Global Dynamic Exposure and the OpenBuildingMap - Communicating Risk and Involving Communities

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Detailed understanding of local risk factors regarding natural catastrophes requires in-depth characterization of the local exposure. Current exposure capture techniques have to find the balance between resolution and coverage. We aim at bridging this gap by employing a crowd-sourced approach to exposure capturing, focusing on risk related to earthquake hazard. OpenStreetMap (OSM), the rich and constantly growing geographical database, is an ideal foundation for this task. More than 3.5 billion geographical nodes, more than 200 million building footprints (growing by ~100'000 per day), and a plethora of information about school, hospital, and other critical facilities allows us to exploit this dataset for risk-related computations.

We are combining the strengths of crowd-sourced data collection with the knowledge of experts in extracting the most information from these data. Besides relying on the very active OpenStreetMap community and the Humanitarian OpenStreetMap Team, which are collecting building information at high pace, we are providing a tailored building capture tool for mobile devices. This tool is facilitating simple and fast building property capturing for OpenStreetMap by any person or interested community. With our OpenBuildingMap system, we are harvesting this dataset by processing every building in near-realtime. We are collecting exposure and vulnerability indicators from explicitly provided data (e.g. hospital locations), implicitly provided data (e.g. building shapes and positions), and semantically derived data, i.e. interpretation applying expert knowledge. The expert knowledge is needed to translate the simple building properties as captured by OpenStreetMap users into vulnerability and exposure indicators and subsequently into building classifications as defined in the Building Taxonomy 2.0 developed by the Global Earthquake Model (GEM) and the European Macroseismic Scale (EMS98). With this approach, we increase the resolution of existing exposure models from aggregated exposure information to building-by-building vulnerability.

We report on our method, on the software development for the mobile application and the server-side analysis system, and on the OpenBuildingMap (www.openbuildingmap.org), our global Tile Map Service focusing on building properties. The free/open framework we provide can be used on commodity hardware for local to regional exposure capturing, for stakeholders in disaster management and mitigation for communicating risk, and for communities to understand their risk.

Keywords: Seismic Hazard and Risk, Exposure, Citizen Science, Big Data
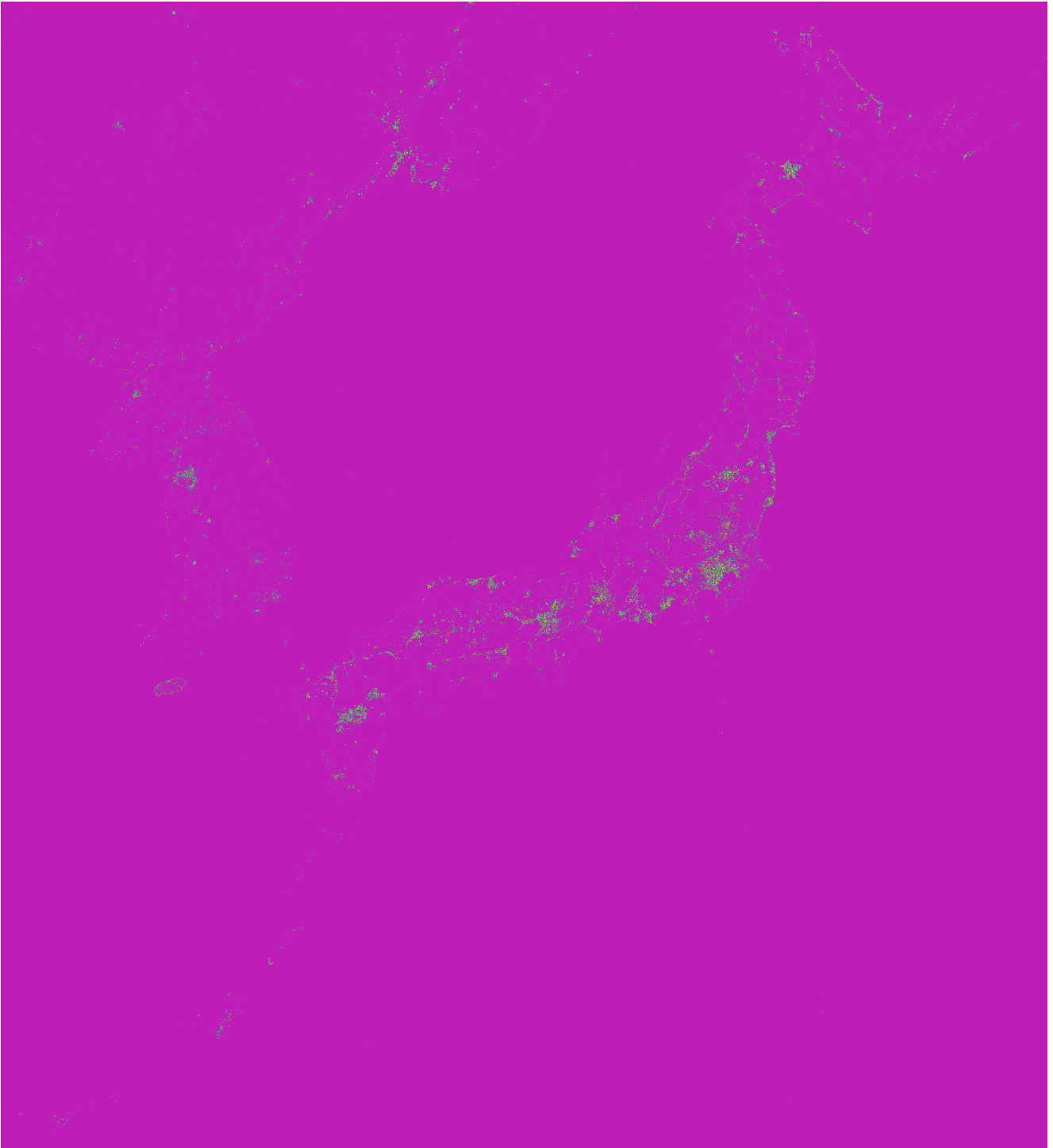
Citizen Earthquake Science in Taiwan: From Science to Hazard Mitigation

