UAV-SfM手法による岩塊斜面の微地形測量：然別火山群・東ヌプカウシヌプリの西面斜面を例に
Micro-topographic survey on the block slope using UAV-SfM method: a case study on the west face of Mount Higashi–Nupukaushi, Shikaribetsu volcanic group, Hokkaido, Japan

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トータルステーションなどによる従来の測量手法は精度こそ高いものの，アクセス困難地での実施は非現実的な場合がある．一方，小型無人航空機（sUAV）による空撮画像のSfM（複数視点の画像から撮影場所および対象物の3次元位置を再現する方法）-MVS（多視点ステレオ）写真測量（以下UAV-SfM手法）によって得られる地形情報は，そうしたアクセス困難地における地形を理解するにあたって十分な空間精度を有していることもあり，様々な調査地にて手法の有用性が示されてきている．そこで本発表では，粗大礫に構成される然別火山・東ヌプカウシヌプリ西面の岩塊斜面を対象に，UAV-SfM手法による微地形測量を実施した例を紹介する．岩塊斜面は一般には周氷河作用の関与が指摘されてきた地形だが，マスムーブメントに起因する場合もあるとされる．したがって，斜面地形発達および斜面プロセスの観点から，いまなお調査の必要性がある地形といえるが，これまでに斜面地形の特徴が精密に調査されることがほとんどなかった．筆者らの調査ではDJI社のPhantom3を用い，高度10-50mから撮影した1124枚の写真を用いてDSMおよびオルソ写真を作成した．UAV-SfM手法を適用することによって，地形と地形物質（巨礫）との関係，とくにプロセスを反映すると思われる岩塊の配列やそれがなす地形について明確化されることがわかった．

キーワード：UAV-SfM手法、岩塊斜面、然別火山群
Keywords: UAV-SfM method, block slope, Shikaribetsu volcanic group

蓼科山頂部に発達する岩塊斜面構成礫の特徴：現場での計測とUAV空撮の複合的手法に基づく斜面形成プロセスの解明に向けて

A survey for the larger block distribution on the block slopes around the summit area of Mount Tateshina, central Japan: an application of combined on-site measurements with UAV-SfM method providing clues as to the understanding of block slope development

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従来，岩塊斜面に関してはさまざまな研究がなされており，その形成要因は，斜面崩壊や地すべりといった重力性の物質移動，もしくは周氷河作用による礫の生産およびその移動・堆積，の二つが主とされてきた．しかし、これらの成因論は試案にとどまるものが多く、今もなお議論の余地が残されている．本研究の対象地である蓼科山頂部のように，岩塊斜面はアクセスの比較的困難な場所に発達し，さらには斜面傾斜が30°前後と大きいこと，岩塊斜面を構成する礫間が空隙となっていることがあり，斜面の成立条件としての地形測量の実施が一般に困難であることなどから，これまで十分な調査がなされてこなかった．
本研究では，岩塊斜面地形をつくる巨礫の配置状況について現場にて計測調査を実施し，さらにUAVを用いた空撮により，上記のような特徴を持つ岩塊斜面調査におけるその有用性を検討した．現場では蓼科山の西向きおよび南向き斜面に斜面傾斜方向に沿う測線を設け，地形縦断面測量，礫の長径・長軸方向・風化程度の測定を行った．また，南向き斜面においてUAVによる空撮を実施し，現場で得たデータとの比較に基づき，その有用性を確かめた．以下に現時点での結果を示す．
岩塊斜面を構成する礫の長径の分布および長軸方向によれば，西向き斜面では斜面下部に巨礫が多く分布する箇所があり、また南向き斜面では巨礫が斜面下方に多く分布する傾向が顕著であった．後者については，UAV空撮に基づくオルソ写真から判読される巨礫の分布と整合した．同様に空撮写真から作成したDSMにより，岩塊斜面の詳細な地形図が作成され，斜面の地形条件と斜面構成物質としての巨礫の配列との関係が明確となった．巨礫の長軸方向は，両斜面とも，斜面と平行に配列される傾向にあることが明らかとなった．
以上により，斜面を構成する礫は重力性の移動によって巨礫が斜面下方に集中した後，周氷河作用が働くことによって長軸方向が斜面の傾斜方向と平行になるように配列されたとも推測される．現在の蓼科山では，その標高からみて周氷河作用が強く働いている可能性は低い．さらに，山体の形成期が最終氷期の後半であることから，山頂ドーム形成以後の急激な気候環境変化に対する斜面ごとの応答の違いにより，形成プロセスに差異が生じ，全体としては複合的要因によってできた斜面である可能性が指摘される．ただし，岩塊斜面の末端部は舌状で，斜面の縦断形から小崖が確認できたことなどから，岩塊斜面の形成要因として最も重要な役割を果たしたのは周氷河性作用であると考えられる．
今後，西向き斜面においてもUAVを用いた空撮を実施し，現場からのアプローチが実質不可能な範囲も含めた，面的な地形情報の把握に務めたい．

