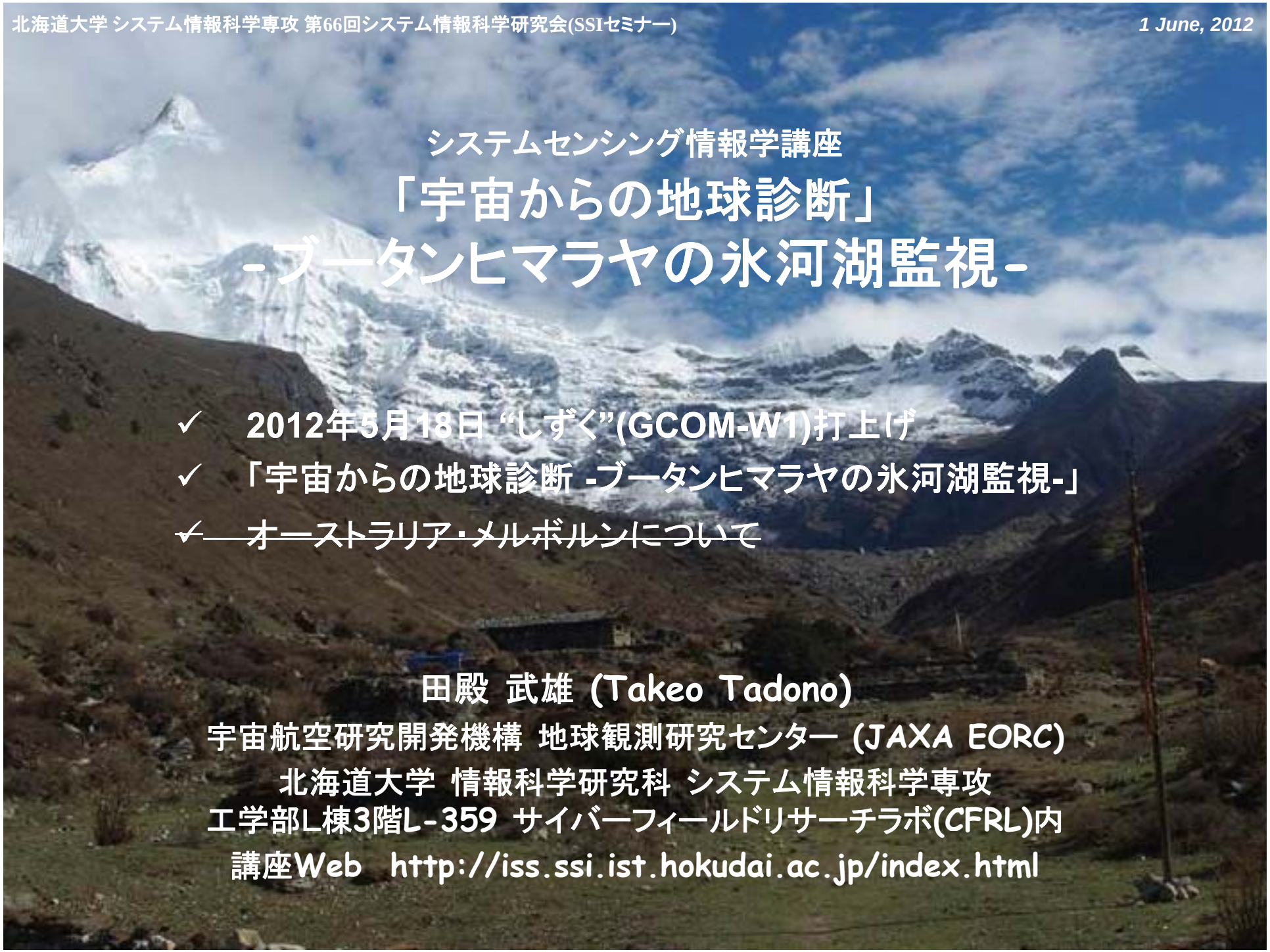


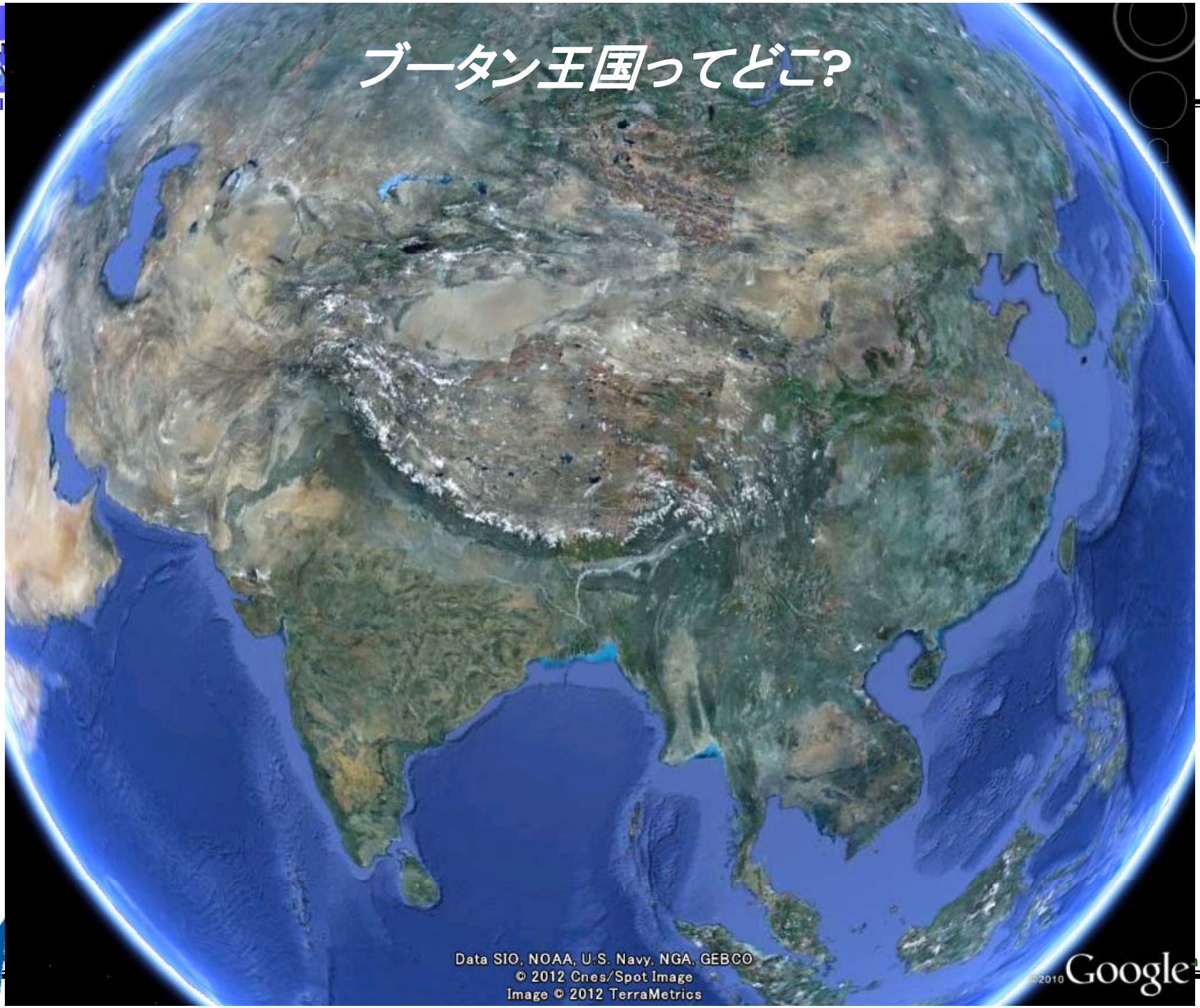
システムセンシング情報学講座

「宇宙からの地球診断」
-ブータンヒマラヤの氷河湖監視-

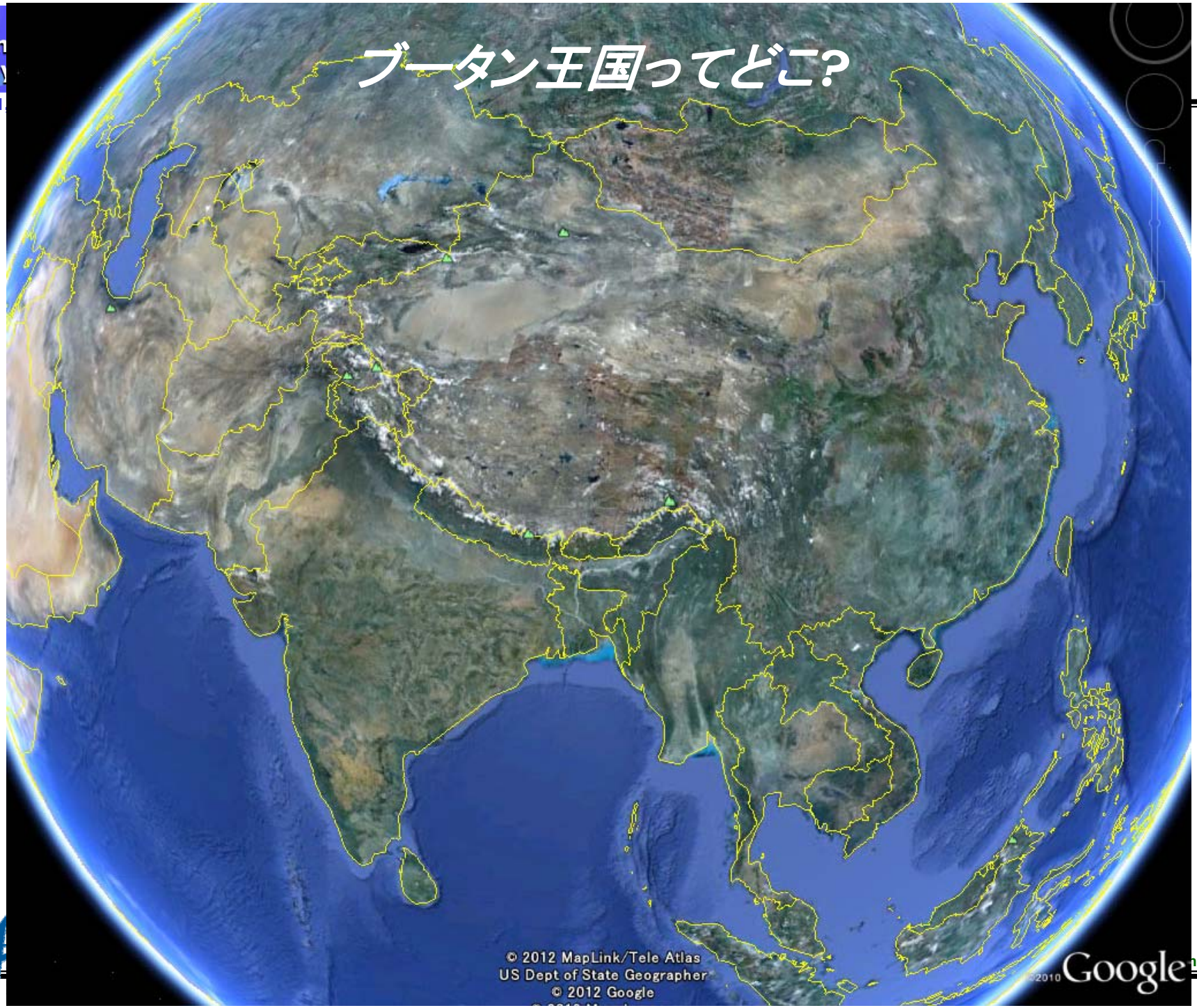
- ✓ 2012年5月18日 “しずく”(GCOM-W1)打上げ
- ✓ 「宇宙からの地球診断 -ブータンヒマラヤの氷河湖監視-」
- ~~✓ オーストラリア・メルボルンについて~~

田殿 武雄 (Takeo Tadono)
宇宙航空研究開発機構 地球観測研究センター (JAXA EORC)
北海道大学 情報科学研究科 システム情報科学専攻
工学部L棟3階L-359 サイバーフィールドリサーチラボ(CFRL)内
講座Web http://iss.ssi.ist.hokudai.ac.jp/index.html

ブータン王国ってどこ?


Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Image © 2012 TerraMetrics
Google

ブータン王国ってどこ?


© 2012 MapLink/Tele Atlas
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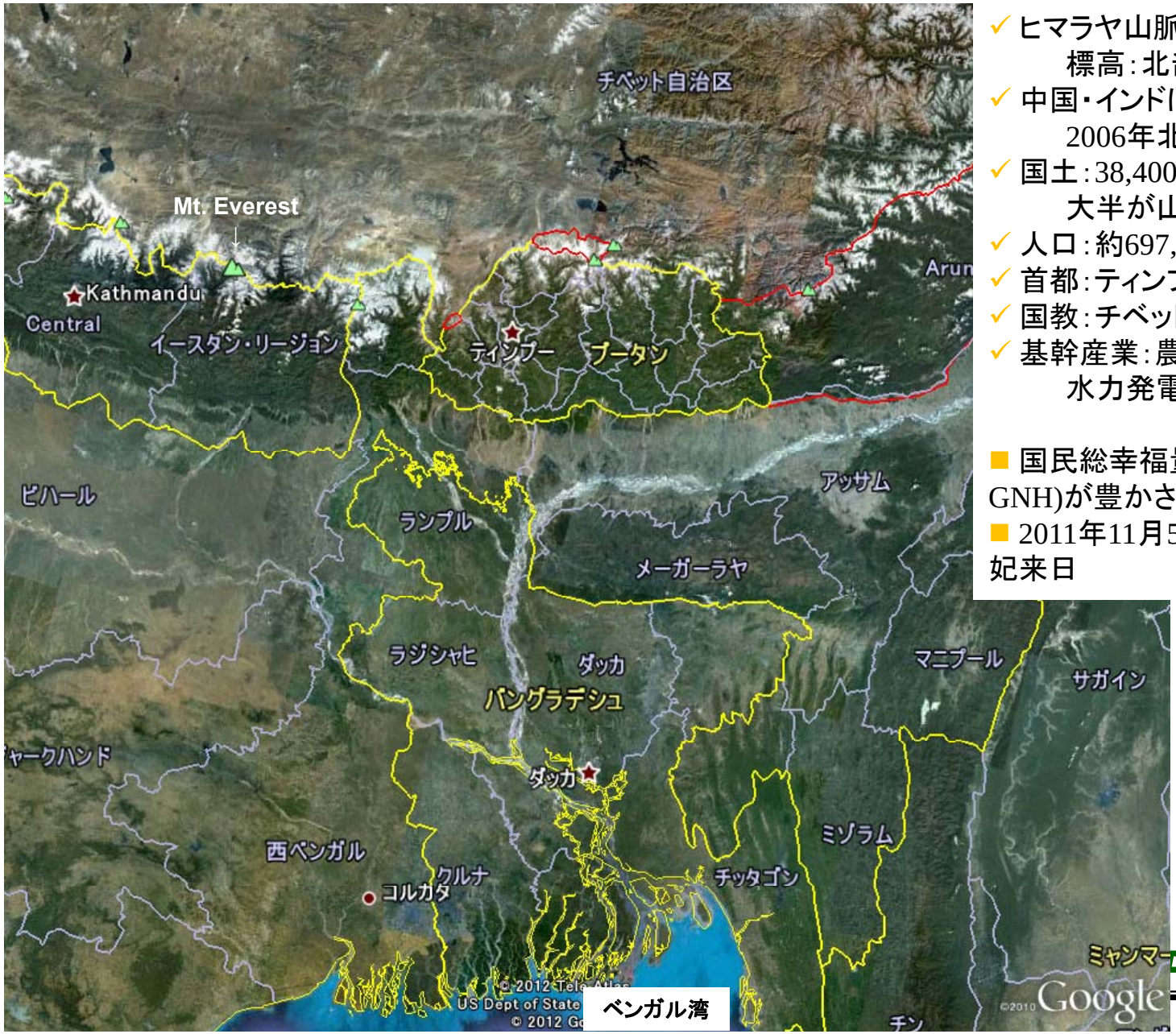
ブータン王国



- ✓ ヒマラヤ山脈南麓
  標高：北部7,000m級, 南部100m
- ✓ 中国・インドに隣接
  2006年北側国境線が変更
- ✓ 国土：38,400 km^2 (九州と同程度)
  大半が山岳地形
- ✓ 人口：約697,000人
- ✓ 首都：ティンプー
- ✓ 国教：チベット仏教
- ✓ 基幹産業：農業, 観光業に力
  水力発電による電力をインドへ輸出

■ 国民総幸福量(Gross National Happiness, GNH)が豊かさの指標
■ 2011年11月5代ワンチュク国王, ペマ王妃来日

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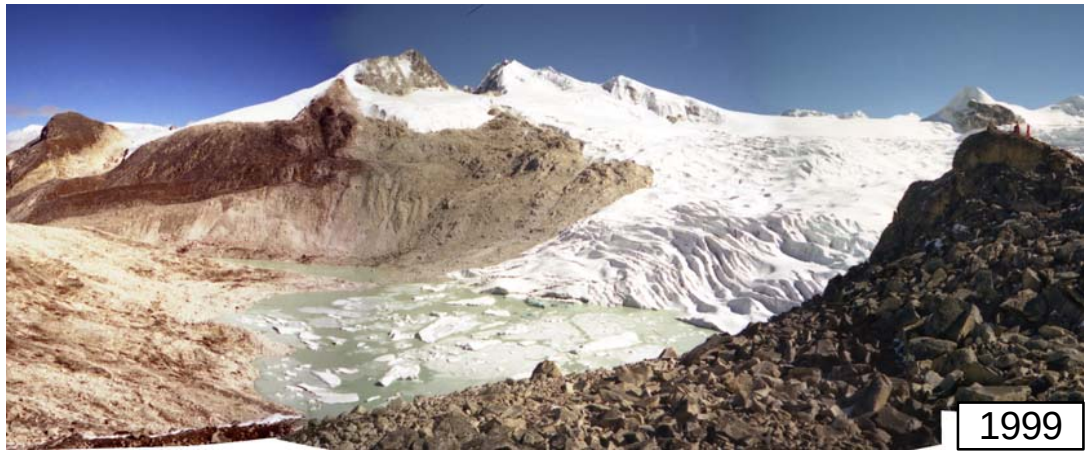
ブータンで今，何が起きているか?



