

Significance and Course of Damage Maps of the Area hit by the Tsunami of 2011, North-east Japan 1:25,000-scale

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The huge tsunami associated with the 2011 Tohoku earthquake, which struck the Pacific coast areas, killed about 20,000 people and swept up numerous constructions. During the following several weeks, it was difficult to understand the whole conditions of damaged areas, because they were too vast and most of the roads were closed.

We interpreted air-photos taken immediately after the tsunami by Geospatial Information Authority of Japan, and mapped limits of tsunami inundation as well as catastrophically damaged areas. No-photo areas were also mapped using Google Earth and so on. Finally, we compiled our mapping results on topographic maps with a scale of 1:25,000. During mapping, all maps were cross-checked by several geomorphologist.

The purpose of this mapping is to promptly provide basic information about extent of tsunami inundation and distribution of devastated area for all people conducting countermeasures against the disaster.

Our map is characterized by the following four points. (1) The limit lines of tsunami inundation were identified with taking into account the topography and the flowing routes on the stereoscopic view. (2) Most of the air-photos we used were taken within a few days, before loss of the trail after the tsunami. (3) Since the accuracy depends on the scale of air-photos, our interpretation criteria is consistent in the whole mapped area. (4) Inaccessible areas were able to be interpreted by air-photos. The weak points of our map are that (1) the limit lines are possibly different from the true inundation edges because we judged mainly based on drifted deposits, and (2) most of the lines are not confirmed at the actual fields.

Because it is difficult to judge the limit lines of tsunami inundation on the field survey without measuring the salt level at each site, there is no perfect inundation map. We have to conduct multi-discipline approaches including air-photo interpretation, to reveal the actual tsunami-inundation areas.

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Keywords: 2011 off the Pacific coast of Tohoku Earthquake, Tsunami, Damage Map, Aerial-photo interpretation

Tsunami flow on the Sendai and Ishinomaki plains in relation to their landforms and geoenvironment

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Landforms of the Sendai and the Ishinomaki plains in northern Japan, which are strongly affected by the tsunami disaster on March 11, 2011, are characterized as the strand plain with several rows of beach ridges. Mapping on aerial photos taken just after the tsunami disaster shows characteristics of tsunami flow on the two coastal plains. The run-up tsunami invaded into the plains about 4.5 km from the coast and showed several flow types. Concentration, diversion and confluence can be seen according to the characteristics of the topography, distribution of buildings and vegetation on the plains. Direction of the back wash flow in southern part of the Sendai plain is almost towards the coast and perpendicular to the coastline. But the directions of the back wash flow in the central and northern part of the Sendai plain were various, whereas the run-up flow direction was almost perpendicular to the coastline. These characteristics of the back wash flow were controlled by the topography, building and vegetation on the plains. Lower reaches of small rivers were eroded by strong backwash flow. Wedge-shaped channel pattern in the lowest reaches of the streams were formed due to the concentration of backwash flow.

Keywords: Tsunami flow, Landforms, Geoenvironment, Sendai Plain, Ishinomaki plain

Inland Liquefaction in Tochigi Prefecture Caused by the 2011 Tohoku Earthquake

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The inland liquefaction and the damages in the Tochigi prefecture by the 2011 Tohoku Earthquake were investigated by the field surveys. The typical phenomena of sand boiling, ground depressions, and ground tilting caused by the soil liquefaction were observed. Several characteristic factors among the inland liquefaction area were the locations of the river floodplain and swamp area, the surface unconsolidated river sand-gravel layers, very shallow groundwater level, and the recent foundation - improvement works within several ten years. Additional contributing factors were the maximum 6+ of the intensity and the longer strong-motion duration of 70 seconds of the earthquake wave. These factors induced the soil liquefaction even in the inland Tochigi prefectural area by the Tohoku Earthquake

Keywords: liquefaction, 2011 Tohoku Earthquake, sand boiling

Distribution of Liquefaction Damage in Inland Area and its Evaluation in Hazard Map: A Case Study of Abiko City

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Aside the tsunami disaster, major liquefaction damage caused by the off the Pacific coast of Tohoku Earthquake occurred in Tohoku and Kanto districts. Liquefaction damage in inland area was concentrated into a small extent where special land histories exist, e.g. reclaimed land, former river channels and filled former valleys. The authors investigated the distribution of liquefaction damage in Abiko City, Chiba Prefecture, examined whether risk evaluation of liquefaction hazard map met with actual damage or not, and considered the problems of the process of risk evaluation. As conclusion, they discuss how hazard map should be created and used.

Keywords: off the Pacific coast of Tohoku Earthquake, liquefaction, land history, filled land, liquefaction hazard map

Effectiveness of interoperability of GIS data in wide-area disaster: Case in the Great East Japan Earthquake

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In this study, we introduce interoperability of geo-spatial information (web-based HTTP interface for GIS data in WMS, WFS, WCS, KML, etc., formats). We show the usefulness of interoperability and future tasks through the case of the supporting activity in the Great East Japan Earthquake.

Keywords: GIS, interoperability, the Great East Japan Earthquake

Geographic characteristics information of hazard area in large earthquake

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Geospatial Information Authority of Japan (GSI) has been developing the system which provides a governmental disaster countermeasures office with the information about the expected disasters based on the geographical characteristics of the large seismic intensity area within 30 minutes. GSI had developed the system which automatically accepts seismic intensity and outputs the expected results based on 1-km grid about the possibility of earth surface deformation, such as slope collapse, landslide and liquefaction, using existing information such as DEM, landform classification, geological map and landslide distribution maps. Now, GSI is just going to improve the anticipation algorithm of this system by comparing the output of the system with the disaster situation of the past large earthquake.