The Application of Unmanned Aerial Vehicle (UAV) for Biotope Monitoring Program

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Nature conservation is carried out at Miyagase Dam area, Kanagawa Prefecture since 1996. Construction work is held in 1992-1994 period for nature restoration works, and its effect is monitored by biotope mapping survey. Observation of living organisms and region temperature at study area are done during 1996-2014 period. In 2014, UAV aerial imaging has been deployed for additional 2D/3D data analysis. The observation used three cameras, e.g. optical camera (Canon S100), Near Infra-Red (NIR) camera (Canon S110 Yubaflex) and a thermal camera (Thermo Shot F30S) board on a Multicopter, which flew with flight altitude of 100m. The 2D/3D mapping products from optical images were derived using Structure from Motion (SfM) method and its results are used for spatial distribution of vegetation and habitat mapping (Fig.1a). Ground moisture and thermal mapping using NIR camera and thermal camera are used in thermal habitat study (Fig.1b, Fig.4). This observation method can be used for monitoring of biotope's environment on the finest scale. In this study, to observe the effect of local temperature changes, we observed the population and habitat of *Poikilotherm*, organisms which have body temperature that can be affected by the surrounding temperature, such as dragonflies.

The observation result shows that the combination of UAV data and field survey data of biotope give a new perspective and good accuracy on 2D/3D data analysis, i.e. 5-31 cm resolution on vegetation and habitat mapping. Normalized Difference Vegetation Index (NDVI) map derived from optical image shows spatial distribution of chlorophyll content which correlates with tree canopy structure (Fig. 2). High NDVI index shows spatial vegetation distribution of Japanese cedar (*Cryptomeria japonica*). Whereas, the distribution of autumn leaves (e.g. konara oak (*Quercus serrata*), etc.) is shown as high normalized index of band red and green ($(b2-b3)/(b2+b3)$) retrieved from NIR image (Fig. 3a). The analysis of ground moisture level of study area is derived using the normalized difference of green and red band of NIR image. On Fig. 3b, red area shows high moisture level which is habitat preference of dragonfly. Since band math calculation can be affected by tree shade, masking is suggested on preprocessing. Thermal camera captured optical and thermal images simultaneously. Field temperature measurement was held during flight time and its result shows good correlation with thermal map. Although thermal mapping with 31 cm resolution can provide good temperature distribution on observed area, the development of thermal camera sensor is needed for higher accuracy, enable image metadata (Exif) modification for GPS recording to provide 2D/3D thermal mapping using SfM method.

Long term monitoring is useful to detect changes in biotope presence and structure. We observed population increase of species which has strong adaption to high temperature, e.g. Ito Tombo (*Coenagrionidae*). This species usually lives in or near pond and waterbody without streams, where temperature is warmer during spring to fall compare to the river area. Although few literatures addressed about the change of dragonfly population due to temperature, we conclude that the increase of dragonfly population possibly affected by the increase of temperature at observed area about 1.5℃ during 1996-2014.

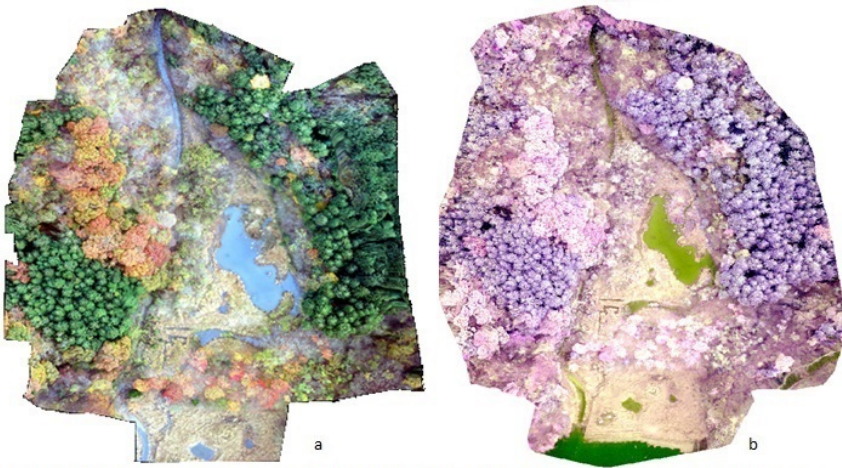Keywords: UAV imaging application, biotope monitoring, optical image, nir image, ndwi/ndvi, temperature rise effect

