



# **Emergency observation and initial GLOF assessment of glacial lakes in western Bhutan by ALOS-2**

Earth Observation Research Center,  
Japan Aerospace Exploration Agency

July 3, 2015

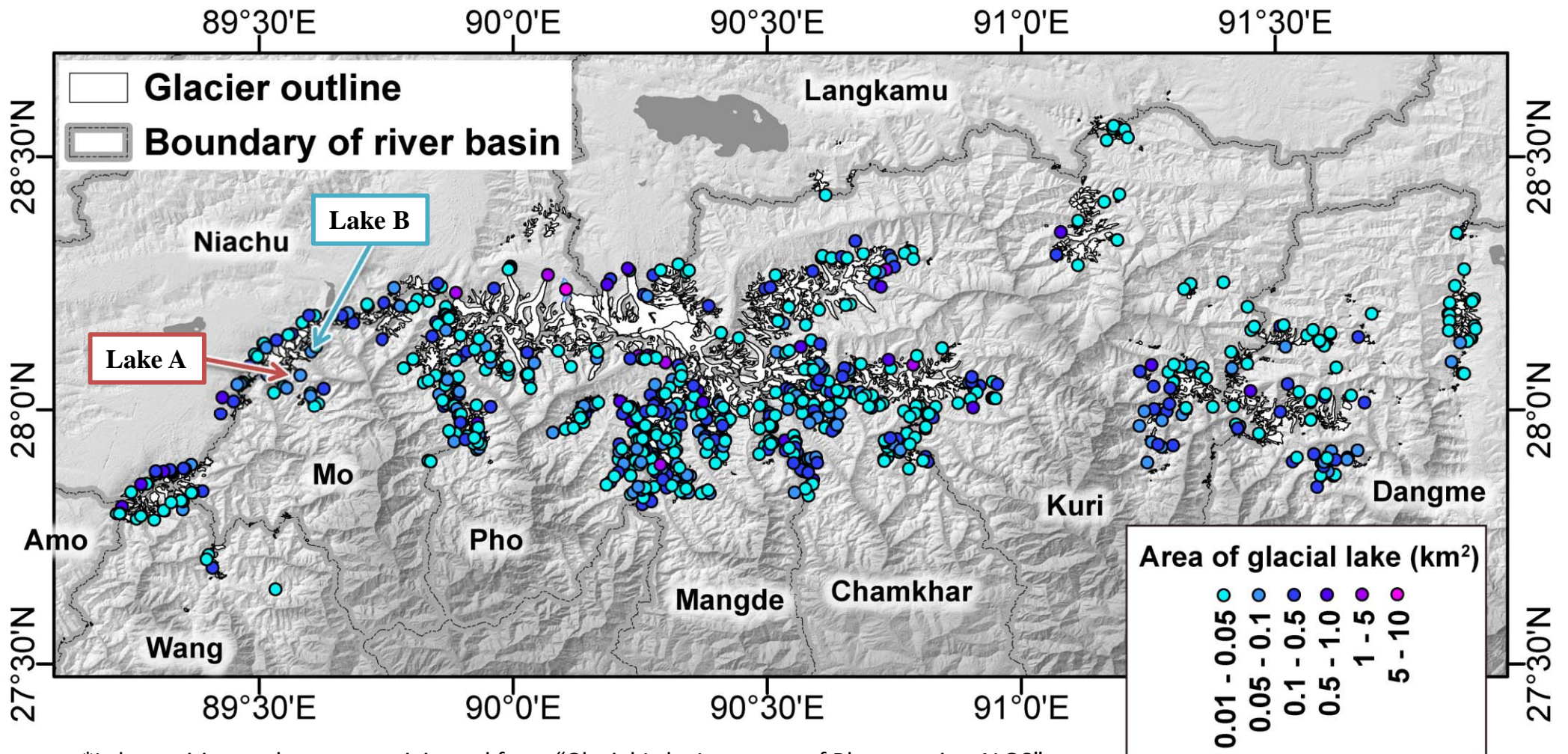
# Overview

- Glacial lake outburst flood (GLOF) was reported in western Bhutan on Jun. 28, 2015 (local time).
- Emergency observation of PALSAR-2 onboard ALOS-2 was performed on Jul. 2, 2015 by Japan Aerospace Exploration Agency, corresponding to a request from Sentinel Asia.
- Outlines of Lake A (ICIMOD id: mo\_gl\_200) and Lake B (ICIMOD id: mo\_gl\_201) were delineated manually.
- Temporal changes of lake area were traced using past images of PALSAR-2, Landsat-8, and ALOS PRISM/AVNIR-2.
- Remarkable lake area change is recognized in Lake A, i.e. large increasing between Mar. 8 and Apr. 23 (+48.0%) followed by large decreasing between Apr. 23 and Jul. 2 (-52.9%) in 2015, whereas no remarkable area change is recognized in Lake B (<20.0%) in the two periods.
- Collapse of an end moraine is recognized in front of Lake A after the GLOF event.

# Location of glacier lakes

**Lake A**  
[89°34'50.0"E; 28°4'7.7"N]  
(ICIMOD id: mo\_gl\_200)  
(JAXA local id: gl\_mo\_893450E280408N)

**Lake B**  
[89°36'7.7"E; 28°6'54.1"N]  
(ICIMOD id: mo\_gl\_201)  
(JAXA local id: gl\_mo\_893608E280654N)



\*Lake position and area are originated from "Glacial Lake Inventory of Bhutan using ALOS".

URL: [http://www.eorc.jaxa.jp/ALOS/en/bhutan\\_gli/index.htm](http://www.eorc.jaxa.jp/ALOS/en/bhutan_gli/index.htm)

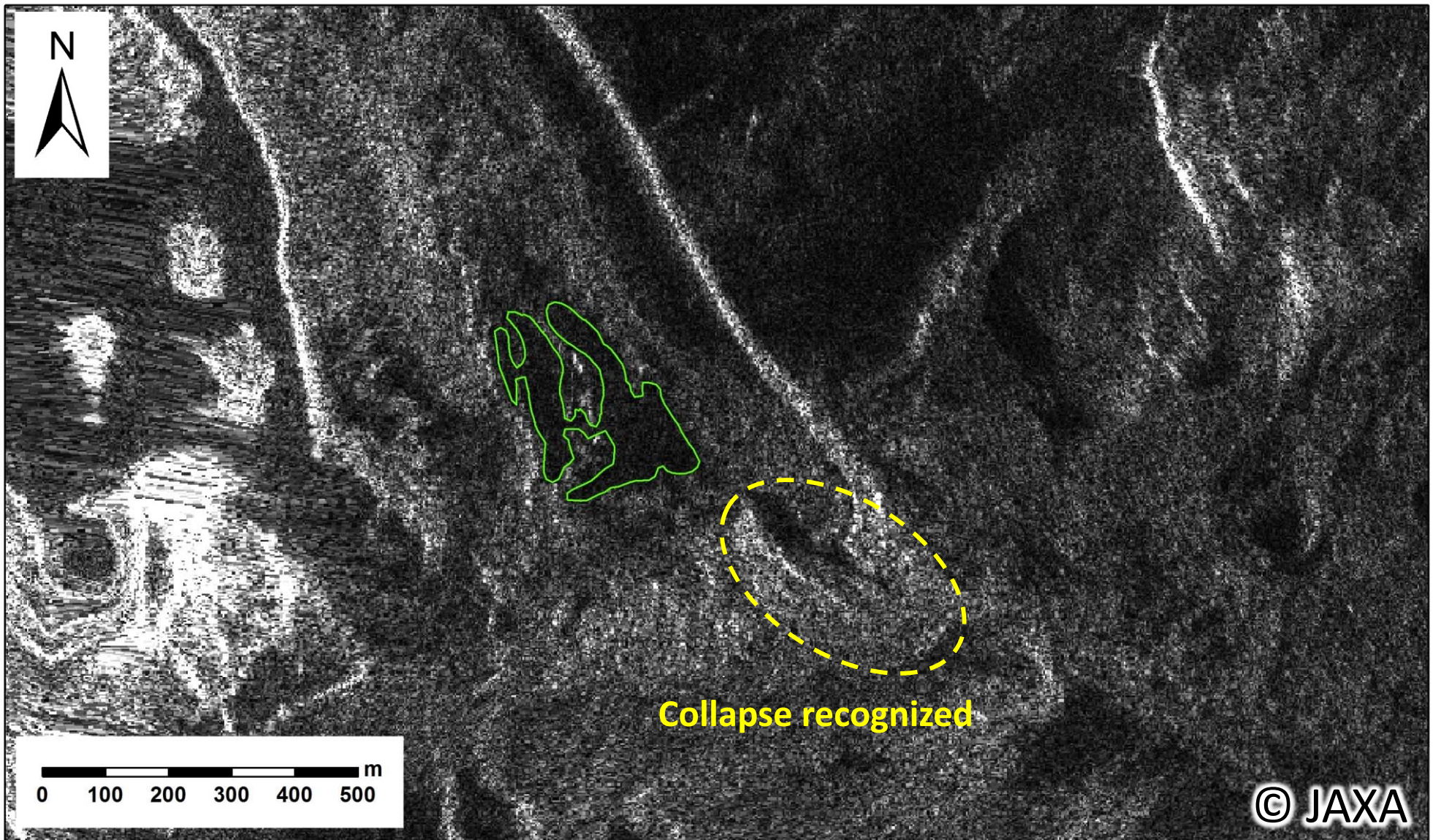
\*Glacier outlines are originated from Nagai et al. (2014).



# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake A** (ICIMOD id: mo\_gl\_200) (JAXA local id: gl\_mo\_893450E280408N)

2015-07-02



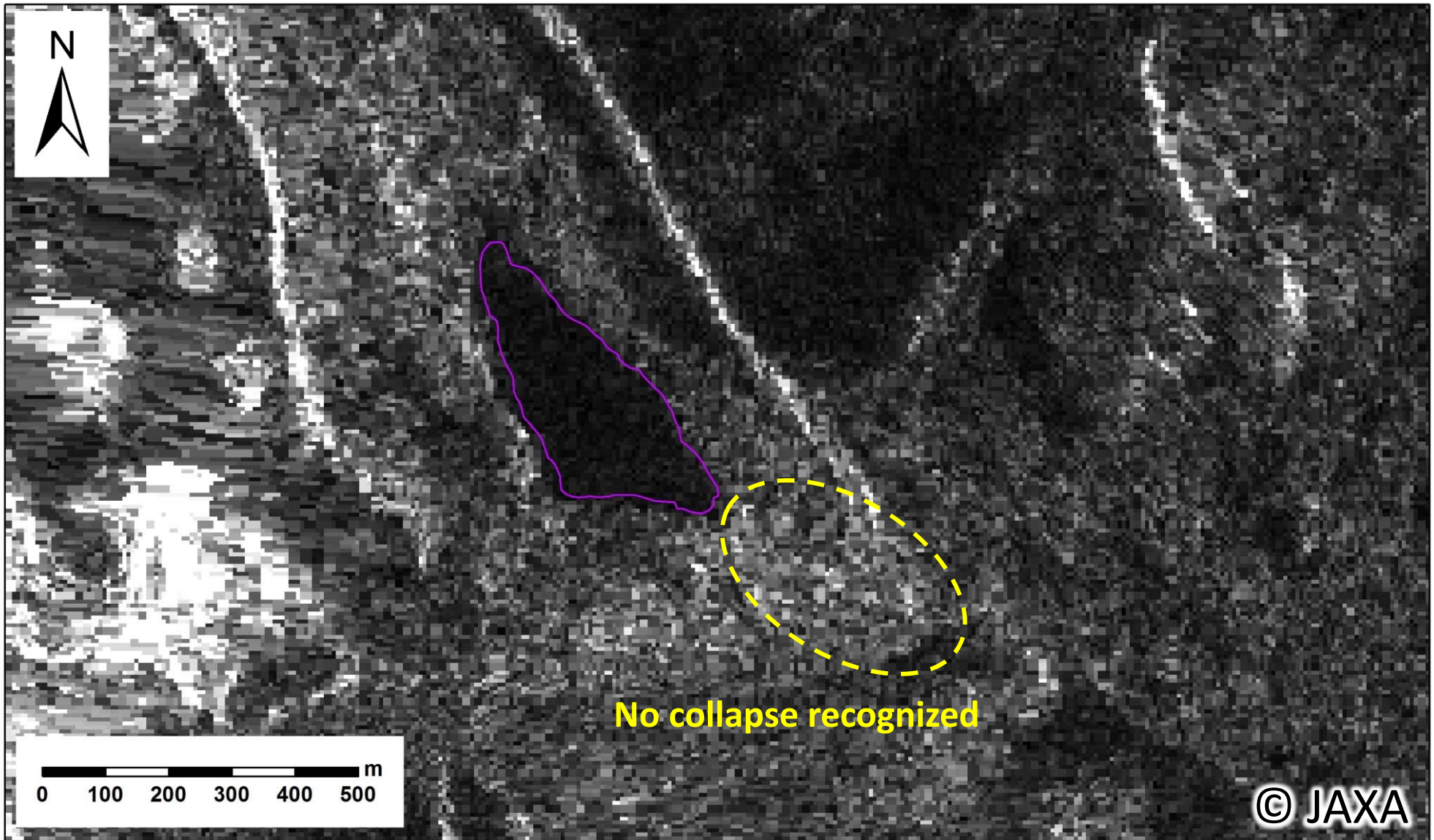
PALSAR-2 / HH / Ortho-rectified amplitude imagery (Product level 2.1) /  
Path: 46 / Spatial resolution: 3m



# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake A** (ICIMOD id: mo\_gl\_200) (JAXA local id: gl\_mo\_893450E280408N)