The geographic characteristic information of the large seismic intensity area is required by a governmental disaster countermeasures office. Then GSI has been trying to produce the outline sheets of the local geographic characteristic information such as landform and geology, and to send the sheets of the large seismic intensity areas to the office when large earthquake has occurred. The fundamental view of the creation of local geographic characteristic information sheets is introduced here.

At first, the quick report of seismic intensity will be announced and corresponding sheets, which are divided several geographic divisions in each prefecture, e.g. "northern Ibaraki Prefecture" and "southern Ibaraki Prefecture", will be sent.

Next, the observation data of every seismograph placed at each city, town and village are announced and corresponding sheets, which are divided a number of geographic divisions in each prefecture, will be sent. Because the distribution of seismographs is too dense for government level, the geographic division will be summarized over some cities, towns and villages. The summarize area will be decided to consider the large scale landform classification and the geological structure zone. It is more desirable for geographic divisions to have undivided local governments, but natural boundary such as large scale landform classification or geological structure zone will be given higher priority. The trial division of Ibaraki Prefecture is shown in Fig. 1. The authors think it is appropriate to divide by large scale landforms, such as plains, basins, hills and mountains first, and to divide mountains by geology second.

Northern Ibaraki Prefecture is divided into mountains area and "Central Ibaraki Hill" division which consists of plains and hills around Mito City first. Mountains area is divided into four divisions by geology as follows: "Northern part Pacific Coast and Abukuma Mountains" division is the area of the Abukuma granite and the Hitachi metamorphic rocks. "Kuji river and Sato River, Neogene" division is Neogene sedimentary rocks area. "Yamizo Mountains" division and "Keisoku Mountains" division are the areas of Jurassic sedimentary rocks.

Keywords: large earthquake, geographical characteristics, seismic intensity, large scale landform classification, geological structure zone



Practical-use of GIS by municipality and civilian considering continuity between normal and disaster period

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As condition of useful GIS during normal and disaster period, risk-adaptive regional management information system (RARMIS) concept is proposed (Hatayama et al. 1999). Yurihonjo city, which is located in northern part of Japan, has been using spatial-temporal GIS based on RARMIS concept since 2008. One of the most important concepts is continuity between normal and disaster period. Based on this concept, this paper describes on disaster prevention drill and active usage in normal period by municipal staffs and civilians.

Keywords: disaster prevention, GIS, municipality

Development of risk communication method on the town reconstruction planning

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This paper describes development of risk communication method utilizing a Risk Information Platform (e-Community Platform) on the town reconstruction planning in Ofunato city, Iwate that is East Japan great earthquake disaster stricken area. And we set up Town Revival Map Center as tool of the inhabitants participation that making and print are possible in various map information in Temporary construction mall.

Keywords: stricken area, reconstruction, town planning, residents participation, risk communication

Archive activities of tsunami escape action to interview for business place

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311 Marugoto Archives which is government-private sector jointed project records activities and phenomenon of Great East Japan Earthquake and Tsunami 2011 for carrying on the experience, lesson and message to build safe society. Recorded date is not used only for education in disaster prevention and rethinking the action plan in times of disaster, but also supporting remaking community and creating employment in disaster areas.

In this presentation, it is introduced that the archive activities of tsunami escape action to interview for business place at Kamaishi City, one of archive activities of 311 Marugoto Archives.

Keywords: the Great East Japan Earthquake, tsunami escape, Archive, Kamaishi City

Discussion on the social demand level of hazard estimation

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The 2011 Tohoku earthquake caused enormous unexpected damage, which raised a problem inherent in the hazard estimation itself. I think the most serious problem is that the demand level of hazard estimation has not yet been clarified. The demand level used to be the most serious historical hazard. Subsequently, after the earthquake, it changed to be the most serious hazard that could occur theoretically. However, the methodology to estimate the theoretical maximum hazard has not been established. Furthermore, the society is not yet ready to accept such a serious estimation. Therefore, the society should discuss the demand level of hazard estimation again in their initiative.

Keywords: hazard estimation, hazard map, social demand level

Co-seismic uplift and active fault around in the western part of Noto peninsula, central Japan

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We investigated tectonic relives along the western part of Noto peninsula, central Japan. The marine terrace surfaces are classified into H1, H2, H3, M and L surfaces in descending order. The progressively greater slopes of successively higher marine terrace surfaces clearly record continual crustal tilting to the south. To the north, the Togikawa-nangan fault dislocates them. The amount of vertical displacement is over 20 m since MIS 5e. It is not surprising that the gap in the height of strandline is not documented by geodetic data. The active fault may extend to the submarine active fault about 3 km west of the Shika nuclear power plant. There are emerged wave-cut benches similar to that produces by abrupt vertical crustal movements associated with major historical earthquakes along the coast. The significant crustal movement close to the power plant is not continuous, but coseismic.

Keywords: marine terrace, emerged wave-cut bench, active fault, Shika nuclear power plant, Noto Peninsula

Study on the legends of ancient and historical tsunamis hanbed by Ainu Race

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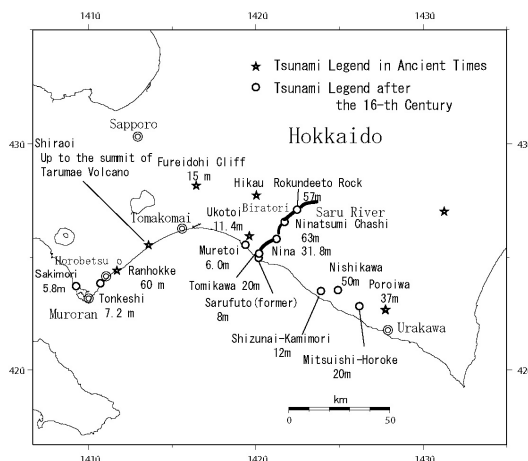
It is well known that there are many traditions of tsunamis in the legend of Ainu race, Hokkaido. On the other hand, geologists recently clarified that deposits of tsunami carried sand were found out at several places on the Pacific coasts of Hokkaido, and several tsunamis hit the coast and in some cases inundation height reach more than 20 meters (Hirakawa et al., 2003,2005), Nanayama et al.(2001, 2001, and 2003).

