insights for subnational mountain regions. These recommendations also emphasize the need for multilevel approaches, since local as well as regional information flows are required to achieve the 2030 Agenda.

3.4 General data availability

The utility of the SDG indicators for monitoring and assessing sustainable development – for example, to provide a basis for policy adaptation and decision-making – depends on the timely availability of data on indicator status. Currently, SDG data come from seven major types of sources (Data4SDGs 2017):

- Census data
- Household surveys
- Agricultural surveys
- Administrative data
- Economic and fiscal statistics
- Geospatial data
- Environmental data

Official national-level SDG indicator data are readily available in the UN Statistics Division's Global SDG Indicators Database (UN-STATS 2018a). With few exceptions, data availability is limited to single years after the year 2000, when the Millennium Development Goal (MDG) measurement period began. The UN Statistics Division also provides metadata files specifying concepts, definitions, methodologies, and institutions in charge of data gathering, as well as sources for Tier I and II data (UN-STATS 2018b). However, since methodologies for about a third of the SDG indicators are currently not defined and/or accepted, proxy data are often used instead. By their nature, proxy data are much more diverse, may only be available for a certain area, and may not be standardized. A comprehensive list of possible sources of proxy data for SDG assessments is provided in Annex 1.

Major efforts are currently being undertaken to extend data sources by including new, innovative, cost-effective, and widely used technologies to collect SDG-related data. Data generated using smartphones, tablets, drones, remote sensing, social media, and other tools of the "data revolution" will increasingly be incorporated in the SDG data repository (IAEG-DRSD 2014; UN-SDSN 2015c).

As a lesson learned from the MDGs, where indicator data were reported with large time lags and too often were of poor quality, the UN Sustainable Development Solutions Network (SDSN) has proposed annual reporting on indicator status by every country (UN-SDSN 2015a). Since many data are collected in the course of censuses and other efforts that are carried out in multi-year cycles, the SDSN has advised that three-year reporting cycles can be sufficient when appropriate methods are used to extrapolate data (UN-SDSN 2015a). However, many of the censuses for the 2020 round, especially in the global South, have already been conducted or are at an advanced planning stage, so it is too late for methodological corrections for this round (TRENDS 2018). In consequence, insufficient baselines and inexact assessments and extrapolations will remain a challenge in reporting on SDG status.

3.5 Spatial disaggregation

To localize the SDGs requires spatial disaggregation of SDG data. This is clearly recognized by the UN:

> *Sustainable Development Goal indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability, and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics* (UN-ECOSOC 2017b).[3]

This principle is recognized by a broad range of actors, as demonstrated in an open consultation among members and observers of the IAEG-SDGs on proposed SDG indicators, during which the need for disaggregated data was mentioned 782 times (IAEG-SDGs 2015). In its 47th session, the UN Statistical Commission agreed that

> *improving data disaggregation is fundamental for the full implementation of the indicator framework and to fully reflect the principles of the 2030 Agenda for Sustainable Development to ensure that no one is left behind, and stressed that efforts should be made to strengthen national capacities in that area and to develop the necessary statistical standards and tools, including by establishing a working group to work on data disaggregation as a subgroup of the Expert Group* (UN-ECOSOC 2017b).

The IAEG-SDGs, which oversees tier classification, is also responsible for implementing data disaggregation. In this capacity, it initiated the Working Group on Geospatial Information in 2016, whose responsibilities (UN-GGIM 2016) include the following:

- Identify geospatial data gaps in the indicators and metadata as well as methodological and measurement issues.

- Consider how geospatial information can contribute to the indicators and metadata (1) as a direct indicator in itself, (2) to support and augment statistical data, (3) to improve the production of statistical data, (4) to validate national statistical data inputs, (5) to communicate and visualize the geographic dimensions and context of the indicators where appropriate, and (6) to provide granularity and disaggregation of the indicators where appropriate.

- Propose methodological strategies for improving disaggregation by geographic location for national and subnational reporting.

First results by the Working Group on Geospatial Information have highlighted the lack of sufficient data for spatial disaggregation in previous surveys and censuses and the lack of access to data due to factors such as institutional barriers, harmonization issues, or lack of funding (UN-GGIM 2017). The UN Statistics Division and the World Bank are currently developing a framework for a stronger embedding of national geospatial information management and systems, especially in developing countries. The framework was launched in August 2018 (UN-GGIM 2018 and https://www.geospatialworld.net/blogs/un-launches-guide-for-countries-to-improve-geospatial-data-management-for-better-decision-making/).

3 It is also recognized in SDG target 17.18: By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing states, to increase significantly the availability of high-quality, timely, and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location, and other characteristics relevant in national contexts.

3.6 Geoportals as data sources

Online geoportals use a geographic information system to organize and publish data on SDG indicators. The current status of an SDG target is available at the national level for most countries on the SDG Dashboard (Sachs et al. 2017; ESRI 2018). For some countries, national statistical organizations are also already providing geoportals that display the status of SDG indicators at a subnational spatial resolution. To the authors' knowledge, three online geoportals were available as of February 2018, although only as beta versions – for Bangladesh (Government of the People's Republic of Bangladesh 2018), Ireland (Government of Ireland 2018), and Peru (Instituto Nacional de Estadística e Informática 2018). Of these, only the Ireland geoportal currently provides GIS-organized SDG data at subnational levels. Thus, geoportals are still an exception and provide only limited information.

4 Conceptual considerations regarding the assessment of sustainable mountain development using SDG indicator data subsets

At the 2016 World Mountain Forum in Mbale, Uganda, the importance of the SDG framework for mountain areas and the possibilities offered through its data basis were widely acknowledged as useful by SMD4GC partners. It was agreed that SDG data could provide a comparatively simple, widely applicable, and globally available database that allows for the assessment of SMD without being too context specific. At the same time, unresolved issues were noted concerning the identification of a reasonably comprehensive subset of indicators as well as the availability of data with which to assess them. The following sections of this paper refer to the decisions taken following the 2016 World Mountain Forum to design a globally applicable indicator subset, and further elaborate on requirements to implement it.

4.1 Criteria for indicator selection

Although the detailed modalities for monitoring the SDGs are still being negotiated, there is an emerging consensus that monitoring at the national level needs to be complemented by monitoring based on thematic subsets of indicators (UN-SDSN 2015a). To this end, the SDSN has proposed 10 criteria for global monitoring indicators (Table 2) based on principles developed for the MDG framework (UN-ECOSOC 2015). The global monitoring indicators are meant to allow national statistical organizations to "report and communicate effectively in a harmonized manner" (UN-SDSN 2015a) on the global status of indicators. However, these criteria can also guide the design of subsets of indicators focused on spatial levels other than global.

Table 2: Criteria for monitoring indicators, based on UN-SDSN 2015a; UN-SDSN 2015b

Principles for criteria	
1.	**Limited in number and globally harmonized** • Global indicators: max. 100 indicators; harmonized reporting on annual basis for all countries • National Indicators: identified by countries for their respective context
2.	**Simple, single-variable indicators, with straightforward policy implications** • Use of metrics consisting of one variable only • Avoidance of indices requiring complex data collection or arbitrary weighting
3.	**Allowing high frequency monitoring** • Annual reporting • Internationally harmonized national monitoring cycles
4.	**Consensus based, in line with international standards and system-based information** • Based on international standards, recommendations, and best practices to facilitate international comparison. • Consistent with systems of national accounts, systems of environmental economic accounting, and other systems-based information
5.	**Constructed from well-established data sources** • Use well-established sources of public and private data • Consistent measurement over time
6.	**Disaggregated** • By characteristics of the individual or household (e.g. sex, age, income, disability, religion, ethnicity and indigenous status); economic activity; spatial dimensions (e.g. by metropolitan areas, urban and rural areas, or districts)
7.	**Universal** • Applicability at global, regional, national, and local levels • Potential to be localized
8.	**Mainly outcome-focused** • Track outcomes or ends rather than means
9.	**Science-based and forward-looking** • Adaptable to changing global dynamics and able to anticipate future changes • Flexibility to allow for new indicators to replace outdated ones
10.	**A proxy for broader issues or conditions**

The SDSN (2015a; 2015b) has also proposed criteria for quick assessment of broad performance on the SDGs, which further refine the principles compiled in Table 2.

