**Large disagreements in estimates of urban land across scales and their implications**

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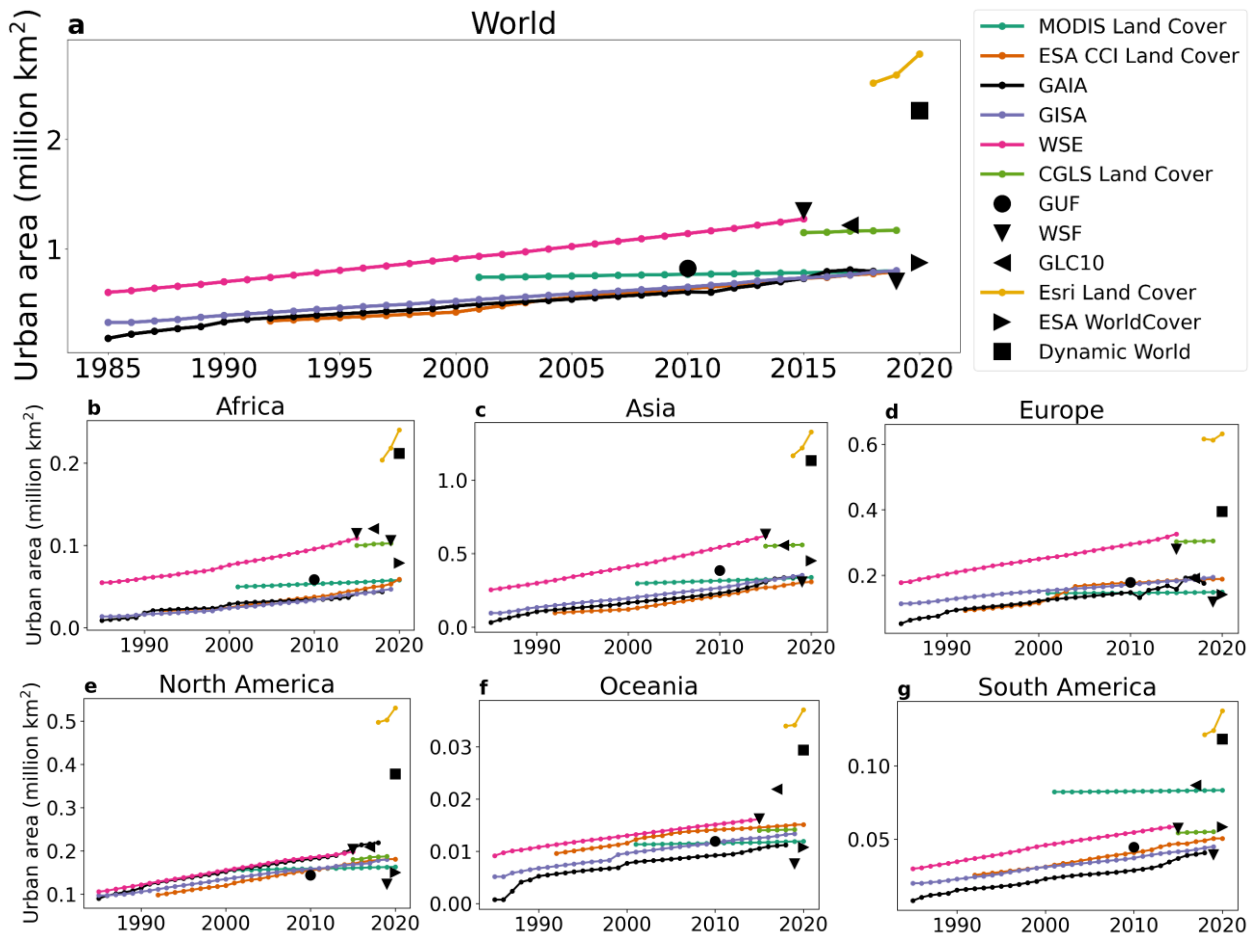[7]Institute for Sustainability, Energy, and Environment (iSEE), University of Illinois at Urbana-Champaign, Urbana, IL, USA.

