

ALOS衛星を用いたブータンヒマラヤにおける氷河台帳の作成 An ALOS-derived glacier inventory of the Bhutan Himalaya

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氷河台帳は氷河の数、面積、空間および標高分布などが含まれる基盤情報であり、水資源の管理や気候変動に伴う氷河の応答、さらには氷河に起因する自然災害を研究する上で基本となる情報を提供する。ブータン・ヒマラヤでは起伏の激しい地形とインド季節風由来の降水によって、季節性の積雪が多く残り、表面を岩屑に覆われた氷河（デブリ氷河）も多く分布する。そのため衛星データによる氷河の自動抽出が困難であり、正確な氷河台帳の作成および整備が欧米など他の地域よりも遅れてきた。著者らはALOS衛星に搭載されたPRISMセンサによるパンクロマチック画像（空間分解能2.5 m）とASTERセンサによる数値標高データ（ASTER GDEM2）を用いて、地理情報システム上での目視判読と手動抽出により、ブータン国内すべてとそれに隣接するチベット南端の一部の氷河を網羅する氷河台帳を作成した。

作成した氷河台帳によれば、1273の氷河（1408.3 km²）が存在し、そのうち210（951.2 km²）はデブリ氷河であった。各氷河の標高を比較すると、デブリ氷河は比較的低い標高に存在する傾向がある。氷河表面の各画素（30 m 四方）を8方位に分類すると、岩屑に覆われていない氷河は北向きの表面が多く含み（16.7%）、南西向き表面が最も少ない（9.2%）。一方のデブリ氷河にはこのように顕著な方位分布の偏りは見られなかった。氷河とそれらを涵養する降水との関係を調べるため、熱帯降雨観測衛星TRMMによる降水プロダクト（TRMM 3B43）を氷河の中央標高（各氷河の面積を二等分するような標高）と比較した。その結果、氷河の中央標高はチベット側へ北上するほど高くなり、降水量（1998-2010の年間平均降水量）の空間分布とは負の相関関係にあることが明らかになった（ $r = -0.48$, $p < 0.05$ ）。この結果は、ブータン・ヒマラヤでは100 km規模の狭い領域においても降水量に大きな南北差があり、それが氷河の存在標高に大きな影響を与えることを示唆する。

キーワード: 氷河台帳, ALOS, TRMM, ブータン・ヒマラヤ

Keywords: Glacier Inventory, ALOS, TRMM, the Bhutan Himalaya

Temporal changes in erosion rates and patterns in Ichinosawa subwatershed of Ohyakuzure landslide, central Japan Temporal changes in erosion rates and patterns in Ichinosawa subwatershed of Ohyakuzure landslide, central Japan

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Erosion of hillslopes has been active within the area of Ohyakuzure landslide since its formation in ca. 300 years ago, and the Abe River is characterized by a vast amount of sediment input from the landslide. Although many portions in the landslide have been controlled by landslide prevention strategies and vegetation on hillslopes is being recovered, hillslope erosion and debris flows frequently occur in uppermost steep subwatersheds in the landslide area. Ichino-sawa catchment is a typical one among such subwatersheds. In the catchment, freeze-thaw weathering of fractured bedrock on hillslopes (shale and sandstone) in winter to spring season provides abundant sediment onto channel beds, which act as a source of debris flows frequently occurring by heavy rainfalls (Baiu rain front and typhoons) in summer season. Although detailed monitoring of debris flows and related topographic changes have long been performed in a field scale, high-resolution assessment of erosion patterns and rates at a catchment scale has been limited due to the inaccessibility of steep slopes therein. Here we examine topographic changes in the Ichinosawa catchment using a time series of high resolution DEMs for 5 years (from 2005 to 2010) obtained by repeated airborne laser scanning (ALS). The 5-year mean basin-averaged annual erosion rate in the Ichinosawa catchment is roughly estimated to be ca. 0.1 m/y. Spatial patterns of erosion and deposition show clear contrast between channel beds and hillslopes, indicating that, as an inter-annual trend, erosion dominates on hillslopes whereas the sediment particles tend to be stored in channel beds. Relationships between the temporal changes in rates and patterns of erosion/deposition and morphometric parameters in the catchment are also examined.

