



*National Aeronautics and Space Administration  
Goddard Earth Science Data Information and  
Services Center (GES DISC)*

# README Document for The Global Landslide Nowcast from the Landslide Hazard Assessment for Situational Awareness model, Version 2.0.0

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Revision History

<b>Revision Date</b>	<b>Changes</b>	<b>Author</b>
02/28/2023	Initial Draft	Thomas Stanley
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# 1.0 Introduction

This document provides basic information for using the Global Landslide Nowcast.

The Global Landslide Nowcast addresses the need for real-time situational awareness of landslide hazard. The Landslide Hazard Assessment for Situational Awareness model (LHASA) combines satellite rainfall estimates from the Global Precipitation Measurement mission (GPM) with soil moisture estimates from the Soil Moisture Active Passive (SMAP) satellite and other factors to produce a map of locations where rainfall-triggered landslide activity is probable. Due to the latency of the rainfall data, the nowcast is a near-real time product with a minimum latency of 5 hours. Although the model could be run every half hour, this archive contains a daily record derived from a retrospective model run.

## 1.1 Dataset Description

The Global Landslide Nowcast is a global grid with a temporal resolution of 1 day and a spatial resolution of 30 arcseconds (approximately 1 km). It shows the probability of landslide occurrence on a scale from zero to one. These values should be interpreted as a hazard ranking, rather than well-calibrated probabilities for use in long-term risk modeling.

## 1.2 Data Disclaimer

The Global Landslide Nowcasts from LHASA attempts to identify rainfall-triggered landslide hazard at the global scale. It does not provide information on landslides initiated by other phenomena such as earthquakes, thermal expansion, freeze-thaw cycles, and human activities. While LHASA is intended to address most rainfall-triggered landslides, it is not relevant to some common types, including: rock falls, rock topples, riverbank collapses, slope creep events, and deep-seated landslides that are triggered by seasonal precipitation. Although a detailed breakdown of model performance is not possible due to data limitations, Global Landslide Nowcasts from LHASA performs better for rapid landslides on steep slopes than for slow-moving landslides on gradual slopes. Furthermore, data on precipitation and other factors have some uncertainty at the global scale, which can result in propagation of some errors to the landslide nowcast.

The Global Landslide Nowcast is intended for situational awareness of landslide hazard over large areas. It is not suitable for planning construction activities at any specific site or issuing evacuation orders. The presence of a high probability (> 50%) at a specific time and location does not indicate that a landslide has occurred. Rather, it indicates that landslides were more probable at that location than most locations on the same date. Given the rarity of landslide events, it is more probable that no landslide occurred within any given grid cell.

### 1.2.1 Data Citation and Acknowledgment

Users of these data are encouraged to cite the following article.

Stanley, T. A., D. B. Kirschbaum, G. Benz, et al. 2021. "Data-Driven Landslide Nowcasting at the Global Scale." *Frontiers in Earth Science*, 9 doi:10.3389/feart.2021.640043

### 1.2.2 Contact Information

For information about or assistance in using any GES DISC data, please contact the GES DISC Help Desk at:

GES DISC  
Code 619  
NASA Goddard Space Flight Center  
Greenbelt, Maryland 20771  
Email: [gsfc-dl-help-disc@mail.nasa.gov](mailto:gsfc-dl-help-disc@mail.nasa.gov)  
301-614-5224 (voice)  
301-614-5268 (fax)

For general science questions and comments, please contact:

Thomas Stanley  
Email: [thomas.a.stanley@nasa.gov](mailto:thomas.a.stanley@nasa.gov)

### 1.2.3 Digital Object Identifier (DOI) and Citation

A Digital Object Identifier, or DOI, is a unique alphanumeric string used to identify a digital object and provide a permanent link online. DOIs are often used in online publications in citations.

DOI for LHASA v2.0.0. data product: 10.5067/8VKQDQFFOTS3

When using this dataset, please cite both the data as shown below.