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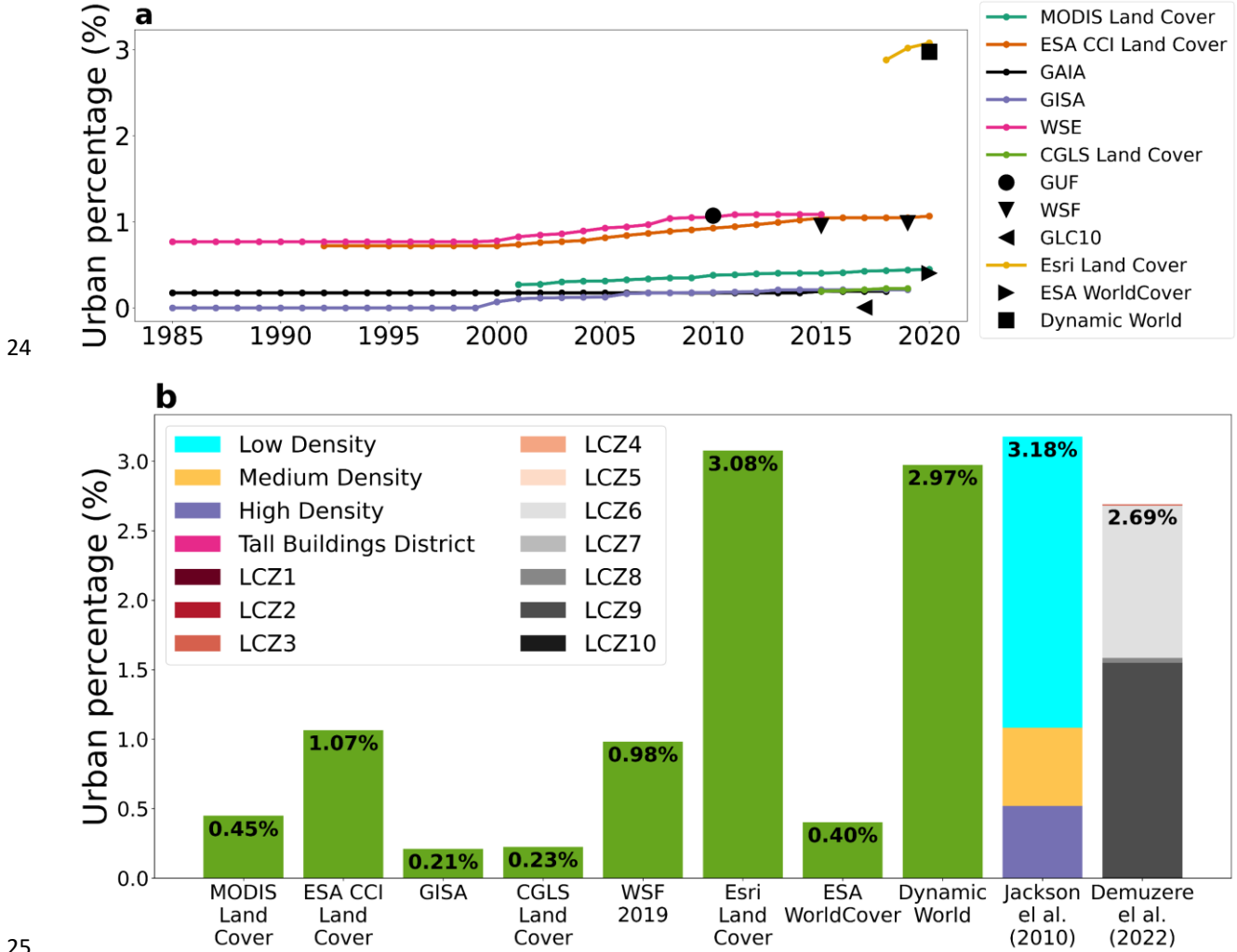
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**Fig. S1 | Urban area and its long-term changes across datasets |** Urban area from 12 global data products for **a** World, **b** Africa, **c** Asia, **d** Europe, **e** North America, **f** Oceania, and **g** South America. Long-term changes are shown for datasets that span multiple successive years.