There are 16 points where the legends of tsunamis were handed down in Iburi and Hidaka Provinces, south coast of Hokkaido. In the present study, we made field survey for those 16 points, and measured the inundation heights.

Those traditions can be divided into two categories; 1) the events happened after the beginning of 16 century, 2) the events which happened in ancient period.

The distribution of tsunami heights is shown in the figure.

Keywords: tsunamis in Hokkaido, legend of Ainu, historical tsunamis, Iburi province, Hidaka province



A reservoir rip by the 2011 storm and flood damage and the influence

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The typhoon that attacked West Japan in the summer of 2011 gave the great damage in each place including Ki Peninsula. A reservoir of Shizuki Kawakami style collapsed in Awaji-shi, Hyogo. The saved water became the muddy stream and attacked the down stream. As a result, the cultivated area was buried among the earth and sand, and the house of the neighborhood of river mouth was flooded in a floor. In this area, I take the big damage at the time of the storm and flood damage of 2004. However, aging and local community transform decline in this area. Therefore the maintenance of a reservoir and the waterway tends to be left unattended far from advancing. By this report, I think about a reservoir excellence local disaster prevention / decrease evil. This is a report of the situation that the downstream village where is totally unrelated to a reservoir for agriculture of upper reaches suffered from.

Keywords: reservoir, flood, rip, GIS, storm and flood damage

Long-term changes of heavy rainfalls in Vietnam

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Every year, Vietnam is strongly affected by the TCs which are originated within the South China Sea (SCS) or are entered the SCS from the Western North Pacific with high frequency in the northern and central region and low frequency in the southern region. Impact from typhoon or TC and its consequence is one of the major natural hazards to the coastal region in Vietnam. This study focuses to understand the long-term change of rainfall and heavy rainfall days caused by TC in the period 1961-2008 for the coastal region of Vietnam using the TC best-track data obtained from the UNISYS website archive and daily rainfall data from 15 weather stations observed by the Vietnamese National Hydro-Meteorological Service.

The results show that TC rainfall has an increasing trend in all regions along the coastline. For TC heavy rainfall day (> 50 mm d-1), a significant increasing trend is found in the central region, but no significant trend is detected in the south region. The long-term change of heavy rainfall occurrences was noted in the previous study, and contrastive trend was noted in northern and southern Vietnam. However, the reason for that feature was unknown. The results suggest that the cause of the increasing trend in heavy rainfall in the central Vietnam can be explained by TC rainfall, while that contrastive trend in the north and south region can be answered by non-TC rainfall.

A significant increasing trend of the annual average TC rainfall and TC heavy rainfall day over 15 selected stations are also found for the 48-year period, in particular, a strong significant increasing trend is seen for the period 1976-1995, but it tends to decrease in the following stage.

Keywords: heavy rainfall, typhoon

A Study from the Questionnaire Result to Youth and Senior Citizens on Preparation for Emergency - Zagreb, Croatia

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This research will study the social survey results on emergency case, especially floods, to the youth and senior citizens in Zagreb, Croatia, in order to find a possible way to build a bridge between past experience and today's life regarding awareness-raising and preparedness in the context Croatian society. The City of Zagreb, the capital of Republic of Croatia, is located between Medvednica Mountain and the Sava River, a tributary of the Danube River. In 1964, the city experienced a huge flood caused by heavy rainfall. Due to the characteristic of its location between the mountain and the river, a large amount of rain water was flowed into the city. The central part of Zagreb city had to be suffered from extensive damage with 17 casualties. Having learned from this bitter experience, a drainage canal (Sava-Odra Canal) and retention dams/flood storage on the rivers from mountain side were constructed. There has been no outstanding flood occurred since then. However, this region in the Balkan Peninsula has some earthquakes and the City municipal government has also been conducting researches on flood simulations of bank/dam ruins caused by a strong earthquake in Zagreb. It was observed from a preliminary social survey that people living in the city know about historical floods event, however, their preparation status is basically individual base as well as they want to know more how to prepare themselves and what to do on emergency cases such as flood and/or earthquakes. Although City Museum did exhibition regarding historical flood events in the city, it seems that there was no sections to encourage interactions of experiences from the past experience and everyday's life. How can flood disaster experiences of the senior citizens be more included and counted for better preparedness and awareness-raising in Croatian context? The social survey result showed that more or less 30% of people answered "I am prepared" in any group and about 70% thinks there will be a flood occurred in Zagreb in future. Received the result, this research tries to answer the above question with seeking a applicability of Japanese experiences. It also tries to study, as way forward, if computational tools such as virtual flood experimental tool can be effective enough as educational tool for awareness-raising.

Keywords: flood, experience, preparedness, educational tool, Croatia

Detection criteria for tsunami-inundation area of the Tohoku earthquake, based on air-photo stereo-pair interpretation

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Air-photos revealed tsunami damages vast and serious, which were taken immediately after the 2011 off the Pacific coast of Tohoku earthquake, northeast Japan. For quick and intensive, rescue and recovery activities, we conducted their stereo-pair interpretation to release '1:25,000-scale tsunami damage map' online 17 days after the earthquake. The latest '2011 final' edition was released on December 11, 2011. Stereo-pair air-photos enable us to identify tsunami-inundation areas when interpreted from the following points of view: landforms, elevations, land conditions, geomorphic histories, land uses, and man-made infrastructures, in addition to tsunami-flow courses. We describe our identified tsunami-inundation evidences, hints, and problems in the mapping, to manage future devastating tsunamis.