Table 3: Principles for quick-assessment indicators.

Principles
1. Limited in number (two to three per goal) but capturing core elements of each goal
2. Applicable to broad range of country settings
3. Recent high-quality data available for as many countries as possible
4. Consensus based, in line with international standards and system-based information
5. Constructed from well-established and accessible data sources

These principles form a meaningful basis for choosing an initial subset of indicators to assess SMD, and guide the subsequent considerations in this paper. However, the SDSN has emphasized that the above-mentioned principles are meant to identify priority areas in which SDG indicators are lagging behind and cannot serve as a management or accountability tool (UN-SDSN 2015b). Furthermore, given the integrative nature of the SDG framework, an indicator subset cannot serve as a substitute for the full set of indicators. A subset will only allow a quick check on the status of indicators in an area and will not assess sustainable development in terms of the understanding of the SDG framework.

4.2 Identification of an initial indicator subset

To identify an initial indicator subset, 85 researchers involved in SMD4GC and MRI efforts were asked between November and December 2016 to identify 15 indicators they considered representative for sustainable mountain social-ecological systems. The number was limited to encourage survey participants to focus on their priorities rather than provide a comprehensive 'wish list'. In total, 32 researchers responded to the survey. Of the 232 indicators, 154 were chosen by at least one survey participant. This highlighted the great heterogeneity in professional backgrounds among participating researchers, leading to very diverse perceptions of representative indicators for sustainable mountain social-ecological systems. To make the subset manageable, it was limited to indicators that were mentioned by at least 10 survey participants, a threshold that marked a clearly distinguishable cutoff point. This resulted in the selection of 18 indicators, covering 16 targets, associated with 10 of the 17 SDGs (Figure 1).

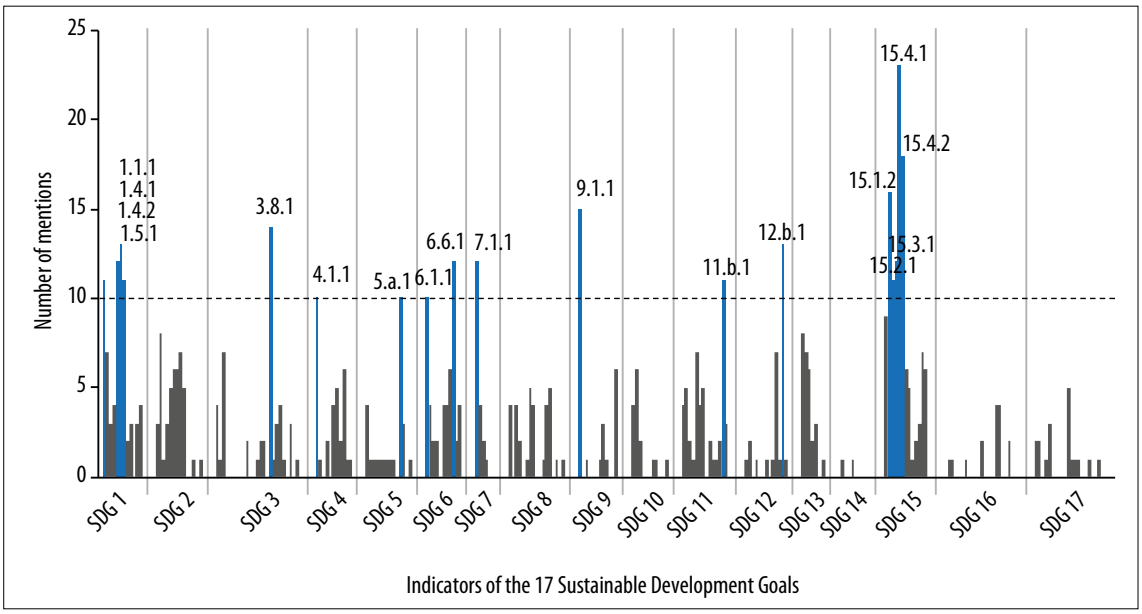

Figure 1: Results of the indicator selection. Indicators selected for the subset are listed above the relevant SDG. Black columns show indicators that received at least one vote but fewer than 10; blue columns show indicators that received at least 10 votes and that were selected for the initial subset. The dashed horizontal line indicates the threshold value of at least 10 votes for selection, the gray vertical lines separate the indicators by SDGs.

The respective indicators and their corresponding targets are described in more detail in Table 4.

Table 4: Overview of SDG targets and indicators.

Targets		Indicators	
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	1.1.1	Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)
1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	1.4.1	Proportion of population living in households with access to basic services
		1.4.2	Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	1.5.1	Number of deaths, missing persons and persons affected by disaster per 100,000 people
3.8	Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	3.8.1	Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)
4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	4.1.1	Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex
5.a	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws	5.a.1	(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1	Proportion of population using safely managed drinking water services
6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1	Change in the extent of water-related ecosystems over time
7.1	By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1	Proportion of population with access to electricity
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.1	Proportion of the rural population who live within 2 km of an all-season road
11.b	By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels	11.b.1	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030
12.b	Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	12.b.1	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools

15.1	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type
15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2.1	Progress towards sustainable forest management
15.3	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	15.3.1	Proportion of land that is degraded over total land area
15.4	By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development	15.4.1	Coverage by protected areas of important sites for mountain biodiversity
		15.4.2	Mountain Green Cover Index

Half of the selected indicators related to SDG 15 (life on land) or SDG 1 (no poverty). The single indicators mentioned most often by survey participants were the coverage by protected areas of important sites for mountain biodiversity (15.4.1), mentioned by 72% of all survey participants, and the Mountain Green Cover Index (15.4.2), mentioned by 56%.

4.3 Methodological clarity of the initial indicator subset

As an initial feasibility assessment, the chosen indicators were ranked according to the IAEG-SDGs criteria (Table 5).

Table 5: Tier assignment of the initial subset indicators.

	Tier I	Tier II	Tier III
Indicator	1.1.1 7.1.1 11.b.1 15.1.2 15.2.1 15.4.1 15.4.2	1.4.2 1.5.1 3.8.1 4.1.1* 5.a.1 6.1.1 6.6.1 15.3.1	1.4.1 9.1.1 12.b.1
Number	7	8	3
Percentage	39%	44%	17%

Source: IAEG-SDGs (2018). Tier assignments are valid as of 11 May 2018.

*Indicator 4.1.1 consists of 3 sub-indicators. Of these, b) and c) are classified as tier II, c) is classified as tier III. Here, this indicator is therefore classified as tier II.

Although data for the seven tier I indicators can be expected to be collected by most countries, more data may be available depending on which countries are assessed since data for tier II indicators are not regularly produced by every country.