ガンリンチェンゼー峠北方氷河の縮小の様子
(写真提供:1984月原敏博, 1999, 2010内藤望)

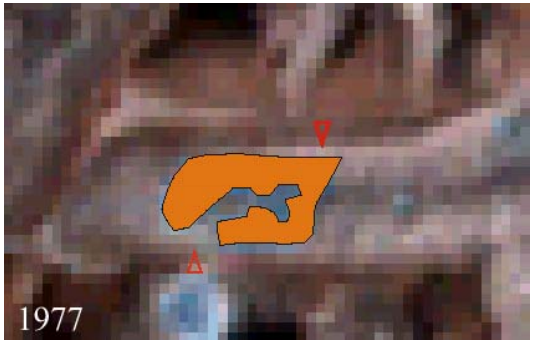

1．氷河上の池

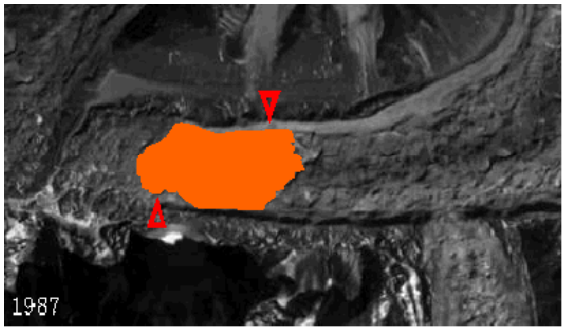

2．拡大過程にある氷河湖
Nishimura and Fujita, 2009

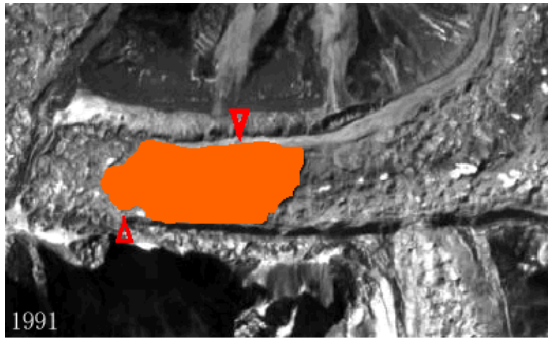

3．拡大を終えた氷河湖：1998年決壊

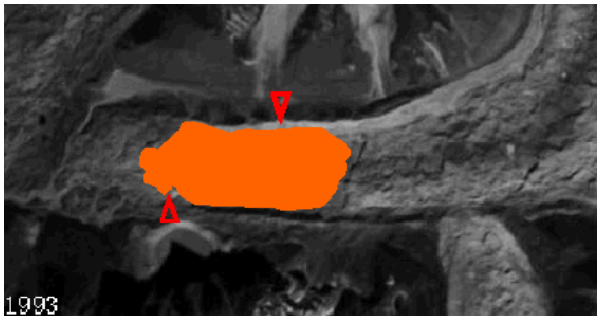
氷河湖の形成・拡大

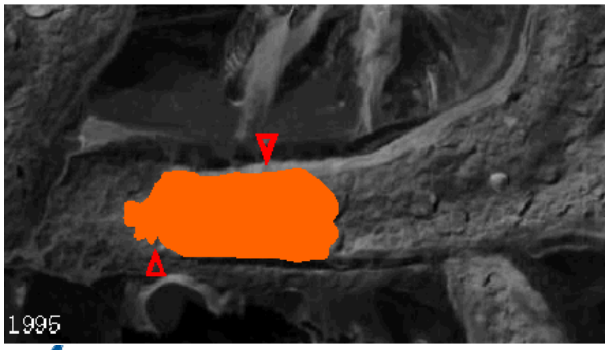
Changing lake size from 1975 to 2000 at Imja Glacial lake, Nepal

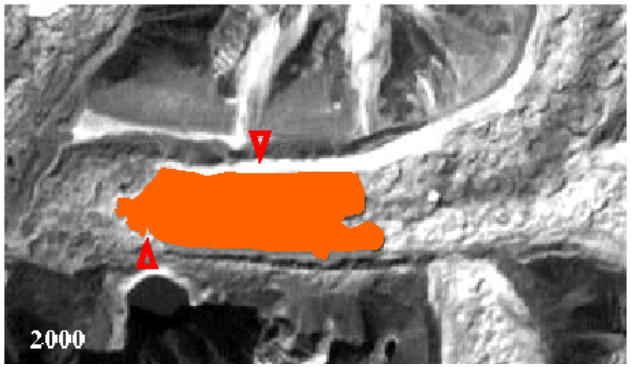








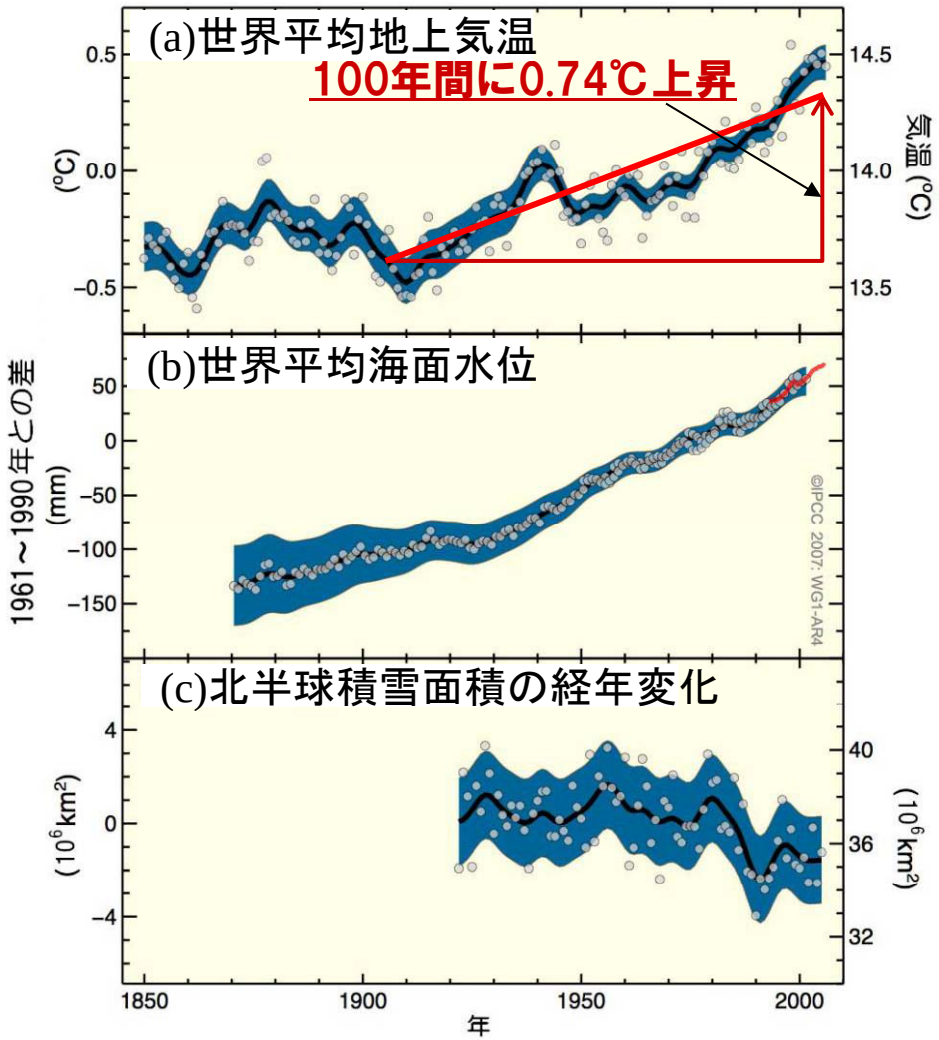




Yabuki, 2002

地球温暖化が原因?

IPCC第4次評価報告書（2007）



出典：IPCC第4次評価報告書第1作業部会報告書政策決定者向け要約（気象庁訳）

IPCC：気候変動に関する政府間パネル

IPCC第4次評価報告書（気象庁訳）

「気候システムの温暖化には疑う余地がない。このことは、

大気や海洋の世界平均温度の上昇、

雪氷の広範囲にわたる融解、

世界平均海面水位の上昇

が観測されていることから
今や明白である」

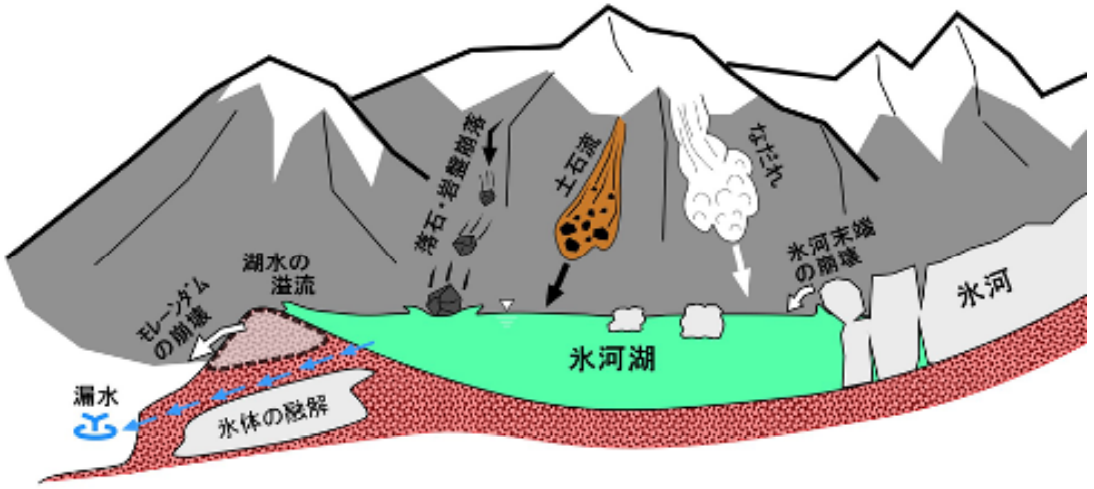
何が問題か?

氷河湖決壊洪水(GLOF):Glacial Lake Outburst Flood > 下流の住民に被害

ブータン，ネパール，中国，南米アンデスなどで発生

- ✓ 中国ツァン・ツァンポ氷河湖(1981年):50km下流まで壊滅的な被害，3つのコンクリート橋を破壊，再建に300万USドル
- ✓ ブータン・ルナナ地方(1957, 1969, 1994年):古都プナカ・ゾンを破壊，洪水はベンガル湾まで達する
- ✓ ブータン・ディグツォ氷河湖(1985年):小型水力発電所，14の橋を破壊
- ✓ ネパール:1977-1998年の間に5回のGLOF発生

- ✓ **氷河湖の現状・実態が把握されていない**
  - ■ 現地へのアクセスが困難
  - ■ 拡大プロセスが分からない
- ✓ **いつ決壊するか分からない**
  - ■ 客観的な危険性が分からない
- ✓ **洪水に対する準備がなされていない**



Nishimura and Fujita, 2009

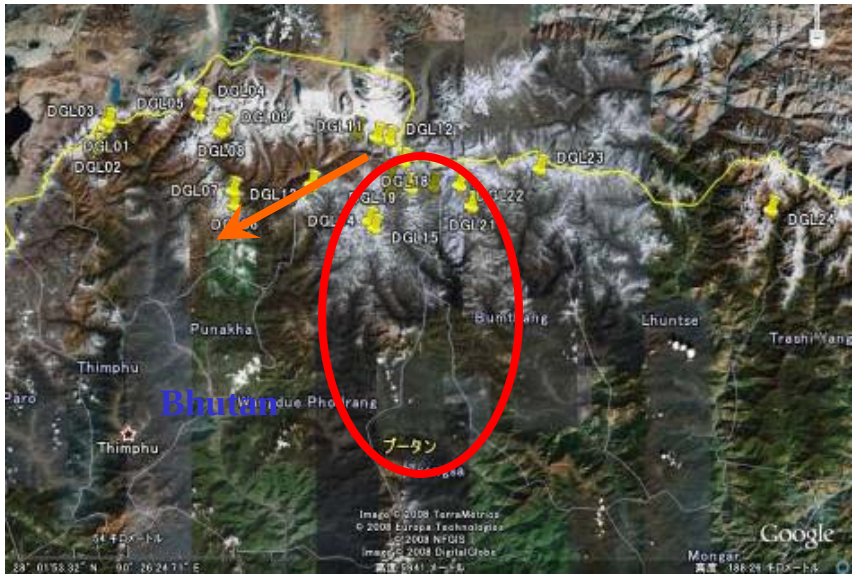
過去の氷河湖調査レポート (ICIMOD)

Mool et al. (2001a, b)

国際総合山岳開発センター(ICIMOD): 氷河湖インベントリ(台帳)

“危険な氷河湖” (Potentially dangerous lakes)

- ✓ 20 in Nepal, 24 in Bhutan
- ✓ Criteria is not clear
- ✓ Not direct measurements
- ✓ Landsat bases inventory : not accurate and new



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JICA/JST「ブータンヒマラヤ氷河湖決壊洪水(GLOF)」

2009-2011年度「地球規模課題国際科学技術協力(SATREPS)」課題

太字：衛星データ利用

氷河湖の観測・分析能力の向上，危険度の高い氷河湖下流における災害対策

現地C/P(ブータン政府地質鉱山局)への技術移転

主要メンバー
- プロセス班：名古屋大
- **衛星班：JAXA**
- アセス班：地球システム科学

洪水被害軽減対策
- ハザードマップ作成
- 早期警戒システムの提案

氷河湖の客観的な危険度評価が可能となる

氷河湖の決壊流出解析・洪水氾濫解析が向上

氷河湖決壊・災害分析
- 現地調査
- 決壊モデル構築，洪水シミュレーション
- 流域社会調査

氷河湖決壊危険度評価
- 衛星データによる危険度の詳細観測と評価
- 過去のGLOF氷河湖再評価

氷河湖拡大メカニズム解析
- 気候学的解析
- 拡大履歴情報収集

JAXA

EORC Earth Observation Research Center

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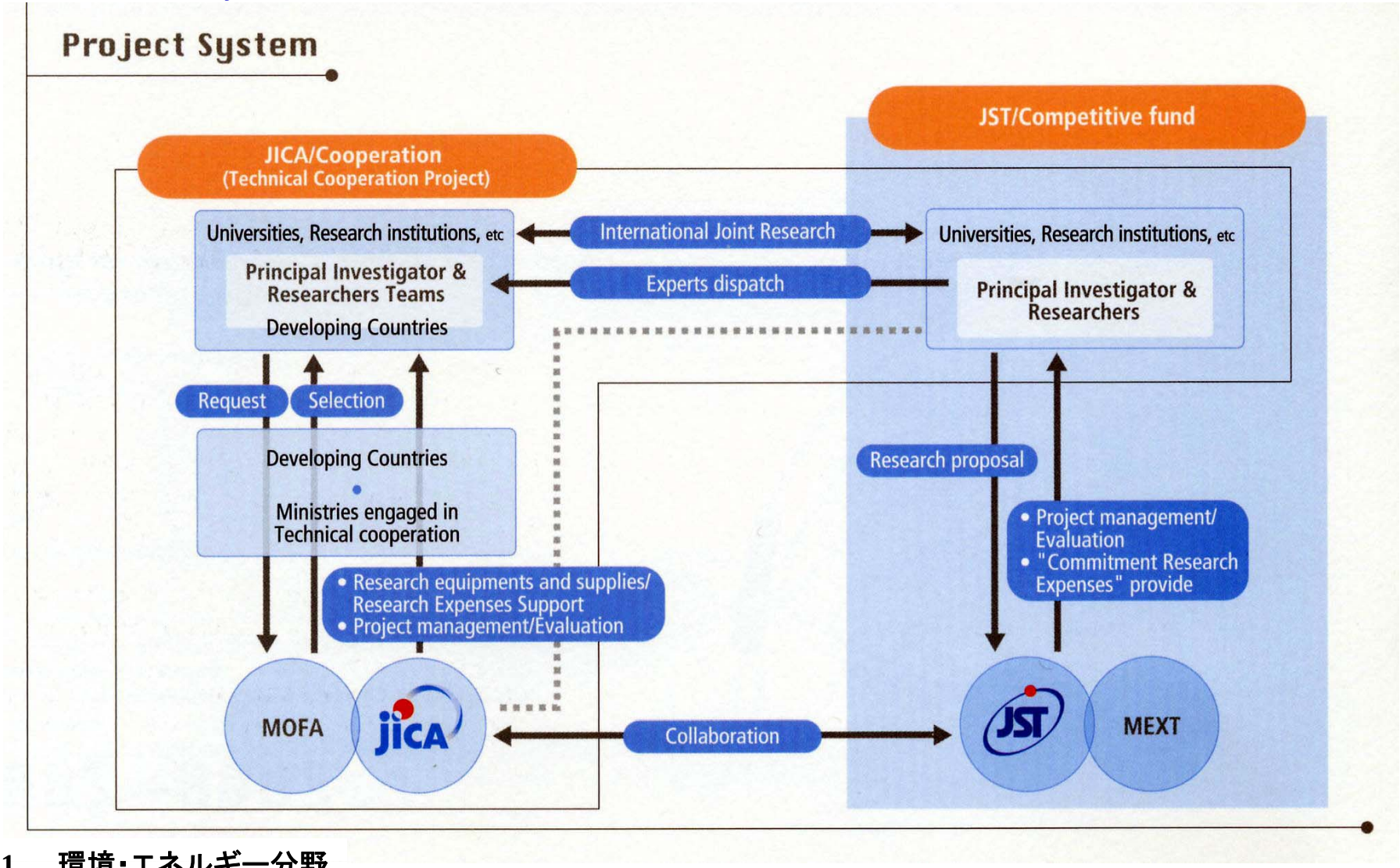
JICA/JST「ブータンヒマラヤ氷河湖決壊洪水(GLOF)」