Keywords: tsunami, landform, air-photo, stereo-pair analysis, 2011 off the Pacific coast of Tohoku earthquake

Comparison between Liquefaction Area Associated with the 2011 Tohoku earthquake and Interferometric SAR Coherence Change

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Preface: In this study, we demonstrate that reductions of coherence values, which obtained from interferometric analyses using SAR data acquired before and after the occurrence of liquefaction, have good spatial correlations with the liquefaction area investigated from field surveys. Associated with the 2011 Tohoku earthquake, liquefaction occurred in Kanto District, mainly in Chiba and Ibaraki prefectures. After liquefaction occurred, serious ground surface changes due to sand boiling etc. are expected to culminate in significant coherence reduction. So far, there have been some reports in which incoherent phase areas in an interferogram have been regarded as liquefaction area. However, it is not necessarily appropriate that the incoherence in an interferogram is used as an indicator of liquefaction area, because the incoherent area does not necessarily reflect the liquefaction in the case that the scattering condition easily varies owing to inherent bad ground condition (e.g., arable land). Thus, in this study, we attempt to make use of a reduction of coherence value as an indicator of identification of liquefaction area. This is why it is presumably expected that coherence values largely decrease associated with serious ground condition changes due to liquefaction and for inherent bad ground condition area there is no significant coherence change.

Analysis procedure: To identify the liquefaction area, we generate a differential image of two coherence images. One coherence image is obtained from an interferometric analysis using SAR data acquired before the 2011 Tohoku earthquake, and the other is from SAR data before and after the earthquake. We here subtract the coherence values of the former image from those of the latter one. We compare the liquefaction areas to the areas where the coherence values decrease. Our studied areas are around the lower Tonegawa River and along Tokyo Bay, where serious liquefaction occurred associated with the 2011 Tohoku earthquake. For the analysis, we use ALOS/PALSAR data acquired on December 28, 2010, February 2, 2011 and March 20, 2011 for the lower Tonegawa River (path 404) and January 4, 2011, February 19, 2011 and April 6, 2011 for Tokyo Bay (path 405).

Result: We find good spatial correlations between the area showing decrease of coherence values and the liquefaction area for both the studied areas. For the lower Tonegawa River, in particular, significant reduction in coherence values can be recognized in Hinode District in Itako City, Sawara District in Katori City, and Nishishiro District in Inashiki City. Especially, we can recognize a high spatial correlation between the two in Hinode District where serious liquefaction in residential area has occurred. For Tokyo Bay, reduction of coherence values distributes along the coastal zone from the city of Urayasu to Narashino. In and around Urayasu City, the reduction of coherence values can be recognized in the coastal zone from metropolitan express way. However, in Tokyo Disney Land and in seaside zones of Minato, Takasu, Akemi, and Hinode Districts, there is no remarkable reduction on coherence. These features observed from the differential coherence image are consistent with the field survey results.

Acknowledgment: PALSAR data are provided from Earthquake Working Group under a cooperative research contract with JAXA (Japan Aerospace Exploration Agency) and are the products that GSI purchased through "Joint Cooperative Agreement between GSI and JAXA for observation of geographic information using Advanced Land Observing Satellite (ALOS) data". The ownership of PALSAR data belongs to JAXA and METI (Ministry of Economy, Trade and Industry).

Keywords: the 2011 Tohoku earthquake, Liquefaction, InSAR, Coherence reduction

Consideration on the distribution of liquefied sites in relation to the micro-topography and land history

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The occurrences of liquefaction damage in the Tone River lowland and Osaki plain induced by the 2011 off the Pacific coast of Tohoku Earthquake were observed and mapped on the basis of field survey and Google Earth images interpretation. The results of GIS analysis and old edition maps which have been published since the Meiji era indicate that a large number of the liquefied sites are located on reclaimed land of former river channels and lakes, and flood plain (backmarsh). In the Tone River lowland, many liquefied sites located on the former river channels and lakes had been reclaimed during 1950 to 1970. We should pay attention to micro-topography and detailed land history in case of mapping the hazard risk of liquefaction damages.

Keywords: liquefaction damage, micro-topography, land history, Tone River lowland, Osaki plain, 2011 off the Pacific coast of Tohoku Earthquake

Liquefaction-Fluidization phenomena in Chiba on Kanto Basin at the 2011 Earthquake off the Pacific Coast of Tohoku

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Outline of liquefaction-fluidization phenomena on the Boso peninsula in the Quaternary Kanto Basin and characteristics of liquefaction-fluidization disaster on Tokyo bay reclaimed land by the 2011 Earthquake off the Pacific Coast of Tohoku are reported in this paper.

OUTLINE OF LIQUEFACTION-FLUIDIZATION PHENOMENA ON BOSO PENINSULA: 1) Liquefaction-fluidization disaster distribute on reclaimed land by Man-made strata. 2) Liquefaction-fluidization phenomena distribute mainly on JMA intensity 5+. 3) Liquefaction-fluidization phenomena distribute mainly on northern Boso peninsula. Because the strength of shaking increase to north of Boso peninsula. 4) Liquefaction-fluidization phenomena are more serious and widely at this earthquake than at 1987 east off Chiba prefecture earthquake. 5) Seriousness of damage by liquefaction-fluidization are different in reclaimed land. The seriousness may depend on facies and thickness of Man-made strata and Holocene formation.