**Fig. S2 | Results for island nations |** Sub-figures **a** and **b** are identical to Fig. 4 and 7a of main text, respectively, but for island nations in the open ocean (not officially part of any continent according to the World Bank dataset).
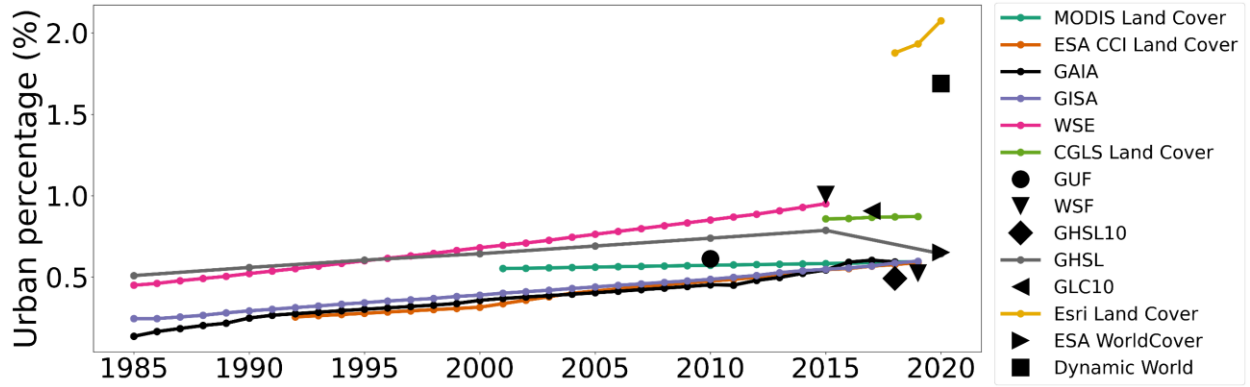
**Fig. S3 | Urban percentage and its long-term changes across datasets (including GHSL) |** Same as Fig. 4a of the main text, but includes the estimates of degree of urbanization ('Semi-dense urban cluster', 'Dense urban cluster', and 'Urban centre') every 5 years (from 1985 to 2020) and the 2018 10 m estimate of built spaces (labelled as GHSL10) from the latest version of the Global Human Settlement (GHSL) layer (P2023A).

**a**

Absolute coefficient of variation of wintertime surface urban heat island intensity (%)