2009-2011年度「地球規模課題国際科学技術協力(SATREPS)」課題

	プロセス班	衛星班	アセス班
主テーマ	現地測量観測、氷河湖拡大メカニズムの解析	衛星データの解析	氷河湖決壊洪水の影響評価
実施項目	- 危険な氷河湖の抽出 - 決壊リスクの評価 - 現地観測 - 氷河湖拡大過程	- 衛星データセットの提供 - 氷河湖(とその拡大に関する)インベントリ作成 - 衛星データ解析研修	- 堰き止めモレーンの物理探査 - 洪水解析 - 社会調査とハザードマップ作成 - 早期警戒システムの提案 - ハザードマップ作成研修
日本側組織	名古屋大学 北海道大学 立教大学 (独)防災科学研究所 広島工業大学 (独)海洋研究開発機構	(独)宇宙航空研究開発機構 (財)リモート・センシング技術センター 新潟大学 総合地球環境学研究所 (独)海洋研究開発機構	(株)地球システム科学 弘前大学 日本大学 帝京平成大学 群馬大学 慶應義塾大学
ブータン側組織	ブータン地質鉱山局	ブータン地質鉱山局	ブータン地質鉱山局

「地球規模課題国際科学技術協力(SATREPS)」



1. 環境・エネルギー分野
2. 生物資源分野
3. 防災分野
4. 感染症分野

JICA+JST総額：1億円程度/年
採択率 10%程度

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衛星班の目的

Objectives of *Remote Sensing Group* (or *Satellite Data Analysis Group*)

- ***Research and Analysis for Glacial Lake Expansion History using Terrain Information Derived by Satellite Data***

✓ Terrain analysis using satellite data for the past Glacial Lake Outburst Floods (GLOFs)

✓ Base map analysis using Terra/ASTER collaboration with Process Study Group

✓ Extract precise terrain information and validation using ALOS/PRISM

✓ Development of Glacial Lake Inventories based on multi-temporal, ortho-rectified satellite imageries (CORONA/KH-9, Hexagon, SPOT, Landsat, JERS-1/OPS, ASTER, PRISM, AVNIR-2, (PALSAR))

✓ Application of flood analysis and hazard maps generation collaboration with Assessment Group

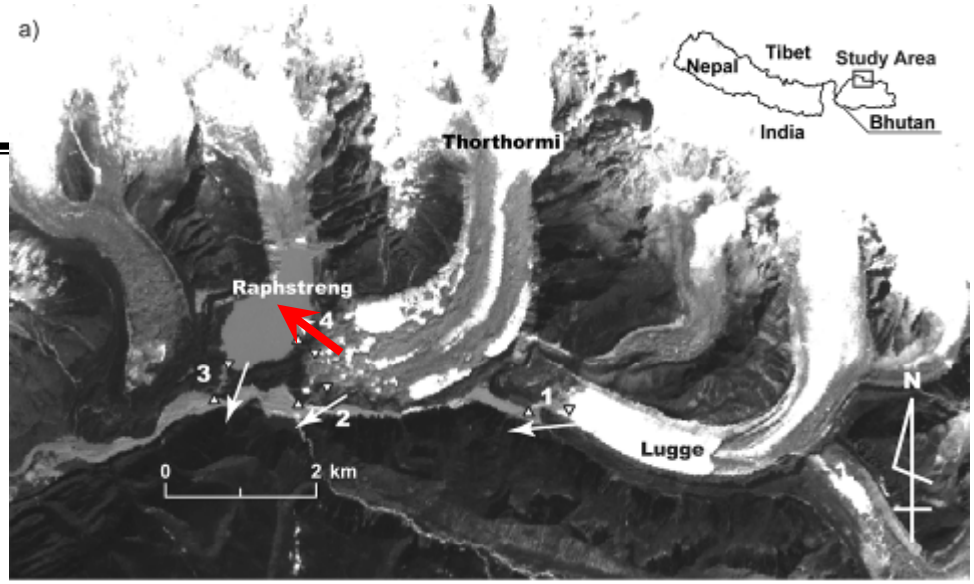
✓ Provisions of technical trainings and systems for Remote Sensing

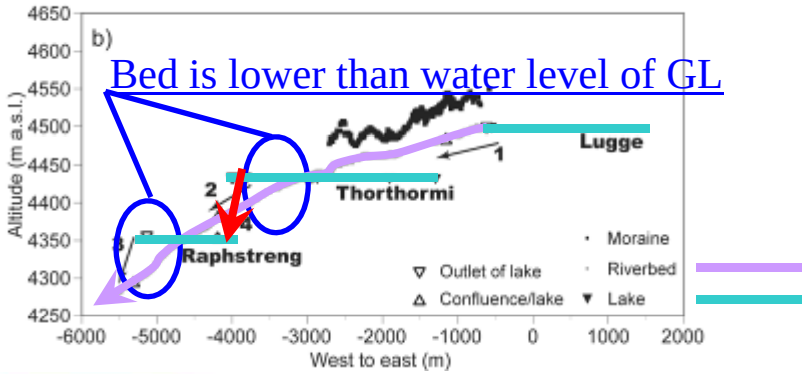
Out Products:

- Precise digital map in the entire states of Bhutan > Pan-sharpened image
- Precise digital elevation data in Bhutan > PRISM Digital Surface model (DSM) mosaic
- ALOS-based Glacial lake inventory
- Analysis results of glacial lake expansion history
- Trainings / OJT on satellite data analysis as technology transfer

客観的な“危険度評価”

- ✓ 湖面の高さと河床の高さ
- ✓ モレーンダム堤体の厚さと斜面勾配
- ✓ 現地調査にもとづく堤体の強さ



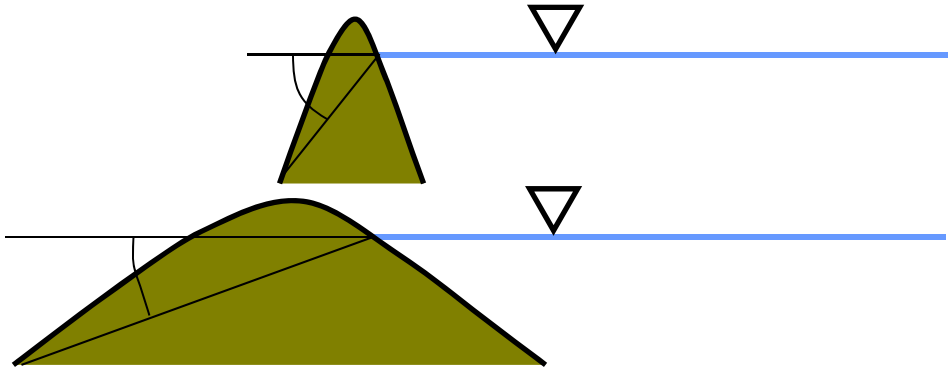


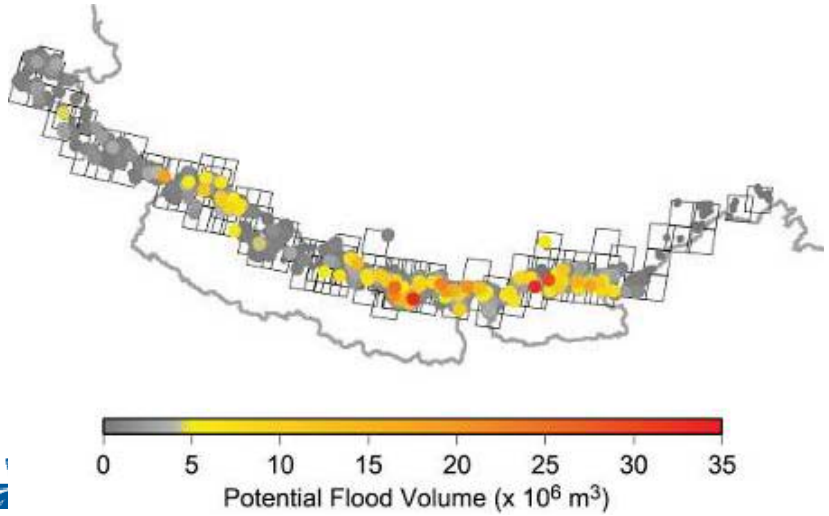
Fujita et al., 2008

客観的な“危険度評価”

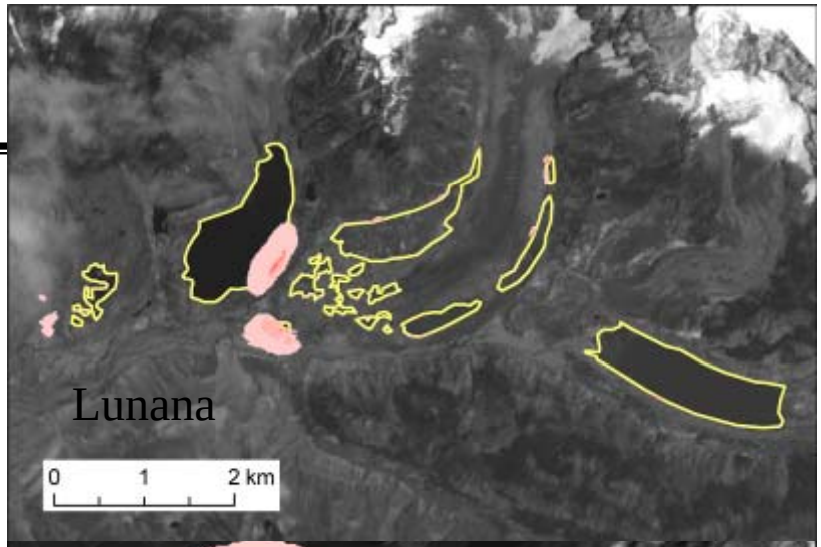
Fujita et al., 2008, 2012

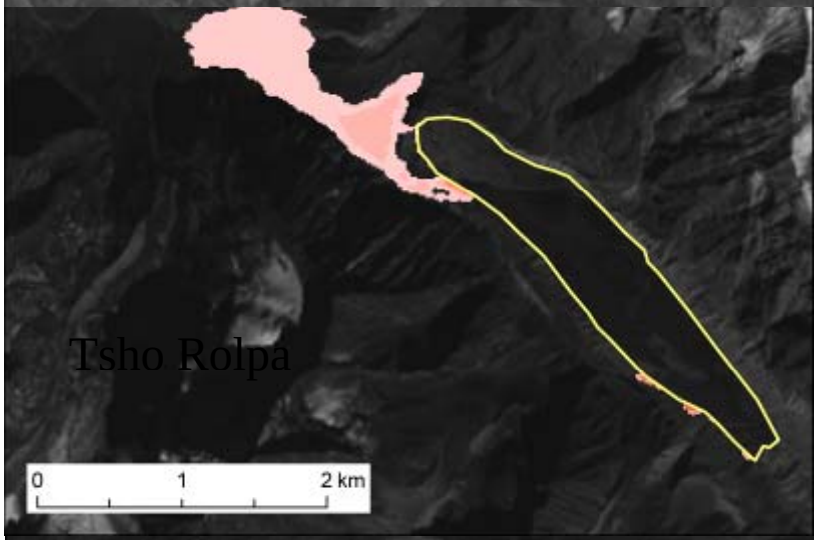
- ✓ 湖面の高さから堤体端部の角度を指標
  - -10度以下と仮設定
- ✓ 高分解能の地形情報(DEM)が必要
- ✓ 過去GLOF発生前の地形情報で検証

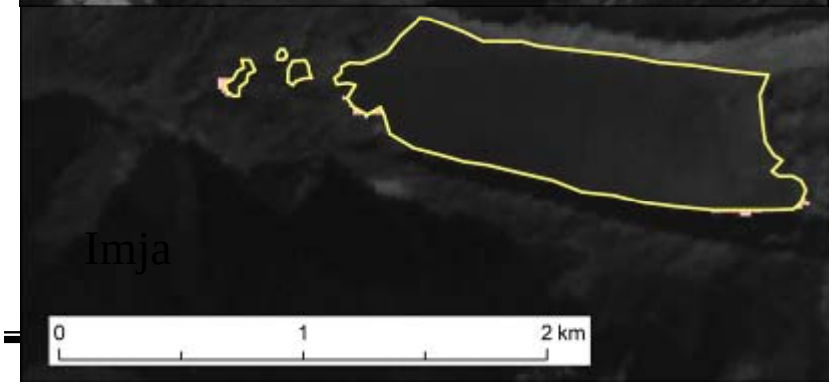




ヒマラヤの氷河湖(2400)について推定された潜在的洪水水量







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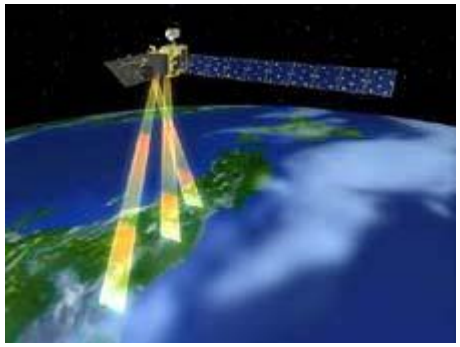
陸域観測技術衛星ALOS 'Daichi'

- **Operation:**
  - 24 Jan. 2006 by H-2A Rocket #8
  - **12 May 2011 Mission ended**
    - ~22 Apr. 2011: Low Load Mode (LLM)
  - **> 1,934 days=5.3 years**
- **Objectives:**
  - Cartography (1/25,000 scale)
  - Regional environmental monitoring
  - Disaster monitoring, *etc.*

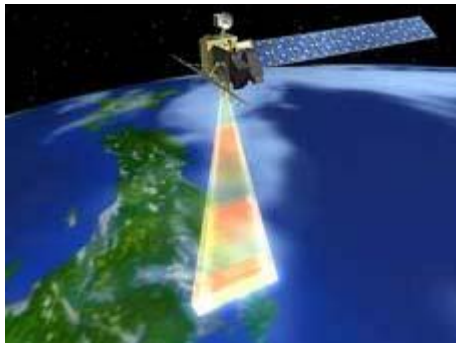
- **Instruments:**

PRISM
Panchromatic Remote sensing Instrument for Stereo Mapping



PRISM can acquire **triplet** stereo imageries by nadir-, forward, and backward-radiometers with **2.5m spatial resolution in 35km** swath.

AVNIR-2
Advanced Visible and Near-Infrared Radiometer type 2



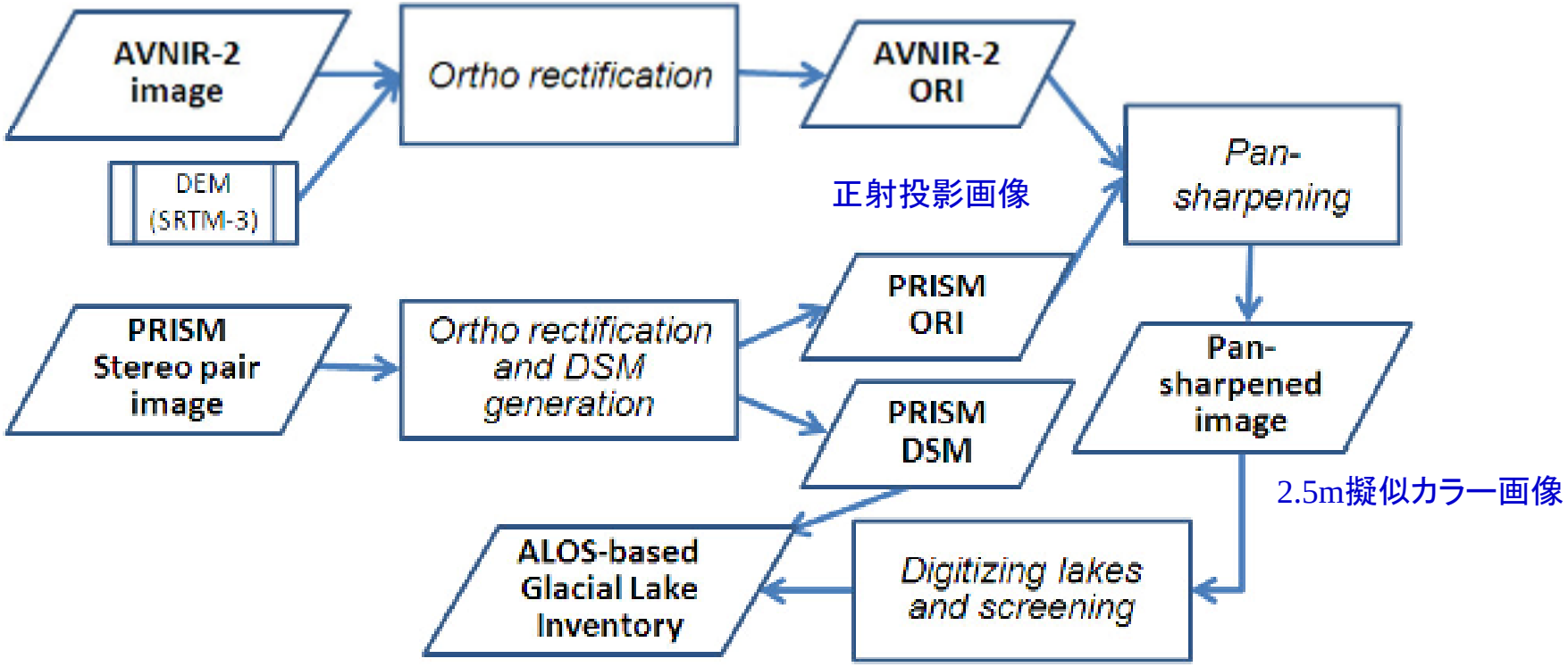
AVNIR-2 can observe with **10m resolution in 70km** swath, and it can be changed the observation area by **pointing capability** within **+/-44 deg.** in across track.