CHARACTERISTICS OF LIQUEFACTION-FLUIDIZATION DISASTER ON SOUTHERN CHIBA CITY IN TOKYO BAY RECLAIMED LAND: 1) Liquefaction-fluidization damage zones with few hundred meters wide distribute on this reclaimed land. Large part of the damage zones distribute on the thick part of the Holocene formation. 2) Liquefaction disaster distribute on sandy strata of Man-made strata, but the disaster distribute little on muddy strata of it (Kazaoka et al.,2000;2003). Liquefaction-fluidization part with one hundred meters wide may depend on the litho-facies lateral change of Man-made strata. 3) Intensity of liquefaction-fluidization phenomena is recognized by deformation of ground surface and amount of subsidence. 4) Jetted sand distribute under 2 meter height, from road surface, in artificial hill. This shows the groundwater table to rise to 2 meters height from road surface. 5) Strong shaking might decrease on liquefaction-fluidization part, because tall furniture toppled little in there. Same phenomena happened at the 1995 Hanshin-Awaji Earthquake (Nirei et al.,1996).

SURVEY POINT FROM NOW: It is very important the next surveys for urban planning against liquefaction-fluidization disaster. 1) Recognition of lateral change of seriousness of damage and ground deformation by liquefaction-fluidization. 2) Recognition of lateral change and vertical change of litho-facies in the Holocene formation and Man-made strata. 3) Recognition of correlation between amplification characteristic of shaking and geological structure. 4) Recognition of groundwater flow and table in each aquifer.

FOR FUTURE RESTORATION AND RECOVERY: 1) Against liquefaction-fluidization damage: It is very important to recognize the geological diversity and sustainable use on each site. It is necessary to consider as follows on damage control, damage situation of this earthquake, land use, geological environment, decrease effect of shear wave by liquefaction. 2) Importance of groundwater: It is necessary to use daily the disaster prevention well and to monitor groundwater table and quality of the well. 3) Continuous landsubside after jetted sand. 4) Disaster education: Most of disaster is earth science field of the science. It is necessary to teach Man-made strata, the Holocene formation and the Neogene strata which disaster occur often on, and to teach geological disaster, Earthquake, Tunami, Landsubside, Slope failure and Geo-pollution. Further it is necessary to teach sustainable use of Geo-resources, such as Land and Groundwater.

Keywords: Liquefaction-Fluidization, The 2011 Earthquake off the Pacific Coast of Tohoku, Boso peninsula, Man-made strata, Tokyo bay reclaimed land, Urban Geology

Distribution of Geoplogical Disaster by Liquefaction-Fluidization Phenomena on Boso peninsula at The-2011 off the Pacific

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Liquefaction-fluidization phenomena were occurred by the 2011 off the Pacific coast of Tohoku Earthquake in Tokyo Bay reclaimed land area. Tone River lowland area and Kujukuri plain in Chiba prefecture. In Tone River lowland, liquefaction-fluidization disaster distributed on man-made strata. In the lower Tone River Plain, some marshes and lakes were reclaimed for paddy fields. Other ponds and lakes resulted from river improvement work were filled by riverbed fine grained sand for paddy fields and houses. Liquefaction-fluidization disaster are more serious and widely at this earthquake than at 1987 off Chiba prefecture earthquake. Seriousness of damage by liquefaction-fluidization is different in reclaimed land. It is supposed that the reason of the difference is the difference of the man-made strata and the Holocene deposits. The ground wave "Jinami" were found in some areas.

Kujukuri Plain characterized over ten of sand dunes are distributed in Kujukuri Plain. Marshes and ponds distributed between the dune lines were filled by fine grained sand of dune sand and the Shimosa Group collecting for houses lots. Along the coast, sand dune was dug for iron sand. Then the sites were filled up again by the iron removed sand. In past this area suffered the liquefaction-fluidization hazards caused by earthquake at December 17, 1987. These artificial beds also liquefied by the 1987 East Off Chiba Prefecture Earthquake (Nirei, et al., 1990). The hazards were more extensive than that of the past same scale earthquakes (Nirei, et al., 1990). The liquefaction-fluidization hazards caused by the 2011 off the Pacific coast of Tohoku Earthquake, on the northern part of Kujukuri plain seen more widely and seriously than the 1987 East Off Chiba Prefecture Earthquake. But the phenomena could not be observed in the southern part of Togane city.

In Asahi city, located in the northern part of Kujukuri plain, the liquefaction-fluidization phenomena occurred more extensively than the 1987 East Off Chiba Prefecture Earthquake. Also the liquefaction-fluidization hazards were more serious. But the degree of damage varies by location. It is considered the impact of the differences in the thickness of the soft sand. Along the coast, sand dune was dug for iron sand. Then the sites were filled up again by the iron removed sand from many local residents -there was testimony that the liquefaction-fluidization hazards occurred. At Komatsu/Hasunuma-Hira, Sanmu city, located near the Kido-gawa river mouth, the severe liquefaction-fluidization hazards occurred. It is considered the impact of the differences in the thickness of the Holocene sediments and to configure the type of strata.

Keywords: Liquefaction-Fluidization, Tone River, 2011 off the Pacific coast of Tohoku Earthquake, 1987 off Chiba prefecture Earthquake, digging of iron sand ore deposit, Kujukuri plain

Optimized shape design of gravel drains in liquefaction countermeasures

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Liquefaction countermeasures are roughly categorized into two methods, one is the gravel drain method, the other is the sand compaction pile method. These methods mainly aim the reduction of excess pore water pressure in underground during earthquakes. We focus on the gravel drain method in terms of optimal shape design of the gravel drains having a superior drainage performance.