4.4 Representativeness of the initial subset with regard to specific challenges for SMD

Despite the comparatively small number of respondents in the survey, the fact that the selected indicators were mentioned by at least 30% of the respondents indicates a widespread sense of the importance of these indicators for sustainable mountain social-ecological systems in the SMD4GC/MRI SMD community. A recent survey by the International Centre for Integrated Mountain Development (ICIMOD) for the Hindu Kush–Himalayan region had similar results. ICIMOD surveyed over 100 scientists from that region to identify priorities for the region and corresponding SDG indicators. The ICIMOD survey identified 40 indicators, including 14 of the 18 selected for this study. The indicators 3.8.1, 4.1.1, 12.b.1, and 15.2.1, selected by participants in this study, were not featured in ICIMOD's selection (personal communication Philippus Wester and Golam Rasul). The overlap in the results of the MRI and ICIMOD surveys suggests that the selected indicators are also perceived as relevant for SMD by a broader field of participants.

Survey participants were not asked to give their reasons for selecting an indicator. Therefore, it was not possible to further clarify why, for example, indicators concerning the ecological dimension prevailed. In consequence, it remains unclear whether the three dimensions of sustainable development (economic, social, and ecological) are sufficiently represented in the subset, or whether survey participants' geographic or disciplinary backgrounds led to an overrepresentation of certain issues. It would be particularly important to know whether the survey participants regarded their selection as representative of broader and interlinked issues. For example, issues pertaining to climate change and addressing climate action (SDG 13) in mountain regions were surprisingly missing in the subset, despite considerable attention to and focus on climate change in mountain areas. Furthermore, indicator 5.a.1 also potentially requires legal certainty that is covered by SDG 10 (reduced inequalities) and SDG 16 (peace, justice, and strong institutions). Indicators addressing these SDGs were not included in our subset. Therefore, the indicator 5.a.1 could potentially serve as a proxy for broader issues.

4.5 Interlinkages between SDGs

The assessment of potential synergies and trade-offs between goals and targets is considered one of the most pressing priorities for research for the SDGs (ICSU and SCCI 2015; Nilsson et al. 2016; Bowen et al. 2017; ODI 2017; Zhou and Moinuddin 2017; Singh et al. 2017; Weitz et al. 2017; Nilsson et al. 2018). Efforts are currently being undertaken to address this issue. For example, the IAEG-SDGs recently conducted a global consultation to identify interlinkages, integrated analyses, and areas and frameworks that can facilitate the monitoring of the SDGs (UN-STATS 2017). Furthermore, the Working Group on Interlinkages of SDG Statistics to Allow for Integrated Analyses in the Monitoring has been initiated with the aim of identifying interlinkages between goals and targets and within the underlying statistics (UN-ECE 2017).

The as yet limited number of results on this issue indicates the complexity of these interlinkages. One effort to address the issue is the website *Sustainable Development Goals Interlinkages and Indicators* (IGES 2018) by the Institute for Global Environmental Strategies, which began by using network analysis methods to highlight the importance of respecting national circumstances when identifying synergies and trade-offs between SDG targets (Zhou and Moinuddin 2017). The Institute also identified five challenges for integrated use of the SDG framework: (1) identification of SDG interlinkages, in particular at the national level, (2) well-defined indicators with reliable data, (3) reliable and trackable data for quantification, (4) the quantification of causality, and (5) the definition of the functions of the SDG network and the selection of appropriate metrics for its structural analysis (Zhou and Moinuddin 2017).

For this project, we conducted a qualitative analysis of the interlinkages between the targets addressed by the indicators of the initial subset and all 17 SDGs using an assessment of target interlinkages by the International Council for Science and the International Social Science Council (ICSU and SCCI 2015). These interlinkages were graphically displayed (Figure 2) to ascertain how the targets of the initial subset are interlinked and whether interlinkages to other SDGs not addressed in the initial subset exist.

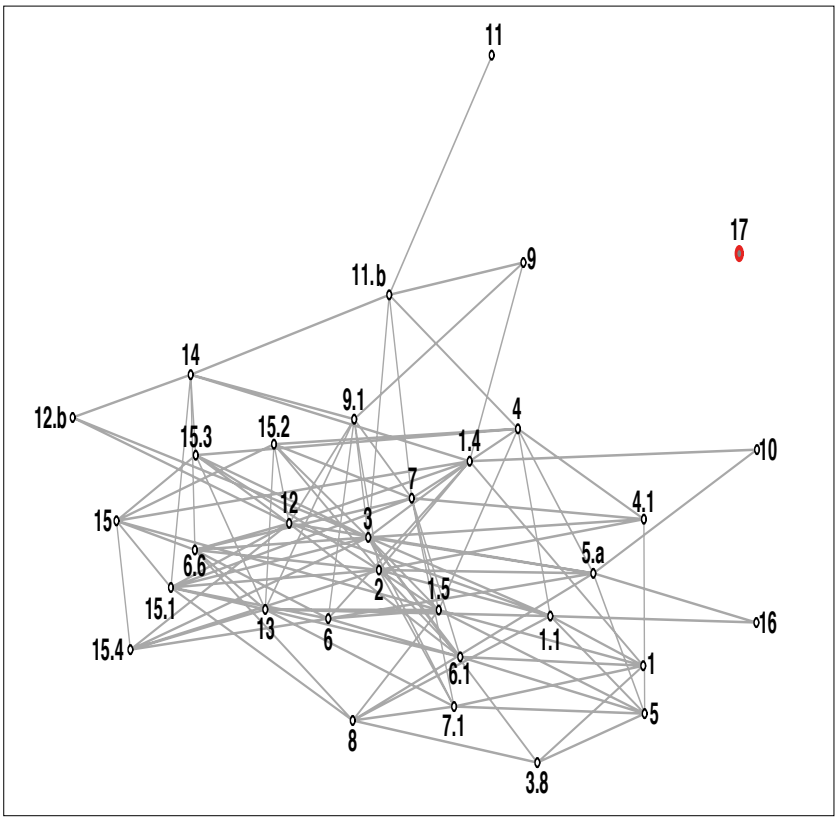

Figure 2: Interlinkages between the SDGs and the targets associated with the selected indicators. The closer the targets and goals are to each other, and to the middle of the graph, the more interlinkages were identified.

This assessment indicated that the targets addressed by the indicators in our subset were linked to most of the SDG goals, including goals not explicitly addressed by the indicators. For example, no targets of SDG 2 (zero hunger) or SDG 13 (climate action) were featured in our subset, but SDG 2 was associated with 10 of the targets addressed by the indicators in our subset and SDG 13 was associated with 13 of the targets. However, this assessment of connectedness does not provide information on whether interactions are synergetic or whether a trade-off between targets exists. In the follow-up of this working paper, the type of interaction between different targets should be scrutinized in more detail. In this regard, a typology of SDG interactions developed by Nilsson et al. (2016) is increasingly used (Weitz et al. 2017; Nilsson et al. 2018) and provides a methodology for assessments of SDG target interactions.

4.6 Delineation of mountain areas

Related to the issue of spatial disaggregation is the assignment of subnational data to administrative units that actually constitute mountain areas. Depending on which definition is applied, the areas delineated as mountain areas may differ substantially (Sayre et al. 2018). As an example, two different mountain designations for central Bolivia are shown in Figure 3.

Differences in delineations of mountain areas can have far-reaching implications; for example, the allocation of resources may depend on whether an administrative unit is considered to lie in a mountain area. This issue is of particular relevance to the use of data that are already disaggregated for mountains. National definitions of mountains and mountain categories may differ substantially, and a comparison of a mountain area that spans several countries may not be possible without further data processing. Mountain definitions are also relevant to indicator 15.4.2 (Mountain Green Cover Index). For this indicator, the Food and Agriculture Organization as custodian agency uses the definition by Kapos et al. (2000) to identify mountain areas (UN-STATS 2018b). However, this definition was developed to map mountain forests and may not always be appropriate for use in, for example, socioeconomic analysis, though it is used for that purpose (FAO 2015).