PALSAR
Phased Array type L-band Synthetic Aperture Radar

PALSAR can acquire the data in not only daytime but also nighttime as well as cloudy and rainy whether conditions.

ter

ALOSによる氷河湖インベントリの作成



ALOS PRISM/AVNIR-2による氷河湖インベントリ作成のフローチャート

過去の衛星データ処理には，ALOS PRISM DSM/ORIを基準(ベースマップ)とする

* DSM: digital surface model, 数値標高データの一種

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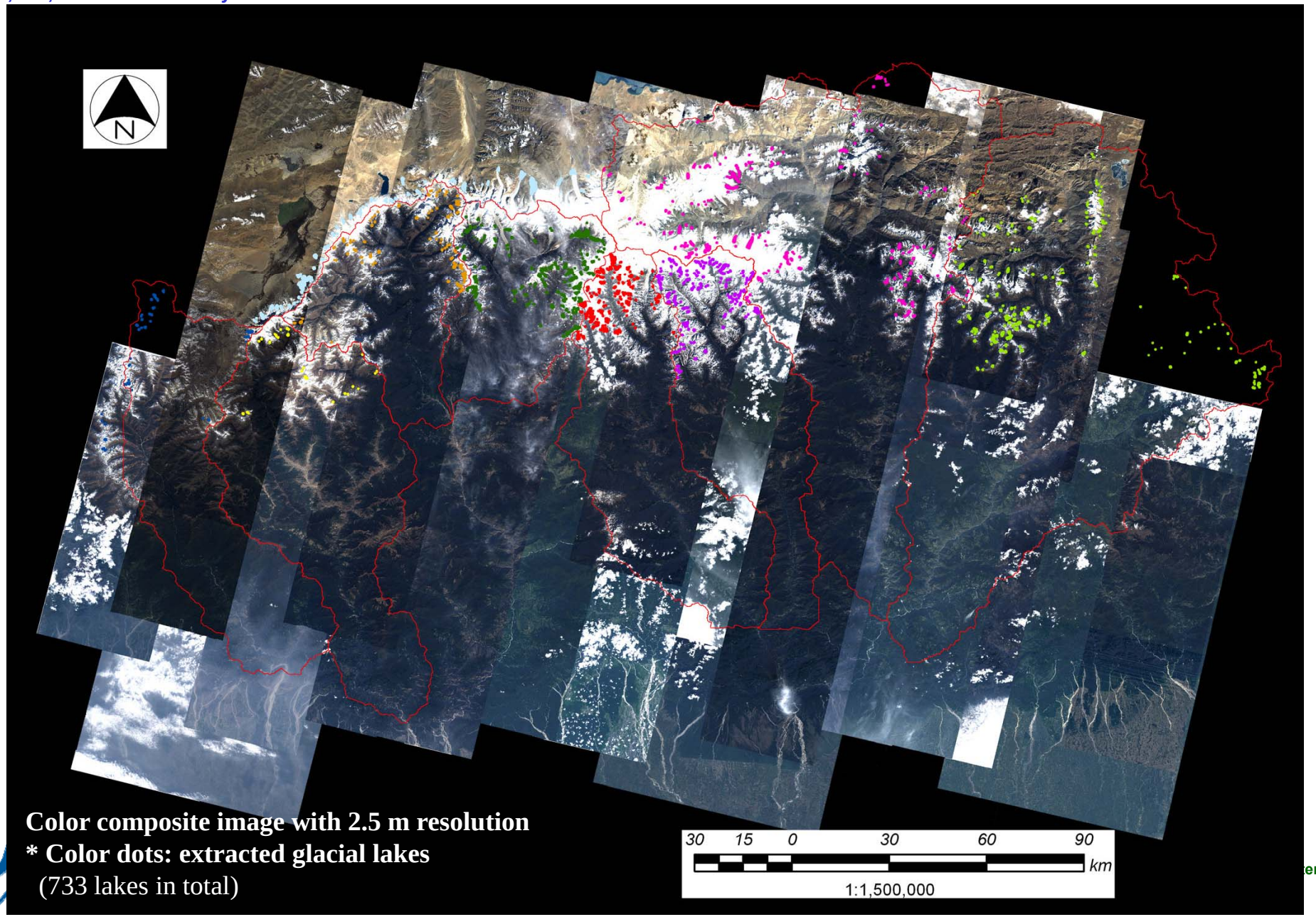
PRISM/AVNIR-2パンシャープンモザイク



Color composite image with 2.5 m resolution
*** Color dots: extracted glacial lakes**
(733 lakes in total)

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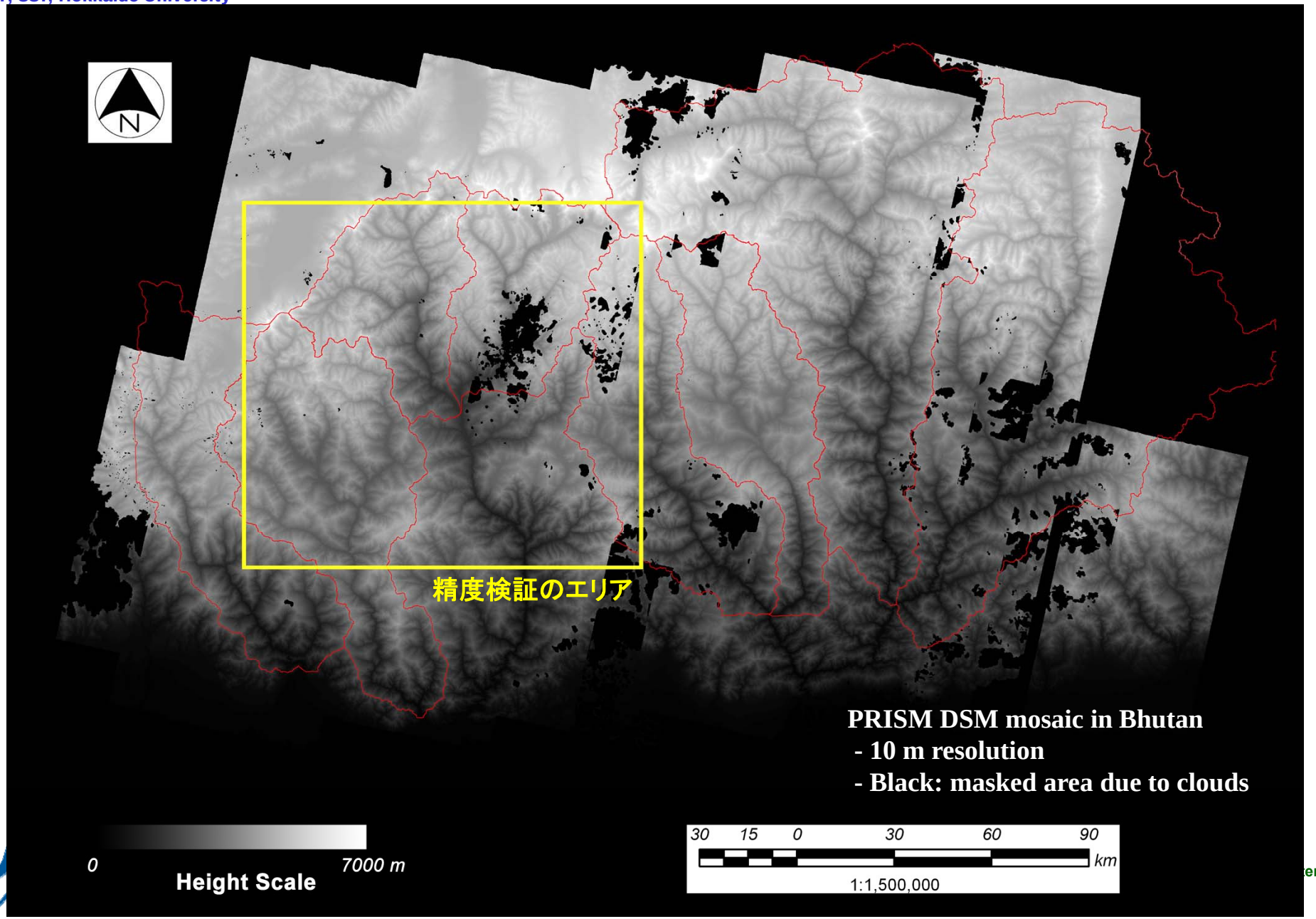
PRISM/DSMモザイク



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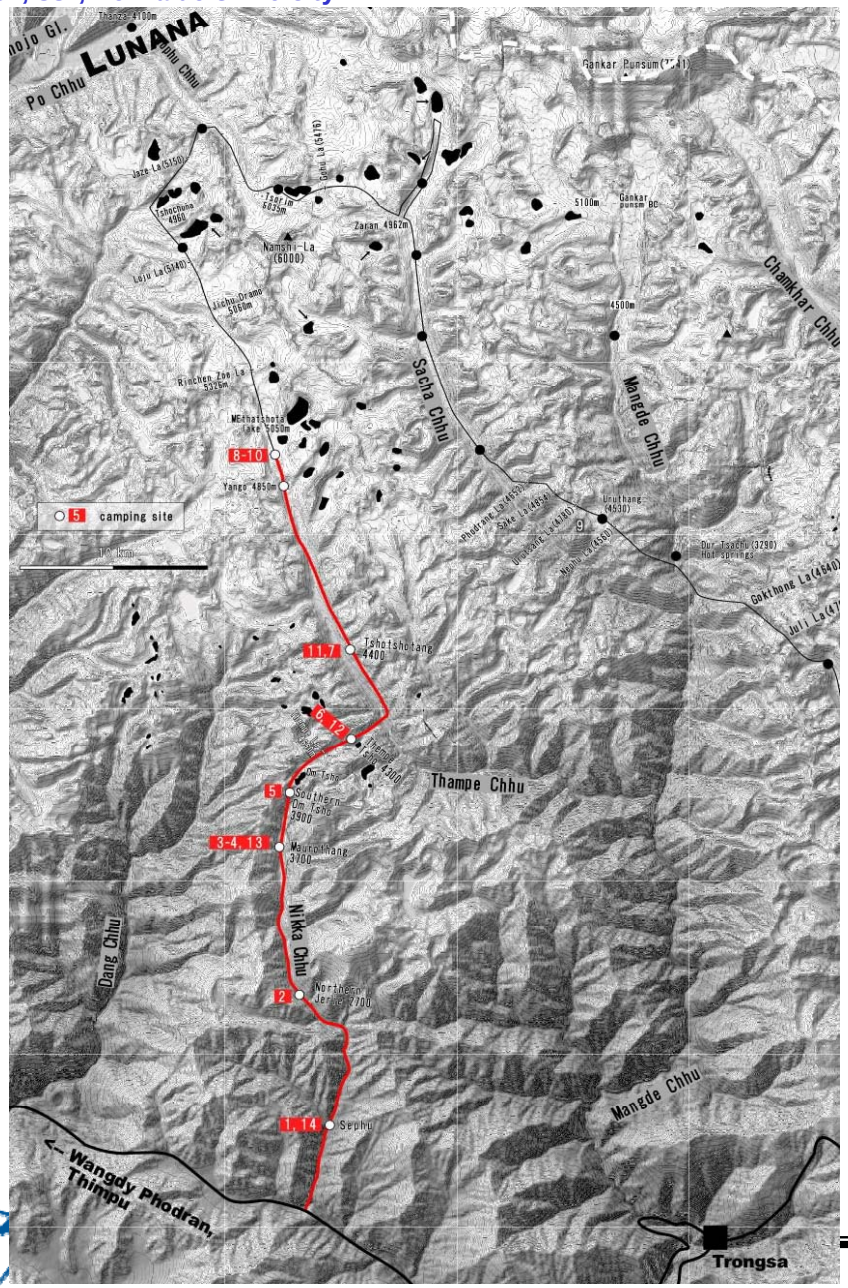
検証用データ取得のための現地調査2010



What we do?

- Ground control points (**GCP**s) for calibration : **GCP**
- Continuous **GPS** measurement for DSM validation : **GPS**
- **Surface spectral** measurement at GLs for validation : **SS**
- Ground truth (measurement) of **GL**s (and glaciers) : **GL**
- **Tree samplings** : **Tree**

Simultaneous observation with PRISM/AVNIR-2 onboard ALOS

Date	Sensor	RSP	Pointing	Where we are?
2010/10/03	PRISM	156D	+1.2 > **-1.2**	Tampe La
11:06-07(LT)	AVNIR-2	156D	0.0	Tampe La

EORC Earth Observation Research Center

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2010衛星班現地調査スケジュール (計画)

Plan of field survey in Mangde Chu upper stream by **Remote Sensing Group**

9/23(木)	-1. Japanese member (1) leave from Japan	
9/24(金)	0. AM: arrive in Thimphu, discussion and pre-orientation of field survey at DGM **GCP**	/ stay in Thimphu (EL 2,300 m)
9/25(土)	1. Preparation | Japanese member (2) leave from Japan	/ Thimphu **GCP**
9/26(日)	2. Preparation | AM: arrive in Thimphu	/ Thimphu
9/27(月)	3. Preparation, 14:30 JICA Office, 16:00- Briefing	/ Thimphu
9/28(火)	4. Leave from Thimphu (8:00 YGH, 9:00 DGM)	/ Sephu (2,300) **GCP**
9/29(水)	5. move	/ northern Jyeri (2,700) **GPS**
9/30(木)	6. move	/ Maurothang (3,700) **GPS**
10/1(金)	7. acclimatization	/ Maurothang (3,700)
10/2(土)	8. move	/ southern Om Tsho (3,900) **GPS**
10/3(日)	9. move *via.* Tampe La (4,660 m), ALOS acquisition	/ Tampe Tsho (4,650) **GL/SS**
10/4(月)	10. move	/ Tshotshotang (4,400) **GPS**
10/5(火)	11. move **GL/SS**	/ Yango or near Methatshota (4,900) **GPS**
10/6(水)	12. Survey for Methatshota	/ near Methatshota (4,900) **GL/SS**
10/7(木)	13. Survey for Methatshota	/ near Methatshota (4,900) **GL/SS**
10/8(金)	14. move	/ Tshotshotang (4,400)
10/9(土)	15. move	/ TampeTsho (4,650)
10/10(日)	16. move *via.* Tampe La (4,660 m)	/ Maurothang (3,700)
10/11(月)	17. move	/ Sephu (2,700)
10/12(火)	18. move to Thimphu	/ Thimphu (2,300)
10/13(水)	19. Debriefing of field survey | Leave (1) Ukita	/ Thimphu (2,300)
10/14(木)	20. Leave from Bhutan	
10/15(金)	21. Arrive to Japan	

- Assenting days are scheduled double of usual trekking plan until Tampe La.

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2010衛星班現地調査スケジュール (実際)

Report of field survey in Mangde Chu upper stream by **Remote Sensing Group**

9/23(木)	-1.	Japanese member (1) leave from Japan	
9/24(金)	0.	AM: arrive in Thimphu, discussion and pre-orientation of field survey at DGM **GCP**	/ stay in Thimphu (EL 2,300 m)
9/25(土)	1.	Preparation | Japanese member (2) leave from Japan	/ Thimphu **GCP**
9/26(日)	2.	Preparation | AM: arrive in Thimphu	/ Thimphu
9/27(月)	3.	Preparation, 9:30 Briefing,14:30 JICA Office	/ Thimphu
9/28(火)	4.	Leave from Thimphu (8:00 YGH, 9:00 DGM)	/ Sephu (2,650) **GCP**
9/29(水)	5.	move	/ Jyeri (3,230) **GPS, GCP**
9/30(木)	6.	move	/ Northern Maurothang (3,520) **GPS**
10/1(金)	7.	move	/ Southern Om Tsho (3,800) **Tree**
10/2(土)	8.	Stay	/ Southern Om Tsho (3,800) **GPS, Tree**
10/3(日)	9.	Stay, ALOS acquisition	/ Southern Om Tsho (3,800) **SS**
10/4(月)	10.	2 Japanese went down, move *via.* Tampe La (4,660 m)	/ Tampe Tsho (4,200) **GPS**
10/5(火)	11.	Stay **SS**	/ Tampe Tsho (4,200)
10/6(水)	12.	Other member went down	/ Maurothang (3,520)
10/7(木)	13.	move	/ Sephu (2,650)
10/8(金)	14.	Move to Thimphu, 18:00- Meeting@DGM	/ Thimphu
10/9(土)	15.	3 Japanese member left from Bhutan | Packing	/ Thimphu
10/10(日)	16.	Reporting	/ Thimphu
10/11(月)	17.	2 Japanese member left from Bhutan	
10/12(火)	18.	Arrive to Japan	
10/13(水)	19.	(Debriefing of field survey)	

Blue colored characters show modified from the original schedule.

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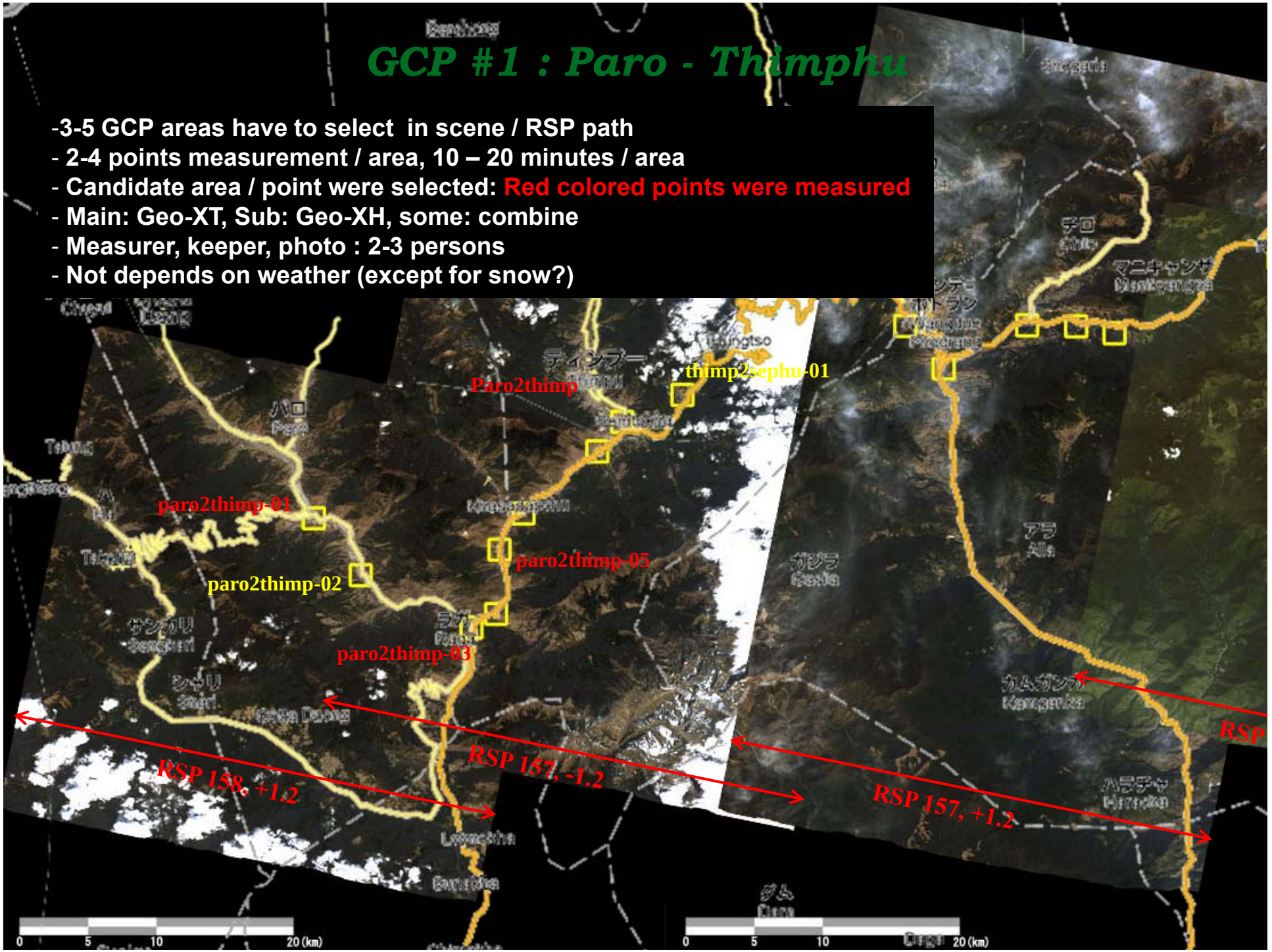
2010衛星班現地調査スケジュール (結果)

- **Unfortunately, we could not reach to Methatshota**
  - The horses could not go down a slope from Tempe Tsho to Tshotshotang
    - It will be possible to go up it > Main Team will be passed
    - We had to only select to back
    - It seems to be logistic problems (we have questions to the agent as well as JICA), therefore we hope that they should be clarified for the feature
  - Even so, the objective have been **achieved ~70%** in the field survey
  - All member could be back **safety**

> We tried to go to 2nd field survey on May, 2011

GCP #1 : Paro - Thimphu

-3-5 GCP areas have to select in scene / RSP path
- 2-4 points measurement / area, 10 – 20 minutes / area
- Candidate area / point were selected: Red colored points were measured
- Main: Geo-XT, Sub: Geo-XH, some: combine
- Measurer, keeper, photo : 2-3 persons
- Not depends on weather (except for snow?)