Keywords: airborne laser scanning, debris flow, GIS, erosion, geomorphometry

Basin hypsometry and topographic evolution in the Arabian Peninsula Basin hypsometry and topographic evolution in the Arabian Peninsula

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Hypsometric Integral (HI) and hypsometric curves have long been used as indicators of stages in landscape evolution. They are also used as a geomorphic tool to detect tectonically active regions. The Tertiary Red Sea rifting, subsequent uplift and formation of drainage basins in the western part of the Arabian Peninsula provide an arena to study the relation between basin hypsometry and topographic evolution. This study analyzes 36 drainage basins whose main axes are perpendicular to the Red Sea coast. The basins were extracted from the 30 m ASTER GDEM. The size of the basins ranges from 522 to 8292 km² with an average of 3121 km². These basins were further divided into subordinate basins according to the Strahler orders. Mean HI values for the main 36 basins are approximately 0.3, but HI varies significantly according to the distance from the southwestern tip of the Arabian Peninsula. High values of HI (>0.35) are found for distances up to 400 km from the tip, and at distances between 1200 and 1400 km. This pattern may be attributed to the lithological variation. Higher values of HI are associated with the Cenozoic flood basalts, while low values of HI are associated with Precambrian crystalline rocks. This empirical study may thus be useful to discuss the nature of the topography and their evolutionary stages in relation to bedrock geology.

キーワード: Arabian Peninsula, hypsometry, drainage, DEM, topography

Keywords: Arabian Peninsula, hypsometry, drainage, DEM, topography

Analysis of river profiles and knickpoint distribution in relation to slope failures Analysis of river profiles and knickpoint distribution in relation to slope failures

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The topographically diverse, mountainous watersheds of Japan are prone to frequent mass movements including slope failures and debris flows. Hillslopes there are constantly modified by slope failures induced by frequent rainfall and earthquakes to achieve dynamic equilibrium. A river course and surrounding hillslopes are coupled in terms of local erosion. The relationship between slope of a river longitudinal profile versus drainage area and that between the slopes versus profile curvature has often been used to study landform development. Here, a 10 m DEM of a mountainous region near Mount Ontake in the Northern Japanese Alps was chosen for this analysis. This highlights the separation between incised and aggraded reaches, and the analysis of river longitudinal profiles and knickpoint distribution are performed. The location of knickpoints is a significant boundary condition for fluvial and slope processes: knickpoints set the base level of erosion in reaches upstream of knickpoints, while incision in reaches downstream of knickpoints may influence failures in surrounding slopes. This study has provided insight into how intense erosion at knickpoints and related slope failures affect morphological development of mountainous watersheds.

キーワード: DEM, knickpoints, longitudinal profiles, watersheds

Keywords: DEM, knickpoints, longitudinal profiles, watersheds

Using back-propagation networks to predict landslides based on an airborne LiDAR DEM

Using back-propagation networks to predict landslides based on an airborne LiDAR DEM

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Landslides are one of the most destructive geological disasters affecting Japan every year, causing huge loss of human lives and properties in Japan over past decades. Although many methods for predicting landslides have been proposed, accurate predictions of landslides are not always realized. This study aims to develop an accurate and efficient method for landslide prediction based on an artificial neural network (ANN) built from seven factors using a back-propagation (BP) algorithm. The method of this study consists of two major phases: 1) data integration and analysis, 2) ANN training and prediction. This study analyzed a mountainous region of Niigata Prefecture. Landslides data are taken from the database of the National Research Institute for Earth Science and Disaster Prevention (NIED). The first phase involves GIS-based statistical analyses related to landslide occurrence, geology, and geomorphological properties derived from a 2-m airborne LiDAR digital elevation model (DEM). The seven factors are elevation, slope angle, curvature, aspect, lithology, distance to geological boundaries, and density of geological boundaries. A total of 1225 potential cases of landslides were used to test the BP algorithm for training and testing the model. The accuracy of the prediction reached >90%, indicating that the presented model with the seven factors is reliable and can be used for hazard mitigation and warning systems.