2015-04-23

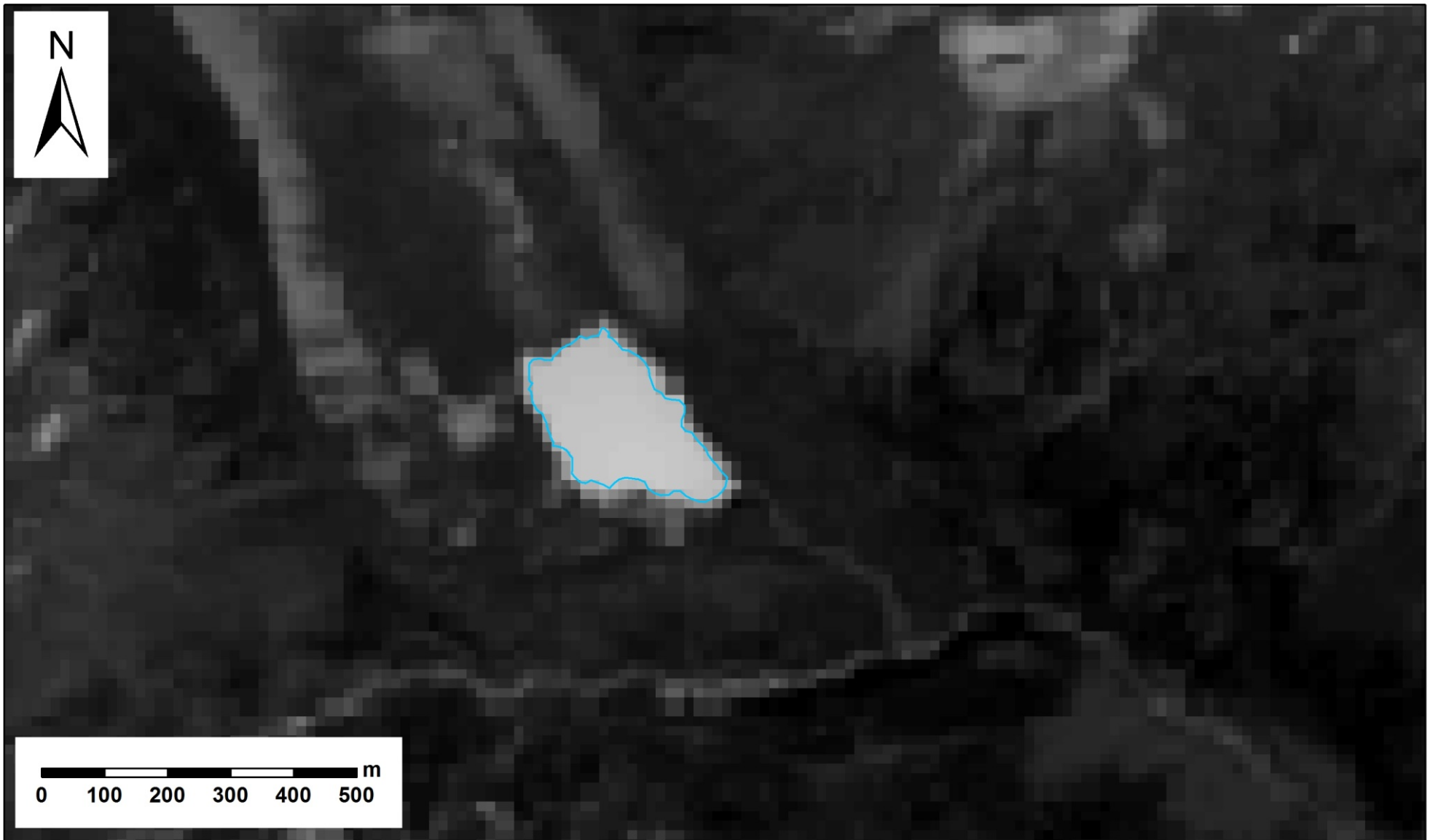


PALSAR-2 / HH / Ortho-rectified amplitude imagery (Product level 2.1) /  
Path: 46 / Spatial resolution: 10m

# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake A** (ICIMOD id: mo\_gl\_200) (JAXA local id: gl\_mo\_893450E280408N)

2015-03-08

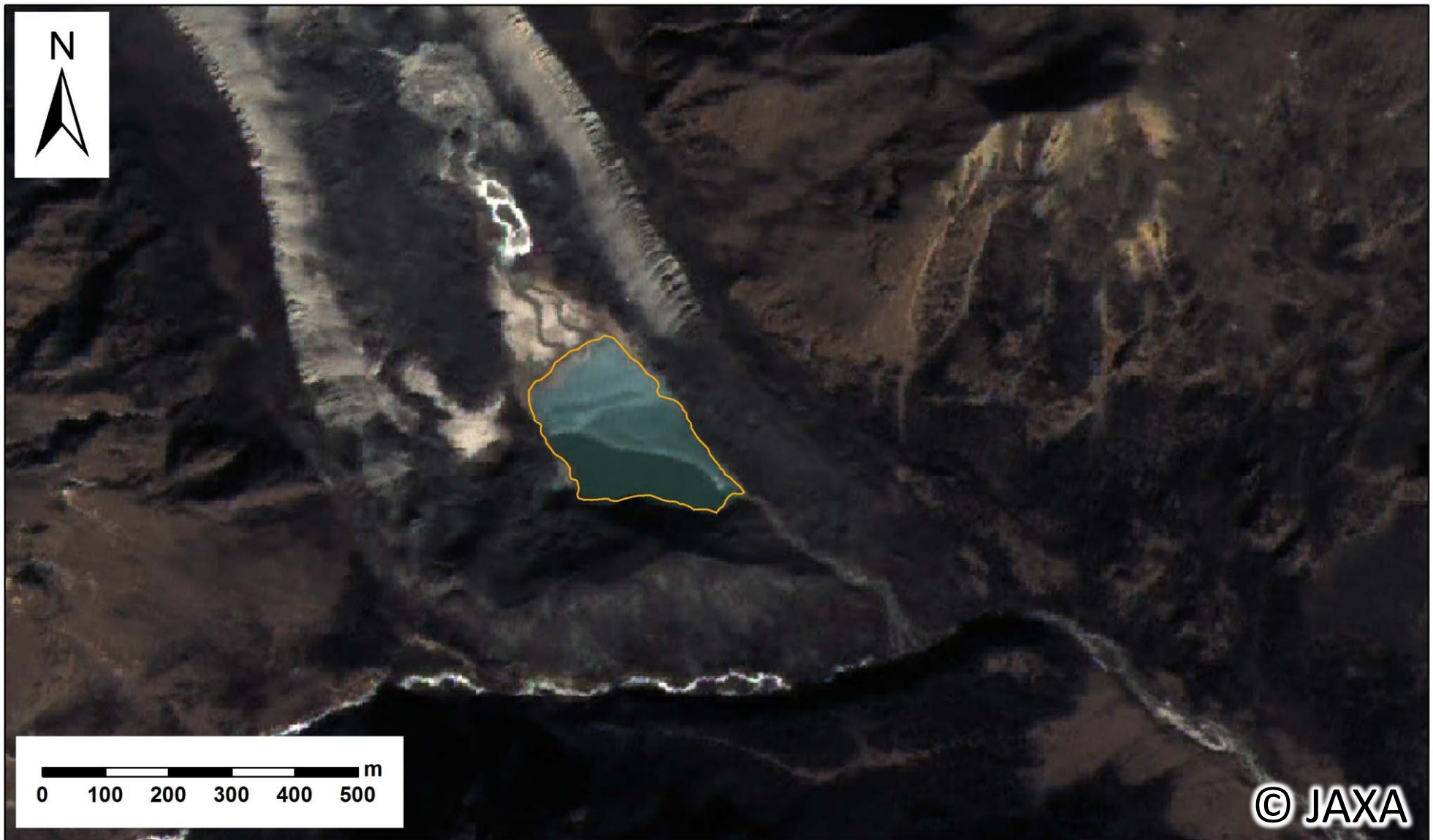


Landsat-8 / Operational Land Imager / Band8 / Spatial resolution: 15m

# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake A** (ICIMOD id: mo\_gl\_200) (JAXA local id: gl\_mo\_893450E280408N)

2010-12-22



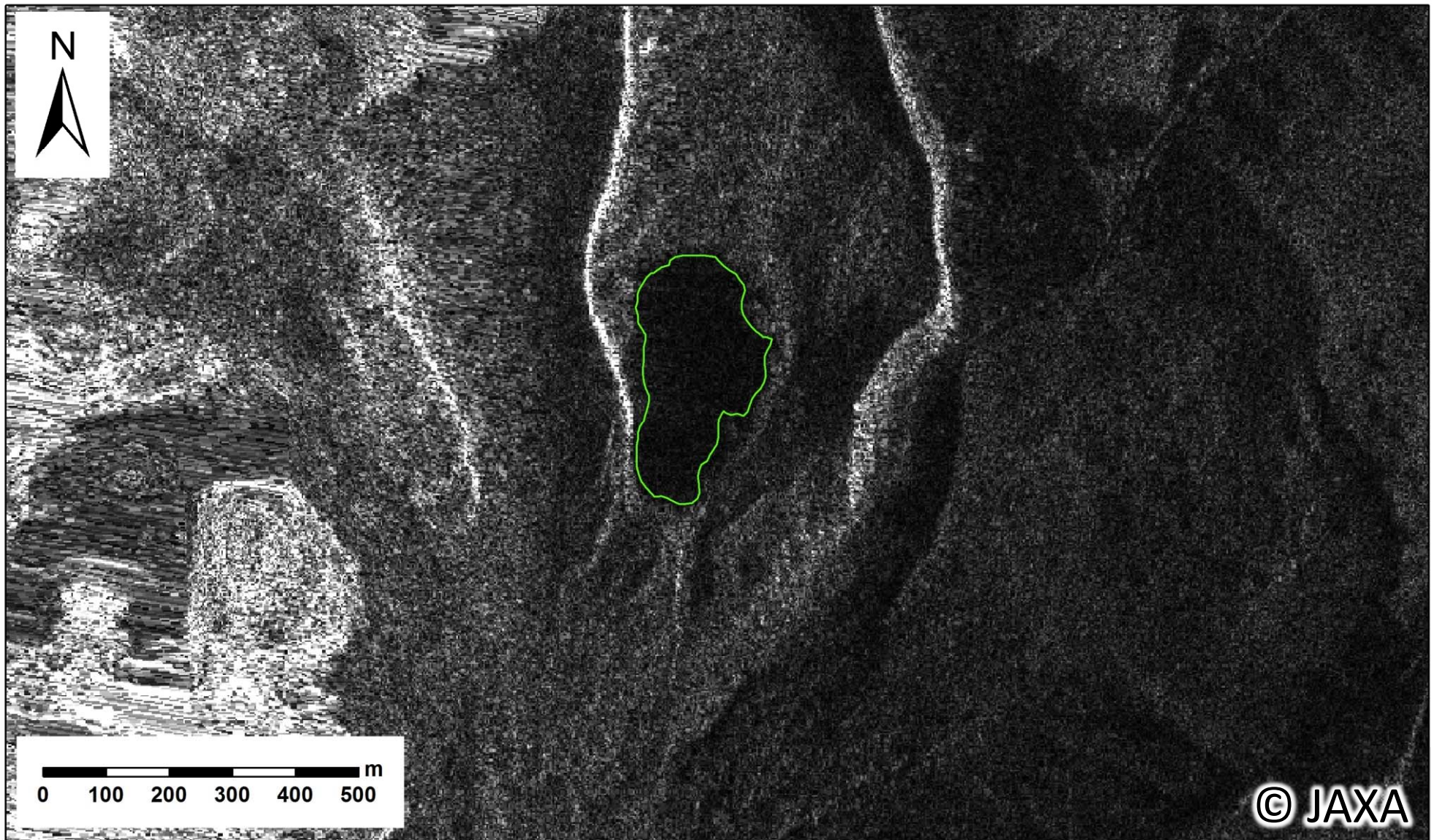
ALOS / AVNIR-2 and PRISM / Pan-sharpened imagery / Spatial resolution: 2.5m  
An outline originated from [“Glacial Lake Inventory of Bhutan using ALOS”](#)



# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake B** (ICIMOD id: mo\_gl\_201) (JAXA local id: gl\_mo\_893608E280654N)

2015-07-02



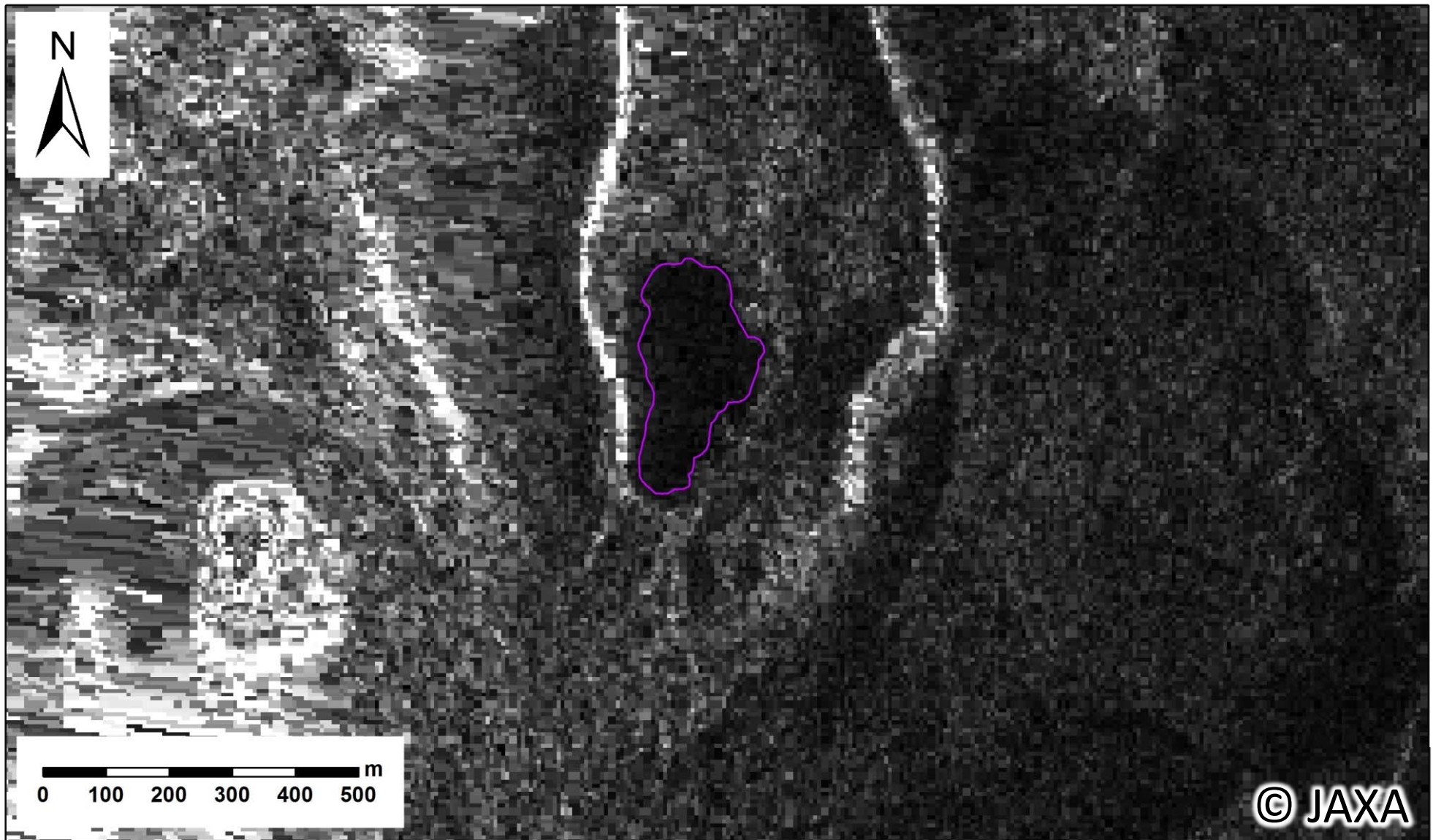
PALSAR-2 / HH / Ortho-rectified amplitude imagery (Product level 2.1)  
Path: 46 / Spatial resolution: 3m



# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake B** (ICIMOD id: mo\_gl\_201) (JAXA local id: gl\_mo\_893608E280654N)