Fig.1 UAV photo result; a) optical image (RGB=123) and b) NIR image (RGB=NIR\R\G). Cooperation with Sagami River Water System Wide Area Dam Administration Office, Ministry of Land, Infrastructure, Transport and Tourism.
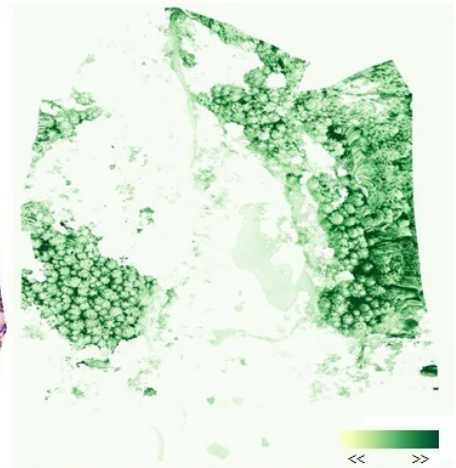

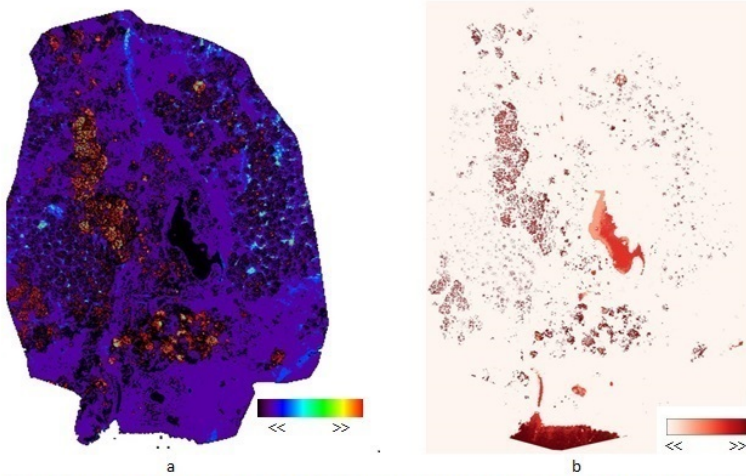Fig. 2 Chlorophyll distribution of NDVI map (optical image)

Fig.3 a) Autum leaves map (konara oak, etc.) and b) ground moisture level map (red is habitat preference of dragonfly) derived from normal difference index of green and red band of NIR image.
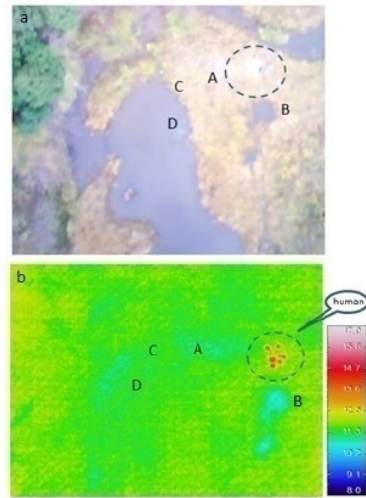

Fig.4 Thermal camera imaging result: a) optical image and b) thermal map. Field temperature measurement (2014/11/28) of A (soil):10.8°C, B (grass):12.3°C, C (near pond):11°C, and D (pond):11.5-11.8°C, show good correlation with thermal map.
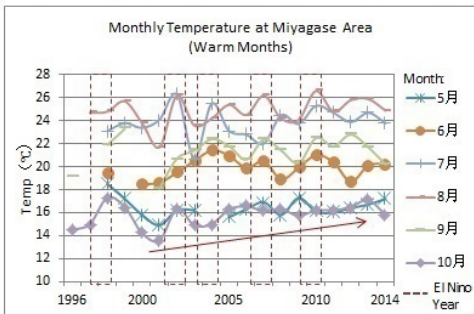

