カフラマンマラシュ（トルコ南東部）地震関連
国際緊急共同研究・調査支援プログラム（J-RAPID）
終了報告書　概要

１．研究課題名：「Kahramanmaraş 地震の強震域の地震動記録と構造物被害に基づく新たな震度計算式の開発および微動測定と揺れの質問票調査に基づく被害集中域の震度の解明 」

２．研究期間：2023 年 8 月～2024 年 7 月

３．主な参加研究者名：

日本側

	氏名	役職	所属	研究分担
研究代表者	森 伸一郎	特定教授	愛媛大学	総括､被害調査と被害震度、微動測定
共同研究者	後藤 浩之	教授	京都大学	震度計算式の開発､被害集中域の震度解明
共同研究者	小山 真紀	准教授	岐阜大学	質問票震度調査､地震計設置自治体の震度分布
共同研究者	四井 早紀	助教	東京大学	質問票震度調査に基づく震度推定法
共同研究者	阪本真由美	教授	兵庫県立大学	トルコにおける震度情報の活用状況の調査
研究協力者	村上ひとみ	非常勤講師	山口大学	質問票震度調査､地震計設置自治体の震度分布
研究協力者	大里 重人	代表取締役社長	土質リサーチ	計測震度と被害震度の評価
研究協力者	千葉 達朗	技師長	アジア航測	空間情報による被害調査，震度マップ作製
研究協力者	羽田 浩二	課長	ニュージェック	微動による被害集中域の震度評価
研究協力者	林田 拓己	主任研究員	建築研究所	微動測定による地震計地点の地盤評価
研究期間中の全参加研究者数　　12　名				

相手側

	氏名	役職	所属	研究分担
研究代表者	Nurcan Meral ÖZEL	Professor	Boğazici University	各自治体における被害データ収集分析､微動測定、質問票震度調査
共同研究者	Gülten POLAT	Associate Professor	Yeditepe University	微動による被害集中域の震度評価
共同研究者	Dilek KEPEKÇI	Former staff	Boğazici University	質問票震度調査､震度情報利活用
共同研究者	Yasemin KORKUSUZ ÖZTÜRK	Associate Professor	Erzincan Binali Yıldırım University	微動測定､震度マッピング、震度情報利活用
研究期間中の全参加研究者数　　4　名				

４．共同研究調査の目的

地震観測網が整備されてからこれまでトルコでは、主に経験した震度は、改正メルカリ震度階（MM 震度階）で震度 8 までが多く、日本の気象庁震度階（JMA 震度階）における震度 6 弱や震度 6 強に匹敵する MM 震度階の震度 9 や震度 10 は 2 地震 5 か所のみであり、日本の震度 7 に相当する MM 震度 11 は未経験であった。今回の Kahramanmaraş 地震では広範囲にわたり未曾有の甚大な被害が発生したと同時に広範囲で強震記録が観測された。被害状況からは市町村によっては MM 震度 10,11,12 として評価すべき状況があるが MM 震度階の震度定義に照らした被害に基づく震度（被害震度）の評価は未実施であった。

本研究の目的は、(1) 今回の地震における広範囲で高密度に記録された地震動の大きさと地震計周辺での構造物被害・地盤被害の程度の対応関係に基づいて、MM 震度で 9 以上の高い被害震度を適切に評価できるような地震動記録を用いた MM 震度（計測震度）計算式を開発し、(2) 地震観測地点を中心とした微動測定と質問票震度調査により各都市の被害集中域の震度を明らかにし、さらに、(3) トルコ国内での震度情報の利活用の現状調査を行い、今後のリスク管理・震災復興や防災教育などでの利活用方法を提案することである。

MM 震度階と概ね 1 対 1 で対応するヨーロッパ震度階 EMS-98 は、建物種別、脆弱性、被害グレード別被害率に基づいてより客観的な尺度として震度を定義している。その震度の定義を参考に、現地調査と被害データに基づき主に地震計設置地点周辺の EMS-98 被害震度を評価し、被害震度と地震動の大きさを対応付けることで、各地域の MM 計測震度を算出する。MM 計測震度計算式の開発は、被害と震度の関係のデータが豊富で長年にわたって検証されて信頼性の高い日本の JMA 計測震度の評価手法を参考にする。

本研究における各実施事項での達成目標は、以下のとおりである。(1)地震動記録と地震計周辺の構造物被害状況を基に新たな MM 計測震度計算式を開発・提示する。微動測定により地震計から離れた地点の震度を推定する。(2)地震計周辺での構造物被害状況と微動測定により明らかになった震度と揺れの質問票調査に基づき、質問票震度算定手法を確立した上で、高密度な震度分布を明らかにして、被害集中域の震度分布図を提示する。(3)明らかにした被害地域の震度分布図などを用いて、トルコにおける震度情報のリスク管理や耐震基準への反映、防災教育、復興での事前・事後活用の方策案を提示する。