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Taiwan is located at seismically highly active area, where is a convergent plate boundary zone between the Eurasian plate and the Philippine Sea plate. To bring seismology in a simple way to citizens at school and home, we are incorporating the Quake-Catcher Network (QCN) program into an educational seismic network that is maintained by teachers in more than 200 high schools in the whole island of Taiwan. We established a web-based educational platform so that users are encouraged to interact with these collected seismic waveform data and even to conduct further signal analysis on their own. In addition, to collect field observations for any earthquake-induced ground damages, such as surface fault rupture, landslide, rock fall, liquefaction, and landslide-triggered dam or lake, etc., we are developing an earthquake damage reporting system for public but particularly relying on trained volunteers who have taken a series of workshops, organized by this project. This Taiwan Earthquake Scientific Report (TSER) system is based on the Ushahidi mapping platform, which has been widely used for crowdsourcing. Some online games and materials for educational purposes on learning earthquakes will be ready in a near real-time manner for students and teachers. All These constructed products are now operated at the Taiwan Earthquake Research Center (TEC). With these newly developed platforms and materials, we are aiming not only to raise the earthquake awareness and preparedness, but also to encourage public participation in earthquake science in Taiwan.

Keywords: citizen science, crowdsourcing, Taiwan Earthquake Science Information System, Taiwan Earthquake Research Center

Japanese New Guidelines for the Information of the Prospect of Seismic Activity after Big Earthquakes and their Applications

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A big earthquake of M6.5 with maximum seismic intensity 7 in Japan Meteorological Agency (JMA) seismic intensity scale occurred in Kumamoto Prefecture at 21:26 on 14 April, 2016 (Japan Standard Time). That was the beginning of the sequence of "The 2016 Kumamoto Earthquake". After 18 hours of this earthquake, JMA issued prospect of aftershock activity that there was a possibility to suffer strong ground motion with JMA seismic intensity 5+ or 6- in some areas by aftershocks for about one week. The probability of aftershocks which cause JMA seismic intensity 6- in some areas was calculated to be 20% for the next 3 days from 16:00 on 15 April, and the number of the probability was announced by JMA. This prospect was based on guidelines determined by the Earthquake Research Committee (ERC) of the Headquarters of Earthquake Research Promotion (HERP) in 1998. However, after 10 hours of the issuance of the prospect, a bigger earthquake of M7.3 with JMA seismic intensity 7 occurred at 01:25 on 16 April in the same region as the first big earthquake of M6.5, and triggered distant earthquakes. The seismically active area was finally spread southwest to northeast up to about 150km long from Kumamoto Prefecture to Oita Prefecture. As this seismic activity was revealed that it was not a simple mainshock - aftershock patterns, JMA stopped issuance of the following information about prospect of aftershock activity. Instead of issuance of prospect, JMA called attention to people to high seismic activity and strong ground motion by big earthquakes on the basis of previous cases in that area.