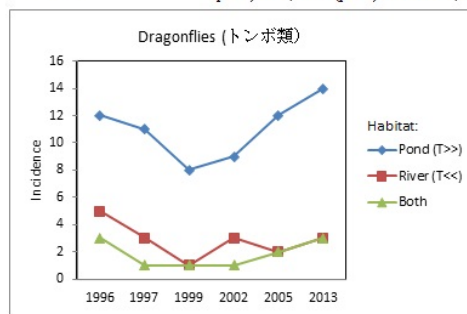Fig. 5 Monthly temperature at Miyagase area during 1996-2014 period

Fig. 6 The incidence index of dragonflies in various habitats during 1996-2013 period

小型UAVを用いた積雪分布の3次元計測
Measurment of snow distribution using small UAV

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Recently aerial photography using small UAV (Unmanned Aerial Vehicle) carrying a compact camera and
SfM (Structure from Motion) technique has been carried out in many areas. As one of the advantages
of the small-multicopter survey it can closely shoot and measure the mountain slope where the
existing manned airplane cannot survey enough because its flight height is relatively high and so
it cannot come close to the object. In addition, because running cost of the small UAV survey is
far less and its operation is relatively easy, repetitive measurements are easier than the existing
methods such as aerial photogrammetry and laser scanning with a manned airplane. We have carried
out the topographic measurements using the above advantages at snow covered area in Niigata
Prefecture, Japan. By the repetitive UAV measurements we have constructed the multi-temporal 3D
models of the surfaces of the ground and snow field and could quantitatively clarify the snow
distribution with higher spatial and temporal resolutions. The snow-depth values estimated by the
UAV surveys corresponded reasonably well with the actual data measured by snow probe. The UAV-SfM
technique has a great potential for a wide range of application, because of its high data accuracy,
low initial and operational costs, allowing high spatial and temporal data recording.

キーワード：無人航空機、Structure from Motion、積雪分布
Keywords: UAV, SfM, snow distribution

Using an unmanned aerial vehicle to examine influence of topography on development of
debris flows in a initiation zone of Ohya landslide, Japan

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In debris flow initiation zones, flows alter the topography of deposited sediments through their
development by entrainment. Although it is possible that such topographic changes influence the
magnitude of subsequent debris flows, this influence is not well understood because of the
difficulty in conducting a temporal series of high-definition topography measurements. Therefore,
to examine how topography affects the development of debris flows, we carried out
structure-from-motion (SfM) photogrammetry from aerial shoots by an unmanned aerial vehicle (UAV)
in the Ichino-sawa subwatershed of the Ohya landslide, in central Japan. Debris flow occurrences
and rainfall were monitored using interval cameras and a rain gauge. In the gully in the hillslope,
the sediment discharge was dominated by entrainment due to the deposited sediments that were
gradually discharged by storm rainfall events. In comparison, deposition several meters thick
typically occurred in the main channel. Consequently, the topographic changes in the main channel
were more complex than those of the gully. Furthermore, in the main channel, the trends in the
changes regarding the amount of sediment differed in the upper and lower parts of the confluence of
the gully. In the upper part of the main channel, sediment entrainment and deposition occurred
repeatedly after each debris flow, whereas entrainment by such flows dominated the topographic
changes in the lower part. Consequently, deposited sediment supplied by a previous debris flow in
the upper part contributed to the development of the subsequent debris flow. The results indicate
that the magnitude of the debris flow was affected by the topography of the main channel created by
previous flows, including flows from the gully.

キーワード：土石流、深層崩壊、SfM-MVS、UAV
Keywords: Debris flow, Deep-seated landslide, SfM-MVS, UAV

Machine Learning Algorithm for impact crater extraction from high resolution DEM derived from SfM data in Vanuatu

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As the 2015 Ontake eruption unfortunately reminded us, volcanic balistic impacts are serious threats to humans and infrastructures alike. To improve disaster risk management, probablisitic and physical models calibration, data on the spatial distribution of ballistic impacts are essentials. Investigating this issue, the present contribution explains the usage of a crowd-sourced high-resolution close-range photogrammetric technique (Structure from Motion), which was used to collect 3d Data of impacts in Vanuatu around an active volcanic vent, and for which a machine-learning algorithm was developed.
The dataset used in this presentation was collected using a GoPro3 camera, which was chosen as it is easy to operate and relatively low-cost, with the goal to simulate a crowd-sourcing exercise. For the present experiment, a student with no experience of SfM and to whom only simple information was given, collected the data at 12 different sites. Out of 12 investigated sites, 8 provided images of sufficient quality, number and overlap.
Using half of the 8 succesfull survey sites as training sites and the other half as test sites, the developed algorithm detects the lowest point in a depression and try to determine whether it has been created by a volcanic bomb or whether it is an unrelated depression. This choice is based on a comparison with an existing dataset of angles of curvatures of the radii of the depression.
The algorithm is meeting some success, increasing the information productivity - which is often an issue in post-disaster management - although its scalability remains to be proven at other volcanoes.