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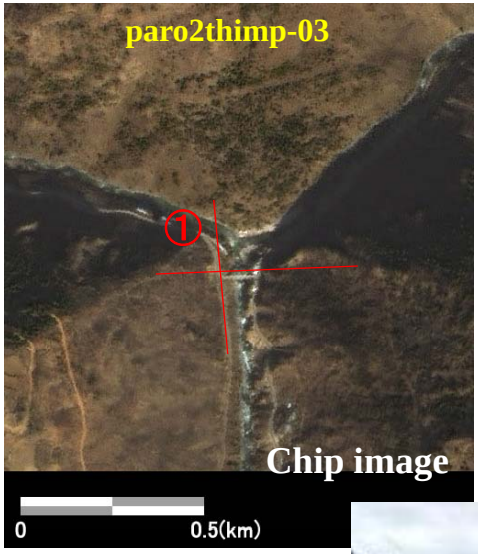
GCP #1 : Paro – Thimphu (24-25 Sep. 2010)



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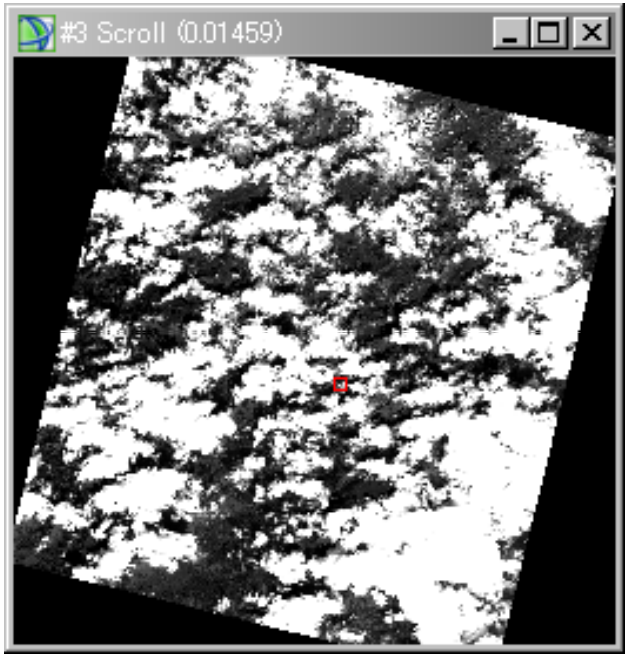
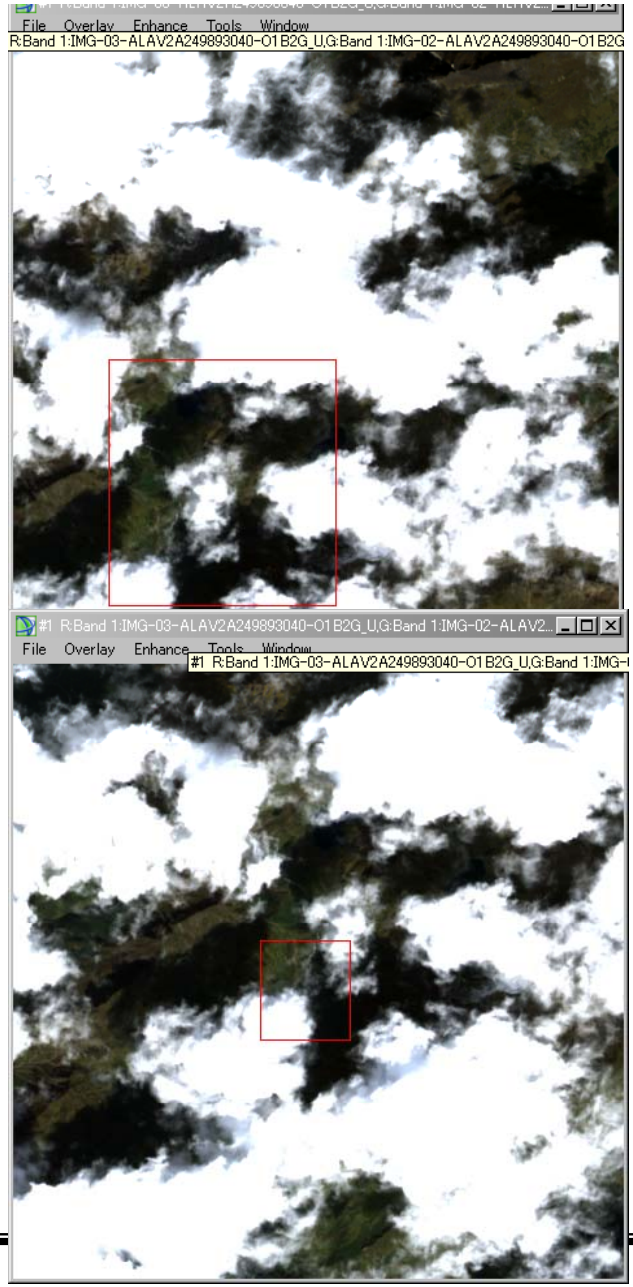
ALOSとの同期観測 (3 Oct. 2010)

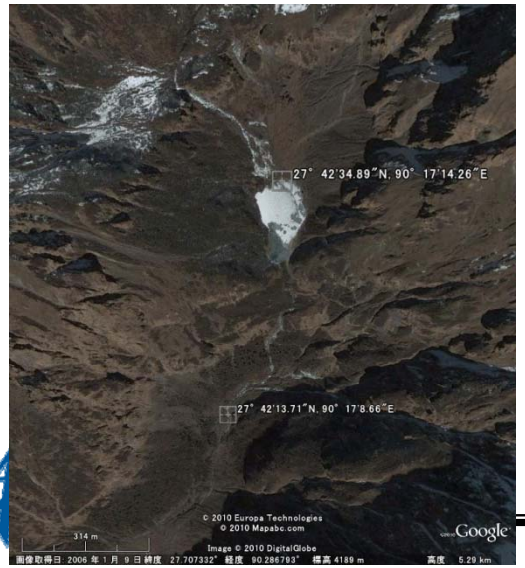
PRISM and AVNIR-2 on Oct. 3, 2010





Small Om Tsho

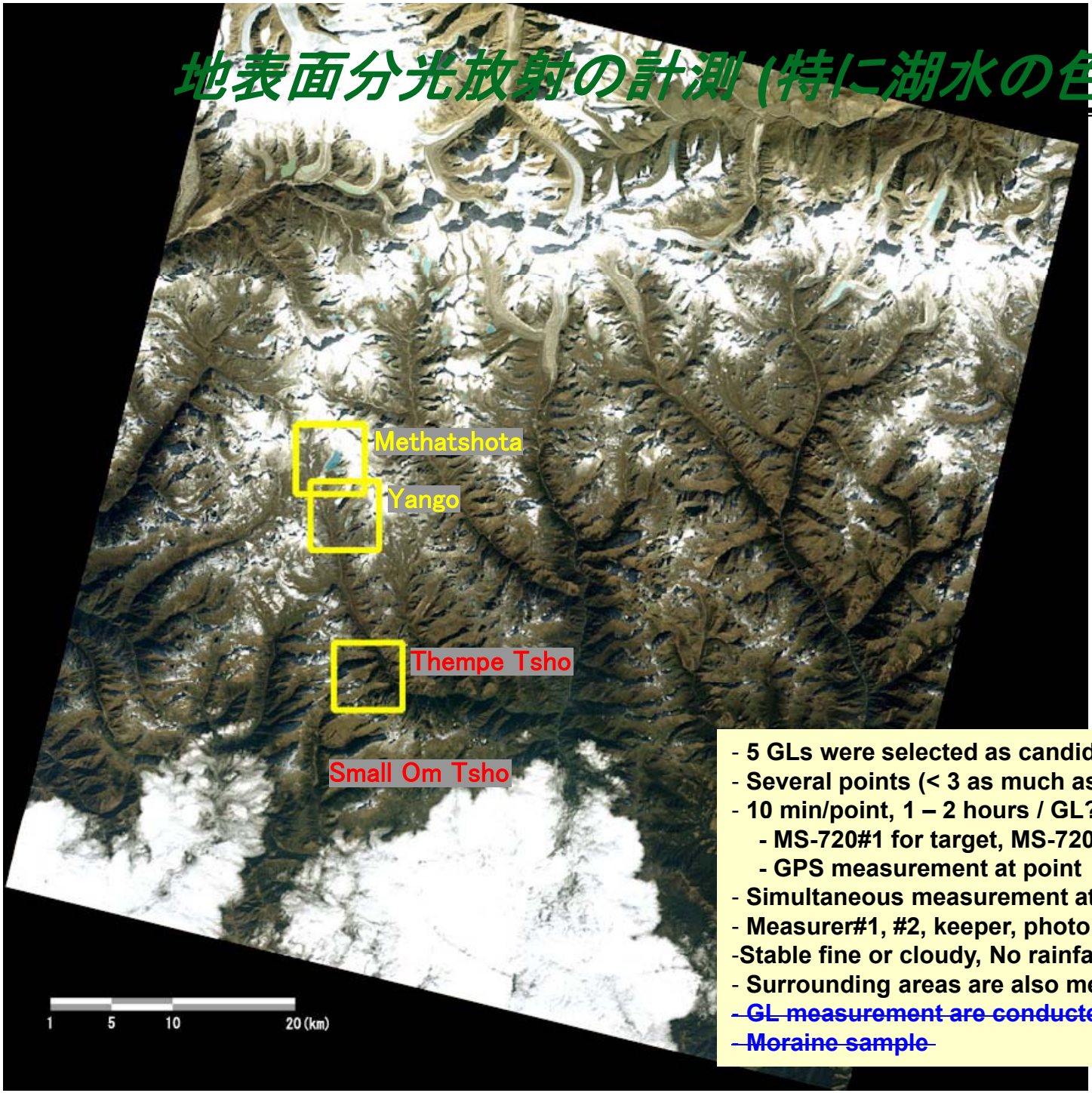
- Surface reflectance



Southern Om Tsho Camp Site

- GCP with target

地表面分光放射の計測 (特に湖水の色に着目)



- 5 GLs were selected as candidate: Two lakes were measured
- Several points (< 3 as much as possible) may select at GL
- 10 min/point, 1 – 2 hours / GL? (discussion)
  - MS-720#1 for target, MS-720#2 for whiteboard
  - GPS measurement at point
- Simultaneous measurement at Small Om Tsho on Oct. 3
- Measurer#1, #2, keeper, photo : 3-4 persons
-Stable fine or cloudy, No rainfall and snowfall
- Surrounding areas are also measured > asked to Main Team
~~- GL measurement are conducted in same time (2 persons)~~
~~- Moraine sample~~

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地表面分光放射の計測

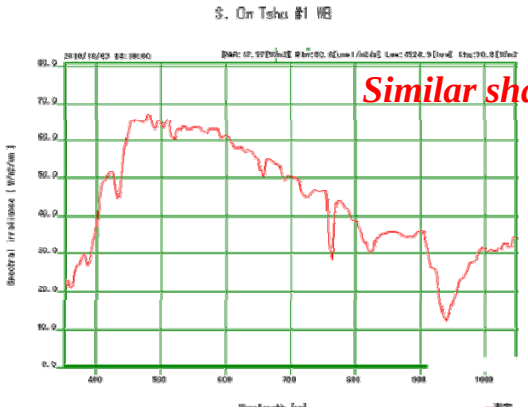
2) Target by #1, and white board by #2

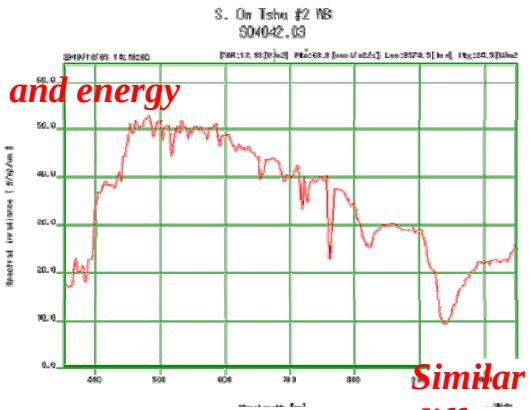
1) White board measurement by #1, #2

2010/10/03 Small Om Tsho

14:10:00 (JST), 11:10:00 (LT) >

1) WB #1 and #2



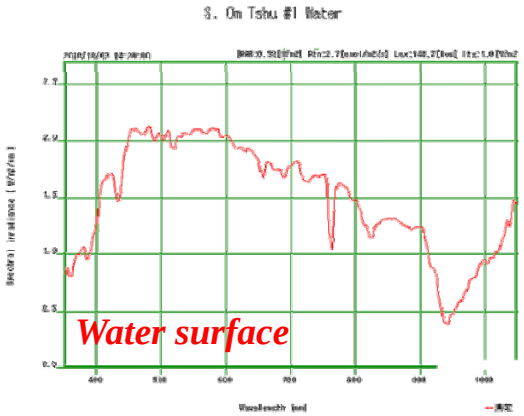


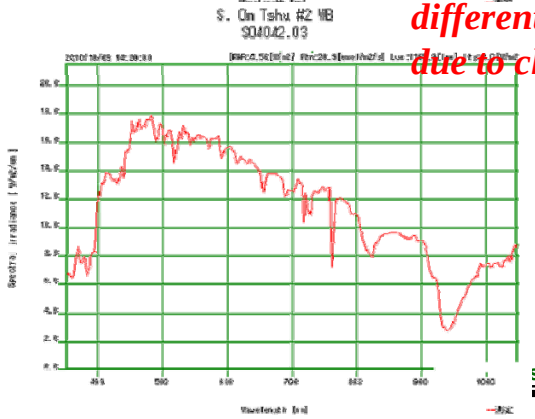
Similar shape and energy

Similar shape, different energy due to clouds

14:20:00 (JST), 11:20:00 (LT) >

2) Water #1 and WB #2





Water surface

3) Calculate surface reflectance at each time, and compare with AVNIR-2 as well as each lake

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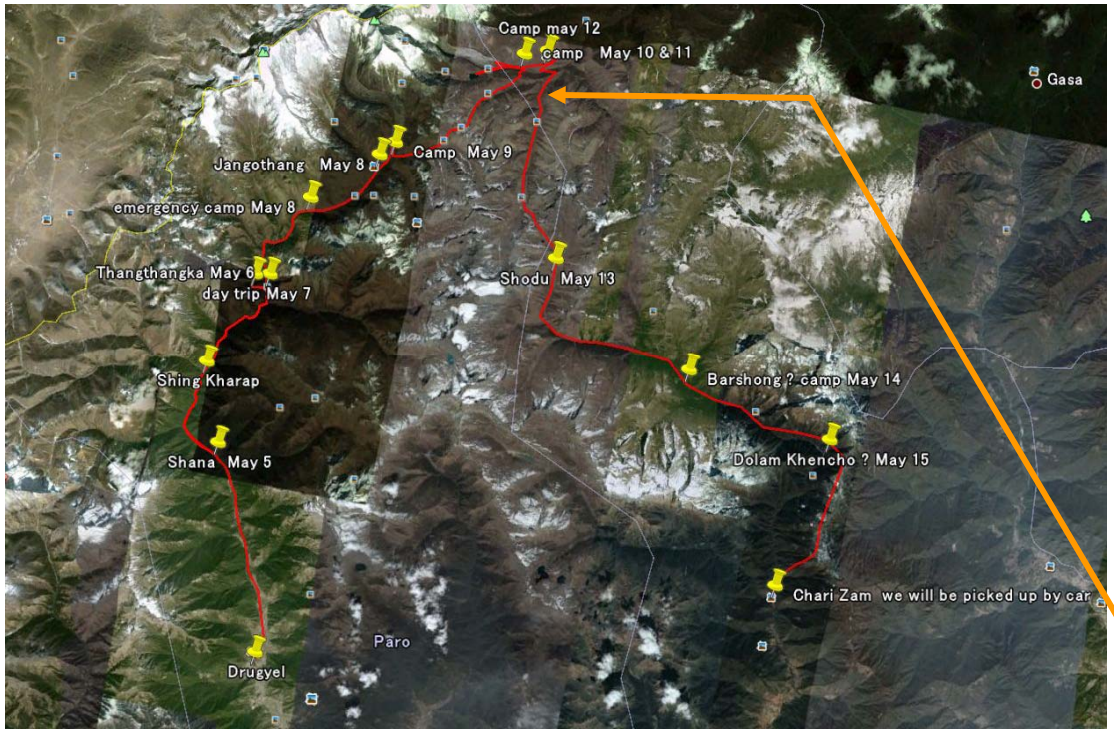
検証用データ取得のための現地調査2011



