# **MOUNTAINS UNCOVERED**

Intercomparable Maps and Statistics for 100 Selected Global Mountain Ranges

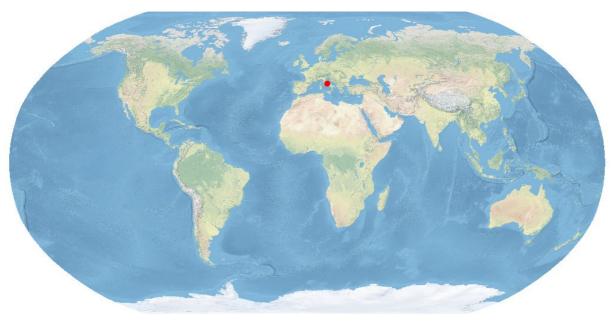
#### **South European Highlands**

#54



# **South European Highlands**

The *Mountains Uncovered* series has been developed by GEO Mountains to provide a set of easily understandable and inter-comparable maps, tables, and figures spanning a range of thematic areas for 100 selected global mountain ranges. This is the report for the **South European Highlands** mountain range. The index page shows an overview of all mountain ranges in the series.



Location of the South European Highlands mountain range [1][2].





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## **1. General Information**

### 1.1. Administrative

The mountain range has spatial overlap with **three** different countries, as shown in Figure 1.1. The overview is based on the GADM dataset [3] of administrative divisions at Level 0.





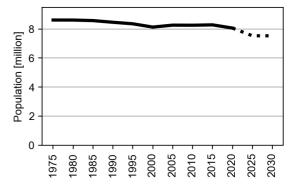


### 1.2. Demographics

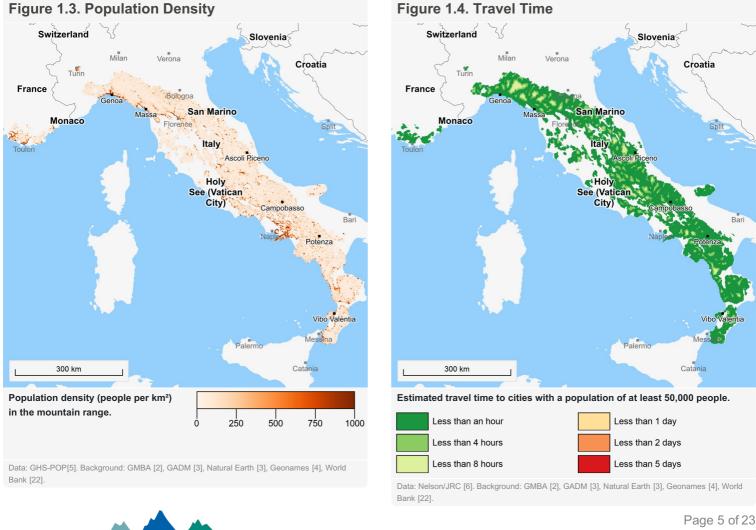
Data on the mountain range's human population are sourced from the European Commission's GHS-POP dataset [5]. According to this source, it is estimated that **8 million** people lived in the area in 2020. This is expected to **decrease to 8 million** by 2030. The largest settlements within the mountain range are **Genoa, Reggio Calabria, Salerno, Massa,** and **Potenza**.

In 2020, the human population in this mountain range was estimated to be 8 million.

Figure 1.2. Population estimates in the mountain range from 1975-2030. The data after 2020 are projections.



The maps show the population density in the mountain range (Figure 1.3), and estimated travel time to the nearest population centre with more than 50,000 inhabitants (Figure 1.4). Estimated travel time can be useful for evaluating accessibility to services and markets.





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### 1.3. Development and Economic Indicators

The Human Development Index (HDI) is determined by a combination of indicators such as life expectancy, literacy rate, access to electricity, Gross Domestic Product (GDP), and others. In 2015, the average HDI in this mountain range was estimated to be **0.89**. This is considered to be a **very high level of development**.

#### Table 1.2. GDP and HDI Indicators over Time

|                          | 1990     | 2000     | 2015     |
|--------------------------|----------|----------|----------|
| Gross Domestic Product   | \$202 bn | \$234 bn | \$224 bn |
| Human Development Index  | 0.77     | 0.83     | 0.89     |
| Source: Kummu et al. [7] |          |          |          |

The total GDP within this mountain range in 2015 was estimated to be **\$224 billion**, an **decrease of \$10 billion since 2000**. Table 1.2. shows an overview of the HDI and GDP indicators over time.