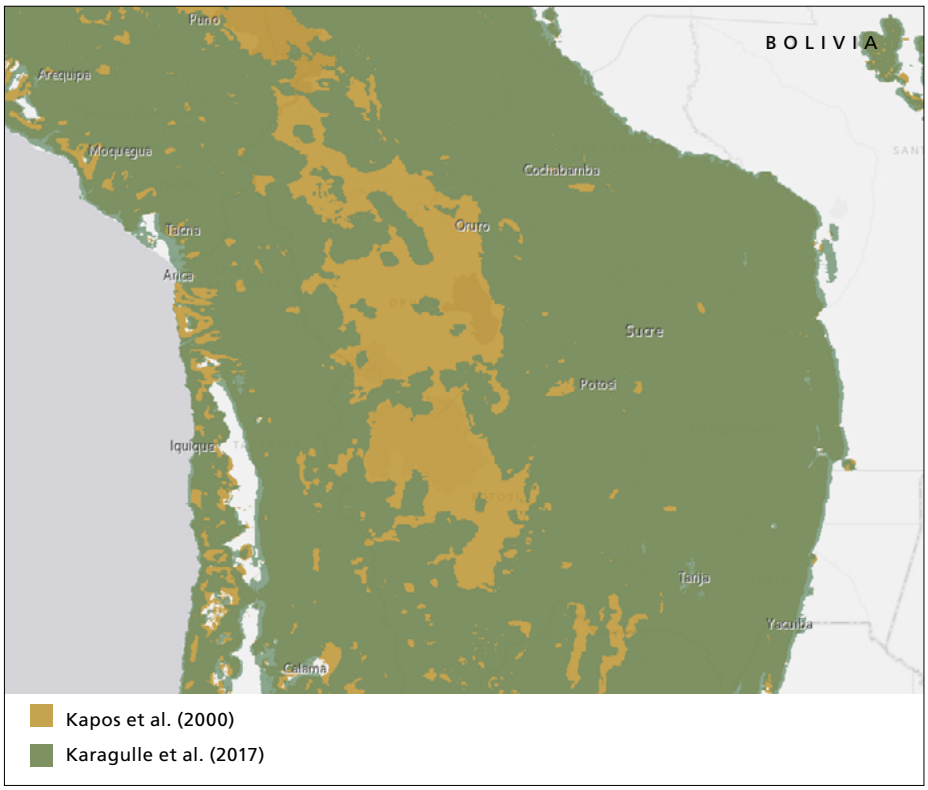

Figure 3: Mountain areas in central Bolivia, as identified based on the definitions of Kapos et al. (2000) and Karagulle et al. (2017) (Image Source: Global Mountain Explorer GME, Sayre et al. (2018); scale not available).

5 Case studies

During a meeting at the 2017 International Conference on Research for Development in Bern, SMD4GC project partners discussed the possibility of assessing the applicability of the mountain indicators subset by performing a desktop study as a pilot test. The Consortium for Sustainable Development of the Andean Ecoregion (Consorcio para el Desarrollo Sostenible de la Ecorregión Andina – CONDESAN) agreed to support the study as the SMD4GC partner organization in the Andean region. Ecuador was nominated for the study since it is frequently described as a global forerunner in data accessibility and was therefore considered a best-case scenario with regard to access to data applicable to the 2030 Agenda. Furthermore, the government increasingly incorporates the SDGs in its planning, such as in the National Development Plan (Plan Nacional Para el Buen Vivir) 2017–2021. It was assumed that the challenges encountered in Ecuador could also be expected for other case study countries with a less well-developed statistical system and a less open data policy. To assess data accessibility in such cases, the process applied for Ecuador was also applied for Chile, Nepal, and Bangladesh, for which data availability was estimated to be more difficult according to experiences by CONDESAN and ICIMOD.

5.1 Data collection and availability

Most published studies incorporating the SDGs focus on targets, not indicators (Annex 2). Methodologically, the target level can be handled more flexibly, since proxy data can be included when indicator data that meet the official SDG indicator definitions are not available. However, if a set of targets or indicators is used for regional monitoring, data corresponding to the official indicator definitions are preferred to ensure consistency.

For Ecuador, major sources of socioeconomic indicator data are censuses that include not only population numbers but also broader household data, such as access to sanitation, electricity, or education. Censuses are conducted by the Instituto Nacional de Estadística y Censos (INEC) at the census tract levels of *parroquias*, *cantónes*, and *provincias*, with *parroquias* (parishes, equivalent to municipalities) having the highest spatial resolution. Censuses were carried out in 1990, 2000, and 2010, and the full census dataset for 2010 is available online (INEC 2010). Further indicator data, such as official agriculture censuses and results from research on ecosystems, were accessible through CONDESAN. Potential sources of spatially disaggregated data were assessed by CONDESAN and are listed in Table 6.

Table 6: Potential data sources for Ecuador.

SDG Indicator		Tier	Data Sources
1.1.1	Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural)	I	Index of Unmet Basic Needs (Necesidades Básicas Insatisfechas) in the census (census contains no income information)
1.4.1	Proportion of population living in households with access to basic services	III	Household infrastructure section of the census
1.4.2	Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure	II	No recent information regarding land tenure status exists.
1.5.1	Number of deaths, missing persons and persons affected by disaster per 100,000 people	II	Data is commonly available via DesInventar, a data base for monitoring the Sendai Framework for Disaster Risk Reduction (www.desinventar.org)
3.8.1	Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population)	III	To explore in second phase, probably in the Ministry of Health
4.1.1	Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex	II	Census data

Table 6 continued

SDG Indicator		Tier	Data Sources
5.a.1	(a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure	II	No recent information regarding land tenure status exists.
6.1.1	Proportion of population using safely managed drinking water services	I	Census data
6.6.1	Change in the extent of water-related ecosystems over time	III	Land Use and Land Cover Change 1990–2016. Definition of water-related ecosystems needed—in Ecuador it could be Páramos and Andean forests.
7.1.1	Proportion of population with access to electricity	I	Census data
9.1.1	Proportion of the rural population who live within 2 km of an all-season road	III	Road maps may be used but information is not consistent. Official sources vary in quality and coverage.
11.b.1	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	I	Development plans of local governments
12.b.1	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools	III	Ministry of Tourism
15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	I	Map of protected areas, Ecosystems map (Cuesta et al. 2017)
15.2.1	Progress towards sustainable forest management	I	Food and Agriculture Organization Global Forest Resources Assessments (FAO 2018)
15.3.1	Proportion of land that is degraded over total land area	II	Land Use and Land Cover Change 1990–2016
15.4.1	Coverage by protected areas of important sites for mountain biodiversity	I	Map of biodiversity conservation priorities for continental Ecuador
15.4.2	Mountain Green Cover Index	I	Map of Ecosystems for Continental Ecuador by the Ministry of the Environment (Cuesta et al. 2017)

Although data sources could be identified for most of the indicators in our subset, they do not in most cases directly meet the official SDG indicator definitions. Therefore, most of the data sources represent proxy data in the strict sense.