**Data Citation:** Thomas A. Stanley, Dalia B. Kirschbaum, Garrett Benz, Robert A. Emberson, Pukar M. Amatya, William Medwedeff, and Marin K. Clark, NASA/GSFC (2023), Global Landslide Nowcasts from LHASA L4 1 day 1 km x 1 km, Greenbelt, Maryland, USA: Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed [**Data Access Date**] 10.5067/8VKQDQFFOTS3

### 1.3.1 Version 2.0.0

Version 2.0.0 retains replaces the heuristic decision tree from version 1.0 with a machine-learning model. Instead of merging all factors other than precipitation into a susceptibility map, LHASA 2.0 takes in each variable as a separate input layer. The most important change is the replacement of the categorical nowcast with a probabilistic output. This will enable users to adjust the threshold to suit their specific application and geographic location.

## 2.0 Data Organization

The data are organized into daily files, with a grid resolution of 30 arcseconds (roughly 1 kilometer).

### 2.1 File Naming Convention

The Global Landslide Nowcast v2.0.0 data files are named in accordance to the following convention:

Global\_Landslide\_Nowcast\_v2.0.0\_YYYYMMDD.nc4

Where:

- YYYYMMDD is a date format for year, month and day.

Filename example: Global\_Landslide\_Nowcast\_v.2.0.0\_20150403.nc4

### 2.2 File Format and Structure

The Global Landslide Nowcast files are in NetCDF-4 format. NetCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data that was developed by UCAR/Unidata (<http://doi.org/10.5065/D6H70CW6>) <https://www.unidata.ucar.edu/software/netcdf/>.

## 3.0 Data Contents

### 3.1 Data Set Attributes (File Metadata)

In addition to SDS arrays containing variables and dimension scales, global metadata is also stored in the files. Some metadata are required by standard conventions, some are present to meet data provenance requirements and others as a convenience to users of **Global Landslide Nowcast v2.0.0** products. A summary of global attributes present in all files is shown in Table 1.

Table 1 Summary of global attributes in the Global Landslide Nowcast.

Global Attribute	Description	Type
ShortName	Short name for the data collection	string
LongName	Long, descriptive name for the data	String



	collection	
VersionID	Data version	string
GranuleID	Name of the data granule	string
Format	File format of the data (NetCDF)	string
DataSetQuality	Overall assessment of quality of data	string
IdentifierProductDOI	Digital object identifier	string
IdentifierProductDOIAuthority	Authority through which the DOI can be resolved	string
ProcessingLevel	Level of data processing	string
Conventions	The metadata conventions followed in the file, e.g. CF-1.6	string
Source	Instruments related to the origin of the data product	string
RangeBeginningDate	Start date of the data in the file (format YYYY-MM-DD)	string
RangeBeginningTime	Start time UTC of the data (format hh:mm:ss.ssssss)	string
RangeEndingData	End date of the data in the file (format YYYY-MM-DD)	String
RangeEndingTime	End time UTC of the data (format hh:mm:ss.ssssss)	String

### 3.3 Geolocation Fields

These fields appear for every data observation

Table 2 Description of Global Attributes

Global Attribute	Description	Diimensions	Type
lat	Latitude (degrees North) -90 to 90	14400	64-bit floating-point
lon	Longitude (degrees East) -180 to 180	43200	64-bit floating-point

## 4.0 Products/Parameters

### 4.1 Data Fields

Table 3 Description of Data Fields.

Data Field Name	Long_Name/Description	Type	Dimensions	Undefined Value	Units
p_landslide	Probability of Landslide Occurrence	32-bit floating-point	time, lat, lon	-9999.0	-

### 4.2 Fill Values

Table 4 Fill Values for the variables

Variable Type	Fill Value
p_landslide	-9999.0

## 5.0 Options for Reading the Data

### 5.1 Command Line Utilities

#### 5.1.1 ncdump

The ncdump tool can be used as a simple browser for HDF data files, to display the dimension names and sizes; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables in a netCDF file. The most common use of ncdump is with the `-h` option, in which only the header information is displayed.

```
ncdump [-c|-h] [-v ...] [[-b|-f] [c|f]] [-l len] [-n name] [-d n[,n]] filename
```

Options/Arguments:

`[-c]` Coordinate variable data and header information

`[-h]` Header information only, no data

`[-v var1[,...]]` Data for variable(s) <var1>, ... only data

`[-f [c|f]]` Full annotations for C or Fortran indices in data

`[-l len]` Line length maximum in data section (default 80)

`[-n name]` Name for netCDF (default derived from file name)