キーワード: Airborne LiDAR DEM, landslide prediction, Artificial Neural Network, Back-propagation

Keywords: Airborne LiDAR DEM, landslide prediction, Artificial Neural Network, Back-propagation

GISを用いた内水氾濫発生箇所における地形・地理的特性の評価手法の検討 Evaluation Method for topographical and Geographical Characteristics of Flooded Areas

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近年、日本で発生する水害は内水氾濫が中心となっており、特に都市域でその被害が顕著である。日本の典型的な都市域である東京都では、内水氾濫に対する対策が進行しているものの、いまだ小規模な浸水や、繰り返し浸水が発生する箇所が見受けられる。そのため、下水道等の排水能力以外にも、地形や土地被覆からも内水氾濫が発生する可能性を検討する必要があるといえる。そこで、本研究では過去に浸水が発生した箇所の地形・地理的特性を把握し、これらの特性が類似する地域をすなわち浸水の可能性がある地域として抽出する手法を検討した。対象地域は、新宿区・文京区・豊島区の一部地域とした。

対象とした範囲における 1989 年～2009 年までの浸水実績は 107 箇所である。これらの浸水箇所を、その発生箇所によって現河道沿いの低地（低地）、台地、台地上の谷（谷）の 3 つに分類し、各浸水箇所における地形・地理的特性に関わる項目の値を抽出した。地形・地理的特性に関わる項目としては、凹地の深さ、凹地の容積、集水域、集水域内の被覆されている面積、集水域内の平均勾配、流域出口までの平均勾配、両者の勾配の差、集水域の最上流～浸水箇所までの流路長、浸水箇所～流域出口までの流路長、両者の流路長の差、谷の深さ、谷幅をとりあげた。各項目の計測には、ArcGIS10、国土地理院提供の「基盤地図情報 5m メッシュ」、東京都都市計画基本図（1/2500）のデジタルデータを使用した。これらの項目を変数とした主成分分析を行ない、この結果をもとに浸水箇所の地形・地理的特性を把握し、浸水の可能性がある地域を抽出した。

キーワード: 内水氾濫, GIS, 地形・地理的特性, 主成分分析

Keywords: inland flooding, GIS, topographical and geographical characteristics, principal component analysis

Smart Data Collection and Real-time Digital Cartography Smart Data Collection and Real-time Digital Cartography

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The development of the Global Navigation System and wireless networking technologies have changed the way we live, communicate, share information and even the collection of geospatial data in the field. Along with wireless networking technologies, the improvement in computational power of handheld devices such as smartphones, tablet PCs, ultra-mobile personal computers (UMPCs) and netbook computers allow field users to connect, store and stream large amounts of geospatial data from the web-server. We are now more flexible and able to collect geospatial data in a timely and convenient manner. In this paper we discuss field data collection using a smartphone and Web-based GIS system, which collects, integrates, visualizes and analyzes the collected data in real-time. We built a Web-GIS system for creating a user account, acquiring coordinates from GPS embedded devices or wireless access points, and providing a user-friendly survey form. The collected data can be instantly visualized and analyzed, such as by thematic mapping, labeling, symbolizing, querying and generating a summary report. We have tested this system on a university campus and management system, in which we collected information on illegal disposal sites and parking events within the university campus.

キーワード: Smartphone, Web-GIS, Real-time Digital Cartography

Keywords: Smartphone, Web-GIS, Real-time Digital Cartography

Road network and transportation facilities in Sri Pada Mountain area ? influence on flow of people along the trails

Road network and transportation facilities in Sri Pada Mountain area ? influence on flow of people along the trails

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Sri Pada Mountain is one of the most sacred places in Sri Lanka in the Peak Wilderness protected area which is covered by 3 districts. The purpose of climbing the mountain ranges mainly from worshipping the foot print on the top of the Mountain (believed to be the footprints of the "Lord Buddha" and other religions have their own perspectives) to site seen. There are many trails to climb the Sri Pada Mountain. Sri Pada Mountain season starts from full moon day (Poya day) of December of each year and ends in full moon day of the following year. Average climbers to the top of the mountain said to be 2-3 million per season each year.