With lessons learned from this, seismologists and JMA discussed under a framework of the HERP, and the ERC of HERP published new guidelines for the information of the prospect of aftershock activity after big earthquakes in August 2016. The points of the guidelines are followings.

(1) JMA calls attention to strong ground motion which is similar level to the first big earthquake for about one week after big earthquakes.

(2) If there were prior cases of foreshock - mainshock - aftershock series or earthquakes with similar magnitude which occurred in the short term near the big earthquakes, JMA calls attention to such cases.

(3) If active faults and assumed source regions of big thrust-type subduction-zone earthquakes existed near the big earthquakes, JMA explains the characteristics and calls keeping in mind them.

(4) After one week, if the active seismic activity continues, JMA issues aftershock probability. The probability is shown by magnification ratio which compares to the probability just after the biggest earthquake and before the big earthquakes.

(5) JMA uses a word "earthquake" instead of "aftershock" when JMA calls to attention to strong ground motion by aftershocks, because the word of "aftershock" gave some impression to people that bigger earthquakes would not occur.

We will introduce new Japanese guidelines and show some actual examples of its applications.

熊本地震が人々の地震へのリスク認知と情報源への信頼に及ぼした影響
The influence of the Kumamoto earthquakes on public risk perception and trust toward authorities

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　2016年に発生した熊本地震では、4月14日に前震とされるマグニチュード6.2の地震が発生し、2日後の4月16日に本震とされるマグニチュード7.3の地震が発生した。当初は、マグニチュード6.2の前震が本震で、それを上回る規模の地震は想定されていなかった。一連の地震を受けて、気象庁は従来のような余震発生確率の発表を取り止めるように方針転換した。このような熊本地震の経験やリスク・コミュニケーションの方針転換は、人々の地震に関するリスク認知や情報源に対する信頼に大きな影響を及ぼしたと考えられる。実際に、福島原発事故という想定外の災害が生じた後、人々の原子力に対するリスク認知や、政府や電力会社といった主要アクターへの信頼が悪化した(大友ら, 2014)。とくに、大規模な事故や災害の後にはリスクの社会的増幅(Slovic et al., 1991)が生じる。リスクの社会的増幅とは、大事故や災害によりリスクに対する評価や否定的反応が過剰に生じることである。そこで、本研究では熊本地震を経験した被災地の人々が、地震や地震情報源に対してどのように認知しているのか検討する。具体的には、前震、本震、気象庁の方針転換後における被災状況や対応行動を測定し、その後の地震に対するリスク認知や情報源に対する信頼に及ぼした影響について検討を加える。
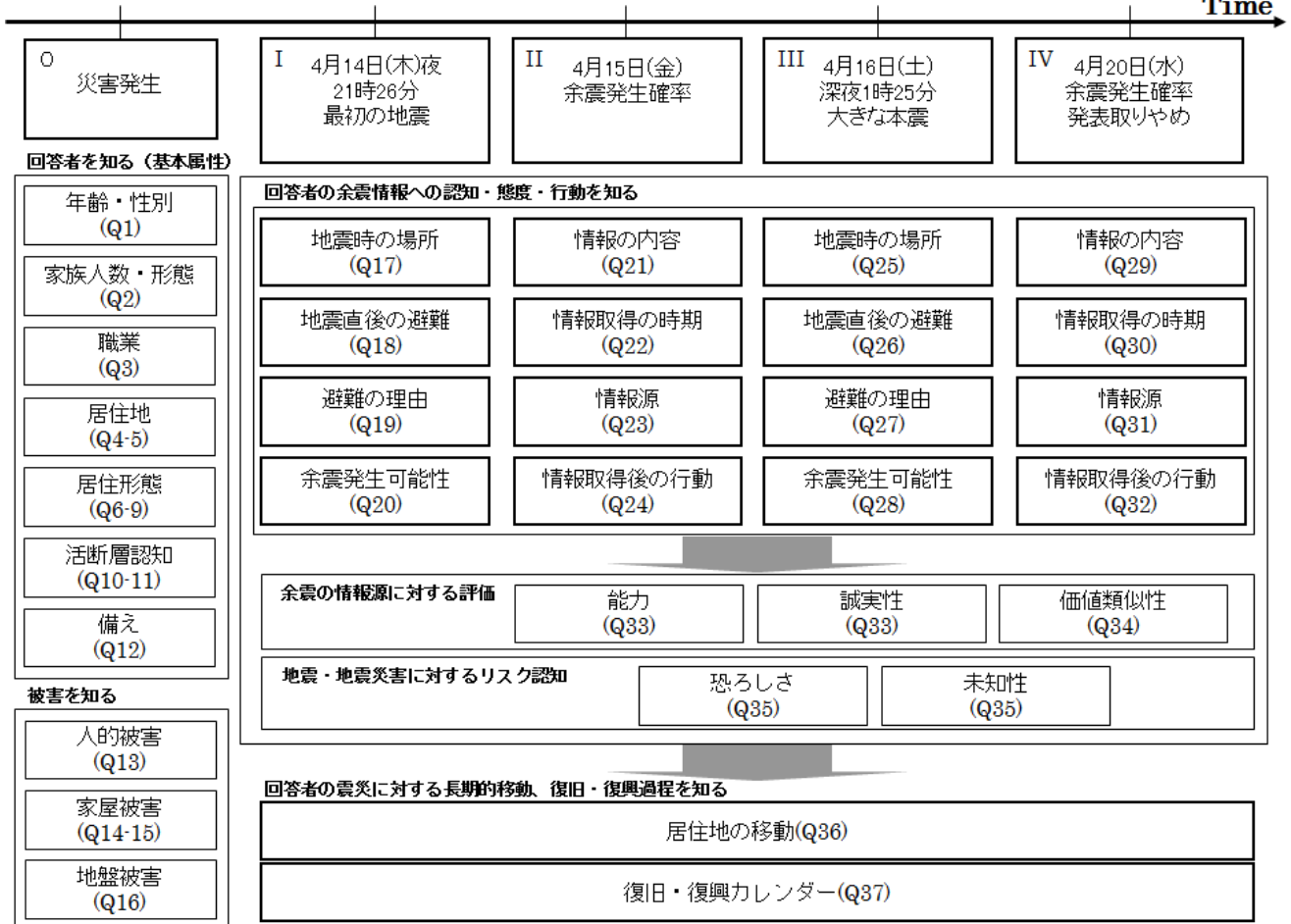
　本研究では、2016年の11月下旬から12月下旬にかけて熊本県の住民を対象に郵送調査を実施した。回答者は地震被害のレベルや人口比率の観点から抽出された。調査フレームは図に示す。とくに、前震、本震、気象庁方針転換の直後の被災状況や避難行動と、地震へのリスク認知、信頼(対象アクター：気象庁、政府、マスコミ、県、市町村)を分析に用いる。

　本研究では、被災者が受けた被害の大きさだけなく、地震後や方針転換後の対応行動のパターンも、地震のリスク認知や情報源に対する信頼に影響を及ぼすことを明らかにする。とくに、前震から本震にかけて対応行動を変化させた被災者と変化させていない被災者との間でリスク認知や信頼に違いが生じていると考えられる。以上、地震に関するリスク・コミュニケーションのあり方について考察する。

キーワード：熊本地震、リスク・コミュニケーション、リスク認知、社会的増幅、信頼
Keywords: Kumamoto earthquakes, risk communication, risk perception, social amplification, trust

Time

| O 災害発生 | I 4月14日(木)夜 21時26分 最初の地震 | II 4月15日(金) 余震発生確率 | III 4月16日(土) 深夜1時25分 大きな本震 | IV 4月20日(水) 余震発生確率 発表取りやめ |

回答者を知る（基本属性）

| 年齢・性別 (Q1) |
| 家族人数・形態 (Q2) |
| 職業 (Q3) |
| 居住地 (Q4-5) |
| 居住形態 (Q6-9) |
| 活断層認知 (Q10-11) |
| 備え (Q12) |