2015-04-23

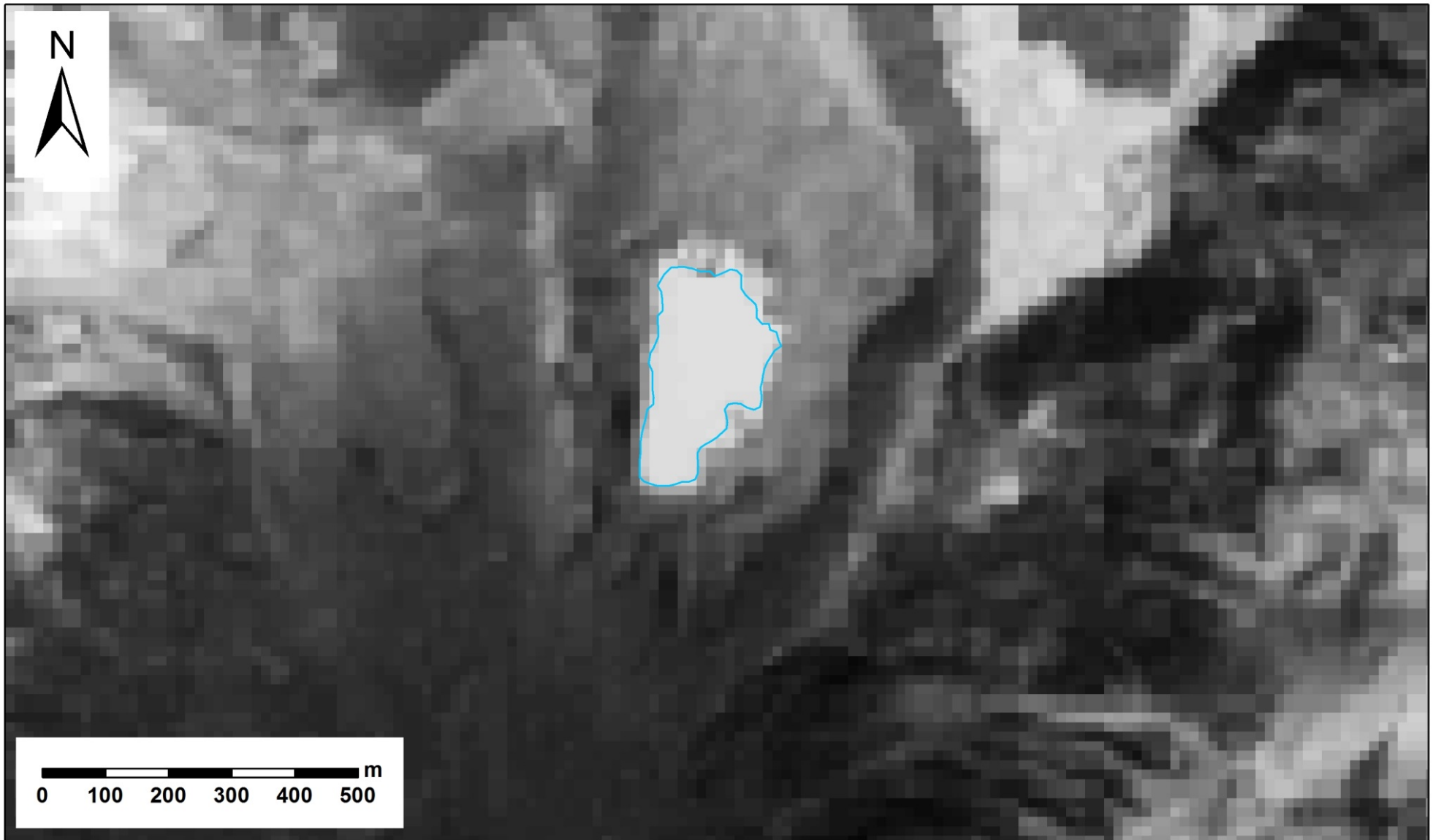


PALSAR-2 / HH / Ortho-rectified amplitude imagery (Product level 2.1)  
Path: 46 / Spatial resolution: 10m

# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

**Lake B** (ICIMOD id: mo\_gl\_201) (JAXA local id: gl\_mo\_893608E280654N)

2015-03-08



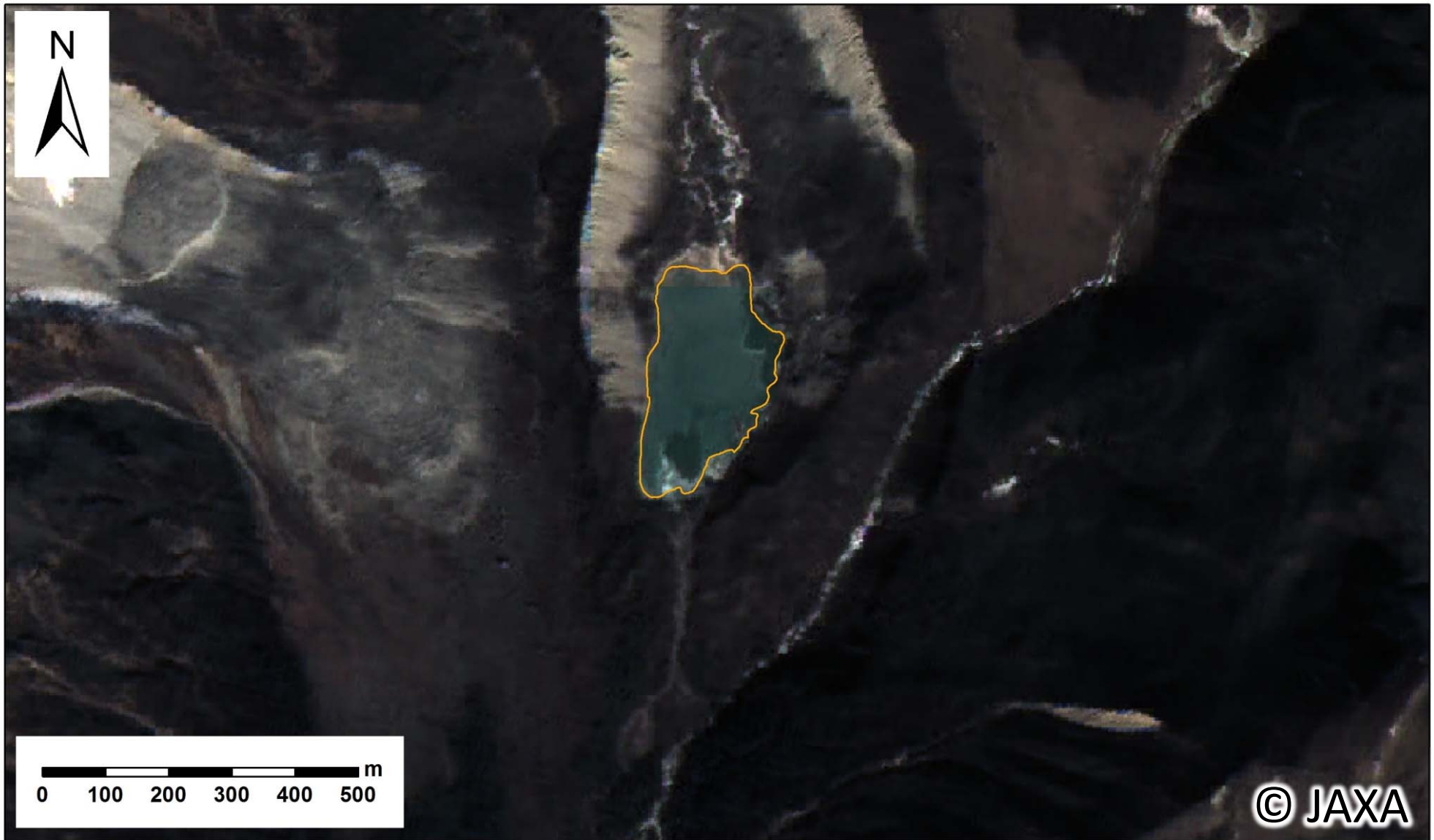
Landsat-8 / Operational Land Imager / Band8 / Spatial resolution: 15m