Keywords: close-range photogrammetry, Structure from motion, Machine learning, Vanuatu Volcano
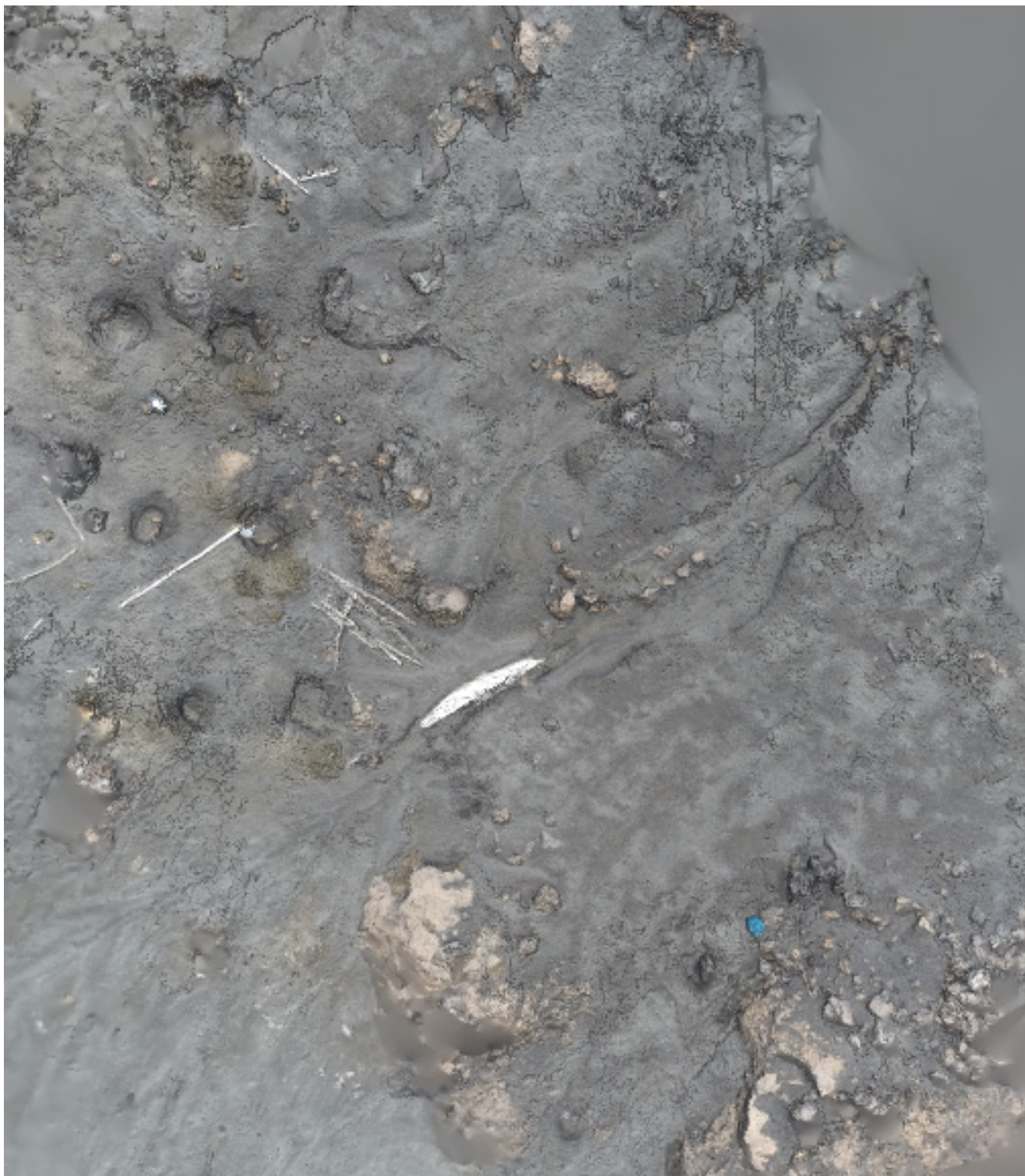
異なるレーザースキャナーを用いた同時航空レーザー測量結果の比較