**b**

**c**

MODIS Land Cover
ESA CCI Land Cover
GISA
CGLS Land Cover
WSF 2019
Esri Land Cover
ESA WorldCover
Dynamic World
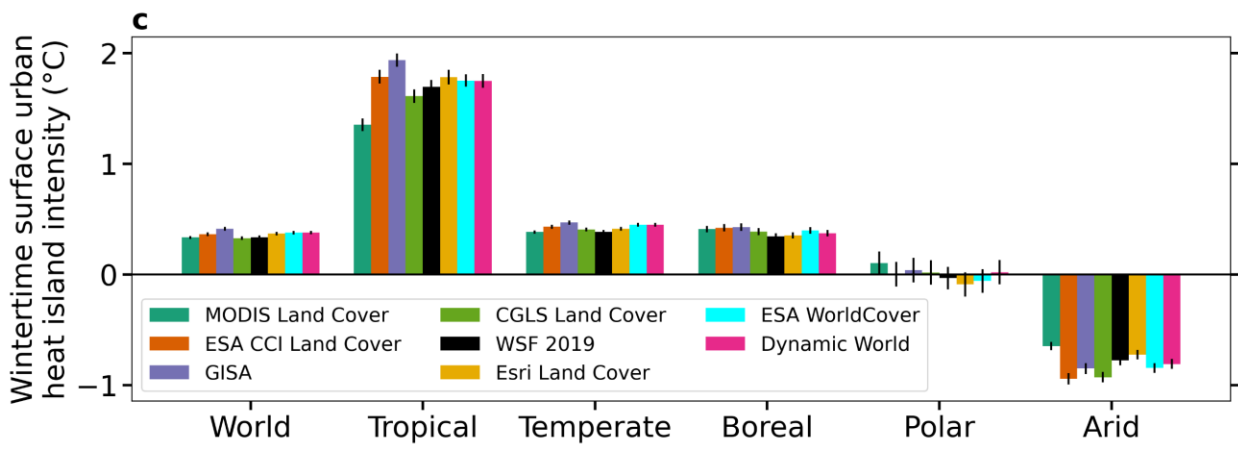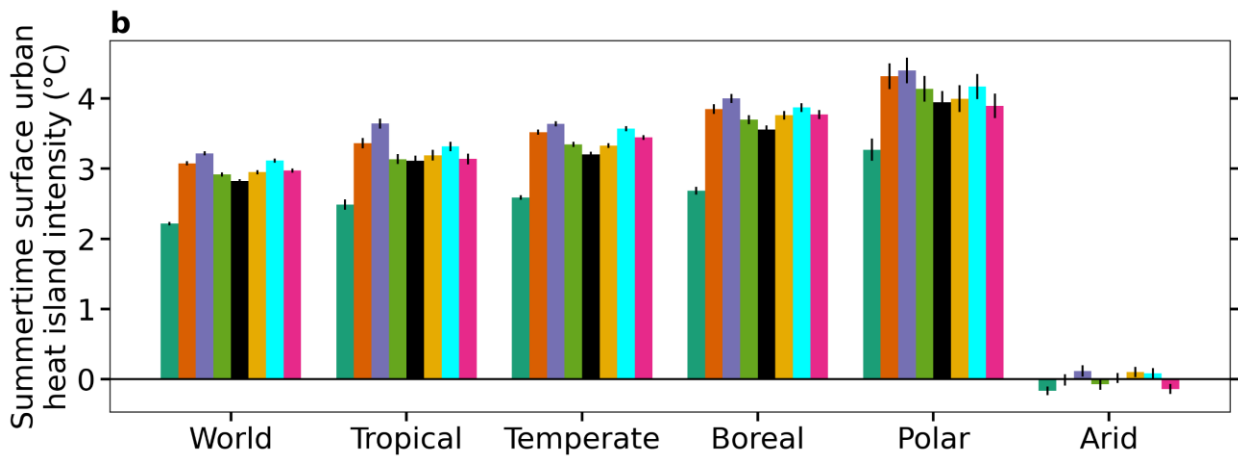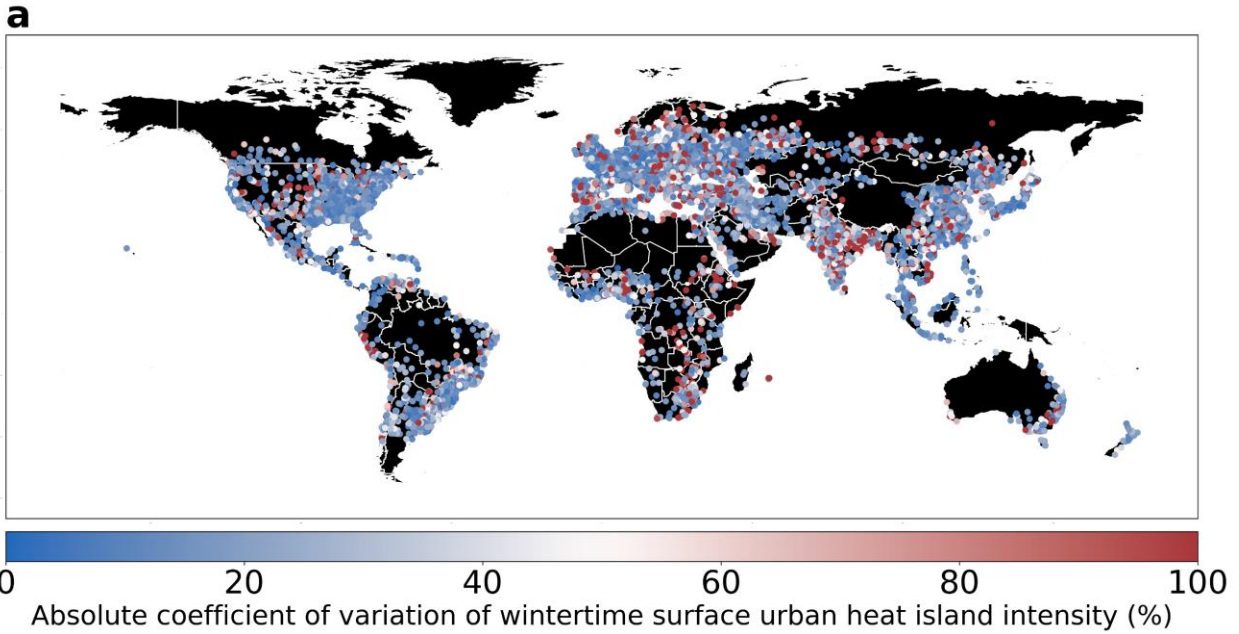
**Fig. S4 | Variability in surface urban heat island intensity based on different datasets |** Sub-figure **a** shows the absolute coefficient of variation in calculated surface urban heat island intensity during 2018-2022 winter for around 10,000 global urban clusters from eight urban land cover

datasets. Sub-figures **b** and **c** show the actual magnitude of the surface urban heat island intensity based on the eight datasets for the world and different climate zones for summer and winter, respectively.