For Chile, Nepal, and Bangladesh, assessments of SMD rely mostly on (proxy) data from UN publications and research articles. The structure of the data often does not allow spatial disaggregation at a level that would be meaningful for an assessment of SMD, such as the national level. For Bangladesh, ICIMOD recently identified challenges and opportunities for sustainable development in the Chittagong Hill Tracts (Rasul and Tripura 2016). Although this study used a broad range of data sources, the data only enabled assessment of proxy indicators for SDGs and could only be disaggregated to the district level, at a spatial resolution of thousands of square kilometers.

5.2 Voluntary National Reviews VNRs

In the course of the identification of data sources, the available VNRs for Chile, Nepal and Bangladesh were analyzed. The main focuses were the current implementation status of the SDG framework in the respective country as well as planned steps and timescales for further implementation. This analysis served to assess future developments in data availability. At the time of writing, the VNR for Ecuador was not yet released but was scheduled for the 2018 High-level Political Forum on Sustainable Development.

Chile
At the institutional level, Chile's VNR (Gobierno de Chile 2017) reported, a national council for the implementation of the 2030 Agenda was established, with the Ministry of Social Development and the Environment as the technical secretariat. An SDG network was established and is supported by 23 ministries. Commissions and working groups have been established with actors from civil society, the private sector, academia, and public institutions. During 2016 and 2017, various activities also involving actors from civil society were undertaken to gather and disseminate information for the definition of SDG baselines. At the level of national ministries, statistical indicator information is currently being identified. For the implementation of the 2030 Agenda at the regional and local levels, regional workshops on SDG diagnosis are being developed, starting with heavily populated regions and/or regions with particular population characteristics (e.g. rural, indigenous, or migrant populations).

In the course of these efforts, the national statistical system is being renewed according to the principles of the UN to ensure technical consistency of the national statistics. The population and housing census was conducted in April 2017, and the next national census is scheduled for 2022. The National Socioeconomic Characterization Survey (Encuesta de Caracterización Socioeconómica Nacional), the main national household survey, has been adapted to allow better estimation of SDG indicators. The importance of data disaggregation to subnational scales is explicitly mentioned only in relation to achieving SDG 3 (good health and well-being).

No further information was found in the VNR related to intended steps to make spatially disaggregated data commonly accessible. However, the annex of the VNR provides baseline indicator status for the year 2015 at the regional level (Chile's top-level administrative division, consisting of 15 *regiones*) for three indicators in our subset: 1.1.1, 1.4.1, and 1.4.2. Proxy data at the regional level are provided for poverty-related targets.

Nepal
The VNR for Nepal (Government of Nepal [National Planning Commission] 2017) pays particular attention to data availability and data gaps. Major data sources are national population and household censuses (conducted every 10 years), national censuses on agriculture (every five years), Multiple Indicator Cluster Surveys (every five years), national demographic and health surveys, living standard surveys, and industrial and labour force surveys. These surveys are complemented by annual reports and reports with varying publication cycles by UN custodian agencies.

The VNR states that the data on development are currently limited, available data are insufficiently disaggregated, and some indicators have no defined baseline. It identifies the establishment and implementation of a system to collect the necessary data with sufficient spatial disaggregation as a major challenge, along with limiting SDG targets relevant to the Nepalese context to a manageable number. It gives priority to SDGs that have multiplier effects and larger impacts on poor and marginalized people.

As also highlighted by IIED (2018), Nepal pays particular attention to results-based monitoring and evaluation in the context of the national SDG framework and therefore to regular tracking of indicator status. Here again, the lack of disaggregated data is identified as a major impediment to the monitoring of outcomes and impacts. The need to include a methodology for data disaggregation in all future surveys is clearly stated. The implementation of institutional mechanisms and SDG implementation committees on the provincial level is planned for the second half of 2018.

Bangladesh
In Bangladesh, the Planning Commission is the leading authority in implementing the 2030 Agenda. A gap analysis for the VNR (Government of the People's Republic of Bangladesh 2017) revealed that data are currently available for 70 indicators and partially available for 108 indicators when existing censuses are

modified by disaggregation. The need to devise a new mechanism for data mining for the remaining 63 indicators is stated. A National Monitoring and Evaluation Framework is being developed and is expected to feature a web-based data repository to facilitate data collection, analysis, progress tracking, and reporting. The VNR clearly states that the collection, analysis, disaggregation, and dissemination of data is considered an enormous challenge that requires multi-level collaboration and sharing of best practices. The localization of SDG targets and indicators, and the alignment of national development plans with the 2030 Agenda, are given high priority. This is also recognized in the Seventh Five Year Plan (2016–2020). The VNR states that "developing a holistic, coherent and coordinated rather than sector oriented implementation strategy would be critically important." (Government of the People's Republic of Bangladesh 2017)

5.3 In-depth case study: Ecuador

To assess the feasibility of mapping SDG indicator data at a subnational spatial resolution, two indicators from our subset were selected and data collection, processing, and mapping were carried out for Ecuador in cooperation with CONDESAN. The selected indicators were:

- 1.1.1: "Proportion of population below the international poverty line", due to its importance for many societies in mountain areas worldwide
- 15.4.1 "Coverage by protected areas of important sites for mountain biodiversity", since this received the most votes from survey participants (72%).

Mountain areas were delineated using the mountain definition by Kapos et al. (2000). Although indicator 1.1.1 is ranked in Tier I, no income information was available from the national census. In Ecuador, poverty is measured using the Unmet Basic Needs (Necesidades Básicas Insatisfechas, NBI) index, which takes into account the per capita consumption of each household. In addition to the cost of a basic food basket that meets minimum caloric requirements, costs for meeting non-food needs are included. The NBI covers five dimensions, each with different indicators:

- Economic capacity (*Capacidad económica*)
- Access to basic education (*Acceso a educación básica*)
- Access to housing (*Acceso a vivienda*)
- Access to basic services (*Acceso a servicios básicos*)
- Overcrowding (*Hacinamiento*)

The broad definition of poverty used in Ecuador therefore does not make it possible to assess indicator 1.1.1 in isolation but integrates aspects of several indicators.[4] Expressed in monetary terms, the general poverty line in Ecuador in 2014 was US$84.4 per capita per month (US$2.8 per day). The NBI can also be further subdivided into extreme poverty, for which the threshold was US$47.5 per capita per month (US$1.6 per day) (INEC 2016). Further details on the NBI are provided by INEC (2018). For this case study, the NBI was mapped at the parish (*parroquia*) level. In the census data, information for 1024 parishes were available for 2010. The percentage of households affected by poverty according to the NBI are shown in Figure 4.

In Figure 4 no clear spatial distribution of people with unmet basic needs in mountains and lowlands emerges. In the 2010 census data, information on the NBI is available for 14,306,573 people. Of these, 47.1% lived in mountain areas and 52.9% in lowland areas. In total, 8,593,825 people had unmet basic needs. In mountain areas, 51.3% of people had unmet basic needs compared to 67.9% in lowland areas. People in mountain areas therefore do not appear particularly disadvantaged with regard to the NBI. However, the lowest incidence of poverty is found in parishes in close proximity to cities, and many of these cities are located in mountain areas (e.g. Quito, Cuenca, and Loja). Of the total population, 11.2% lived in Quito alone in 2010. In more remote areas, a greater percentage of people have unmet basic needs.

[4] These are indicators 1.4.1, the proportion of the population living in households with access to basic services; 4.1.1, the proportion of children and young people in three categories (in grades 2 and 3, at the end of primary school, and at the end of lower secondary school) achieving at least minimum proficiency in reading and mathematics, disaggregated by sex; 6.1.1, the proportion of the population using safely managed drinking water services; and 7.1.1, the proportion of the population with access to electricity.