### 1.4. Protected Areas

Figure 1.3 shows the spatial coverage of protected areas in the mountain range according to the World Database of Protected Areas (WDPA) [8]. A total of **32%** of the mountain range is covered by a protected area. The establishment of protected areas represents a key measure to protect and conserve valuable mountain biodiverisity and ecosystems. These areas vary broadly in their aims, regulations, and effectiveness, however.



Data: World Database of Protected Areas (WDPA) [8]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].

#### A total of 32% of the mountain range is classified as protected in the World Database of Protected Areas.

The largest protected areas are:

| 1. <b>Cilento and Val de Diano</b><br>UNESCO-MAB Biosphere Reserve                               | 2,230 km²   |
|--|-------------|
| 2. <b>Parco Nazionale Del Pollino</b><br>National Park   | 1,824 km²   |
| 3. <b>Parco Nazionale Del Cilento E Vallo</b><br><b>Di Diano</b><br>National Park                | 1,783 km²   |
| 4. Parco Nazionale Gran Sasso - Monti<br>della Laga<br>Special Protection Area (Birds Directive) | i 1,434 km² |
| 5. <b>Parco Nazionale Del Gran Sasso E</b><br><b>Monti Della Laga</b><br>National Park           | 1,434 km²   |



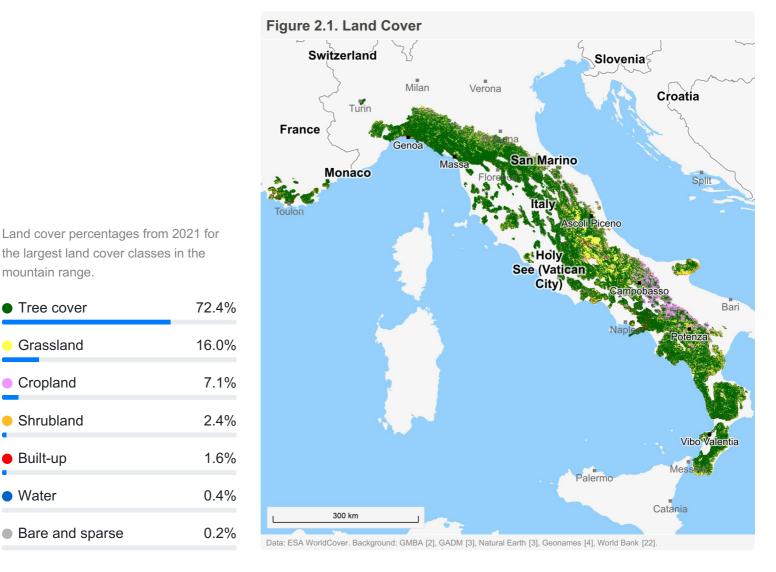
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## 2. Land cover

### 2.1. Land Cover

According to the ESA WorldCover dataset [9], the most dominant land cover types in 2021 were tree cover (72.4%) and grassland (16.0%).



The European Commission's Global Human Settlement Layer (GHSL) [10] classifies 0.4% of the mountain range's area as urban centre, 3.1% as urban cluster, and 96.5% as rural.



Built-up

Water



# 3. Topography

The land surface elevation ranges from a **minimum of -2 m** to a **maximum of 2,912 m at Corno Grande**. The **mean elevation is 644 m**. **50%** of the area lies is between **369 m and 851 m**, and **90% of the area lies between 154 m and 1,167 m**. Figure 3.1 shows a shaded relief elevation map based on the MERIT DEM [11] and a selection of peaks from the Geonames dataset [4]. The distribution of land surface elevation strongly affects local climatic and living conditions in mountains.



Data: MERIT DEM [11], Geonames [4]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].

Observing Mountain Environments



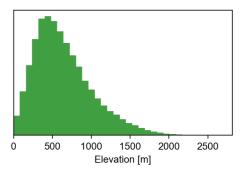


Figure 3.3. Distribution of slope steepness within in the mountain range [21].