Comparison of DEMs derived from simultaneous airborne LiDAR survey using two types of laser scanner

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Airborne Light Detection and Ranging (LiDAR) survey provides geomorphic information with fine details even for forests; thus, it is being increasingly used in measuring landscape. Recently, the survey was operated sequentially for rivers to evaluate geomorphic changes from the difference of elevation, by using digital elevation models (DEMs) derived from each survey. However, it is difficult to apply the difference of DEMs to hill slopes as it often presents unrealistically large values. This is due to errors of DEMs, which can be expected to be higher for hill slopes, considering that denser vegetation cover and steeper slopes prevent the laser beams from the scanner from reaching the ground surface and less ground points are used to produce the models. In addition, it is difficult to estimate the error ranges of DEMs for hill slopes as there are fewer ways to crosscheck the values. To examine the ranges, this study conducted airborne LiDAR survey in four locations in Hokkaido by using two types of laser scanner, old and new version of SkEyes Box (SkEyes Unlimited), and compared the DEM products. One site was located on a volcano fan while three were on mountain slopes that were prone to landslides and covered by trees. The survey was carried out on the same day in each site in October 2015. The laser scanner was mounted on an unmanned helicopter (YAMAHA RMAX G1), which made it possible to operate the survey twice in a day. After ground data was extracted from the survey data, DEM of 1 m, 2 m, 5 m and 10 m sizes were produced for each case. When comparing between DEM values of the same location, finer DEM sizes showed less elevation difference in all the sites. However, 10 to 20% of the 1 m DEM sets presented more than 0.7 m of difference in each site. They were likely to appear along stream banks, slope breaks, and the rim of the survey areas. In addition to elevation, the slope angle was obtained on ArcGIS software using the DEMs and was similarly compared for each site. The larger DEM presented a better agreement for the values at the same locations, although 5 m DEM was considered to be better for analysis to avoid losing the information of fine geomorphic features. In this case, 10 to 20% of the DEM sets in each site presented a difference larger than 5 degrees. These analyses suggested that the DEMs for hill slopes contained the degrees of errors, which were difficult to use for volumetric evaluation from a sequential survey. However, the difference of DEMs from the survey could be still useful to extract the locations of moving slopes as the information of change in the ground surface should be reflected in a group of DEMs on those hill slopes.

Spatial pattern analysis of wall surface modification by weathering in Yoshimi-Hyakuana cave using terrestrial laser scanning

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Detection and quantitative evaluation of actual changes in rock surface morphology are crucial for understanding weathering processes. Repeated measurements by terrestrial laser scanning (TLS) were performed at test sites in the Yoshimi-Hyakuana cave in Saitama Prefecture, central Japan. Six time series of point clouds were obtained in 3 years, and those point clouds were finely aligned to each other at millimeter-scale accuracies applying the ICP algorithm for unchanged domains. Digital elevation models (DEMs) were then produced by projecting the point cloud on a vertical plane at a resolution of millimeters. Centimeter-scale changes in the wall surface were successfully detected. Such changes are particularly active at a wall close to the outlet of the cave, and are found to be concentrated on a certain height above ground. This indicates that the rock surface modification is actively induced by salt weathering where groundwater evaporation is favorable. In contrast, walls located more inside of the cave show less or almost no changes in their surface. The air temperature and humidity monitoring at the wall surfaces supports this fact, suggesting the decreasing effects of environmental fluctuations which are higher around the cave entrance but lower in the inner side. This study is supported by JSPS KAKENHI Grants (20312803, 25702014).