被害を知る

| 人的被害 (Q13) |
| 家屋被害 (Q14-15) |
| 地盤被害 (Q16) |

回答者の余震情報への認知・態度・行動を知る

地震時の場所 (Q17)	情報の内容 (Q21)	地震時の場所 (Q25)	情報の内容 (Q29)
地震直後の避難 (Q18)	情報取得の時期 (Q22)	地震直後の避難 (Q26)	情報取得の時期 (Q30)
避難の理由 (Q19)	情報源 (Q23)	避難の理由 (Q27)	情報源 (Q31)
余震発生可能性 (Q20)	情報取得後の行動 (Q24)	余震発生可能性 (Q28)	情報取得後の行動 (Q32)

余震の情報源に対する評価

| 能力 (Q33) | 誠実性 (Q33) | 価値類似性 (Q34) |

地震・地震災害に対するリスク認知

| 恐ろしさ (Q35) | 未知性 (Q35) |

回答者の震災に対する長期的移動、復旧・復興過程を知る

| 居住地の移動(Q36) |
| 復旧・復興カレンダー(Q37) |

熊本地震が示した個人世帯を対象とした人的被害評価の重要性
The Importance of Seismic Death Risk Assessment Each Household Unit

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1.目的

2016年4月14日に始まった熊本地震の一連の活動は16日に本震を伴い周辺地域に甚大な被害を生じた。特に、熊本県益城町においては、14日（以降、前震）と16日（以降、本震）に2度にわたり震度7を観測し、前震で7人その後の本震で12人の命が建物倒壊に伴い失われた。これらの人々は、前震後の長期の避難生活を避け自宅に戻ってしまったことが死亡につながった一方で、前震の発生が避難を誘発し本震時に死を免れたケースも多かったことがわかっている[1]。このように、地震後の長期避難は熊本地震のような連続して強震動が発生するような地震活動に対し、一定の死者低減効果を発揮する。しかし一般的には、長期の避難生活を望む被災者は稀であり、時間経過と共に自宅への帰還率が増加する。そのため、被災後にあっては避難の必要性を世帯単位で認識できるリスク情報を提供できれば、我が事としてのより強い注意喚起となり得る。現状では「建物の応急危険度判定」が相当の情報となるが、建物の状態のみを3段階で伝えるのみであり、その後の余震（あるいは本震）に対する身の危険の程度が自分自身では判断できない。本研究は、以上の現状認識のもと個人世帯を対象とした人的被害予測式を適用することで、被震後の自宅からの避難の意思決定を支援するリスク情報提供可能性を検討するものである。

2.人的被害評価

個人世帯の死者発生リスクは、地震動入力と各家屋の築年代もしくは耐震評点を既知とする建物損傷度関数を用い建物の被害程度を損傷度で評価し[2]、損傷度に伴う室内残存空間に関するW値関数を用い、構造部材が在宅者に衝突する確率と年齢を考慮したけがの程度（ISS）ごとの死亡率を人体損傷度関数[3]を用いることで評価できる。

3.世帯の死亡リスク評価

上記手法を用い熊本地震の死者が発生した17世帯について前震・本震の死亡率を評価する。ここでは、死亡者が発生した世帯の1例をあげる。住宅は1970年代築とし地震時には3名が在宅しており、70代の3名が1階に在室していた。前震時の震度を6.49と本震の震度を6.77とすると、木造住宅の損傷度別発生確率はD4で12%、D5で6%、D6で1％となり、本震時にはD4で16%、D5で19%、D6で12%となる。前震で被災した建物の耐震性能（耐震評点）が低下していたこととも絡み、本震時に急激に全壊以上（特にD5、D6などの層崩壊）の建物発生率が増加していることが推測される。また、在宅者1名あたりの死者発生確率は前震時1%、本震時5%と増大している。仮にこの建物が1950年代に建てられたと仮定した場合、死者発生確率は前震時4%、本震時12%と住まう建物により死亡率は大きく増減する。また、同様の住宅に40代が3名住んでいると仮定した場合、死者発生確率は1%、本震時には8%となり70代が在宅している場合に比べ死亡率が低い。このように、震度が同じでも耐震性能や世帯の年齢構成により死亡率が異なる。地震の前に世帯ごとのリスク評価を実施し現状を知っておくことが重要となろう。