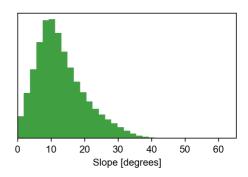


Figure 3.4. Highest peaks in the mountain range according to the Geonames [4] dataset.

| 1. Corno Grande        | ▲ 2,912 m |
|------------------------|-----------|
| 2. Majella             | ▲ 2,793 m |
| 3. Monte Amaro         | ▲ 2,793 m |
| 4. Monte Acquaviva     | ▲ 2,737 m |
| 5. Corno Piccolo       | ▲ 2,655 m |
| 6. Monte d'Intermesole | ▲ 2,635 m |
| 7. Monte Corvo         | ▲ 2,623 m |
| 8. Monte Camicia       | ▲ 2,564 m |
| 9. Monte Prena         | ▲ 2,561 m |
| 10. Pizzo Cefalone     | ▲ 2,533 m |

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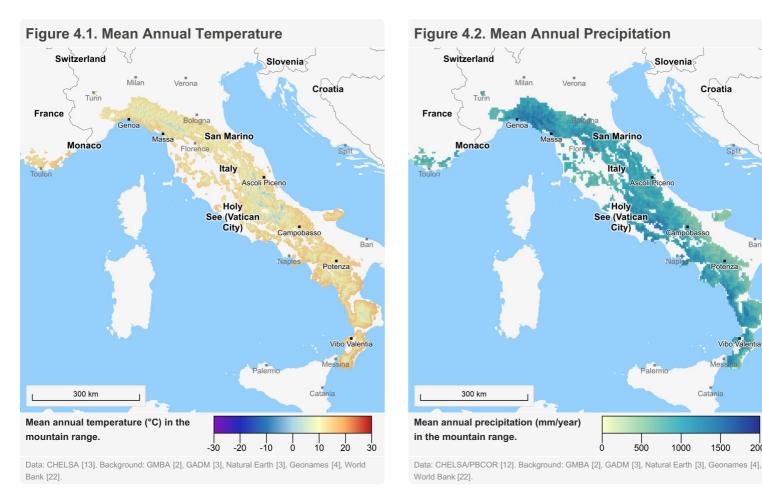
## 4. Climate

### 4.1. Temperature and Precipitation

Precipitation and temperature combine to control local weather and climate, with implications for water availability, vegetation growing conditions, snow and ice accumulation, and extreme events such as floods and droughts.

The mean annual temperature across the mountain range is shown in Figure 4.1. The mean annual temperature for the entire mountain range is 12.1°C, but it varies geographically from a minimum of -0.9°C to a maximum of 18.5°C. The temperature data are extracted from the CHELSA climatology dataset [13].

The mean annual precipitation shown in Figure 4.2. The mean annual precipitation for the entire mountain range is 977 mm, but it varies geographically from a minimum of 478 mm to a maximum of **1,617**. Precipitation data are bias-corrected for use in mountain environments, and are extracted from CHELSA data in the Precipitation Bias CORrection (PBCOR) dataset [12].



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Slovenia

Croatia



1500

2000

1000



The mean monthly temperature across the entire mountain range shown in Figure 4.3, and varies from a **maximum of 21.4°C in July** to a **minimum of 4.0°C in January**. Equivalent statistics for precipitation are shown in Figure 4.4, which vary from a **maximum of 127 mm in November** to a **minimum of 40 mm in July**.

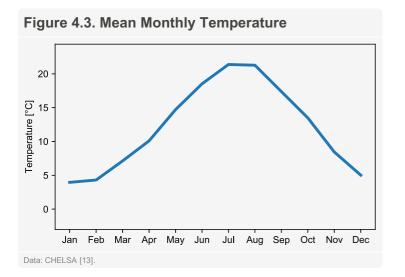
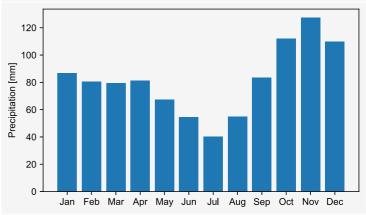


Figure 4.4. Mean Monthly Precipitation



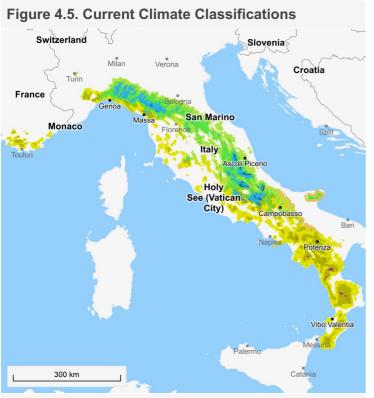
Data: CHELSA/PBCOR [12].