This paper discusses the distribution of road network and other associated facilities with the transportation to find the influence on the flow of people for future planning.

キーワード: Road Networks, Transportation, Historical trails, People flow, Sri Pada, Peak Wilderness

Keywords: Road Networks, Transportation, Historical trails, People flow, Sri Pada, Peak Wilderness

Spatial Predictive Modeling of Agricultural Land Sustainability using Geographic Information System

Spatial Predictive Modeling of Agricultural Land Sustainability using Geographic Information System

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Indonesia is one of countries with a big population growth. The population growth impact the food needs and land necessity for settlement. When the population increased, the needs of land for settlement is rising and it may diminish the agricultural land. To ensure food security, each districts are obligated to maintain the extent of agricultural land in their region so they can comply their own food need. For example Kulonprogo District as a research area, with the population growth reaches 0,47 percent per years, requires at least 5029 hectares as stated in the district regulation no. 1 of 2013. It requires a way to predict the extent and distribution of agricultural land to establish a policy that protect the sustainability of agricultural land.

The aim of this research is map the agricultural land that would be exist for five years later (2018) based on the spatial predictive modeling of landuse change and trend of land necessity for settlement. Multitemporal remote sensing data from 2003 until 2009 used as an input in GIS modeling. This model consider physiographic aspects such as topography, accessibility and land use to distribute spatially the number of agricultural land required.

Based on the model, the result of this research is the built up area ascension due to the settlement needs does not trigger the shortage of agricultural land in Kulonprogo District. At least there are still over than 1000 hectares of land that can be preserved for agriculture until 2018. In this case, GIS plays a role as a prediction tool of sustainable agricultural land management and the scenario resulted can used as a reference for land preservation policy.

キーワード: spatial predictive modeling, agricultural land, Geographic Information System

Keywords: spatial predictive modeling, agricultural land, Geographic Information System

Capturing built-up expansion patterns in the major cities of South and Southeast Asia using GIS and RS techniques

Capturing built-up expansion patterns in the major cities of South and Southeast Asia using GIS and RS techniques

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The purpose of this study is to capture the built-up expansion patterns in the major cities of South and Southeast Asia for the last two decades using GIS and Remote Sensing (RS) techniques. The major cities considered in this study include Bangkok (Thailand), Dhaka (Bangladesh), Hanoi (Vietnam), Jakarta (Indonesia), Manila (Philippines) and Yangon (Myanmar). The RS satellite data (LANDSAT) were downloaded from <http://earthexplorer.usgs.gov/> and <http://glovis.usgs.gov/>. The best available images (i.e. with minimum cloud cover or cloud-free) were prioritized in the image selection. The epochs considered in the analysis were 1990, 2000 and 2010. Except for the 1990 time period for Jakarta and Manila, all the capture dates of the satellite images for all the cities were close to these time periods.

In this study, we considered only two land cover categories, namely built-up and other lands. The built-up category includes buildings, roads and all paved areas and concrete structures, while other lands include vegetated areas, water bodies, among others. The land cover classification was accomplished by employing the Iterative Self-Organizing Data Analysis Technique (ISODATA) unsupervised classification algorithm available in ArcGIS software. Using this technique, 30 clusters or classes were first generated for each satellite image for each time period for all the cities. This is the optimum number of classes we found through empirical examinations. After generating these classes, each class was individually examined whether it belonged to built-up or other lands category by visual interpretation and with the aid of Google Earth maps especially for the latter time periods. The classes that belonged to the same category were eventually merged.

Based on the extent of our study area for each major city, the initial results revealed that from 1988 to 2009, the built-up area of Bangkok has expanded by 95,641 ha; 59% of which occurred between 1999 and 2009. For the case of Dhaka, its built-up area has increased by 10,566 ha from 1989 to 2010; of which 61% happened between 2000 and 2010. For Hanoi, its built-up area has expanded by 8,553 ha from 1989 to 2009; 62% of which occurred between 1999 and 2009. Jakarta has also experienced rapid urban growth in the last decades. From 1994 to 2010, its built-up area has increased by 39,729 ha, of which 67% happened between 1994 and 2001. For Manila, its built-up area has increased by 21,643 ha for the past 12 years (1996-2008); 57% of which occurred between 1996 and 2001. And for the case of Yangon, its built-up area has grown by as much as 15,382 ha from 1989 to 2009, of which 56% happened between 1999 and 2009. These results show that among the six major cities, two of them (Jakarta and Manila) exhibited a comparable trend, i.e. greater increase in their respective built-up areas during the 1990s. In contrast, the other four major cities showed a similar trend, i.e. greater increase in their respective built-up areas during the 2000s. In terms of the rate of built-up increase, Bangkok had the highest rate (4,554 ha/year), followed by Jakarta (2,483 ha/year). Hanoi had the lowest rate (428 ha/year), followed by Dhaka (503 ha/year).