4.おわりに

本手法により得られた世帯ごとの死亡リスクは、事前対策の実施や被災時の避難実施の有無を検討するうえで有用な情報となるであろう。

    - MZZ41-05 -

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キーワード：熊本地震、人的被害、リスク評価
Keywords: The 2016 Kumamoto Earthquake, casualty, Risk assessment

Estimating Resource Management of Nursing Home Support in the Assumed Tokyo Metropolitan Earthquake

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Abstract
This study proposes elements for creating scenarios covering those needing support during a natural disaster, comprising: 1) coefficients for scenarios concerning those needing support during a disaster, and 2) quantitative damage estimation cases related to facilities for those needing support during a disaster. These elements have not been incorporated into conventional damage estimation. The scenarios were applied to Tokyo, which is assumed to be an area affected by earthquakes occurring directly beneath the Tokyo Metropolitan Area, to establish a support system and implement map training.

Estimate the Resources Damage

2011 East Japan Earthquake created disaster awareness in Japan more than ever before. The fact raises awareness more that the possible occurrence of the Mega Urban Earthquake, which directly hits Tokyo is expected 70% in 30 years. The research outcome is highly expected to implement the workable disaster response in social welfare field.

We constructed the geospatial data of social welfare facilities in Tokyo. 1609 facilities exist which contribute facility care services. We overlapped the layer of this map to the seismic intensity map of assumed Earthquake in northern Tokyo Bay, which is expected to bring the most severe damage. There were 12 types of facilities categorized by the class of social services; however, detailed classification is not necessary for disaster responders to consider the resource dispatch in emergency phase. So we re-classified those 12 to 5 focusing on the disaster vulnerabilities. Figure 2 shows the result of the analysis. There were 97.1% facilities are in the area of over intensity 5 upper, which means that 104,879 people might be affected; however their numbers contains self-reliant people. The important thing is to detect how much reliant people in the category named "Diverse Range of Caretakers" in order to implement the resource assessment properly.

As the outcome of this research Tokyo Metropolitan Social Welfare Council decided to improve resource management system based on our research outcomes; 1) construct operational posts of social welfare support in each administrative district, 2) develop task forces in order to be varied to suit the situation after disasters. The resource management model made it possible to vary the situation on real time basis. The goal of this study is to establish disaster reduction measures to avoid a national crisis by ividing the fluctuating and independent part: the former is addressed by disaster reduction policies, while the latter is tackled by proposing and implementing disaster reduction action plans. The research results were proposed in "study committee of broad welfare support for disasters in Tokyo" to facilitate better understanding of the assumed damage of those needing support and welfare facilities during earthquakes occurring directly beneath the Tokyo Metropolitan Area. The accomplishments of this study include proposing components for scenarios to be established concerning those needing support during a national crisis disaster. For this purpose, a study on the services of an organization structure, including expert volunteers, was led by the Tokyo Council of Social Welfare, which usually works for those who

needs nursing care.

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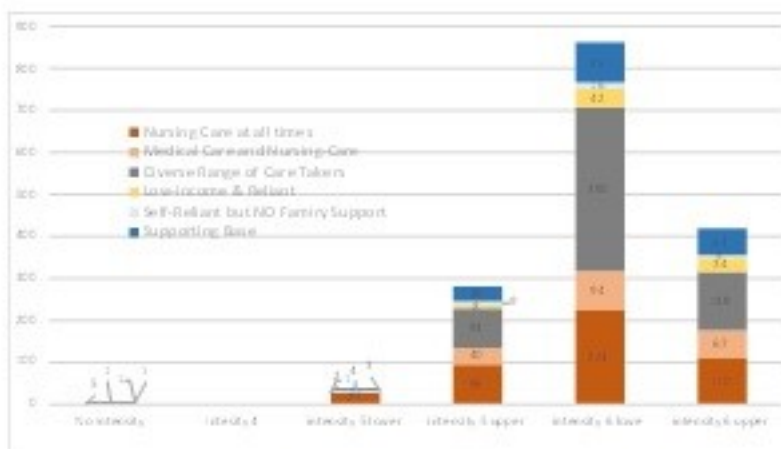
Fig. Social Welfare Facilities Classified in Assumed Seismic Intensity Scale of the Japan Meteorological Agency