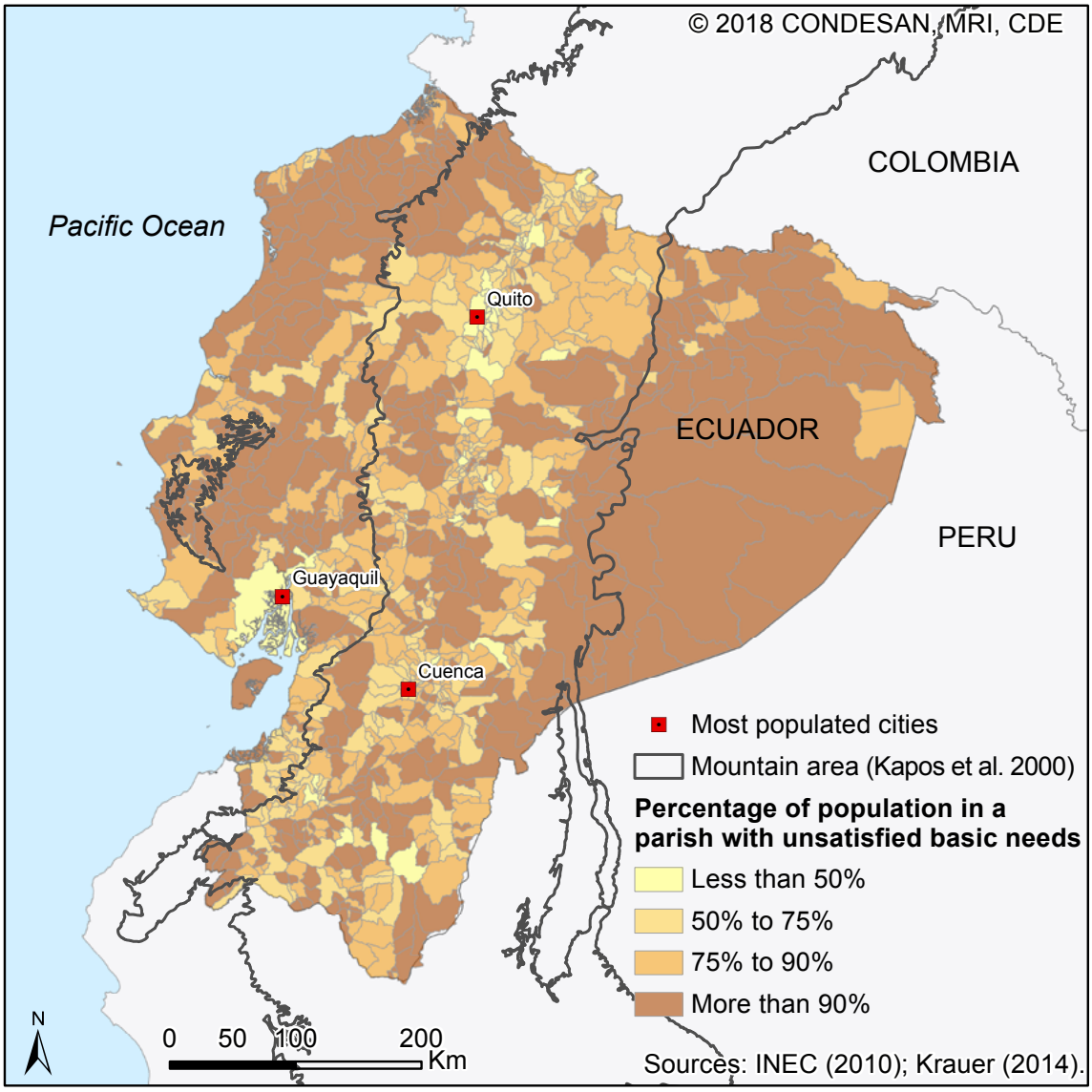

Figure 4: Poverty by parish in Ecuador in 2010, measured using the NBI (Source: Census data).

These patterns suggest that for the follow-up to this working paper, additional data such as population density or further differentiation by elevation should be considered. Due to time restrictions, such in-depth analysis was not feasible. The finding that the incidence of poverty differs strongly between parishes also highlights the need for a high spatial resolution of data to adequately assess indicator status. Although the NBI is not an SDG indicator, it may capture the multidimensionality of poverty more effectively than several isolated indicators or a simple monetary poverty line. The need for up-to-date data is also evident, since considerable progress has been achieved in recent years in the reduction of multidimensional poverty in Ecuador (INEC 2016). Therefore, data collected in 2010 only allows a rough approximation of the incidence of unmet basic needs in 2018.

For indicator 15.4.1, we compared areas identified as important for mountain biodiversity in a study that used conservation planning software, areas of remnant vegetation identified in ecosystem maps provided by the Ecuadorian Ministry of Environment, and Ecuador's National System of Protected Areas (Cuesta et al. 2017); the result is shown in Figure 5.