Our future plan for this research is to examine the built-up expansion patterns for each major city along the gradients of spatial variables (e.g. distance to city center, distance to major roads and elevation). The resulting patterns will be used to calibrate a spatially explicit land cover change model, which will then be used to project future built-up expansions.

キーワード: GIS, remote sensing, urbanization, land cover change, South and Southeast Asia

Keywords: GIS, remote sensing, urbanization, land cover change, South and Southeast Asia

アセットマネジメントのための橋梁保守システムの開発 Development of bridge maintenance system for asset management

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日本では、高度経済成長期に大量の社会資本（建設構造物）が整備されてきた。これらの構造物は、供用開始から30～50年経過しており、今後は急速に高齢化することが想定されている。このような状況を考えると、「適切かつ効率的な維持管理」は、社会インフラの重要なテーマとなる。とくに、鉄道構造物の多くは、日本の他の社会インフラよりも先に建設されている。そのため、鉄道構造物には、耐用年数を超えた多くの老朽化した構造物が存在している。とくに、道路橋が製造されて30年経過しているのに対して、鉄道の橋は製造から平均60年が経過している。このように、鉄道橋の維持が喫緊の課題となっている。このような背景から、本研究では、鉄道橋に着目した。

橋梁の構造を適切に維持していく、さまざまなデータを蓄積するために一元的に管理する必要がある。記録と補修図形または変状を記録するための維持管理の展開図にはいくつかの課題がある。第一に、展開図は寸法の持っていない概略図であること。第二に、展開図は工事および検査で共有されていない。第三に、時系列を管理することが難しい。このような理由から、著者らは、視覚的な表現に優れた3Dデータの活用が有効であると考えた。本研究では、簡単に展開図を作成する方法と変形図や修復図形を管理できる3Dモデルを開発した。

システム開発に加えて著者らは、ステレオ写真の測定機を開発した。著者らは、機器を使用して測定精度を検証し、その測定結果は、明らかに測定精度が確保されていることを示している。この装置は、構造物から離れた場所から写真を撮るだけでよく、現地作業で近接による計測を必要としない。機器の重量は1.5キログラム未満である。そのため、エンジニアの撮影作業の負担も小さい。この装置の開発により作業性と安全性の向上の両方の効果が得ることができた。

このシステムは、既存の図面やステレオ写真の詳細寸法を使用して3Dモデルのサイズを変更することが可能である。その結果、サイズを変更することで、より現実的なモデルを作ることが可能である。加えて、3Dモデルから正確な2Dの図面（展開図）を作成することができる。すなわち、本システムによれば、どのように複雑な構造であっても迅速かつ正確に出力することができる。さらに、点検と修理位置も、実際のサイズが3Dモデルで表現されているため、点検や修理の写真と記録（面積、長さ、位置）の管理が一元管理できるシステムとなっている。

維持管理においては、写真の適切な位置を管理することが重要だ。しかしながら、撮影写真に対して撮影位置を付与する管理が非常に面倒な作業になっていた。これらの問題を解決するために、本システムでは、位置関係を視覚的に把握することができるようシステムが作成されている。3Dモデルと写真は別の日または別のエンジニアが写真を撮った場合でも、3Dモデルと一致しているため簡単に関連付けできるようになった。このシステムによって一元管理し、効率的に写真管理することが可能となった。