調査スケジュール

5/5	Paro -> Drugyel(2580) -> Shana(2850)
5/6	Shana -> Thangthangka (3610)
5/7	Thangthangka (walk around for acclimatization)
5/8	Jangothang (4080)
5/9	Jangothang　survey for glacier and lakes
5/10	Lingshi (4010)
5/11	Lingshi　survey for glacier and lakes
5/12	rest day
5/13	Shodu (3750)
5/14	Barshong (3720)
5/15	Dolam Kensho (3290)
5/16	Thimphu

積雪により、Lingshiより先のアクセスが不可であったため、Drugyel側へ戻るルートを取った。

ジョモラリ、リンシ氷河湖調査

【調査期間】
2011年5月5～16日

【目的】
1. 衛星画像解析結果の検証用データ取得
（GCP取得・湖水の分光放射計測）
2. 拡大する氷河湖の現況調査
（湖岸線のGPS測量など）

【参加メンバー】
日本側:
小森　次郎、 山之口　勤、 冨山　信弘
ブータン側:
Ms. Sonam Lhamo, Ms. Pema Deki, Mr.Phuntsho Tshering

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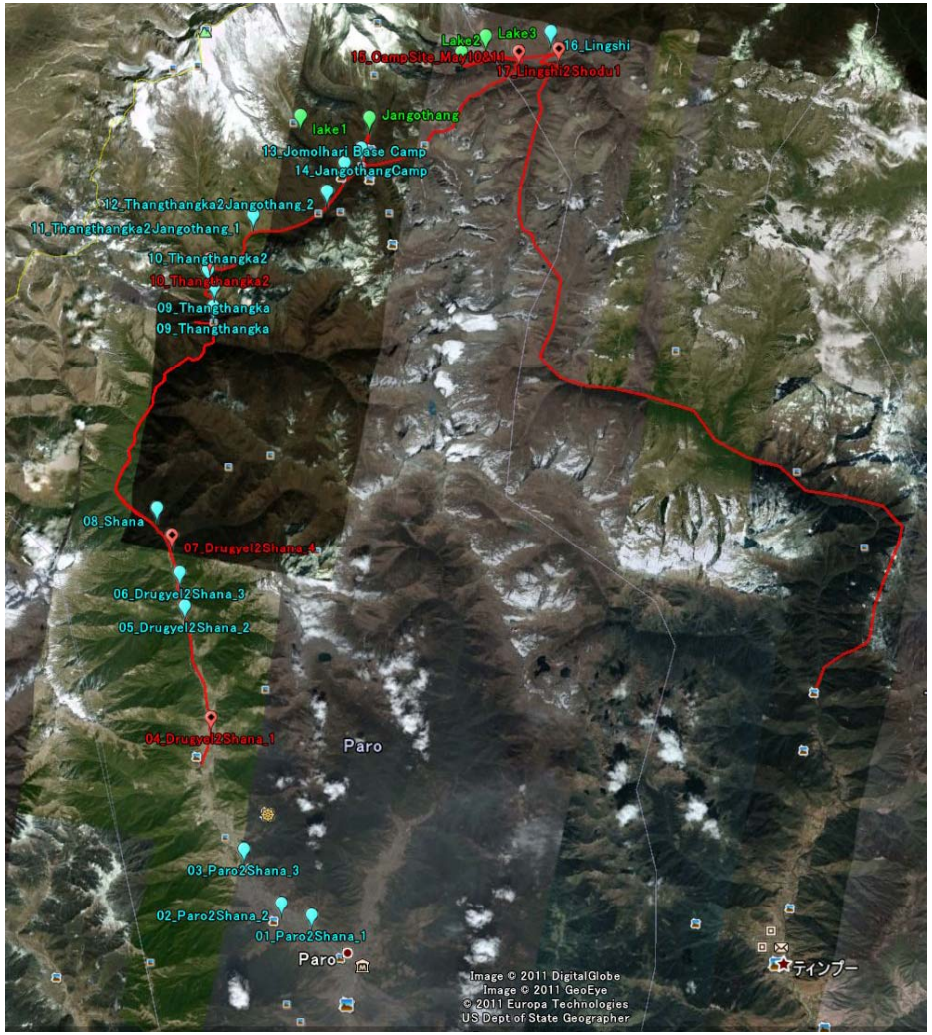
GCP計測



GCP候補
GCP候補（重点）

全GCP候補17点のうち、7点
（No.4,7,8,10,12,13,15）を取得

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湖水の分光放射計測

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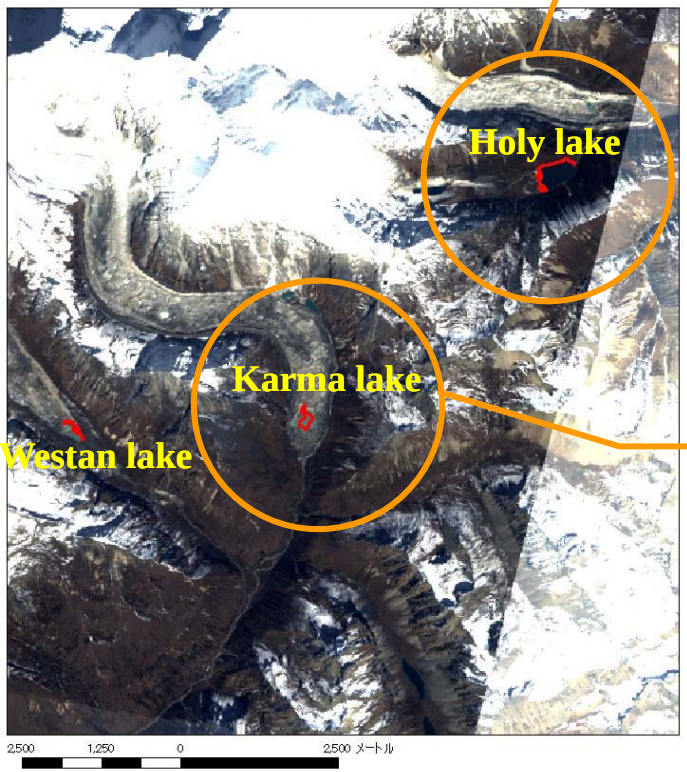
湖岸線のGPS測量



歩行による計測

決壊の痕跡？

ボートによる計測

約12mの水位低下

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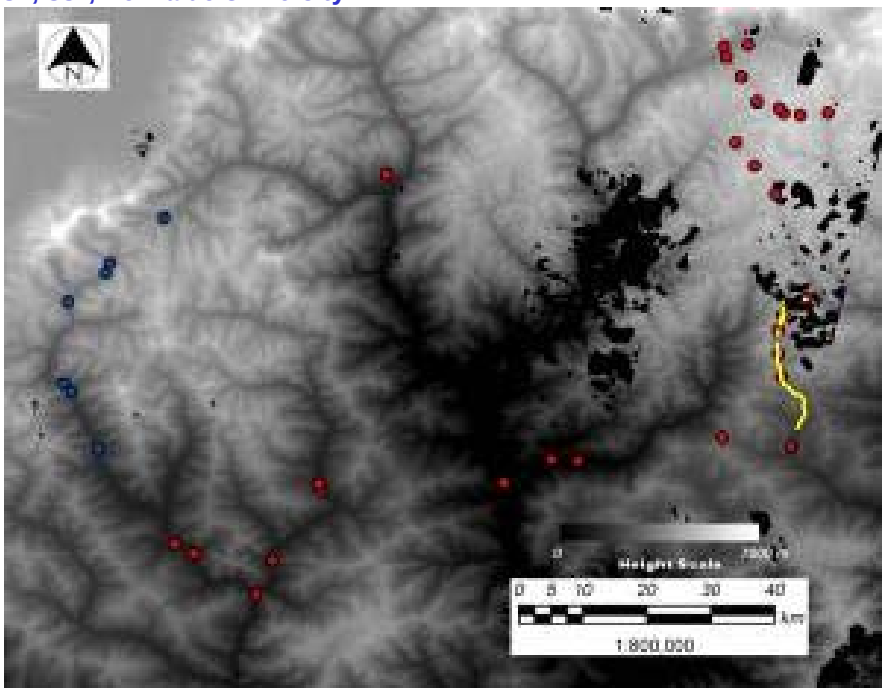
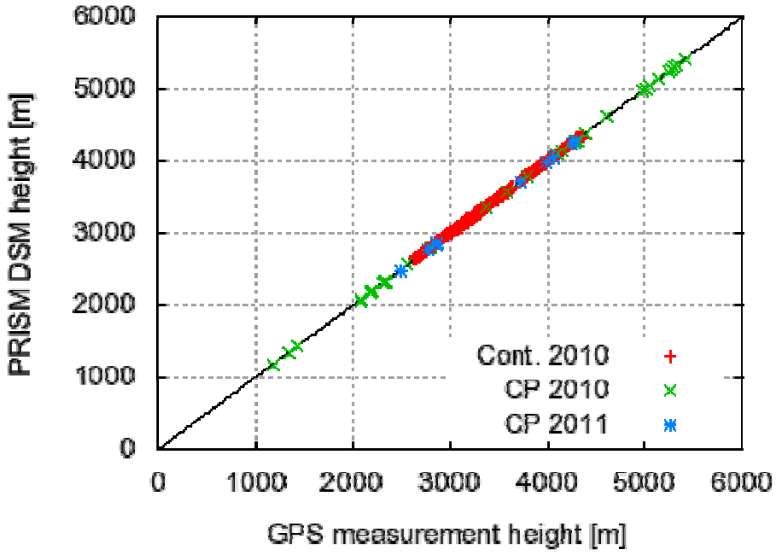
PRISM DSMモザイクの精度検証

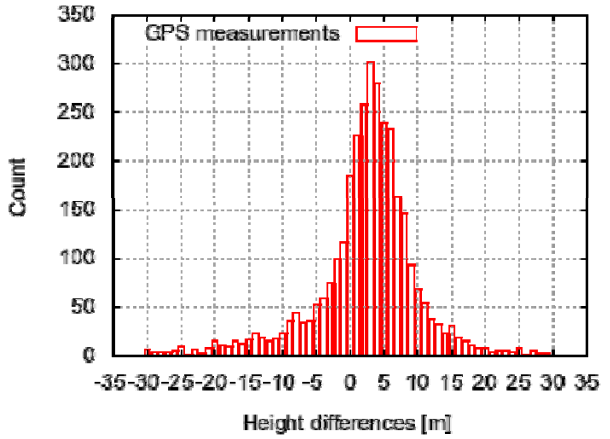


Magnified PRISM DSM mosaic and location of GPS measurements points (yellow: continuous measurement in 2010; red: CPs in 2010; and blue: CPs in 2011).

The points **within +/-30 m error**s compared with the PRISM DSM were selected due to condition and accuracy of GPS.



Comparison of height between the GPS measurements and PRISM DSM (red: continuous measurement in 2010; green: CPs in 2010; and blue: CPs in 2011).



Total: 3,268 points
Bias=2.28m, STDEV=7.79m, RMSE=8.12m

* Acknowledge to Prof. Naito, Prof. Sawagaki, Dr. Yamaguchi, Prof. Jiro Komori, and Prof. Fujita

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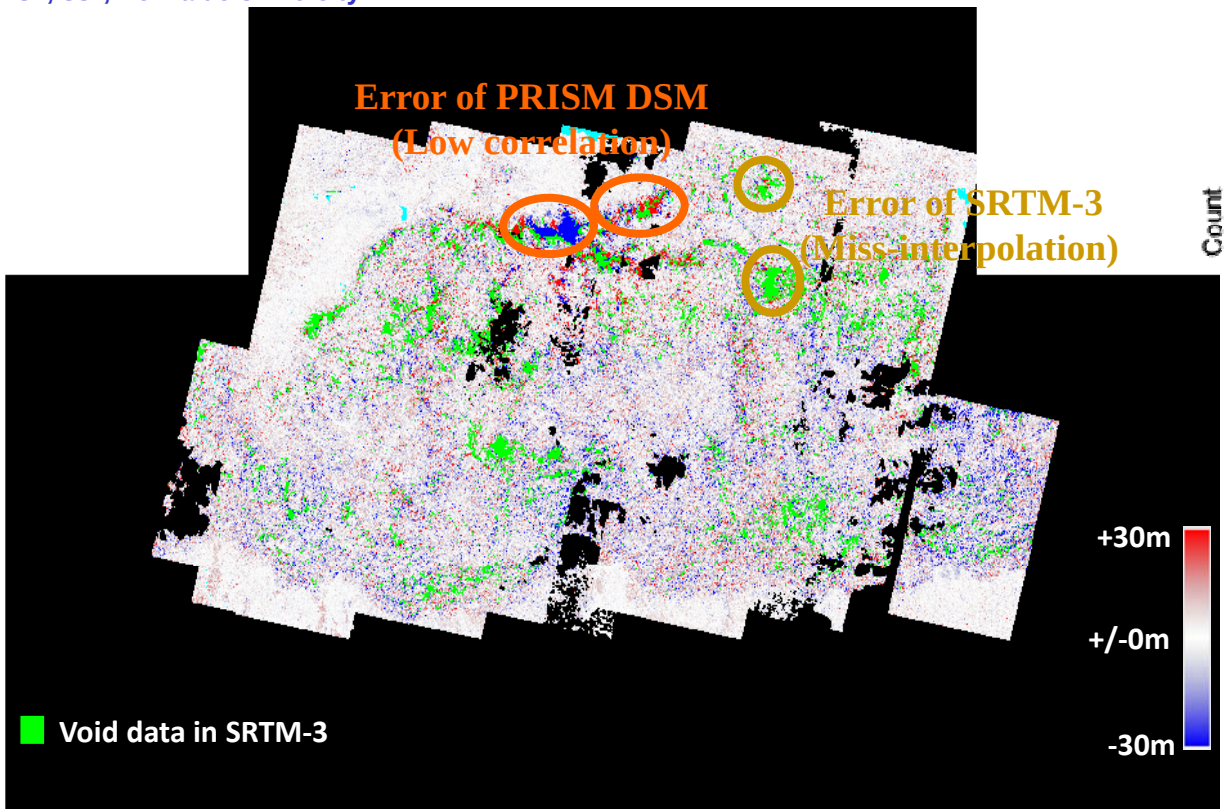
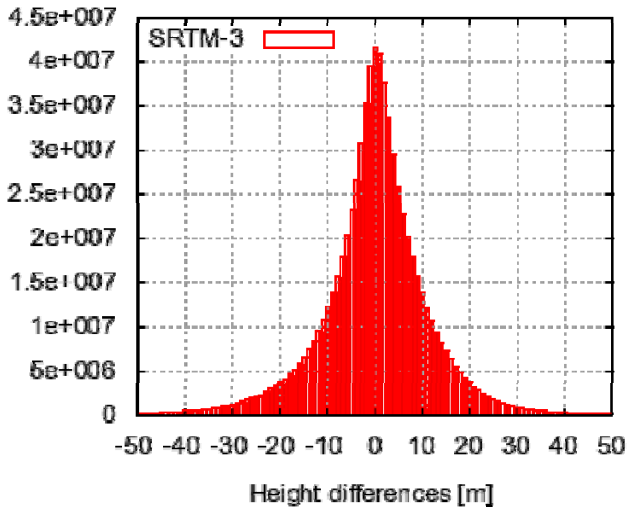
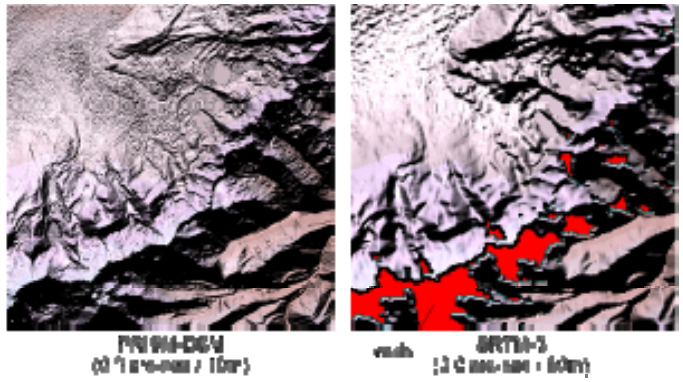
PRISM DSMモザイクの精度検証(2)



Height difference (*i.e.*, PRISM DSM minus SRTM-3) in the Bhutan Himalayas. The black colors indicate the masked areas in the PRISM DSM, while the green indicates the void data areas in SRTM-3.



Histogram of height difference between PRISM DSM and SRTM-3.



Visual comparison between PRISM DSM (left) and SRTM-3 (right).