`[-d n[,n]]` Approximate floating-point values with less precision filename File name of input

netCDF file

(<https://www.unidata.ucar.edu/software/netcdf/workshops/2011/utilities/Ncdump.html>)

### 5.1.2 HDFView

HDFView is a Java based graphical user interface created by the HDF Group which can be used to browse HDF files. The utility allows users to view all objects in an HDF file hierarchy which is represented as a tree structure. Additional information about HDFView can be found at <https://support.hdfgroup.org/products/java/hdfview/> and for HDF at <https://portal.hdfgroup.org/display/support>

## 5.2 Tools/Programming

The product files can be read and queried using the NetCDF4 library and tools maintained by Unidata (<http://www.unidata.ucar.edu/software/netcdf/>). Support for reading NetCDF is offered in many programming languages, including Python, Matlab, IDL, C/C++ and Fortran. NetCDF4 files are legal HDF5 files with additional bookkeeping information managed by the NetCDF4 library. It is therefore possible to inspect and copy data out of the NetCDF4 files by using the HDF5 utilities and libraries maintained by the HDF Group ([https://www.hdfgroup.org/products/hdf5\\_tools/index.html](https://www.hdfgroup.org/products/hdf5_tools/index.html)) or by using the HDF5 interface in your favorite programming language. However, the two libraries should not be considered fully interchangeable.

Matlab users should note that the Matlab NetCDF4 interface is currently (as of version R2017a) not able to read attributes that are string arrays, and will throw an exception if that is attempted.

### 5.2.1 Python

The following code snippet shows how to read the variable lat, lon, and nh3\_vmr from the dataset with the name "filename". Also shown are some basic information about the size of the variables arrays.

```
import netCDF4
from netCDF4 import Dataset

nc_fid = netCDF4.Dataset( filename ,mode='r',format='NETCDF4')

#read in the variables
lat = nc_fid.variables['lat'][:]
lon = nc_fid.variables['lon'][:]
```

```
nh3 = nc_fid.variables['nh3_vmr'][::]

# print out the minimum, maximum, and dimensions for the three variables
print("-- lat Min/Max values", lat[:].min(), lat[:].max())
print("lat.shape:", lat.shape)
print("-- lon Min/Max values:", lon[:].min(), lon[:].max())
print("lon.shape:", lon.shape)
print("-- nh3 Min/Max values:", nh3[:].min(), nh3[:].max())
print("nh3.shape:", nh3.shape)
```

## 6.0 GES DISC Data Services

If you need assistance or wish to report a problem:

**Email:** [gsfc-help-disc@lists.nasa.gov](mailto:gsfc-help-disc@lists.nasa.gov)

**Voice:** 301-614-5224

**Fax:** 301-614-5268

**Address:**

Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center Code 610.2 Greenbelt, MD 20771 USA

### 6.1 How To Articles

The GESDISC web site contains many informative articles under the “[How To Section](#)”, “[FAQ](#)” (frequently asked questions), “[News](#)”, “[Glossary](#)”, and “[Help](#)”. A sample of these articles includes:

[Earthdata Login for Data Access](#)

[How to Download Data Files from HTTPS Service with wget](#)

[How to Obtain Data in NetCDF Format via OpeNDAP](#)

[Quick View Data with Panoply](#)

[How to Read Data in NetCDF Format with R](#)

[How to read and plot NetCDF MERRA-2 data in Python](#)

## 7.0 More Information

<https://landslides.nasa.gov/> contains descriptions of other landslide research conducted at NASA, especially the citizen science portal, Landslide Reporter.

The most recent Global Landslide Nowcast will continue to be available at <https://landslides.nasa.gov/viewer>. This application enables users to interact with the nowcast, search for specific locations, and view related information, such as historical landslides and current rainfall.

<https://gpm.nasa.gov/> provides a wide variety of information on GPM, including visualizations, sensor descriptions, and links to downloadable precipitation data.

## 8.0 Acknowledgments

This project was funded by the NASA Disasters Program (grant no. 18-DISASTER18-0022). The NASA Center for Climate Simulation has also provided the server and web portal necessary for the routine publication of the Global Landslide Nowcast.

## 9.0 References

Stanley, T. A., D. B. Kirschbaum, G. Benz, et al. 2021. "Data-Driven Landslide Nowcasting at the Global Scale." *Frontiers in Earth Science*, 9 doi:10.3389/feart.2021.640043