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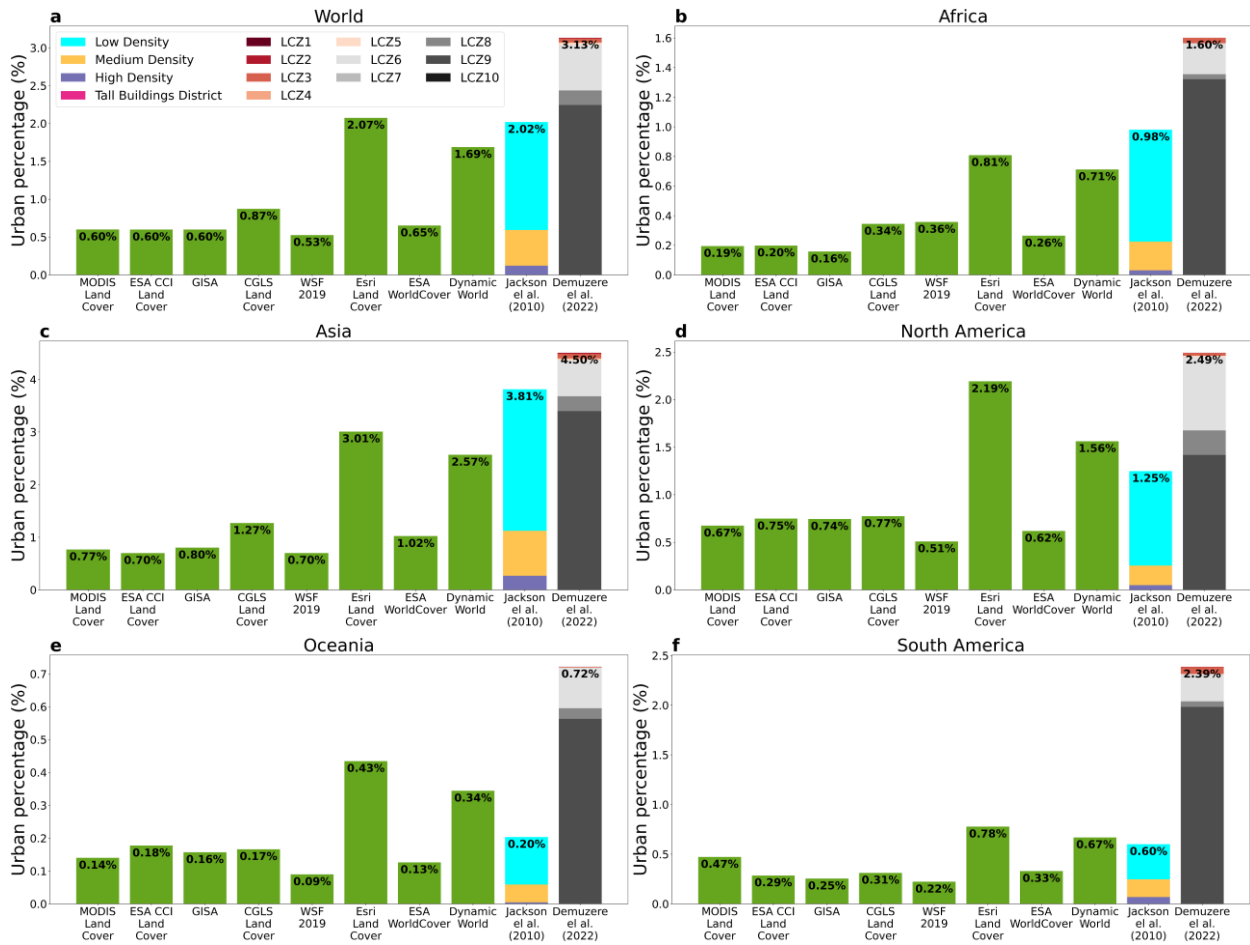
**Fig. S5 | Urban percentage in observations and models |** Urban percentage across eight datasets as well as two additional estimates of urban areas used in weather and climate models for **a** World, **b** Africa, **c** Asia, **d** North America, **e** Oceania, and **f** South America. LCZ stands for local climate zone.