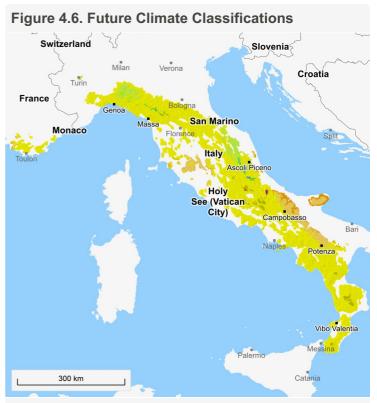
### 4.2. Climate Classifications

Figures 4.5 and Figure 4.6 show Köppen-Geiger climate classifications for the present day (1980-2016) and for projected future conditions (2071-2100), respectively. Future conditions are derived from an ensemble of 32 climate model projections under the RCP 8.5 "business-as-usual" scenario [14].



Köppen-Geiger climate classification for the present day (1980-2016).

Data: GloH2O [14]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].



Köppen-Geiger climate classification for ensemble mean projected future conditions (2071-2100) under the RCP 8.5 scenario.

Data: GloH2O [14]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].



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| Classification                            | Current | Future | Change         |
|---|---------|--------|----------------|
| Csa Temperate, dry summer, hot summer     | 35.9%   | 83.3%  | <b>▲</b> 47.4% |
| Cfb Temperate, no dry season, warm summer | 18.7%   | 0.6%   | <b>▼</b> 18.0% |
| Cfa Temperate, no dry season, hot summer  | 17.9%   | 4.7%   | ▼ 13.2%        |
| Csb Temperate, dry summer, warm summer    | 16.1%   | 1.7%   | <b>▼</b> 14.5% |
| Dfb Cold, no dry season, warm summer      | 7.3%    | 0.1%   | ▼ 7.2%         |
| BSk Arid, steppe, cold                    | 3.0%    | 7.2%   | <b>▲</b> 4.2%  |
| Dfc Cold, no dry season, cold summer      | 0.7%    | 0.0%   | <b>•</b> 0.7%  |
| BSh Arid, steppe, hot                     | 0.0%    | 2.3%   | ▲ 2.3%         |
| Source: GloH2O [14].                      |         |        |                |

#### Table 4.1. Changes in climate classifications between current (1980-2016) and future (2071-2100) conditions

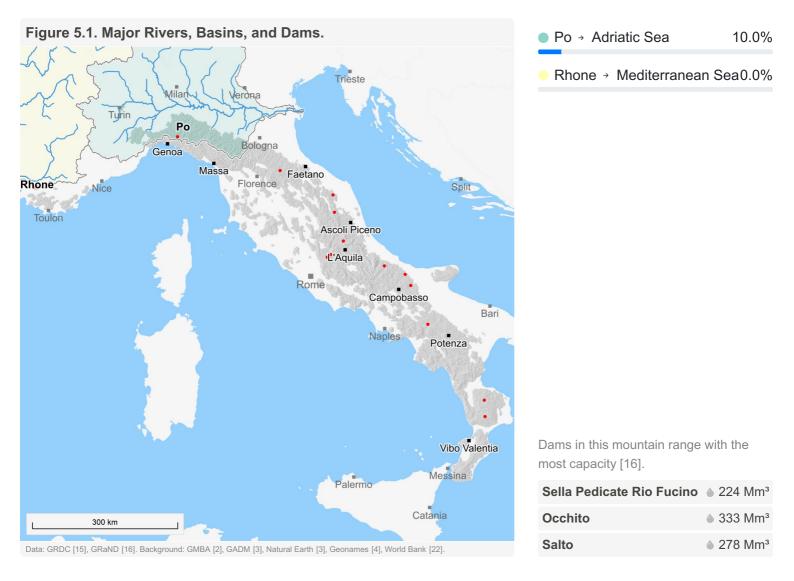




## 5. Hydrology

According to the GRDC Major River Basins dataset, **two major basins** intersect the mountain range [15]. The **Po has the most overlap with 10%** and drains into the **Adriatic Sea**.

Within the mountain range, there are a total of **14 dams** listed in the Global Reservoirs and Dams (GRanD) database [16]. The main usages of these dams are **hydroelectricity (7)**, **water supply (5)**, **none (1)**, and **irrigation (1)**. The total capacity of these dams is estimated to be **1,623 million m**<sup>3</sup>. Figure 5.1 shows major rivers, basins, and dams (red points) that intersect with this mountain range.