To detect such optimized drain shape, we convert the practical problem into a mathematical programming problem involving the partial differential equations concerning seepage flow. Then an efficient mathematical programming technique in conjunction with the finite element method (FEM) is employed.

The problem solving process consists of three operations:

- (1) Solve the partial differential equation for seepage flow by the FEM.
- (2) Perform the sensitivity analysis based on the adjoint variable method.
- (3) Solve the mathematical programming problem to update the design variable.

These operations are continued until the convergence with respect to the objective function value and robustly detect the optimized drain shape within a reasonable CPU time.

The tendencies and remarks of the obtained optimal drain shapes are clearly found that those optimized shapes are similar to the roots of plants in the underground and dramatically reduce the mean of hydraulic head as compared with those of the normal gravel drains. Moreover, it is also found that the fractal dimension of the optimal drain shape is measured as $D=2.3$, which corresponds to those measured in blood capillary systems inside the living creatures.

Keywords: liquefaction, gravel drain method, finite element method, optimization

Rough forecast damage just after earthquake

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Rapid grasp of damages is very important for emergent countermeasures of large disaster in government level. However, outline of damage is not easy to grasp immediately after the big earthquake. For example, the outline became clear by live TV picture in case of the Southern Hyogo prefecture earthquake in 1995; it was 2 hours after the shock. The whole aspect of damage of Yamakoshi village became clear in the next morning in case of the Mid Niigata Prefecture Earthquake in 2004.

Lack of information is probable even now by darkness, bad weather, complication of information, and damage on communication line. In this case, rough forecast of damage based on seismic intensity and regional characteristics must be serviceable just after earthquake.

Early Estimation System (EES) of Disaster Information Systems (DIS), which cabinet office operates, quantitatively forecasts buildings and human damages. This study targets on geo-disasters, which EES do not target; slope collapse, landslide (as narrow sense), and soil liquefaction. We try to automatically calculate and send rough forecast information to related authorities within 30 minutes. The calculation uses real time information such as estimated seismic intensity distribution map by Japan Meteorological Agency, and existing geospatial information such as Digital Terrain Mode (DTM), geomorphologic data, geological data. The system also automatically output some overlay maps of real time information and existing geospatial information. The system provides environment to exchange ideas between assembled and non-assembled staff referring the rough forecasts and the overlay maps.

Automatic calculation of rough forecast is workable triggered by the real time information at the time of writing this manuscript. But it the calculation results are not in practical-use level. Other functions of the system are in developing. Calculations are in 1 km grid, and now improving to 250 m grid.

Rough forecast of slope collapse is based on the Rokko formula, which is developed by National Institute for Land and Infrastructure Management. The Rokko formula is depending on maximum acceleration, slope, and curvature. Maximum acceleration is estimated using seismic intensity. The Rokko formula is separated into acceleration part and slope/curvature part. Therefore slope/curvature part is calculated and histogram of the part within each cell is obtained before earthquake using 10 m grid DEM; its decrease amount of calculation at earthquake.

Rough forecast of land slide is calculated by table operation of seismic intensity and land slide area ratio, which is ratio of transportation and sediment area over the whole area of the grid cell.

Rough forecast of soil liquefaction is calculated by table operation of seismic intensity and geomorphologic data. We use Wkamatsu's geomorphologic data, because the data was produced by same method over whole Japan.

Keywords: realtime damage forecast, earthquake

Grasping damage situation by accessibility to internet servers

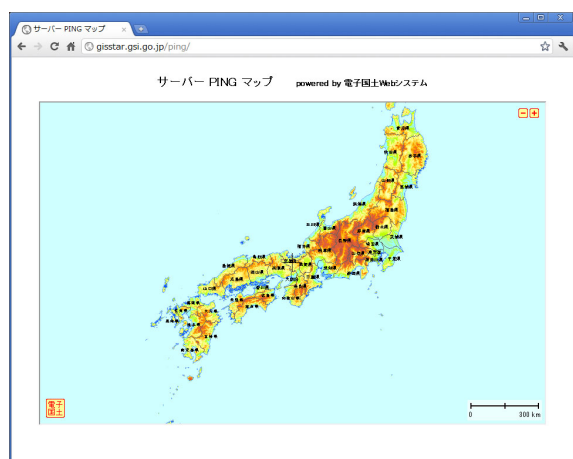
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Rapid grasp of damages is very important for emergent countermeasures of large disaster. However communication to damaged area may not be available. Accessibility to servers via internet may be useful as a source of grasping damaged area. Therefore, a system to check servers and to map the result using cyber Japan web system is developed. The system employs 3 kinds of check method: replay of ping (replay of ICMP echo request), replay of TCP connection request, and replay of HTTP request via proxy server.

Reasons of no response except damage of the server or location of the server are following; server down not caused by the disaster, damage on internet backbone network, access implosion to server or internet, damage on power plant or power transmission backbone network. On the other hand, a server in earthquake resistant building with emergency power supply may respond even the area suffered serious damage. Furthermore, a server may not be at building of server owner but at data center. Selection of servers and interpretation of result are farther problems.

Keywords: Grasping damage situation, ping



Relief energy of slope failures area affected by the Mid Niigata Prefecture Earthquake in 2004

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The Mid Niigata Prefecture Earthquake in 2004 caused various scales many slope failures in the Chuetsu area. The distribution of them was interpreted by aerial photographs and the disaster condition maps of the earthquake were published by the Geospatial Information Authority of Japan. In this study, we investigated the characteristics of the relief energy at the slope failures using polygon or polyline data indicating them in the disaster condition maps. The large scale slope failures indexed by polygon data are considered landslides and the small scale ones indexed by polyline data are considered surface failures.