著者らは、従来の方法との比較検証をしている。まず、著者らは技術者数および作業時間について検証し比較している。結果では、作業時間やエンジニアの数の減少が見出された。次に、著者は、測定精度についての比較検証を行った。筆者らは、個々の修理箇所を抜粋し、従来の方法と本システムの測定法による面積の差を計算した。結果から、このシステムは、測定値が信頼できるため、保守管理に十分に適用することができる。

キーワード: 橋梁保守システム, アセットマネジメント, 3次元モデル, 写真測量

Keywords: bridge maintenance system, asset management, three-dimensional model, photogrammetry

Spatial Methodologies for the Analysis of Vulnerability in Urban Areas - A Case Study for Terrorism in Tokyo, Japan

Spatial Methodologies for the Analysis of Vulnerability in Urban Areas - A Case Study for Terrorism in Tokyo, Japan

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The geographic analysis of crime risk, criminogenic factors and their spatial influence has gained legitimate interest in the past, most notably by the increased popularity in the Risk Terrain Modeling (RTM) methodology by Caplan & Kennedy. Our research is an attempt to apply this concept to the analysis of vulnerability to terrorism in urban areas. In the course of this effort we developed a generic Spatial Urban Vulnerability Analysis (SUVA) framework. The aim is to analyze the distribution of vulnerability in space based on the attributes of the objects defining that space (such as people, buildings and infrastructures).

This paper is a case study of an application of the SUVA framework in a central area in Tokyo, Japan. First we outline the underlying vulnerability concept, which consists of two factors: susceptibility and disutility. Then we explain the general SUVA framework and analysis methodologies. In the next part we briefly introduce the study area, present the selected vulnerability factors for this case study, and explain their selection process. This is followed by a detailed description of the operationalization of the vulnerability factors using spatial and non-spatial methodologies. We move on to the object-based vulnerability maps and the calculation and visualization of the vulnerability factors' spatial influence. Lastly we combine the single factor maps to a comprehensive vulnerability map of the study area. We conclude the paper with an evaluation of possible target audiences and the overall usefulness of the presented methodology.

キーワード: GIS, spatial analysis, vulnerability, urban, terrorism, Tokyo

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Geospatial simulation of tsunami evacuation using agent-based modeling Geospatial simulation of tsunami evacuation using agent-based modeling

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In the last decades, applications using agent-based modeling (ABM) and geographical information systems (GIS) have increased. Previously, GIS was focused on representing the world as the static aggregation of population holding information that was queried and cross-related by the user. Therefore, for years one of the main criticisms to the past GIS models is the use of largely homogeneous entities with the same characteristics (e.g. population). However, certain systems cannot be represented only statically. Most of the social phenomena fall into the category of complex and dynamic systems. To understand such systems with its geographical features (e.g. congestion, segregation, risk), agent based models have contributed on the simulation of human systems and their individual behavior and decisions. Thus, with the integration of ABM models, capable of exploring the system at the level of their constituent elements (agents); plus the GIS technology, suitable for the spatial representation of the world; much more social phenomena can be more adequately represented and simulated.

Geographical Information Systems (GIS) contain powerful tools to analyze phenomena in nature that are particularly static and in some cases dynamic. For years, temporal representation has been a challenging task in GIS platforms. However, application programming interfaces (APIs) allow the use of GIS tools as optional libraries on software. Then, GIS data and tool routines can be imported or linked to simulations of other nature. An example of this is the multiagent programmable modeling environment known as NetLogo. The library extension of GIS permits the use of spatially projected data into the NetLogo world for agents to recognize them in the space.

This study aims on the integration of GIS urban data and the spatiotemporal tsunami numerical simulation output database into an agent based model of human behavior for tsunami evacuation. Agent-based modeling is a powerful technique to simulate social phenomena such as tsunami evacuation. Each agent or evacuee evaluates the surrounding environment provided by the spatial and temporal data to schedule and adjusts his actions. The tsunami propagation inland and its features are updated at each simulation step to evaluate the human body instability using the inundation depth and velocity.

The geospatial simulation of individuals during tsunami evacuation and the analysis of the emergent behavior and outcomes will contribute on the decision process for future tsunami mitigation measures.

キーワード: tsunami evacuation, geospatial simulation, evacuation model, agent based model

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