## 6. Cryosphere

### 6.1. Glaciers and Permafrost

The Randolph Glacier Inventory dataset contains **one glaciers** that intersect with this mountain range [17]. They cover a **total area of 0 km<sup>2</sup> (0.0%)**. In addition to the glaciers, it is estimated that under favourable conditions, permafrost occurance is possible across **0 km<sup>2</sup> (0.0%)**, and is likely across at least **0 km<sup>2</sup> (0.0%)**. Figure 6.1 shows glaciers and permafrost extents. Glaciers and permafrost represent (largely non-renewable) water sources for mountain people and ecosystems, and can be implicated in hazardous events.



The Randolph Glacier Inventory lists **one glaciers** within this mountain range, covering a **total area of 0 km**<sup>2</sup>.

Data: Randolph Glacier Inventory [17], Permafrost Zonation Index [18]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].





#### 6.2. Snow Cover

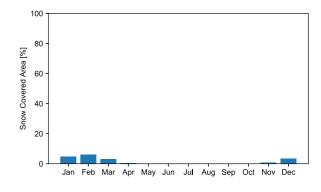
The proportion of the mountain range's area that is covered by snow each month on average (according to monthly snow cover data between 2000-2020 by ESA's Climate Change Initiative [18]) is shown in Figure 6.2.

The average snow covered area varies between **a minimum in July of 0 km<sup>2</sup> (0.0%)** (Figure 6.3) and a **maximum in February of 5,426 km<sup>2</sup> (6.1%)** (Figure 6.4). Snow cover extent acts as an indicator of seasonal downstream water availability, is a crucial factor in winter tourism, and is a key determinant of vegetation growing conditions.

Figure 6.3. Mean Snow Covered Area (July) Switzerland Mila Croatia Turin France Genoa Massa Faetand Florence Italy Ascoli Piceno L'Aquila Campobasso Potenza Vibo Valentia sina 300 km Data: ENVEO/ESA-CCI [17]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4],

Data: ENVEO/ESA-CCI [17]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].

Figure 6.2. Monthly mean snow covered area percentage (2000-2020) [18].





Data: ENVEO/ESA-CCI [17]. Background: GMBA [2], GADM [3], Natural Earth [3], Geonames [4], World Bank [22].

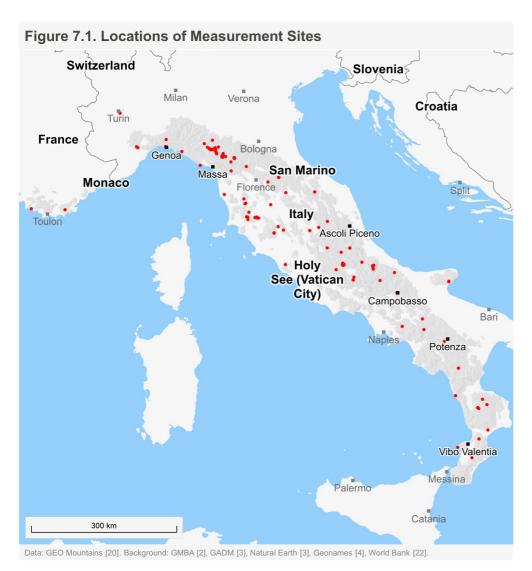


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## 7. Measurement Locations

The GEO Mountains Inventory of In Situ Observational Infrastructure (v2.0) lists a total of **127 measurement sites** in this mountain range [20]. Their locations are shown as red dots in Figure 7.1. In situ measurements are crucial for a range of scientific and practical application in mountains, yet the locations of measurement sites are often difficult to gain an appreciation of. Measurement sites include weather and climate stations, river gauging stations, networks of stations, experimental basins, and others.



According to the GEO Mountains Inventory of In Situ Observational Infrastructure, there are 127 measurement sites in this mountain range





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### Index

The index shows an overview of the 100 mountain ranges in version v1.0 of the *Mountains Uncovered* series.