For analysis on the relief energy, elevation data of 10m-mesh digital elevation model in the fundamental geospatial data were used. Two kinds of relief energy were calculated. The first relief energy is defined as the elevation difference between maximum elevation and minimum elevation in the unit area whose sizes are 0.01km², 0.25km² and 1km². The second relief energy is defined as the elevation difference between the two landform models of summit level and valley level. In the calculation on the models, we set the minimum watershed area whose sizes are 0.04km², 0.09km² and 0.25km². We overlaid the scarps of the large scale slope failures, the landslide masses of them and axes of active folding with these relief energy maps by GIS. We clarified two results in the calculation cases of 1km² of the unit area or 0.25km² of the minimum watershed area. It seems that the relief energy is larger at the area between anticlinal axis and synclinal axis, and it is easy to confirm that the relief energy tends to be larger at the area where the large slope failures occurred in comparison with the surrounding areas.

The coordinates of the centroid, the distance from the epicenter and the two kinds of relief energies at the centroid on scarps, landslide masses and the small scale slope failures were analyzed by GIS. Many graphs plotted with relief energy on their landforms and random points for as the vertical axis and the distance from the centroid as the horizontal axis were prepared. By analyzing these graphs, it was clarified that the occurrence of the landslides concentrated within about 11km distance from the epicenter. This trend appeared more clearly on the large slope failures. We clarified two results by the comparison of their landforms and random points. The slope failures tend to occur in the area where is larger than some value of the relief energy and to be difficult to occur in the area where is smaller of the relief energy at far distance from the epicenter. The latter trend appeared more clearly on the small slope failures. It is easy to understand these characteristics from the graphs on larger unit area or watershed area in the calculating relief energy.

Consequently, we pointed out a possibility that the basic factor of the slope failures induced by the earthquake is not only the erosion by rivers but also the active folding and that the incentive of them is the seismic ground motion by the overlay analysis between various kinds of relief energy and landforms such as large landslide, etc.

Keywords: relief energy, DEM, slope failure, landslide, The Mid Niigata Prefecture Earthquake in 2004

Geomorphic characteristics of landslides caused by the Northern Nagano Prefecture Earthquake of Mar. 12, 2011

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A lot of landslidings were caused by the Northern Nagano Prefecture Earthquake (M=6.6) of Mar. 12, 2011. Based on the air-photo interpretation, the characteristics of landsliding localities were classified into five types, i.e. 1)crest slope surrounding slopes of which had collapsed in the past; 2)upper end of some old landslide scarp; 3)steep slope along small stream which is lower than the apparent knick line; 4)undercut slope of Chikuma River and 5)inner area of moving mass of old landslide. From the geomorphological point of view, these are all unstable part of slopes.

Keywords: earthquake, slope failure, air photo, knick line, unstable slope, geomorphology

Effects of school education for disaster prevention -An evaluation through the experience of the Tohoku Earthquake-

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The author had involved in education for disaster prevention in some schools in Sendai and Yamagata before the Tohoku Region Pacific Coast Earthquake in 2011. The practices were as follows;

- August to September in 2007 at Sendai City Kitarokubancho Elementary School: Twelve school hours of Integrated Studies for fifth-grade children including special lecture by the author and workshop (town watching and mapping).

- June in 2010 and February in 2011 at Yamagata City Dai-yon and Dai-san Junior High Schools respectively: Two school hours of Home Economics for seventh-grade students including special lecture by the author.

Questionnaire surveys were conducted to the students who had attended the class in July to September in 2011. According to the result of the surveys, the effects of the practices are positive in general. However, some students express they have forgotten the contents. School education for disaster prevention should be embedded in the curriculum, so that the children and students learn systematically along the developmental stages.

Keywords: earthquake disaster, education for disaster prevention, evaluation, the Tohoku Region Pacific Coast Earthquake

”100 Active fault-scape in Japan” movement and its implication in reduction of disaster risk

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The Active fault 100 selection subcommittee of Japanese Society for Active Fault Studies will present our activities of ”100 views of active faults in Japan” movement and its implication in reduction of disaster risk.

We run the 2011 photo-contest of active faults in Japan as an activity of aiming the popularization of active fault. In addition, we carried out one day excursion to 3 of 100 views of active faults in Japan, in order to promote further understanding of active fault.

1. Result of the 2011 active fault photo-contest

-Number of applicants and photos; 20 and 61 respectively

-Types of photos; surface earthquake fault, view from sky, outcrop of active fault or tectonic geomorphology, views including trench

-Prize winner: Mr. H. Kurosawa (outstanding performance award), Mr. Y. Kohriya, Dr. H. Goto, Mr. J. Tamura, Dr. M. Watanabe

The photographs are uploaded in the homepage of the society.

2. Excursion of the active faults

We carried out one day excursion of Neodani fault just after the 120th memorial symposium of the 1891 October 28th Nobi earthquake, Miura-Hanto fault group on November 27th after the annual autumnal academic meeting and Tachikawa fault 28 January next day of its lecture. The followings are a few more details.

-Types of excursion; one day trip for mainly professionals by bus to Neodani fault and Miura-Hanto fault group, and one day on-site explanation for non-professional visitors or citizens of Tachikawa city.

-Participants of three excursion; 35, 25, and 190. ratios of member to non-member, 1:2 for the former two and 1:10 for the third.

-Positions of non-member participants: prefectural and city assembly members, disaster-prevention division's staffs of local governments, disaster-prevention leader and volunteers, teachers, meteorological observatory staff, university students, geotechnical engineers, media reporters or TV crews.

3. The implication of photo-contest and excursions for reduction of earthquake disaster risk and its expectation

In diffusion of information of active fault and tectonic geomorphology, it will be very important for not only professionals but also non-professionals to participate such events.