Total: 738,107,875 points
Bias=-0.44m, STDEV=20.71m, RMSE=20.72m

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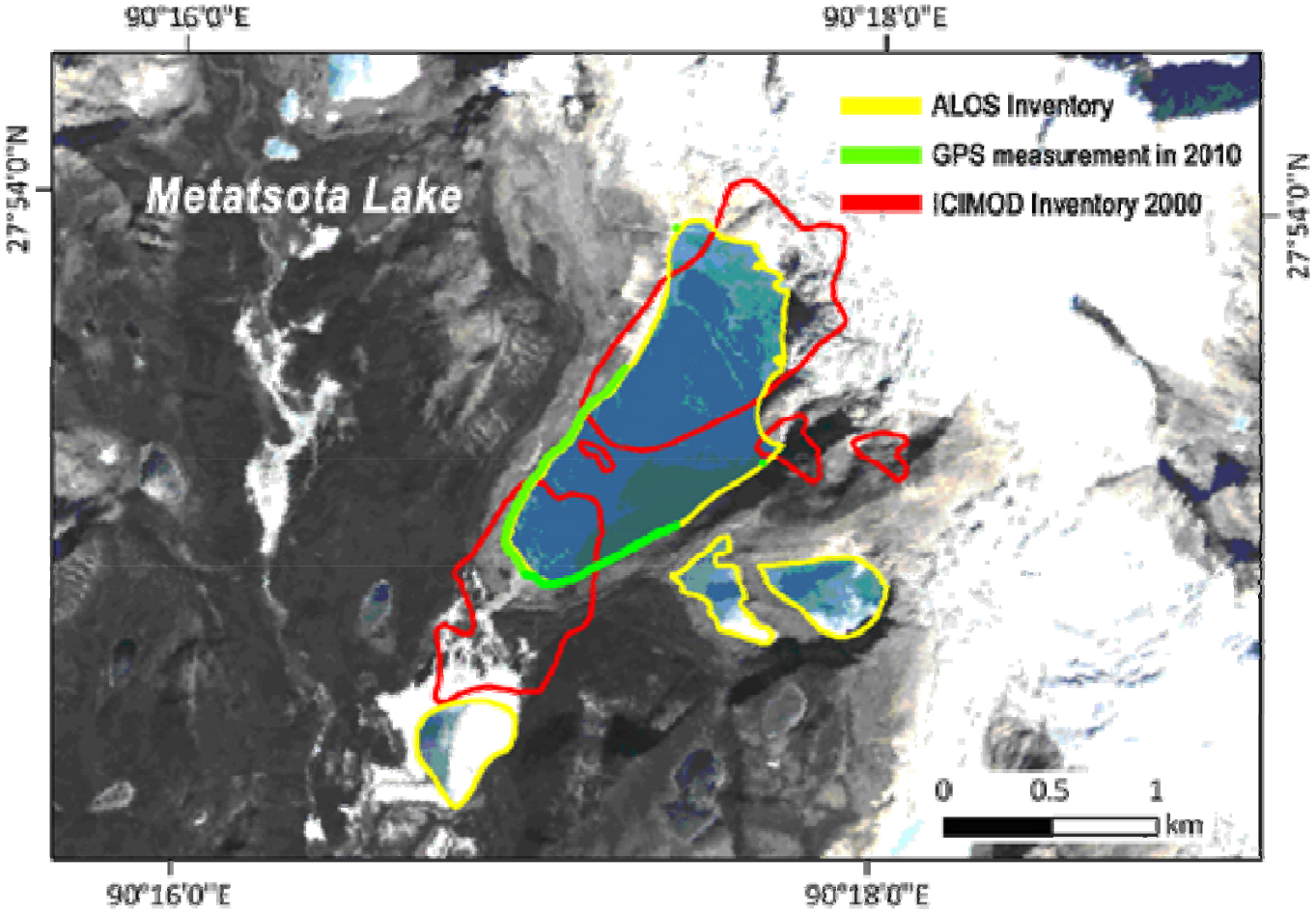
氷河湖インベントリの精度検証



Comparison of lake polygons at Metatsota glacial lake among the ALOS-based inventory (yellow) , the ground-based GPS measurements in 2010 (green), and ICIMOD inventory 2000 (red) at Metatsota lake. We confirmed that 9.5 m (averaged error), and 11.9m (RMSE) accuracy of the ALOS-based inventory compared with the GPS measurement.

References: Ukita *et al.* (2011) Annals of Glaciology, 52(58), pp.65-71 2011;
Tadono *et al.* (2012) Bhutan Geology, in press?

* Acknowledge to Prof. Naito, Prof. Sawagaki, Dr. Yamaguchi, and Prof. Komori

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氷河湖インベントリの精度検証(2)

The western lake
- Good geolocation
- Similar shapes

Karma lake
- Good geolocation
- Larger shapes
  > Seasonal change
  > Careful in expansion history

Comparison of polygons between the ALOS-based inventory (yellow) and the ground-based GPS measurements (green) at two lakes in 2011.

Reference: Tadono *et al.* (2012) Global Environmental Research, in press

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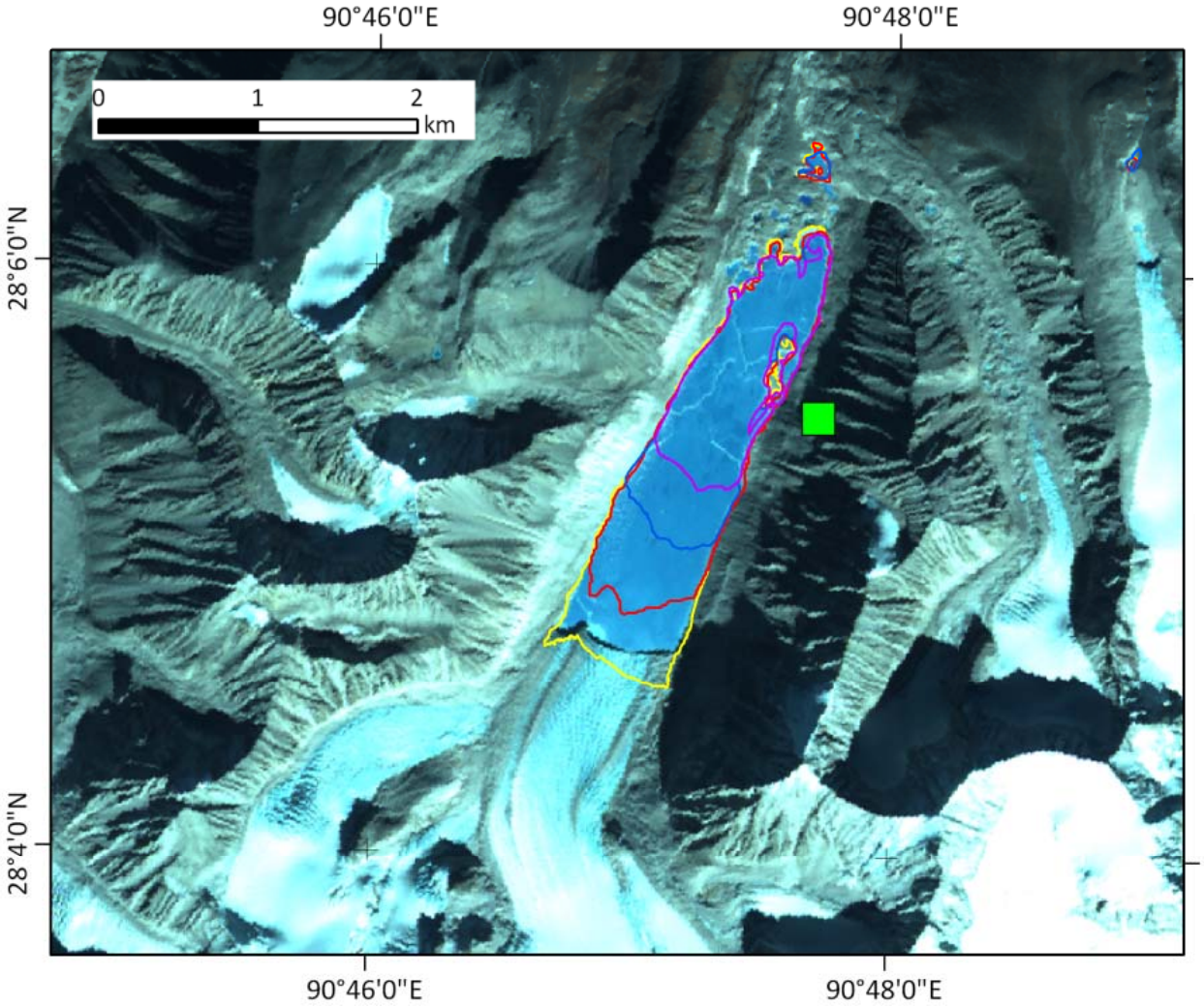
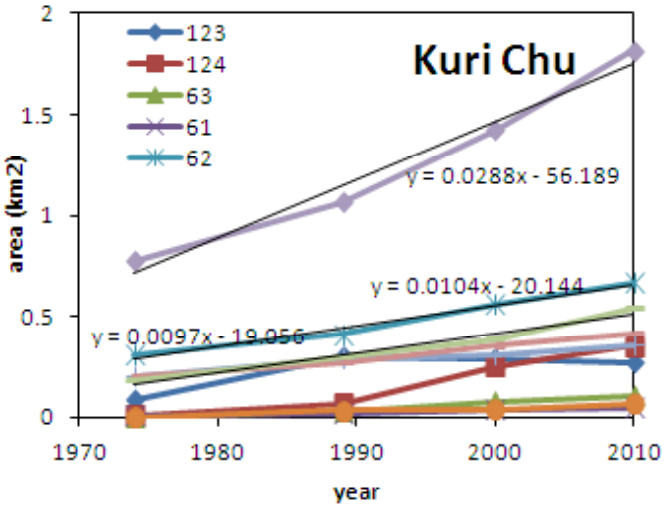
氷河湖拡大履歴の解析





Historical satellite data
- Hexagon (1974, purple)
- SPOT (1989, blue)
- Landsat-7/ETM+ (2000, red)
- ALOS (2011, yellow)

Example of analysis of glacial lake expansion history using multi temporal satellite images in Kuri Chu. The color polygons show extracted lake areas in individual image, and time trend of area changes (right).

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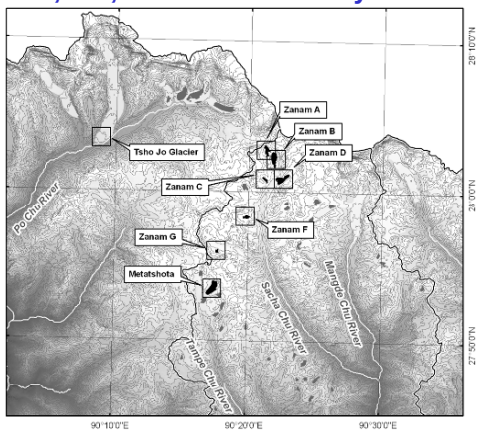
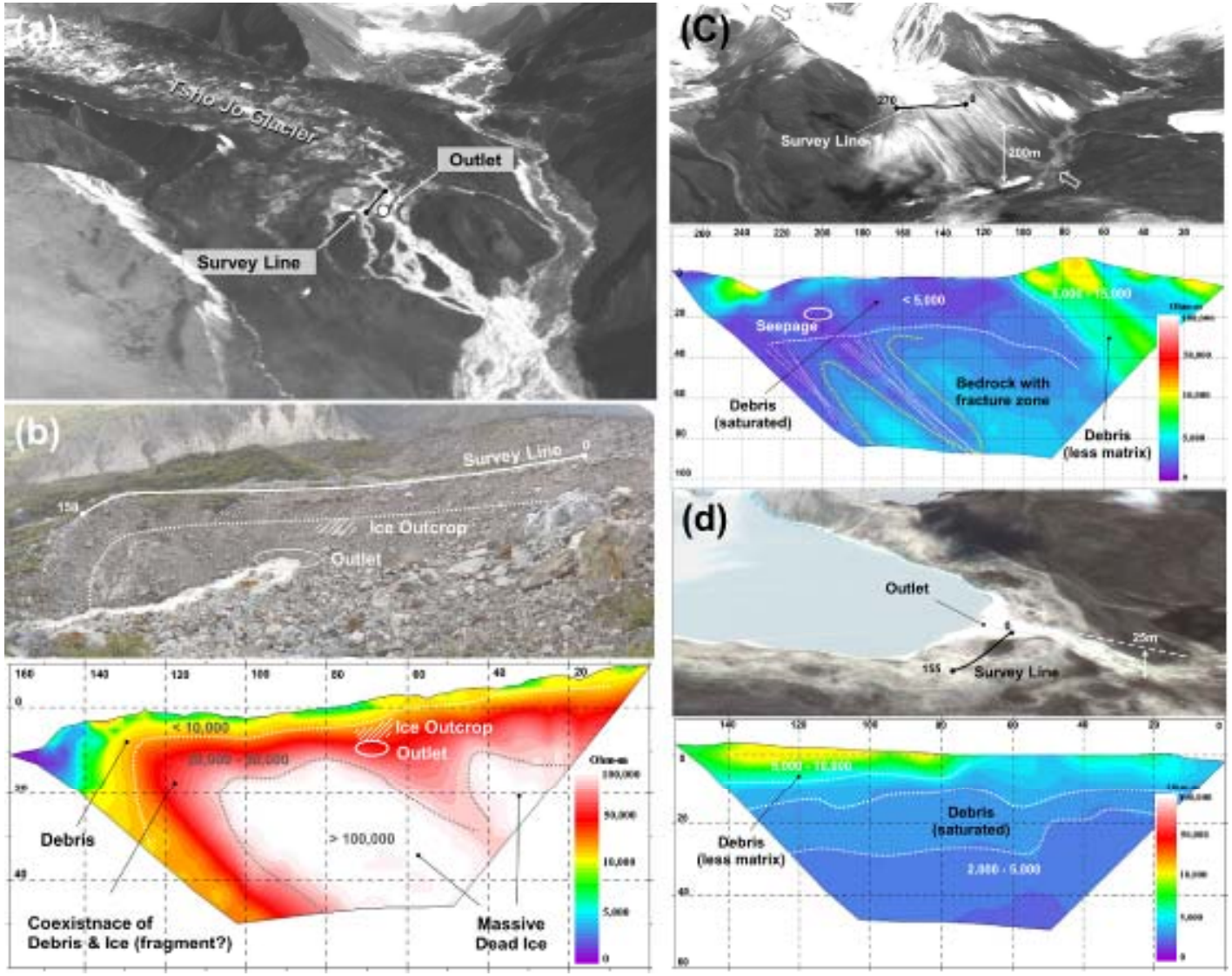
モレーンダムの堤体：物理探査





対象氷河湖における物理探査結果(Ohashi et al., 2012)
(a)ツォジョ氷河鳥瞰図, (b)ツォジョ氷河, (c)ザナムC湖, (d)メタツォタ湖

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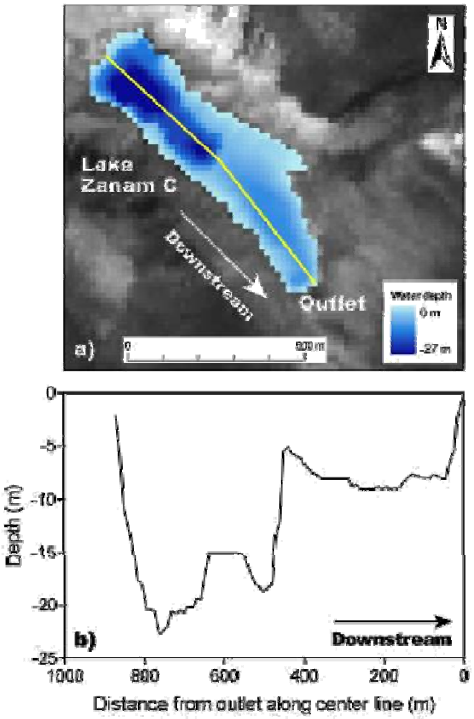
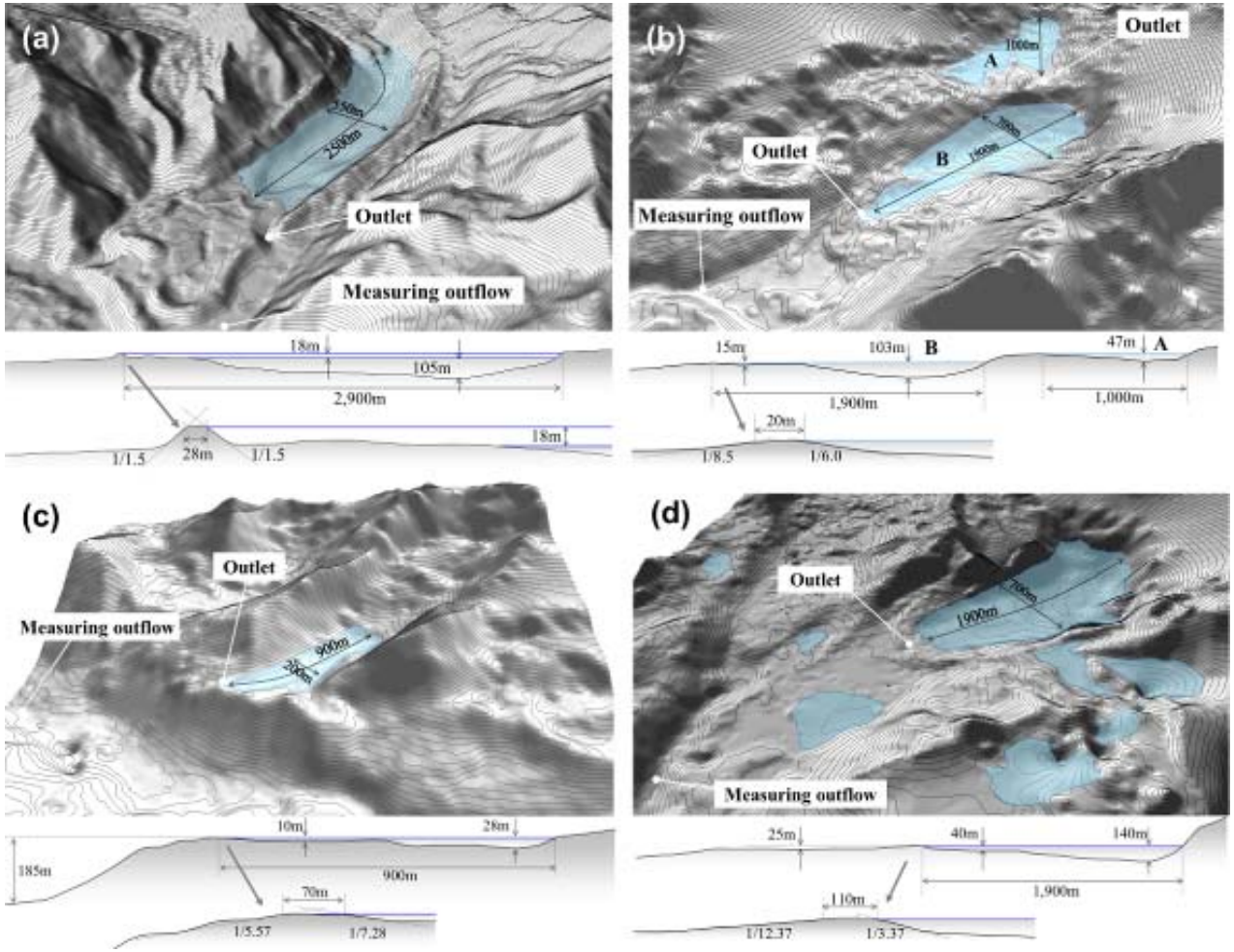
氷河湖の湖盆図作成と水量推定