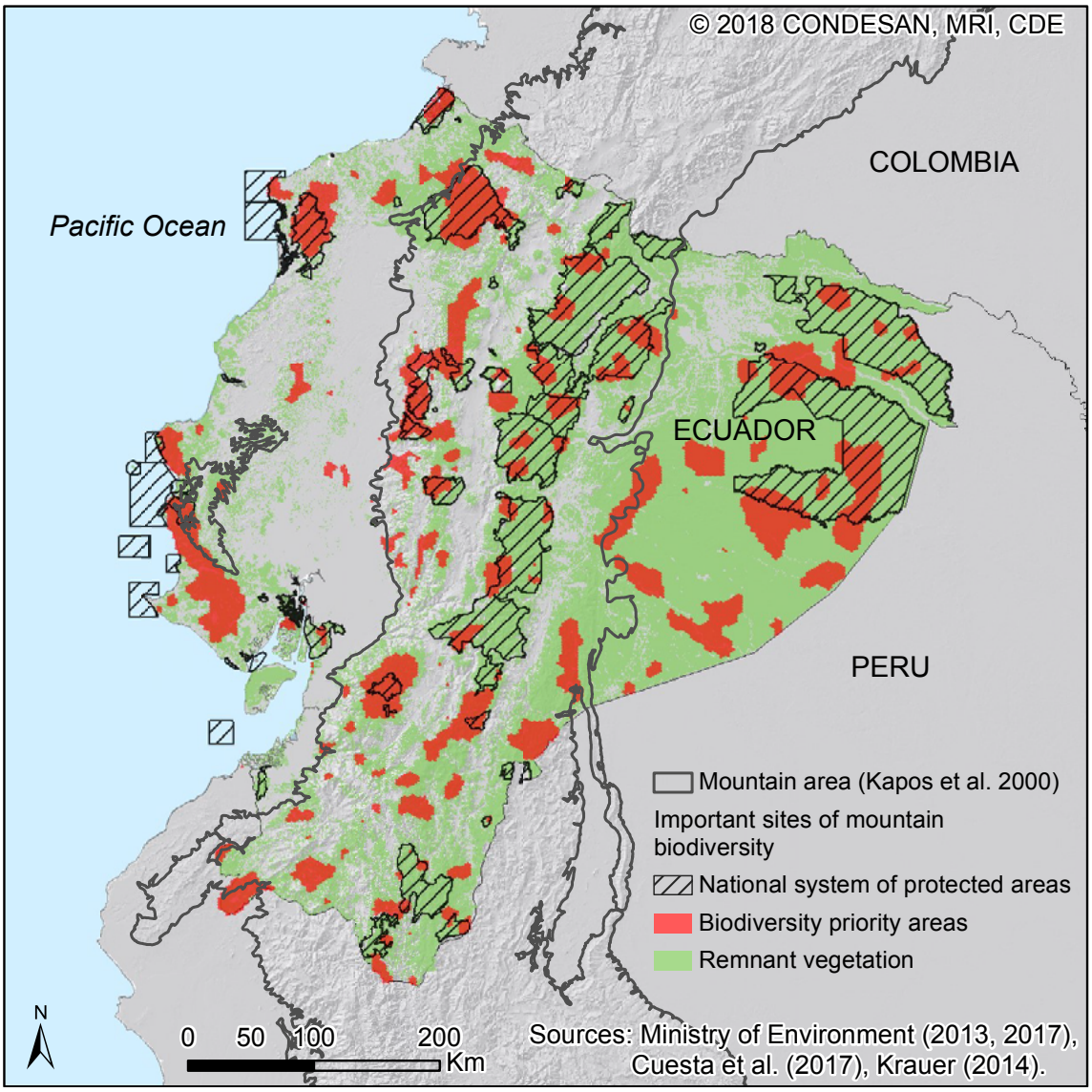

Figure 5: Important biodiversity sites and protected areas in Ecuador.

According to a recent geostatistical analysis (Cuesta et al. 2017), biodiversity priority areas cover 26.0% (1,669,281 of 6,409,254 ha) of the remnant vegetation in the Andean region of Ecuador. Of those biodiversity priority areas, 37.9% (633,328 of 1,669,281 ha) lie within areas defined by the National System of Protected Areas. Thus, 9.9% (633,328 of 6,409,254 ha) of remnant vegetation areas are covered by the National System of Protected Areas. These numbers raise the question of whether SDG target 15.4 (By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits which are essential for sustainable development) can only be achieved once the status of indicator 15.4.1 is 100%. According to the official definition of indicator 15.4.1, protected areas are subdivided into seven categories, also including protected areas with sustainable use of natural resources (UNSTATS 2018b). However, which forms and which levels of intensity of natural resource use are considered to be sustainable is a question that has to be assessed from case to case. Depending on how the sustainable use of natural resources is assessed, indicator 15.4.1 may never be 100% achieved. However, what percentage is acceptable is hard to define. Furthermore, to assess only the coverage by protected areas of important sites for mountain biodiversity may leave out or ignore other important aspects of biodiversity conservation, such as connections between habitats. Therefore, although indicator 15.4.1 is ranked as a Tier I indicator, ambiguities remain in how this target and indicator can be assessed in practical terms.

6 Conclusions

The 2030 Agenda and the associated SDGs represent the most comprehensive approach to sustainable development in history, covering all dimensions of sustainability and assigning responsibility to all nations. The tremendous concerted efforts currently being undertaken to acquire and globally harmonize indicator data open unprecedented opportunities to globally assess and track the status of sustainable development. However, in the relatively short time since coming into effect, the SDG framework has not achieved complete methodological clarity of indicator definitions, harmonization of data acquisition systems, and disaggregation of indicator data.

Given the large number of SDG targets and indicators, the need to focus on indicator subsets in order to continuously monitor specific reference frameworks (such as mountain areas) is widely recognized. Although it is questionable whether subsets allow for assessments of sustainable development, they provide a suitable tool for assessing and monitoring spatial and temporal changes in indicators that can be considered representative of broader aspects of sustainable development. The development of a meaningful indicator subset therefore requires careful consideration of interlinkages, synergies, and trade-offs between targets and indicators. This may be achieved, for example, by defining subsets tailored to specific challenges to the sustainable development of a mountain region that take into account local characteristics.

However, even if consensus on a meaningful subset for a specific region is reached, the current lack of methodological clarity makes it difficult to use indicator data that meet official definitions. In such cases, proxy data may be used. By their nature, proxy data are much more diverse, may only be available for a certain area, and may not be standardized. Furthermore, sources of proxy data need to be identified for every country, and the implications of using different proxy data collection methods must be discussed and clearly stated.

A further challenge for assessing SMD is that spatial disaggregation of indicator data – by administrative units as well as by topographical features – is indispensable. However, official SDG indicator data are currently only reported on the national level and, given the immense resources required for data disaggregation, it is questionable whether spatially disaggregated data will be made commonly available anytime soon. In this regard, the importance of collaboration with local partner organizations is clear; they often have good knowledge of past or current projects in their regions that could provide proxy data and can help identify scattered sources of proxy data that allow at least a coarse spatial disaggregation.

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Annex

Annex 1: Potential Sources of Data for SDG Indicators

This table represents a shortened version of the "Tool 1 Essential Minimum Data Package" by Data4SDGs. The full table is available under: http://www.data4sdgs.org/resources/tool-1-essential-minimum-data-package.

Category of data	Recommended Frequency of Collection	Sample Representativeness	Minimum Recommended Level of Spatial Disaggregation
Census Data			
Population and Housing Census	Every 10 years		Lowest Administrative Unit
Economic Census	Every 10 years		Lowest Administrative Unit
Agricultural and Livestock Census	At least once every 10 years		Lowest Administrative Unit
Household Surveys			
Demographic and Health Surveys (DHS)	Once every 2.5 years	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Multi-Indicator Cluster Surveys (MICS)	Once every 2.5 years	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Living Standards Measurement Surveys (LSMS) or Income & Expenditure Surveys (IES)	Once every 3 years	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Reproductive Age Mortality Surveys (RAMOS)	As Needed	Local	Urban (City) / Rural (Village)
Core Welfare Indicator Questionnaire (CWIQ)	Annual	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Agricultural Surveys			
Land Holding Surveys/Farm Structure Survey (Europe)	Every 2 to 3 years	National, Sub-National	Land Parcel Level
Farm Accountancy Data Network (FADN) (Europe)	Annual		Land Parcel Level
Farm Management and Cost of Cultivation Studies (FMCCS)	Annual	National, Sub-National	Rural (Village)
Cost of Production Survey (Same as FMCCS except Crop Specific)	Annual	National, Sub-National	Rural (Village)
Yield Survey	Every 5 years	National, Sub-National	Land Parcel Level
Livestock Resources Surveys	Annual	National, Sub-National	Rural (Village)
Input Use Survey	Annual	National, Sub-National	Rural (Village)
Crop Estimation Surveys	Annual	National, Sub-National	Rural (Village)
Administrative Data			
Education Management Information Systems (EMIS)	Real Time		Lowest Administrative Unit
Civil Registration and Vital Statistics (CRVS)	Real Time		Lowest Administrative Unit
Management Information Systems for Health (MIS)	Real Time		Lowest Administrative Unit