As for photo-contest, many of photos of surface earthquake faults of Idosawa and Yunodake fault formed during the Fukushima Hamadori earthquake(Mjma 7.1) on 11 April 2011 were applied by non-member citizens, where not a few non-professional as well as many professionals were told to visit the areas of the surface faults. Four of seven prize winners'photos were selected from non-member non-professional. Both results seem to be a favorable tendency to lead citizens to understand non-divisible relationship between active fault and earthquake, especially under the present special circumstances after the great 2011 Tohoku earthquake. It may be suggested that both the applicants and winners will be expected to become good promoters of understanding or storyteller of active fault. Field excursions of such surface earthquake faults must be one of suitable events for citizens as well as professionals to understand the importance of active fault triggering earthquakes and reduce the risk of earthquake disaster.

Based on the results of the two excursions and on-site explanation of active faults, there were characterized by participants of peoples who were responsible for preparations for disaster-prevention measures or were presumed to be deeply involved in reduction of disaster risk. We will present some suggestive facts for reducing the risks of earthquake disaster, which are drawn from analyses of on-site questions and the questionnaire of excursion.

Keywords: active fault, active geomorphology, active fault 100, 100 views of active faults, earthquake disaster risk, Science and disaster education

Liquefaction-Fluidization phenomena in the 2011 Tohoku Earthquake : Tokyo bay reclaimed land in Urayasu area

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Large scale Liquefaction-Fluidization phenomena was caused by the 2011 off the Pacific coast of Tohoku Earthquake in Tokyo bay reclaimed land areas. Serious liquefaction disaster is recognized as the boiled sand, ejection of sandy water, deformation ground surface, land subsidence and floating underground tanks.

The leveling between the surface bench mark and the 10m piled bench mark indicates that compaction of the shallow strata reached about 14cm. The measuring upward displacement of the piled buildings reveal the serious liquefaction subsidence area. The value of upward displacement is harmonious with liquefaction degree. The maximum displacement reached 95cm more over. Heavy Liquefaction-Fluidization zones correspond to the distribution of thick Holocene formation and/or deep trench of dredge under Artificial formation.

On reclaimed land area, most buildings were existing in the residence area, however, comfortable life are destroyed. Liquefaction-Fluidization phenomena is an exceptional event, however, it is a big problem for low lying and reclaimed land areas because of the immediate heavy damage caused.

Keywords: Liquefaction-Fluidization Phenomena, Tokyo bay reclaimed land, land subsidence, upward displacement, leveling, piled bench mark

Development of a tunable differential absorption lidar using a mid-infrared laser to detect toxic gasses

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Shinshu University is cooperating with RIKEN to develop a differential Absorption LIDAR (DIAL) using a mid-infrared laser to detect toxic gasses with a high sensitivity. The gasses have the individual absorption spectrum in mid-infrared region. So we are developing a tunable laser with the spectral range of 6~10 micro m. In this talk, we present the detail lidar system, especially with a data acquisition system.

Keywords: lidar, DIAL, mid-infrared laser, toxic gass

Tropical cyclone activities and their impacts on greenhouses under Agricultural Disaster Compensation System

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In recent studies, the specific anomalous tendency of steering flow to control a tropical cyclone track and stronger influences of tropical cyclones on subtropical East Asia have been pointed out in the western North Pacific. There is a viewpoint that this phenomenon is related with the global warming, and it is concern with the possibility of continuous tendency in future. In this study, to recognize the impacts of such a climate variation on a regional agriculture, we discuss the institutional issues including the business deployment of agricultural mutual aid associations as a specific example by the damage of horticultural facility in Okinawa.

The best track data, compiled by the Regional Specialized Meteorological Center Tokyo (RSMC Best Track Data), were used to clarify the interannual variation of the frequency distribution of tropical cyclone centers near the shore area of Okinawa Prefecture in late years. The result showed that the frequency of tropical cyclone center from June to October significantly increased around the west of Okinawa Island in the 2000s, and this was observed corresponding to the increasing damage of the horticultural facility in Okinawa.

Based on the results mentioned above, the major factors of damage to horticultural facilities and the business deployment of agricultural mutual aid associations in the agricultural disaster compensation system were analyzed in Okinawa Prefecture. Then the regional difference of damage to horticultural facilities and its influences on the agricultural disaster compensation system were discussed in the case within the jurisdictional district of the agricultural mutual aid association in Kunigami County, the northern part of Okinawa.

There is the continuity and a certain regularity of occurrence in the damage to horticultural facilities over the whole country, and Okinawa Prefecture has a high damage ratio. The occurrence of damage depends on the locations and existence time in passing typhoons, the wind direction and speed, and the form of green house covered by the mutual aid system. In the case of the jurisdictional district of agricultural mutual aid association in Kunigami County, that has the especially high ratio of damage to horticultural facilities in Okinawa Prefecture, the strong wind with typhoons and green houses with low resistance to wind cause the extent of damage. There are also the regional differences both of participation rate and of the damage ratio in each municipality within the district, related to the distinctions of implementation contents in the grant-aided project of the national and local governments to the construction of horticultural facilities, and to those of dominant crops. Therefore, the damage of horticultural facilities combines the aspect of natural disaster by typhoon and that of social disaster reflected in the grant-aided projects to the facilities and to encourage producing centers. These regional differences cause the conflicts of coverage options between areas.

It can be considered that the risk management of agricultural mutual aid association will have two types of change, that is, the correspondence with individualization, and the realignment of jurisdictional districts with the reorganization of agricultural mutual aid associations.

Keywords: tropical cyclone, typhoon damage, Okinawa, greenhouse, agricultural mutual aid association