# Lake area comparison between a GLOF event on Jun. 28<sup>th</sup>, 2015

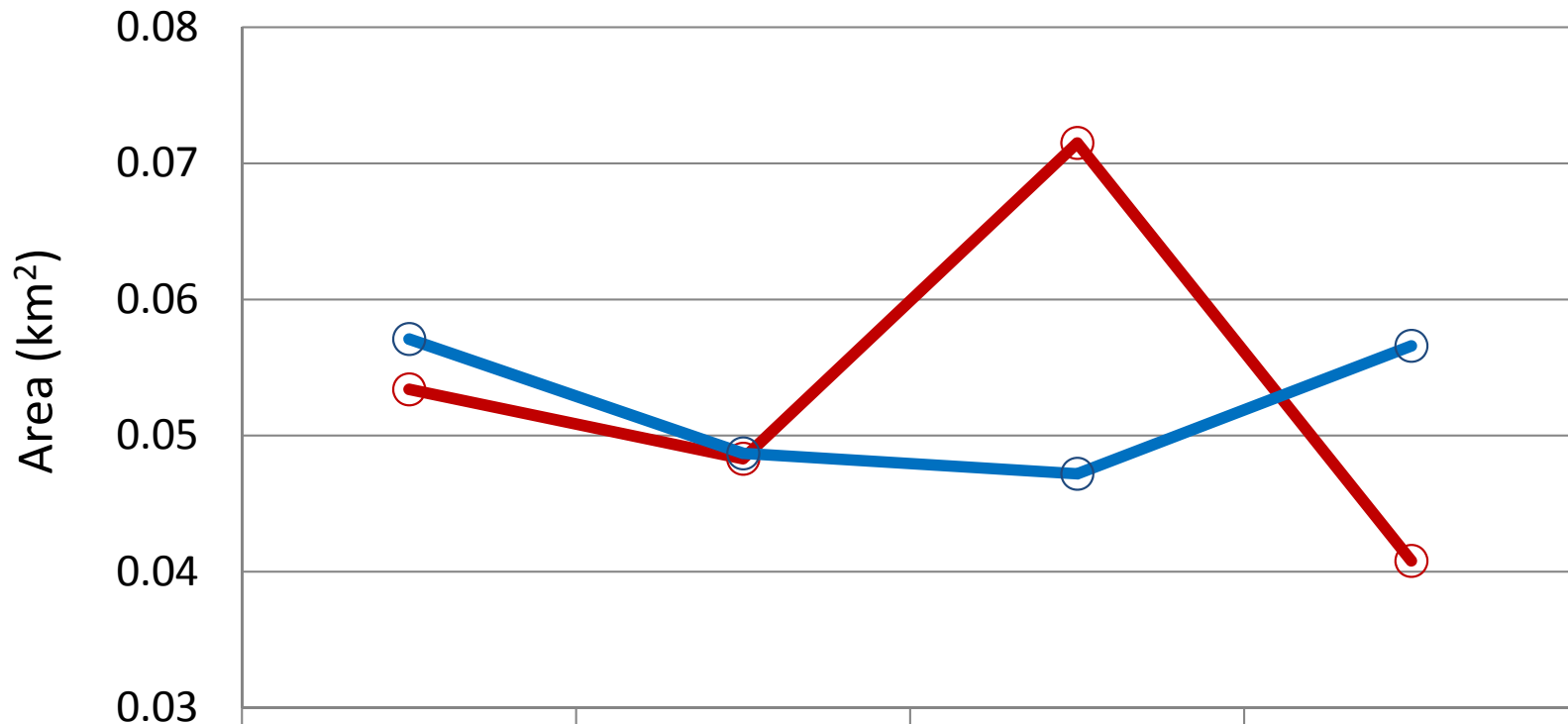
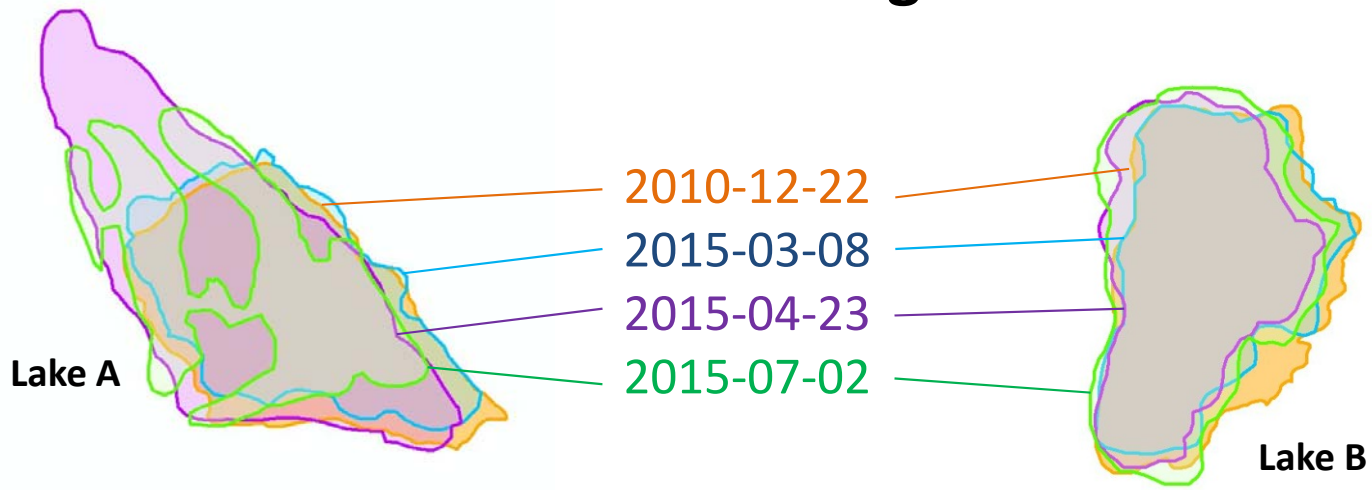
**Lake B** (ICIMOD id: mo\_gl\_201) (JAXA local id: gl\_mo\_893608E280654N)



2010-12-22



ALOS / AVNIR-2 and PRISM / Pan-sharpened imagery / Spatial resolution: 2.5m  
An outline originated from [“Glacial Lake Inventory of Bhutan using ALOS”](#)

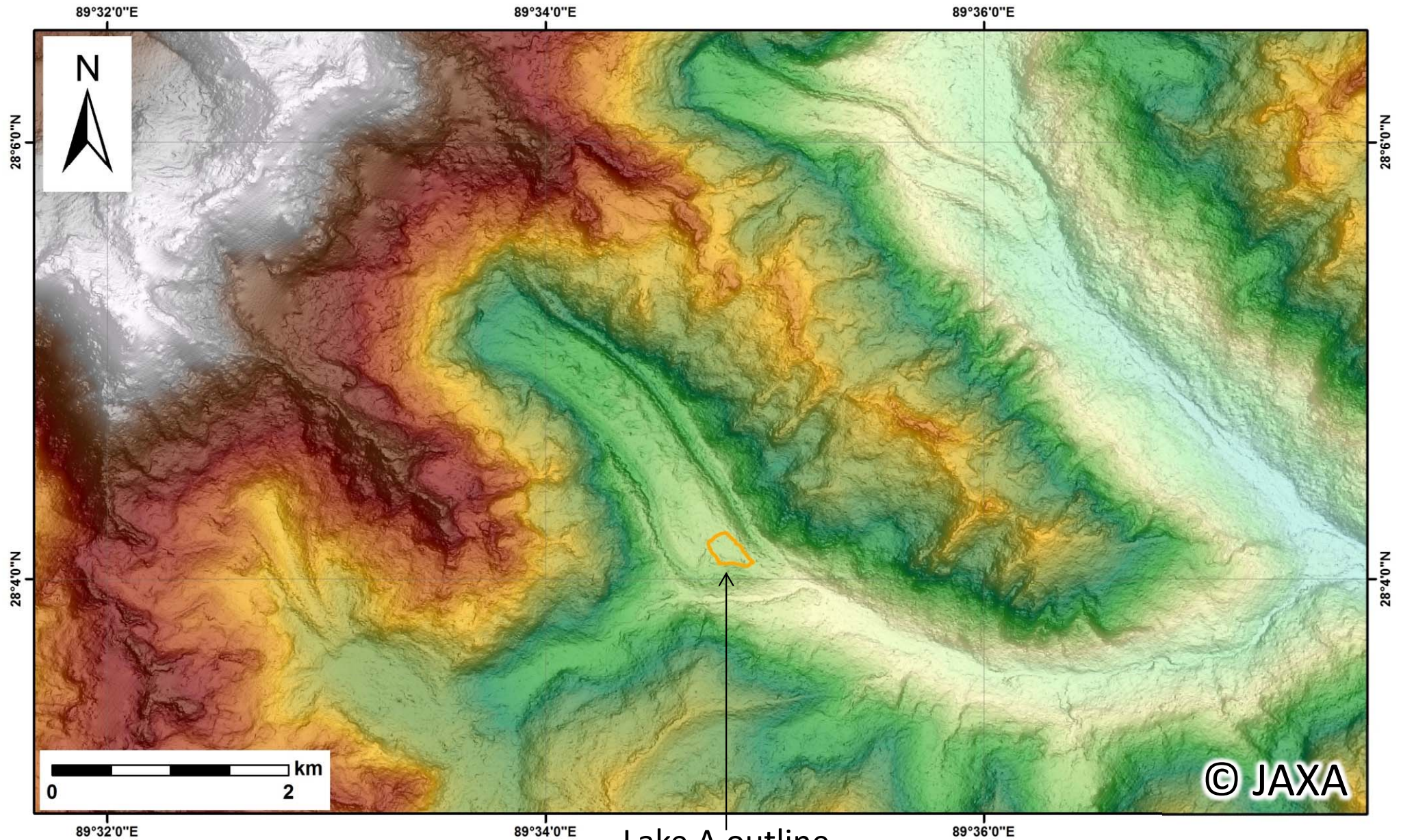
# Lake area changes



	2010-12-22	2015-03-08	2015-04-23	2015-07-02
 Lake A	0.0534	0.0483	0.0715	0.0408
 Lake B	0.0571	0.0487	0.0472	0.0566