Category of data	Recommended Frequency of Collection	Sample Representativeness	Minimum Recommended Level of Spatial Disaggregation
Economic and Fiscal Statistics			
Labor Force Surveys (LFS)	Monthly or Quarterly	National, Sub-National, Urban/Rural	Urban (City) / Rural (Village)
Enterprise Surveys/Industry Surveys/Establishment Surveys	Annual	National, Sub-National	Urban (City) / Rural (Village)
Price Statistics (CPI and ICP)	Monthly/Quarterly (As Relevant)	National	Urban (City) / Rural (Village)
National Accounts	Quarterly		
Government Operations (GDP aggregates, budgeted and actual revenues and expenditures at the functional level.)	Quarterly/Annual		
Depository Corporations and Central Bank Survey, Interest Rates and Stock Markets	Monthly		
Balance of Payments	Quarterly		
External Debt	Quarterly		
Trade Statistics (Customs etc.) - Quantity and Commodity Import/Export	Monthly		
Statistics of International Trade in Services and Tourism (SITS)	Annual		
Procurement Data (Spending/ Expenditure))	Annual		Lowest Administrative Unit
National Budget	Annual		
Geospatial Data			
Land Use / Land Cover (including Forest Cover)	On Demand		Pixel Size
National Infrastructure and Facility Inventories (NIFI)	On Demand		
Satellite Imagery	Depending on Imagery (Daily, Fortnightly, Monthly, Annual)		Pixel Size
Administrative and Enumeration Boundaries, Place Names etc. (Auxiliary Information)	One Time with Regular Updates		Any
Disaster Risk Mapping	On Demand		Sub-National, Local
Environmental Data			
GHG Emissions	Annual	National	National
Freshwater Access and Water Quality	Annual	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Landfill/Waste Generation	Annual	National, Sub-National, Urban/Rural	Local (Urban/Rural)
Cooking Fuel Usage	Annual	National, Sub-National, Urban/Rural	Lowest Administrative Unit
Climate Monitoring	Monthly		Pixel Size
Air Quality	Daily	Local	Lowest Administrative Unit
Biodiversity	Every 4 years	National	Sub-National

Annex 2: Use of the SDG Framework in Published Studies

Reference	Regional focus	Thematic focus	SDG goal, target or indicator referenced	Data sources	Key findings regarding use of SDGs
Fullman et al. 2017	188 countries	Global Burden of Diseases, Injuries, and Risk Factors Study 2016	37 of the 50 health-related SDG indicators	• National data and subnational estimates • Wide range of data sources • Indices that represent overall performance	• Each indicator was transformed to a scale of 0–100. This made it possible to compare relative performance on very different SDG indicators and to produce an overall health-related SDG index by calculating an arithmetical or geometric mean of the scaled values.
Gao and Bryan 2017	Australia	Feasibility of achieving multiple SDG targets for the land-sector	Targets 2.1, 2.3, 6.4, 6.5, 6.6, 7.2, 13.2, 15.1, 15.3, and 15.5	• National data	• Indicators were chosen based on four criteria: high relevance to the SDGs, high priority for the land sector, simplicity and clear policy implications, and scientific credibility.
OECD 2017	OECD countries	Distance to achieving SDGs	131 indicators	• 65 OECD indicators "directly comparable" with SDG indicators • 14 proxies from OECD databases • 37 indicator data from the UN Global Indicators Database	• Some OECD countries (not named) could only report on 25% of selected indicators. • Available data allowed assessment of only 57% of SDG targets.
Rasul and Tripura 2016	Bangladesh (Chittagong Hill Tracts)	Present situation and key issues and gaps in achieving SDGs	Goals 1, 2, 3, 4, 5, 6, 7, 8, 9, 15, and 16	• Local data from published reports by the Bureau of Statistics, Ministry of Water Resources, and others (e.g. Multiple Indicator Cluster Surveys)	• SDGs need to be tailored to the local context. • Often data seem to be only available if SDG directly ties to indicators already used in MDG framework. • Few actual SDG indicators were addressed; mostly involved data that could serve as proxy. • Data were not always timely (mostly older than 5 years).
Rasul 2016	South Asia	Interdependences in the food-water-energy nexus	Goals 2, 3, 6, 7, 8, 12, and 15	• National data published by national agencies, UN organizations, research papers	• Highlights interlinking of SDGs • Little effort in South Asia to understand interdependencies in terms of resource use and policies
Sachs et al. 2016; Sachs et al. 2017	157 UN member states	Identifying suitable quick metrics using official SDG indicator data	99 indicators	• Published national-level data • Where official indicator data are insufficient, official and other metrics published by reputable sources	• Unofficial indicators had to be included due to lack of official data • OECD-only indicators (not official SDG indicators) were included to fill gaps. • Technical experts had to be consulted to add metrics published by official or other reputable sources.
Simon et al. 2016	5 cities	Test of an "urban SDG targets and indicators" subset to complement SDG 11 (sustainable cities and communities)	14 indicators, covering 7 targets	• Readily available data produced by local authority dataies	• Universal applications of a subset is difficult to achieve (definitional issues, discrepancies among local realities, varying practices of data collection, local definitions used) • substantial work necessary to make even well-established sources available and applicable • Improvement and harmonization of coherence of recording processes needed

Reference	Regional focus	Thematic focus	SDG goal, target or indicator referenced	Data sources	Key findings regarding use of SDGs
Weitz et al. 2017	Sweden	Mutual influences of SDG targets on each other	34 targets	• Expert judgement	• Cross-impact matrix and network analysis applied to identify positive and negative influences among targets and clustering of mutually reinforcing targets. • Seven-point typology from Nilsson et al. (2016) used and considered to serve the purpose well. • Quality of matrix analysis depends on assessment of interactions; approach is therefore vulnerable to deficiencies in scoring; if matrix is invalid, all further steps are pointless. • Workshops with policymakers and other stakeholders recommended to define matrix scoring. • Establishing matrix required a great amount of work.

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CDE Working Papers

1 *EU Trade Agreements and Their Impacts on Human Rights. Study Commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ).* Elisabeth Bürgi Bonanomi. 2014.

2 *Mit Eco-Drive gegen Strassenlärm. Evaluation eines Interventionsprogramms zur Förderung eines leisen Fahrstils.* Stephanie Moser, Maja Fischer, Elisabeth Lauper, Thomas Hammer, Ruth Kaufmann-Hayoz. 2015.

3 *Challenges and Opportunities in Assessing Sustainable Mountain Development Using the UN Sustainable Development Goals.* Christoph Bracher, Susanne Wymann von Dach, Carolina Adler. 2018.

CDE Working Papers present reflections on sustainable development issues of concern to researchers, development experts, and policymakers around the world.

The 2030 Agenda for Sustainable Development and the associated Sustainable Development Goals (SDGs) represent a comprehensive approach to assess progress towards sustainable development, covering multiple dimensions of sustainability and allocating responsibility at the national level for prioritization, monitoring, and reporting. As part of the Promoting Sustainable Mountain Development for Global Change (SMD4GC) programme, the Mountain Research Initiative (MRI) and the Centre for Development and Environment (CDE) are developing an approach to assess sustainable mountain development (SMD) using the SDGs as framework. Such assessments can help contextualize and highlight the specific needs of and challenges for mountain communities and ecosystems in addressing SMD. They can help inform policy and decision-making at the global, national, and subnational levels in steering SMD efforts for the benefit of people living in highlands and adjacent lowlands.

This study presents the outcome of a survey of mountain researchers to identify a subset of SDG indicators that are relevant to monitoring and reporting on SMD, and the results of a subsequent desktop study to investigate data availability and accessibility of these indicators. Challenges to and opportunities for reporting on the mountain-related SDG indicators are identified and recommendations for further work are offered. Disaggregating the SDGs to subnational levels and applying subsets of SDG indicators to monitor their status are two emerging considerations for reporting on SMD. However, little guidance exists on methodology for disaggregation of SDG data that takes mountain specific challenges into account. Furthermore, the capacity to spatially disaggregate existing SDG indicator data is relatively underdeveloped. Methodologically robust and timely subnational data are not consistently available. However, there are many sources of proxy data that can be used to help fill gaps in SDG data. Collaboration with local partner organizations is important, as they have good knowledge of local conditions, relevant actors, and sources of data. An additional challenge that needs to be taken into account is that there is no commonly agreed delineation of mountain areas, since such delineations depend on the information needs of the end-user, among other factors.