キーワード：地上レーザ測量、風化、点群、デジタル標高モデル
Keywords: terrestrial laser scanning, weathering, point cloud, digital elevation model

A Diversified Approach to Generate High-Resolution Topographic Data on the Maunakea
Summit, Hawai'i Island

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The Maunkea summit (3200-4205 m) of Hawai'i Island is a unique aeolian-driven stone alpine desert
ecosystem created by late stage volcanism and glaciation. The summit area geomorphology contains
steep cinder cones, scoria, and glacial moraines and erosional features, producing a somewhat
complicated pattern of surface mineralogy. The summit is also home to the world's most advanced
constellation of telescopes and numerous endemic or rare plants and arthropods. Surprisingly,
little high-resolution topographic data exists over much of the area, which are needed to further
understand summit erosional processes and to better conserve and manage endemic species habitat. To
rectify this situation, we used a VZ 400 Riegl terrestrial laser scanner to collect a
high-resolution lidar dataset (33 pts/m^2 average) over ~15 km^2 across the summit area in 2014. The
lidar coverage contained occlusions due to environmental obstacles and perspective issues. To
'fill' two of the largest/important occlusions (36,081 m^2 within the interior crater of a cinder
cone and a 256,485 m^2 exterior slope of another remote cone) we generated new topographic datasets
vie Structure from Motion (SfM) by taking photos of the missing areas from ground and airborne
(unmanned aerial vehicle) camera campaigns. The lidar and SfM-derived point clouds were then merged
together to create a blended and continuous topographic dataset. Vertical errors from the
ground-based photo campaign were generally higher than for the UAV survey, ranging between +3.76
& -1.75 m, though after geoprocessing the average vertical errors for both datasets was <0.05 m.
Lessors learned include the importance of creating enough overlap between the raw lidar and SfM
point cloud datasets to be able to register them together, instead of solely relying on
differential GPS coordinates for ephemeral ground control points. The merged dataset will be
compared to future topographic survey campaigns to detect areas of active geomorphic change and
quantify contemporary erosion rates. These data are also being used to define quality habitat for
the endemic wekiu bug and serve as a template for habitat restoration following future telescope
decommissioning.

Keywords: UAVs, Geomorphic, Lidar

重力偏差テンソルの固有値・固有ベクトルを用いた富山県の既存断層の表層傾斜角推定
Estimation of dip angles of faults near the surface in Toyama by eigenvalues and
eigenvectors of the gravity gradient tensor

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and Engineering for Research, University of Toyama, 3.National Institute of Advanced Industrial
Science and Technology

富山県内には，呉羽山断層をはじめ，石動断層，高清水断層，黒菱山断層等の活断層が存在する。それらの活断層について，これまで多くの地形学的研究，地質学的研究，地球物理学的研究がなされてきた．
地震防災を考える上で，活断層が動いた時に，どれくらいの範囲がどの程度揺れるのかを予測する強振動シミュレーションが重要な役割を果たす。このシミュレーションでは，断層長，断層幅の他に，断層傾斜角が重要なパラメータとなっている。断層傾斜角は，通常，反射法地震波探査等により推定するが，この探査は非常に高額である。重力探査による断層形状の推定も可能であるが，重力異常だけでは解がユニークに決定しないため，やはり地震波探査結果や深層ボーリングデータといった補助データが必要である。
近年，重力偏差探査という言葉が日本でも散見されるようになってきた。重力偏差探査とは，地下に埋没している物体による引力3成分(g_x，g_y，g_z)の各方向への微分値(g_{xx}，g_{xy}，g_{xz}，g_{yx}，g_{yy}，g_{yz}，g_{zx}，g_{zy}，g_{zz})を測定するものである。この微分値9個をまとめて，重力偏差テンソルとよんでいる。重力偏差テンソルは，対称テンソルであることが知られており，また対角成分の和は，ラプラス方程式により，0となる。したがって，重力偏差テンソルは，5つの独立成分よりなっており，測定点1点につき，この5つの情報を得る。従来の重力探査は，地下に埋没している物体が生じさせる引力3成分のうち，鉛直下向きの成分g_zのみを計測し，構造探査に利用していた。したがって，重力偏差探査は，重力探査に比べ，5倍の情報量をもっている。
この重力偏差テンソルの固有値・固有ベクトルを用いた断層あるいは構造境界の傾斜角の推定手法が，Beiki and Peterson (2010)，Beiki (2013)，楠本(2015)により開発されてきている。この手法は，重力勾配テンソルの最大固有ベクトルが構造の方を向くという特性を利用し，そのベクトルと地表面がなす角度から断層あるいは構造境界の傾斜角を，地震波探査やボーリングデータ等の補助データなしで推定する。
富山県内では，重力偏差計による重力偏差測定が行われていないが，既存の重力異常から重力偏差テンソルの各成分を計算する手法がMickus and Hinojosa (2001)により確立されているため，この手法により，富山県内の重力異常から重力偏差テンソルを推定した。Mickus and Hinojosa (2001)の手法とは，①重力異常をフーリエ変換し，②フーリエ領域での積分により引力ポテンシャルを求め，③それを各方向に2階微分し，④フーリエ逆変換を施すことで，空間領域での重力偏差テンソルの各成分を得る。
富山県内の石動断層，高清水断層，呉羽山断層，黒菱山断層について，上述の方法により断層傾斜角を推定したところ，いずれも45°〜60°の範囲に推定された。これらの断層は，地表踏査から，いずれも45°〜60°の傾斜角をもつことが判明しており，既存研究結果(例えば，活断層研究会，1991)と調和的な結果を得た。これまで200 kmを超えるようなスケールの断層傾斜角に対して有効であることは示されていたが，今回の研究により，10 〜20 km程度の断層傾斜角推定にも有効なことが示され，今後の活断層研究に有用な情報を提供できるのではないかと考えている。