54 **Table S1.** Summary of all urban land cover datasets considered in this study.

| Dataset name | Acronym used | Spatial resolution | 'Urban' class name | Class definition and/or other notes | References |
|---|---|---|---|---|---|
| Moderate Resolution Imaging Spectroradiometer Land Cover Type Version 6.1 | MODIS Land Cover | 500 m | Urban and Built-up Lands | At least 30% impervious surface area including building materials, asphalt, and vehicles. | [1] |
| European Space Agency Climate Change Initiative Land Cover | ESA CCI Land Cover | 300 m | Urban Areas | Identified based on a combination of the Global Human Settlement Layer and the Global Urban Footprint datasets | [2] |
| Global impervious surface area | GISA | 30 m | Impervious surface area | No predefined urban mask used | [3] |
| Copernicus Global Land Service Dynamic Land Cover map | CGLS Land Cover | 100 m | Urban / Built up | Land covered by buildings and other man-made structures; urban class is based on World Settlement Footprint 2015 | [4] |
| World Settlement Footprint 2019 | WSF 2019 | 10 m | Human settlement | Built-up areas with roads removed | [5] |
| Environmental Systems Research Institute, Inc land Cover | Esri land Cover | 10 m | Built Area | Human-made structures; major road and rail networks; large homogenous impervious surfaces, including parking structures, office buildings and residential housing. | [6] |
| European Space Agency WorldCover | ESA WorldCover | 10 m | Built-up | Land covered by buildings, roads and other man-made structures such as railroads. Buildings include both residential and industrial building. Urban green (parks, sport facilities) is not included in this class. Waste dump deposits and extraction sites are considered as bare. | [7] |
| Dynamic World | - | 10 m | Built Area | Clusters of human-made structures or individual very large human-made structures.<br><br>Contained industrial, commercial, and private building, and the associated parking lots.<br><br>A mixture of residential buildings, streets, lawns, trees, isolated residential structures or buildings surrounded by vegetative land covers.<br><br>Major road and rail networks outside of the predominant residential areas. | [8] |

| | | | | Large homogeneous impervious surfaces, including parking structures, large office buildings, and residential housing developments containing clusters of cul-de-sacs. | |
|---|---|---|---|---|---|
| Global Urban Footprint | GUF | 12 m | Built-up area | Similar to WSF 2019, but developed using commercial imagery | [9] |
| Global Annual Impervious Area | GAIA | 30 m | Artificial Impervious Area | Primary urban masks are first created based on Sentinel-1 Synthetic Aperture Radar data before further classification. Greater than 50% impervious area pixels are defined as urban | [10] |
| World Settlement Evolution | WSE | 30 m | Human settlement | Cannot detect settlements that shrink over time | [5] |
| World Settlement Footprint 2015 | WSF 2015 | 10 m | Human settlement | Similar to WSF 2019, but using Sentinel-1 and Landsat 8 instead of Sentinel-1 and Sentinel-2. Raw imagery not fine enough to mask out roads | [11] |
| Finer Resolution Observation and Monitoring of Global Land Cover 10m | GLC10 | 10 m | Impervious | Training data developed using 30 m Landsat data were transferred to Sentinel-2 imagery to classify them at 10 m. | [12] |

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**Table S2.** Accuracy estimates of all land cover datasets considered for representing present-day for the world and different continents.

| Region | MODIS Land Cover | ESA CCI Land Cover | GISA | CGLS Land Cover | WSF 2019 | Esri Land Cover | ESA WorldCover | Dynamic World | Sample Size |
|---|---|---|---|---|---|---|---|---|---|
| **World** | 80.26% | 88.19% | 99.21% | 91.59% | 99.16% | 98.89% | 81.22% | 96.36% | 2571693 |
| **Africa** | 68.00% | 81.10% | 98.35% | 91.32% | 98.35% | 98.20% | 88.54% | 94.04% | 150127 |
| **Asia** | 80.96% | 88.50% | 98.93% | 94.23% | 98.88% | 98.30% | 87.50% | 91.63% | 768022 |
| **Europe** | 79.76% | 89.57% | 99.41% | 91.97% | 99.40% | 99.10% | 74.40% | 98.95% | 322635 |
| **North America** | 82.80% | 90.43% | 99.44% | 89.08% | 99.44% | 99.38% | 72.01% | 98.92% | 847882 |
| **Oceania** | 62.29% | 69.28% | 98.06% | 87.69% | 96.80% | 97.76% | 83.95% | 97.40% | 60300 |
| **Seven seas (open ocean)** | 0.00% | 54.77% | 100.00% | 5.92% | 100.00% | 100.00% | 24.05% | 100.00% | 524 |
| **South America** | 82.19% | 89.77% | 99.84% | 92.99% | 99.79% | 99.75% | 92.29% | 98.75% | 344117 |

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