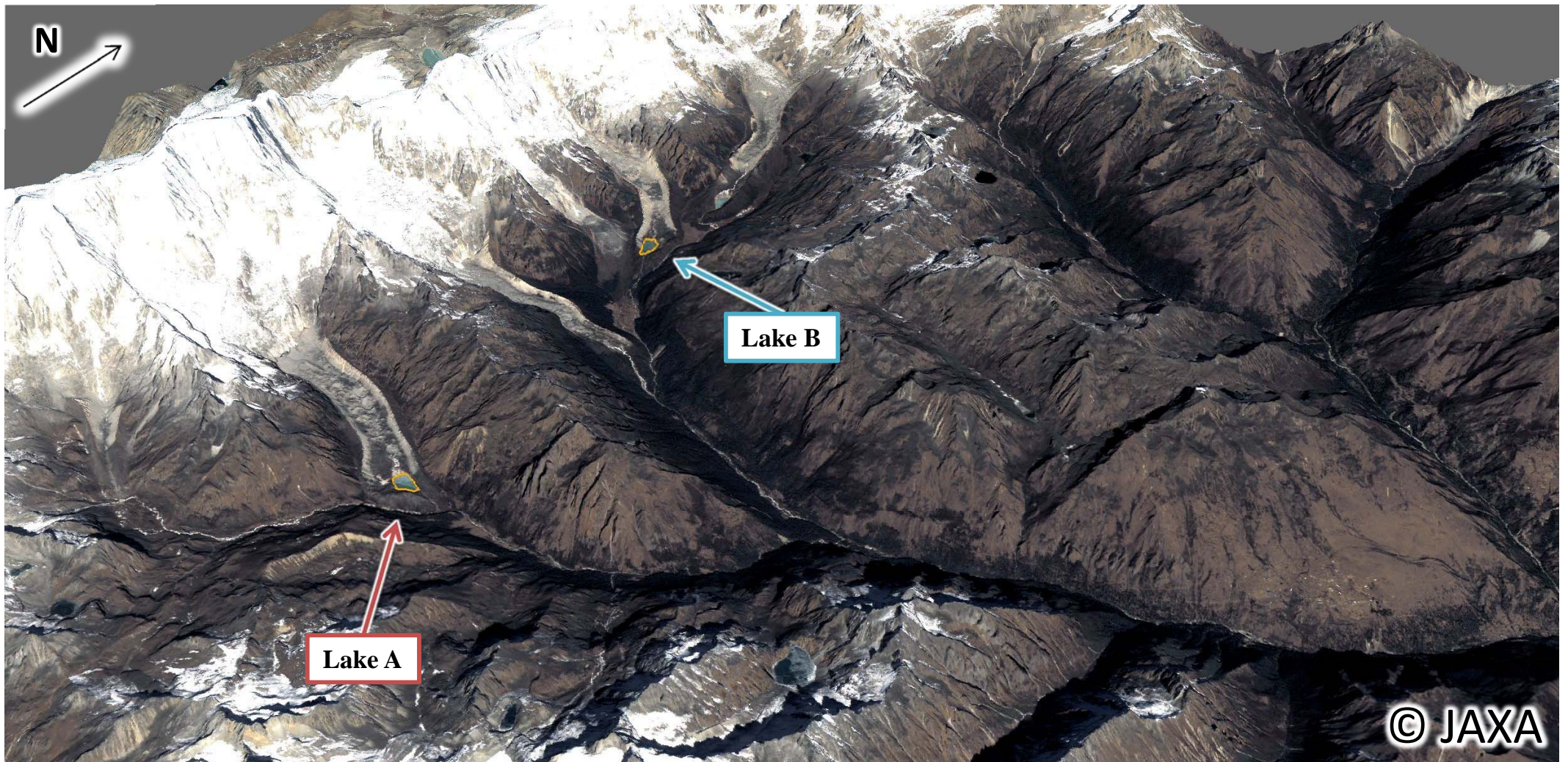
# Topography around Lake A derived from ALOS digital surface model (spatial resolution: 2.5m)



Lake A outline  
(2010-12-22)