ザナムCの湖盆図
b)は中央線沿い(a図中の黄色線)の水深分布(Fujita et al., 2012)



各対象氷河湖外観および断面（Koike & Takenaka, 2012）
(a)ルゲ湖, (b)ザナムB湖, (c)ザナムC湖, (d)メタツォタ湖

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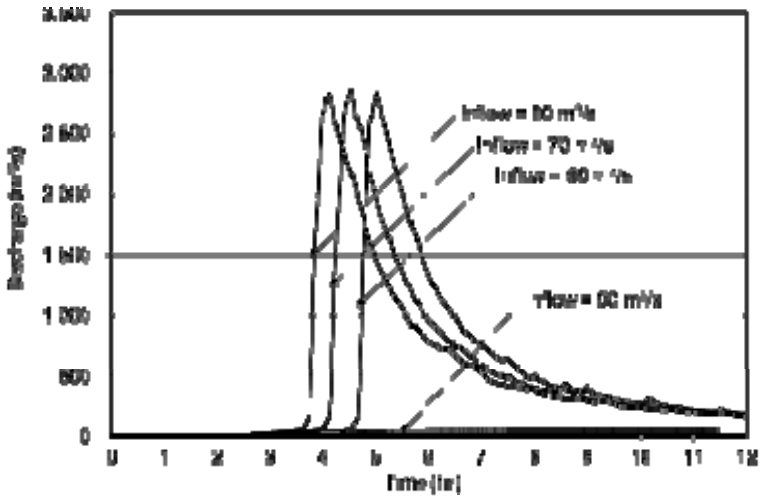
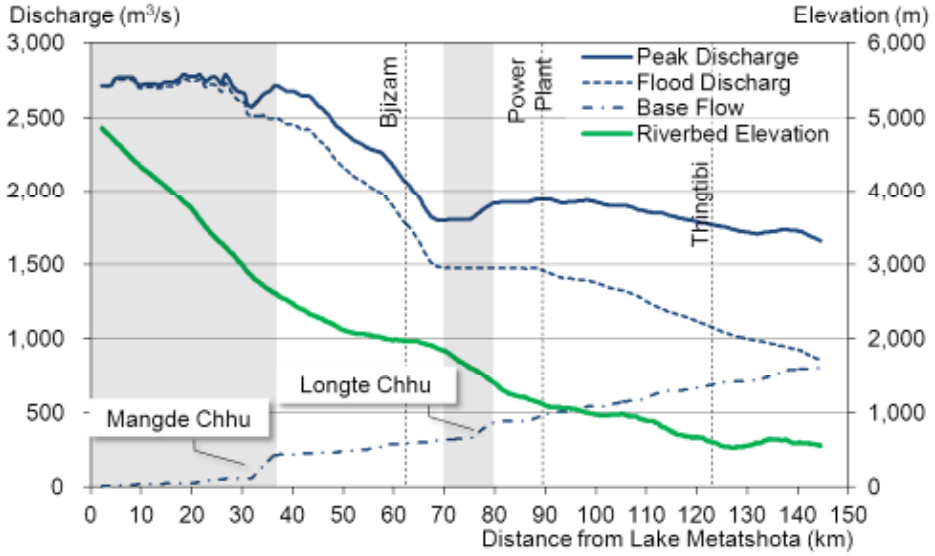
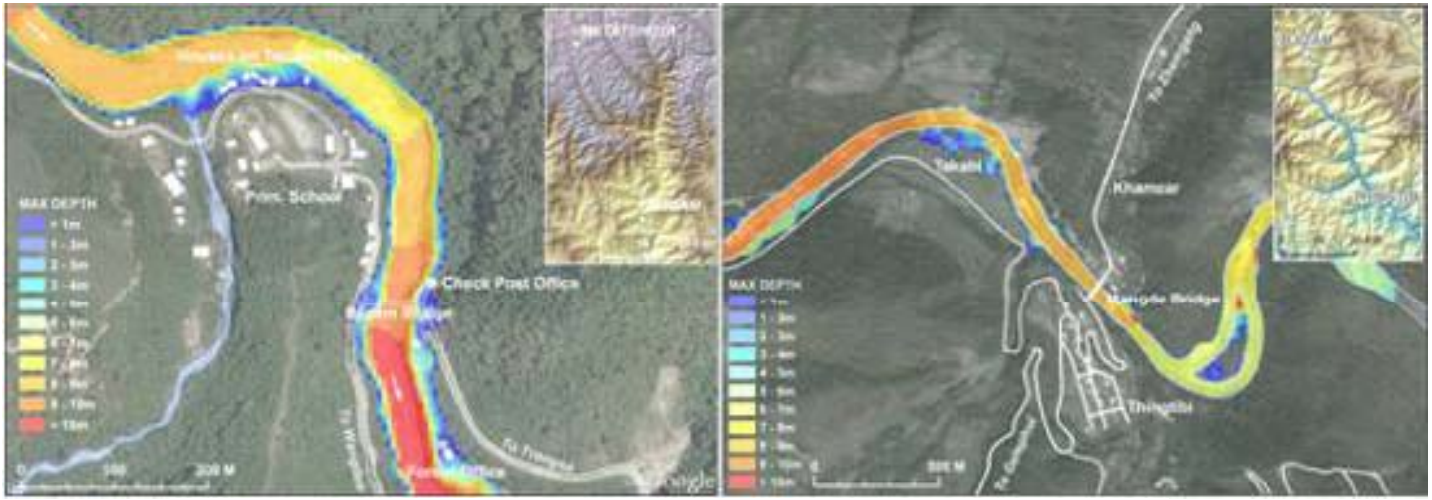
洪水シミュレーションとハザードマップ作成



メタツォタ湖の決壊ハイドログラフ



メタツォタ湖からの距離とピーク流量との関係



メタツォタ湖決壊洪水を想定した場合のジーザム村, ティンティビ村における浸水予測図 (Koike and Takenaka, 2012)

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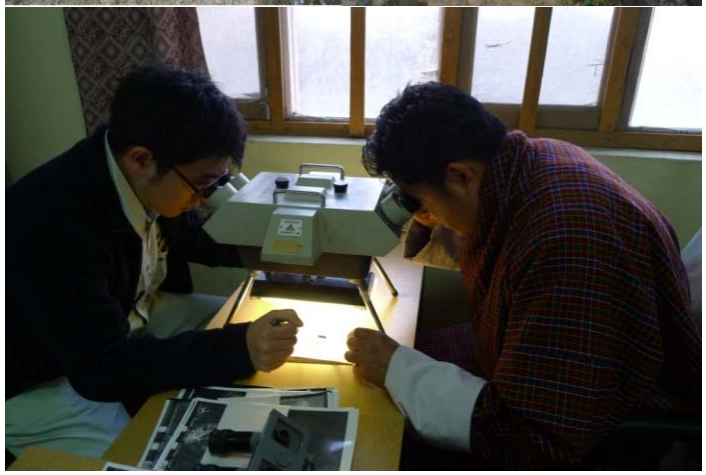
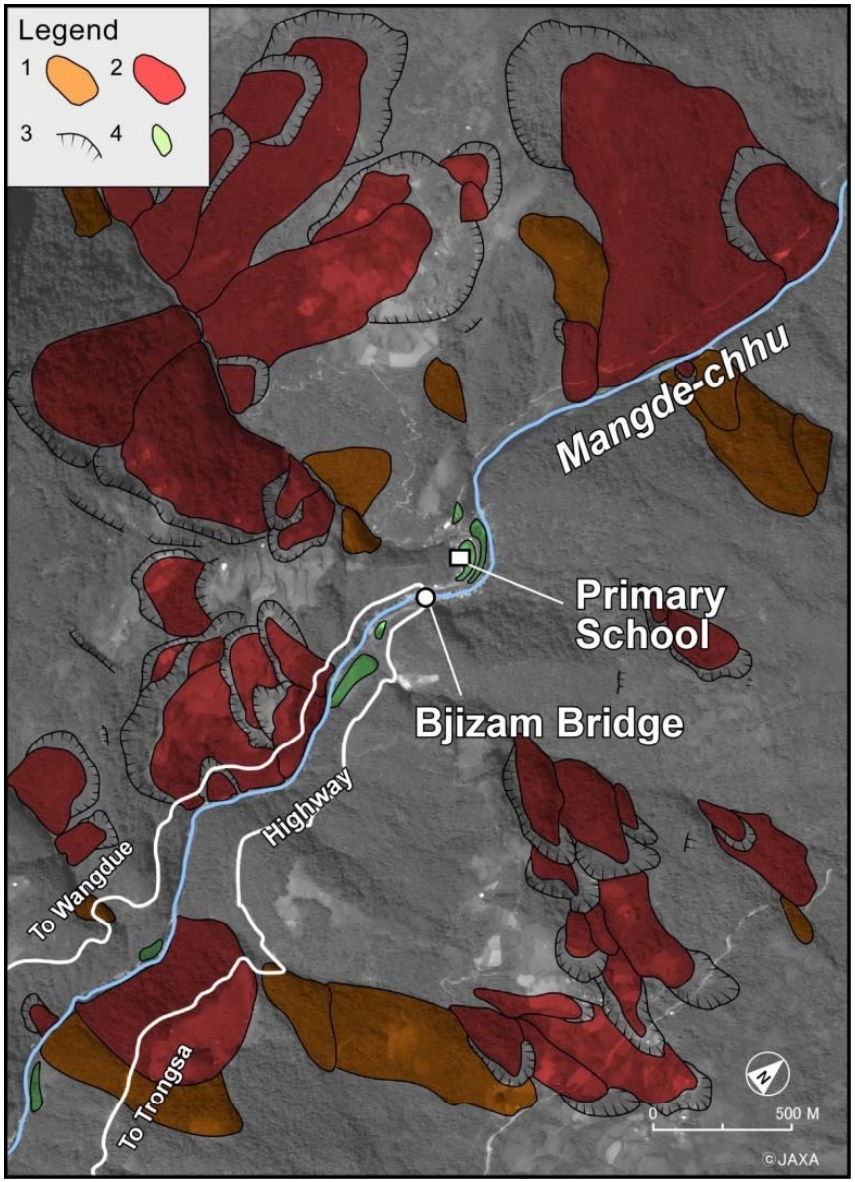
土砂崩れインベントリ





Potential hazards induced by GLOFs, floods, and earthquakes

- Assessment Group conducted trainings to identify potential of dangerous landslide areas using PRISM stereo pair images.

1: Rock creep 2: Landslide 3: Scarp 4. Terrace
Higaki and Sato (2012)

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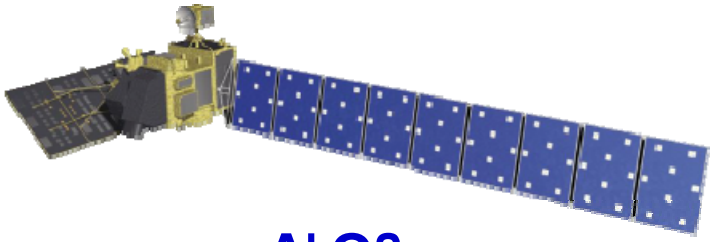
ALOS to ALOS-2 and ALOS-3

2006 2011 2013 2015 2018 2020

ALOS (Optical imager & SAR)

ALOS-2 (SAR)

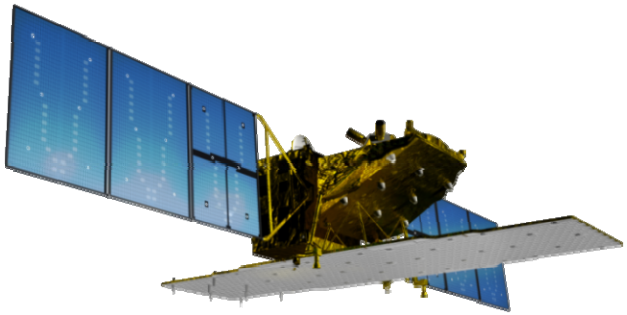
ALOS-3 (Optical)



ALOS

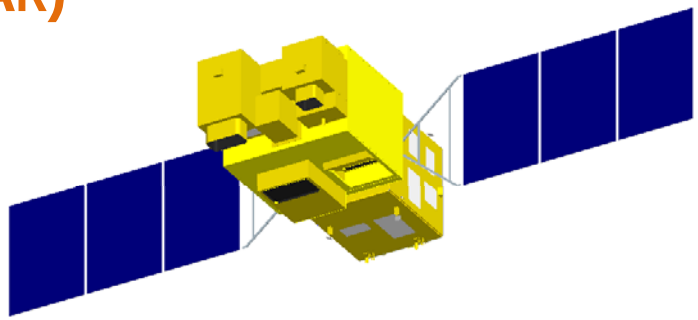
(Optical imager & SAR)

2006 - 2011



ALOS-2 (SAR)

JFY2013



ALOS-3 (Optical imager)

JAXA

EORC Earth Observation Research Center

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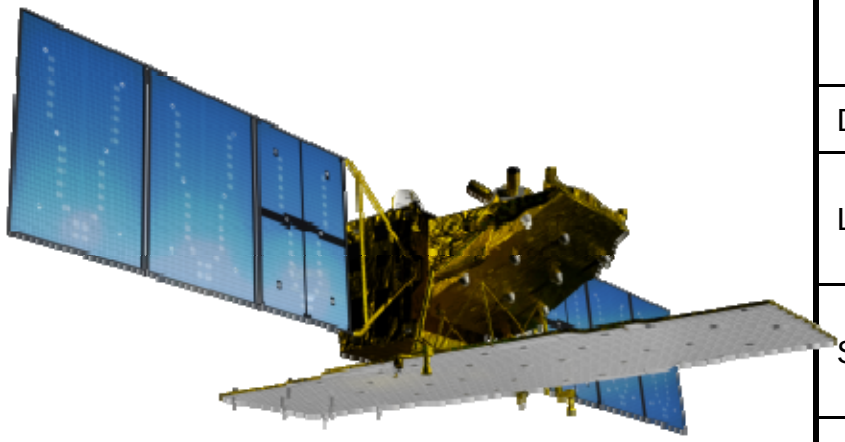
ALOS-2 Specification



ALOS-2: SAR Satellite

August, 2009: Project Team was established
~December 2009: Preliminary Design Phase
~October 2010: Critical Design Phase
Now: manufacturing EM

ALOS-2 Research Announcement (RA) will release on July 2012. The detail will publish on Web.

Orbit		Sun-Synchronous Sub-Recurrent
		Altitude: Approx. 630km
		LST: 12:00 in descending orbit
Design Life		5 years
Launch	Target	JFY2013
	Rocket	H-2A
Satellite	Mass	Approx. 2 ton
	Solar Paddle	Two-wings type panel
Mission Data Transmission		Direct / via. Data Relay Satellite
Mission Sensor		Synthetic Aperture Radar (SAR)
Frequency		L-band (1.2GHz)
Major Observation Mode	Fine	Resolution: 1-3 m, Width: 25 km
	Basic	Resolution: 3 / 6 / 10 m Width: 50 / 50 / 70 km
	Wide	Resolution: 100 m, Width: 350 km
Mission Objectives		Crustal change, volcano monitoring, surface deformation
		Sea ice, river, forest and agriculture monitoring etc.

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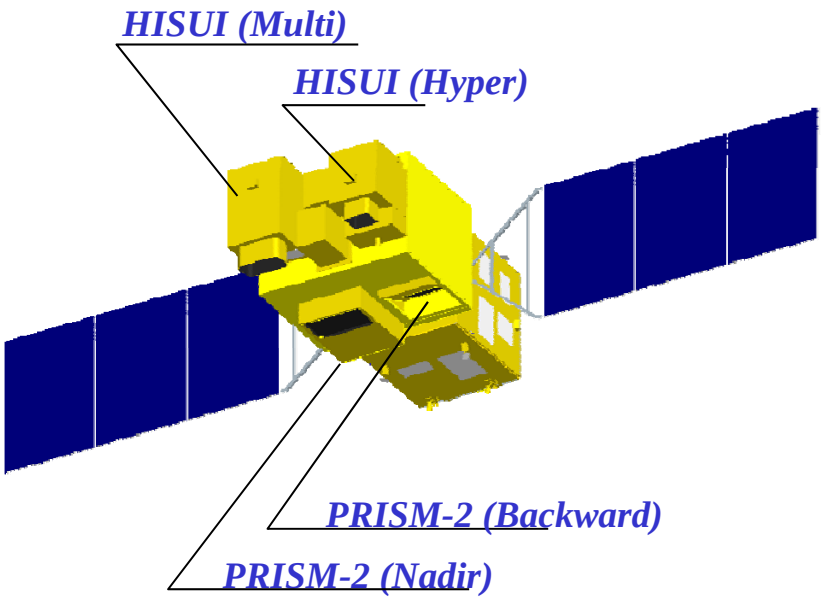
ALOS-3 Specification (TBD)



ALOS-3: Optical Sensor Satellite

- ✓ 50km swath / 0.8m GSD = 62,500 pxls
- ✓ 11 bits quantization
- ✓ JPEG 2000 onboard compression
- ✓ Stereo function (two telescopes)
  - BWD: < 2.5 m GSD (at Nadir)
    50 km swath width (TBD)
- ✓ Body pointing function (+/-60 deg.)

Orbit		Sun-Synchronous Sub-Recurrent, 60 days
		Altitude: 618 km
		LST: 10:30 in descending orbit
Design Life		5 years
Launch	Target	JFY 2017
	Rocket	H-2A
Satellite	Mass	Approx. 2 ton
	Solar Paddle	Two-wings type panel
Mission Data Transmission		Direct / via. Data Relay Satellite
Mission Sensor		Optical instruments
	Panchromatic	Nadir: 0.8 m resolution, 50 km width Backward: <2.5 m, 50 km (TBD)
	Multi spectral	Resolution: 5 m, Width: 90 km
	Hyper spectral	Resolution: 30 m, Width: 30 km
	Thermal	Compact InfraRed Camera *experimental
Mission Objectives		**Land management:** cartography, agriculture, disasters monitoring, surface change detection **Environ. monitoring:** forest, glacier, glacial lake, costal region monitoring etc.