Evaluation of TWI-Derived Soil Depths and DEM-Assisted Terrain Slopes in Tainan Mountain Areas

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The study is aimed at evaluating the soil depths from topographic wetness index (TWI) method, and the terrain slopes from a 5m resolution digital elevation model (DEM) in Tainan mountain areas, located in southern Taiwan. The field surveys (field work) for validating the results have been being implemented in recent months. During the field surveys, a soil auger and a Nikon laser rangefinder are used for obtaining the soil depths and terrain slopes, respectively. The related methodologies for obtaining TWI-derived soil depths and DEM-assisted terrain slopes (office work), and the comparison results for office and field works will be well described in this paper. We hope that the research is able to determine the accuracies of the TWI-derived soil depths and the DEM-assisted terrain slopes in Tainan mountain areas.

Keywords: TWI, DEM, Soil Depth, Terrain Slope

Interpretation of Terrain Features by Self-Developed Red Relief IMAGE MAP

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We produce the Red Relief Image Maps (RRIMs) to aid terrain feature interpretations, especially in potential landside areas. RRIM is generated based on openness and slopes derived from a digital elevation model (DEM). In this study, we use software of Fortran and generic mapping tools (GMT) to produce the Self-Developed RRIMs. The related programs and theories are being constructed and are going to be completed. All kinds of terrain features will be well chosen and analyzed in the following tests. The purpose of this research is to develop a new visualization of topographic maps to provide subtle and useful terrain information and further bring contributions to the regions of disaster prevention, soil and water conservation, environmental monitoring, and resource exploration.

Keywords: RRIM, DEM, GMT

可視光衛星画像から推定する浅海域の海底地形ー日本周辺海域での利用に向けてー
Shallow water bathymetry derived from visible satellite image: toward application to the
waters around Japan

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浅海域において詳細な海底地形データを取得する手段として，人工衛星から得られる可視光の画像を利用して
水深情報を抽出する技術の開発が近年各国水路機関の注目を集めている．こうした水深情報はSatellite
Derived Bathymetry（SDB：衛星画像推定水深と訳す)と呼ばれている．
人工衛星搭載の光学センサによって計測された衛星画像を用いて，光は水中において指数関数的に減衰してい
くという基本理論に基づき水深を算出する．ただし，実際には，光の水中における減衰率は海域によって一定
ではなく，海底面の反射率も海底面の被覆物によって異なるなど，様々な要因がセンサで受信される光の量に
影響を与えるため，その過程は複雑である．
著者らは，Lyzenga(1978)の手法を基にして，わが国の海域の特性を考慮しながらSDBの解析手法を開発し，実
用に向けた検証を行ってきた．2009年10月に利用可能となった光学衛星WorldView-2は，8バンドの光学センサ
(うち可視光は6バンド)を搭載し，1.8mの解像度が得られることから，本研究ではこの衛星画像を解析に用いて
いる．浅海域の海底地形や航路障害物の短期間での概要調査や，津波シミュレーション等に使用できる海底地
形データの取得に効果的であると期待している．
本ポスター発表では，日本周辺の各地の海域でSDBの解析を実施し，既存のマルチビーム測深や航空レーザー測
深による測量結果と比較検証を行った結果を紹介し，こうして得られる海底地形データの利用法について考察
する．
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査研究」の一環として行っています．

キーワード：海底地形、浅海域、衛星画像、可視光
Keywords: bathymetry, shallow waters, satellite imagery, visible bands