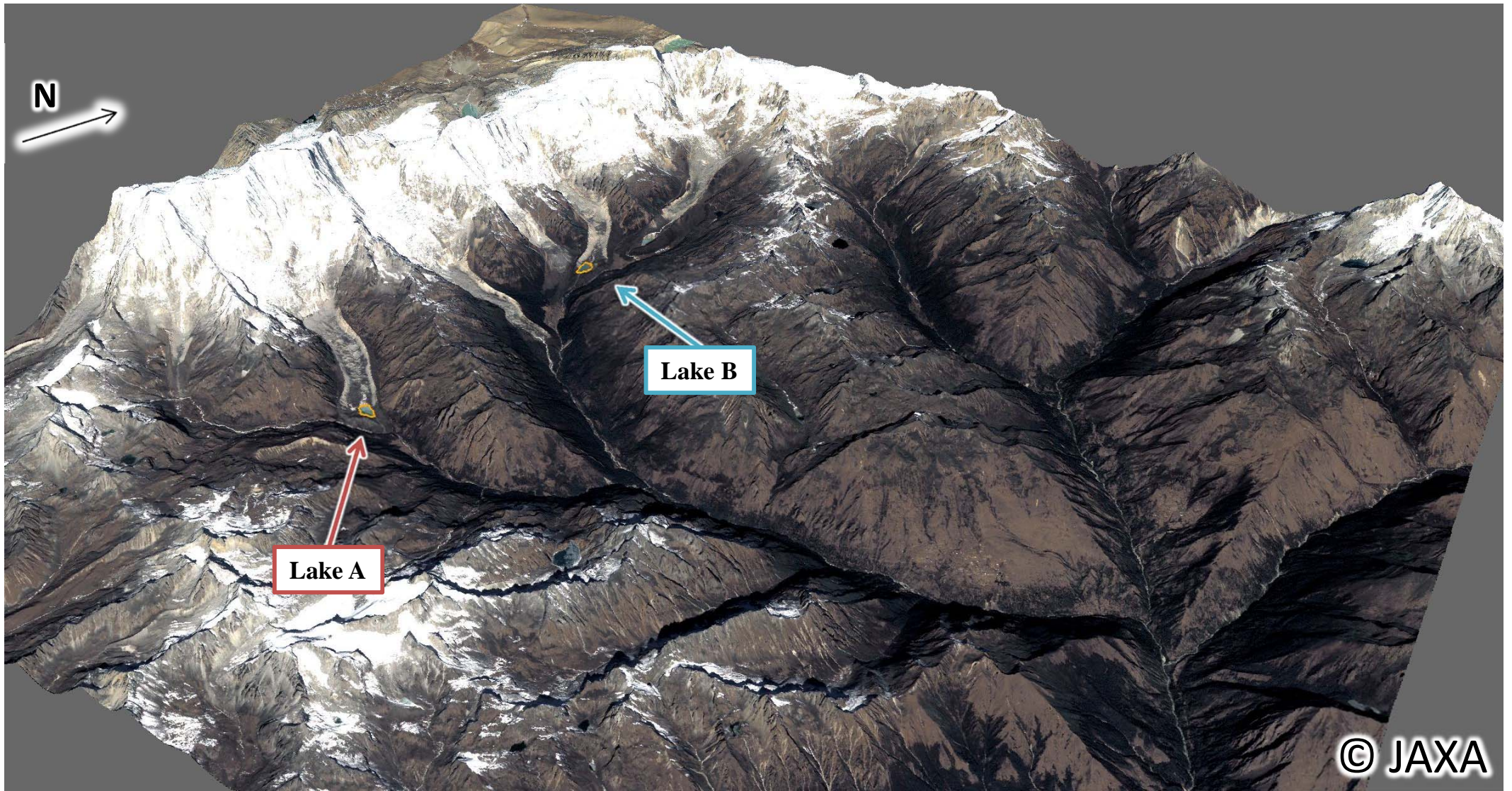


**3D view around Lakes A and B derived from  
ALOS digital surface model and pan-sharpened imagery  
(Dec. 22, 2010)**



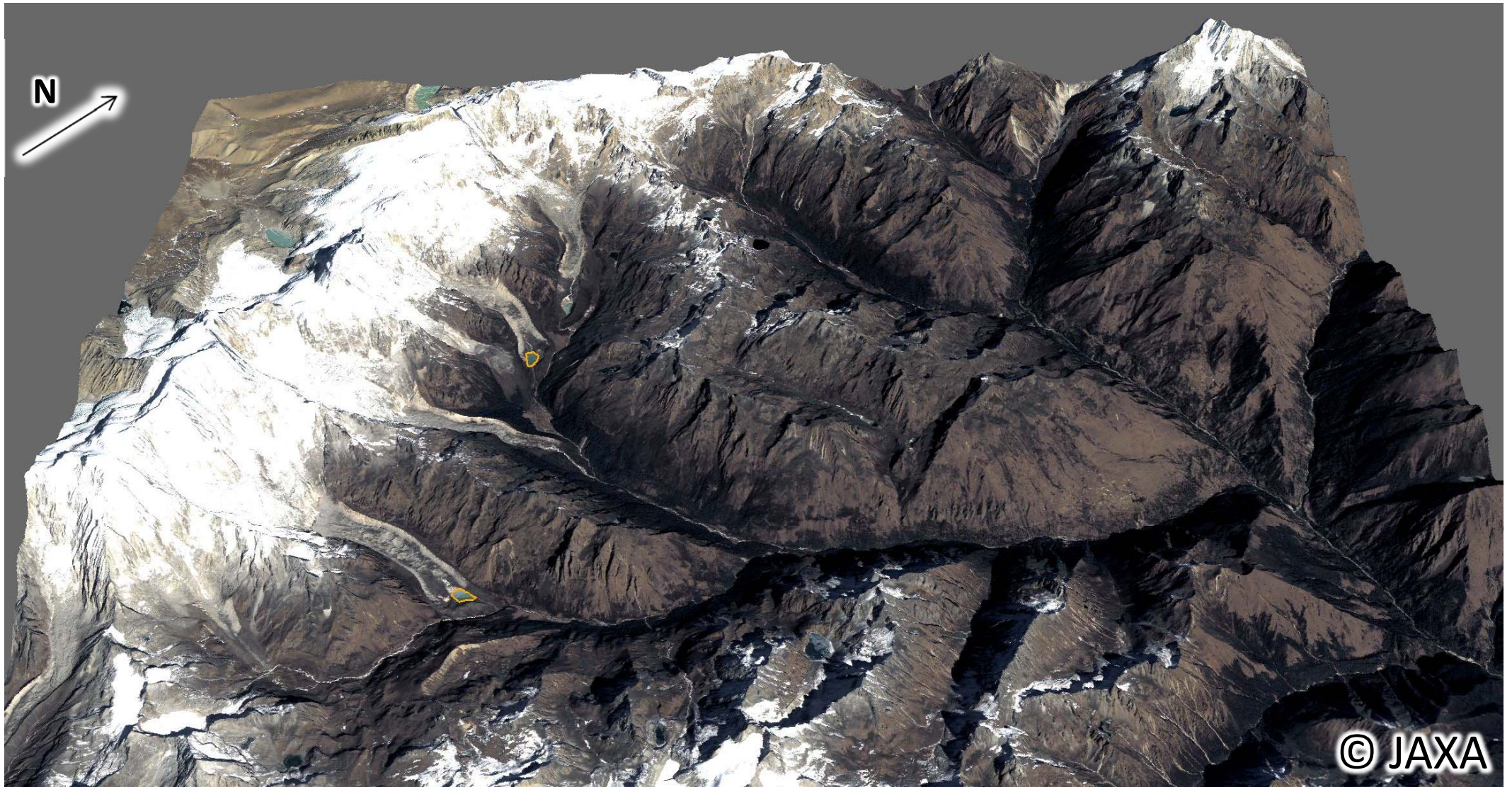


**3D view around Lakes A and B derived from  
ALOS digital surface model and pan-sharpened imagery  
(Dec. 22, 2010)**



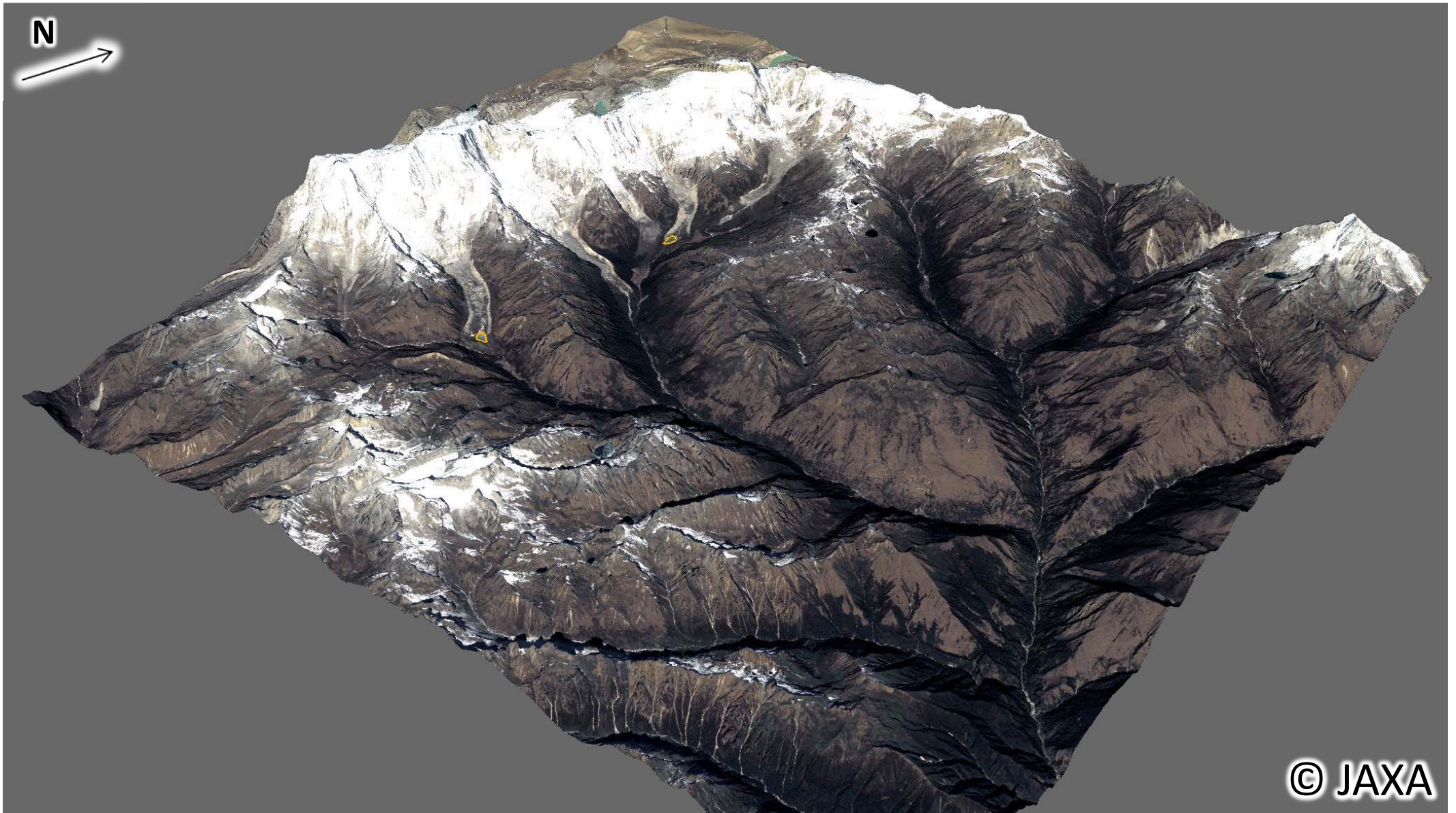


**3D view around Lakes A and B derived from  
ALOS digital surface model and pan-sharpened imagery  
(Dec. 22, 2010)**





**3D view around Lakes A and B derived from  
ALOS digital surface model and pan-sharpened imagery  
(Dec. 22, 2010)**





**3D view around Lakes A and B derived from  
ALOS digital surface model and pan-sharpened imagery  
(Dec. 22, 2010)**