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- 50. Qionglai Shan

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- 54. South European Highlands
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- 66. Appalachian Mountains
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- 69. Cascade Range (North America)
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Oceania

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77. Idaho-Bitterroot Rocky Mountains



## **About the Series**

#### Aims

The *Mountains Uncovered* series (v1.0) aims to provide an easily understandable overview of the key characteristics of 100 selected mountain ranges around the world. Comparisons between mountain ranges can also readily be made. The series was developed by collating and visualising a variety of current global scale data products. We hope that the series will be a useful resource for researchers, policy-makers, environmental managers, educators, and others seeking to better understand the Earth's major mountain regions, and that over time it will inspire the generation of additional datasets, analyses, and products.

### Citation and Sharing

The *Mountains Uncovered* series (v1.0) has been developed on the basis of exclusively open global spatial datasets. In turn, all visualisations, statistics, and code generated are shared under the Creative Commons BY 4.0 license. You may use, distribute, and reproduce the product in any medium, provided appropriate acknowledgement is given. Please cite the series as:

GEO Mountains (2023). The Mountains Uncovered Series: Intercomparable Maps and Statistics for 100 Selected Global Mountain Ranges (v1.0). doi: 10.5281/zenodo.8010166

Before the reuse of the products, the licence terms associated with the underlying third-party datasets should be carefully checked, and those datasets should also be appropriately cited; please see the reference list provided for further details and links.

GEO Mountains assumes no responsibility and accepts no liability for the product's use, and remains neutral with respect to the locations of any borders and the place names shown in the third-party datasets employed.

### Limitations

Users should note that data and information are limited in many mountain regions around the world. As a result, the figures, maps, and graphs presented in this series are associated with uncertainties, and these uncertainties must be taken into account when interpreting the information given.



To ensure that any comparisons made between individual mountain ranges are as fair as possible, globalscale datasets were used (without any additional modification). Consequently, the series does not necessarily represent a compendium of the "best" data available in any given mountain range or local area, but rather a common, generally intercomparable set. For applications at local and regional scales, alternative datasets to those shown may be more suitable.

Indeed, in parallel to the ongoing development of the global series, more local and regional "bottom-up" engagements and activities to improve the quality and availability of data should also be undertaken, since data on these scales also play a crucial role in supporting decision-making for the benefit of mountain people and ecosystems.

### Get Involved

While many global mountain regions remain notoriously data-scarce, new datasets are being released regularly. If you are aware of any datasets you would like us to consider including in a potential future release, please provide the necessary details via this form. Likewise, if you become aware of any errors, omissions, or other potential modifications that could be made in a future version, please let us know via the same form. By taking these actions, you will help us expand the scope and improve the impact of the *Mountains Uncovered* series. Feedback concerning the underlying datasets will be collated and shared with the relevant organisations or data providers.

### Contact

For any general queries or comments, please contact: geomountains@mountainresearchinitiative.org

Many thanks for your interest, support, and contributions to global mountain data, policy, and education!





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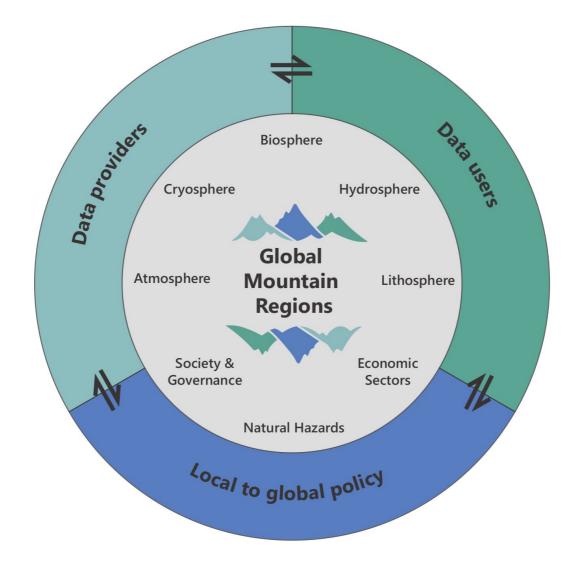


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### **About GEO Mountains**

GEO Mountains is an Initiative of the Group on Earth Observations (GEO). It aims to bring together research institutions and mountain observation networks to enhance the discoverability, accessibility, and use of a wide range of relevant data and information pertaining to environmental and socio-economic systems – both in situ and remotely sensed – across global mountain regions. In doing so, we hope to help facilitate scientific advancements and support decision makers at local, national, and regional levels. The figure below illustrates the scope of the Initiative.



GEO Mountains is an open and inclusive network. We aspire to follow the principles of open data and open science wherever possible.