５．共同研究調査の成果

５－１　共同研究調査の成果、今後の展開見込、社会への波及効果

(1) MM 計測震度の計算式の開発

・今回の Kahramanmaraş 地震における広範囲で高密度に記録された地震動の大きさと地震計周辺での構造物被害・地盤被害の程度の対応関係に基づいて、MM 震度で 9 以上の高い被害震度を適切に評価できるような地震動記録を用いた MM 震度（MM 計測震度）計算式を開発した。米国 USGS（地質調査所）で活用されている MM 計測震度（Wald ら 1999, WQHK1999 式）やトルコで多用されている MM 計測震度（Bilal and Askan2014, BA2014 式）を開発する計算式の比較対象とした。それに加えて、高震度で被害程度で検証されている JMA 計測震度と関係づけるため、JMA 計測震度と WQHK1999 式の計測震度の関係式を導いた功刀(2000)の式（K2000 式）を検討対象とした。さらに、Chernov(1989)、Chernov-Sokolov(1999)、Sokolov(2002)、Sokolov-Wald(2002)と開発・検証されてきた FAS（フーリエ振幅スペクトル）レベルから決定した MM 震度と JMA 震度の関係式を導いた Sokolov-Furumura(2008)による JMA 震度（JMAI）からの MM 震度換算式（MMI=-0.32+1.703×JMAI）（SF2008 式）も加えた。31 地点の現地被害調査による EMS-98 に準拠して評価された MM 被害震度と地震加速度記録から評価された各種の MM 計測震度との比較検討の結果、SF2008 式が MM 被害震度に最もよく適合することがわかった。そこで、短時間パルス状の

大振幅による震度過大評価の課題を解決するために剛塑性モデルの導入により修正 JMA 震度を開発した Goto-Mori(2024)を SF2008 式に適用した。その結果、その SF2008-GM2024 式も MM 被害震度に良く適合し、過大評価を改善できたことを確認した。すなわち、SF2008 式と SF2008-GM2024 式を MM 被害震度に良く適合する MM 計測震度の計算式として提示することができた。

(2) 地震計 37 地点と被害集中域ほか 43 地点の合計 80 地点において地盤の微動測定を行い、微動特性と被害震度の関係を調査した。その結果、多くの地点で被害震度の違いほどに地盤の微動特性や速度特性の違いが現れず、この地震による被害の大きかった地域における被害震度は地盤特性よりも建物特性が支配的であることがわかった。したがって、地震計のない地点における計測震度評価のために微動測定により地盤増幅特性を考慮するということは必要がないことがわかった。そもそも、「微動測定により地震計から離れた地点の震度を推定する」ことの目的は、日本や米国などの表層地盤の地震動増幅特性が揺れを増幅させ、震度を増加させるものとの仮定からであった。しかし、実際に多くの地点で測定した結果では、当該対象地域の地盤は Vs30 が 400m/s 以上の硬質地盤が多く、いわゆる表層地盤の増幅が見込まれない地盤が大半であった。このことは、MM 計測震度の推定にこれまで考えられてきたような表層地盤増幅は見込まなくてもよいということがわかった。これは、トルコの対象地域の地盤特性の特徴としての新たな発見であると言える。

(3) 質問票震度調査は、被害の大きかった 7 県（アドゥヤマン，ガジアンテプ，ハタイ，カフラマンマラシュ，マラティヤ，オスマニエ，シャンルウルファ）の国民教育庁教育長を通して調査の許可を得て、学校単位で保護者を回答者としてオンラインで実施した。質問項目は 32 問であり、地震時の居場所、音・揺れ、建物種別、人の感じ方、家の中の家具の動き、建物の被害状況、道路被害、ケガや救助の有無等を含む。その結果、14,737 件の回答が得られ、被災 7 県で、県（Province）、郡（District）、住区（Mahalle）という位置が特定できた回答数は 12,726 件となった。Hatay 県の調査結果によれば、地震観測地点のある住区（Mahalle）での質問票震度は、地表断層沿いの地点では 9.5～10 であり、MM 計測震度とよく合うことがわかった。したがって、地震計のない地域での MM 震度推定に、開発した質問票震度調査は有効であることが確認された。

(4) トルコ国内での震度情報の利活用の現状調査を行った結果、リスク管理・防災教育などどの面でも全く利用されていないことがわかった。そこで、プロジェクトにおいて今回の地震の震度調査結果を用いてパンフレットを作成し、4 つの学校において震度を活用する防災教育を試行した。

５－２　国際連携の成果

・地震被害調査に慣れている日本側と相対的に被害地震の頻度が低いトルコ側と地震被害調査を一緒に行ったことにより、被害調査手法の技術移転ができたと言える。

・今回の調査対象地点が地震を引き起こした地震断層の近傍であったことから、地盤特性の違いも大きくなく、地盤特性の影響があまり出てこない事例となったが、地盤特性が地震動増幅特性として現れることが多いことから、微動測定調査を多数地点で一緒に行ったことは、技術移転とデータ共有がなされたと言える。

・質問票震度調査はトルコ側研究者のおかげで広範囲な地域における多数の調査を成し遂げることができ、優れたデータを多数得ることができた。また、そのことは日本側で長年培ってきた調査法を礎として、共同で信頼できる質問票震度の算定式の開発につながったと言える。

６．本研究調査に関連したワークショップ等の開催、主な口頭発表・論文発表・その他成果物（例：提言書、マニュアル、プログラム、特許）、受賞等（5件まで）

発表/論文/成果物等	・主催したワークショップ、セミナーなど:名称、開催日 ・口頭発表:発表者名、タイトル、会議名 ・論文: 著者名、タイトル、掲載誌名、巻、号、ページ、発行年 ・その他成果物(例:提言書、マニュアル、プログラム、特許)、 ・メディア
口頭発表	Shinichiro Mori, Shigeto Osato, Tatsuro Chiba, Nurcan Meral Özel, Gülten Polat, Seismic motions and structural damage in various locations during the 2023 Kahramanmaraş, Turkey, earthquakes. Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba,2024.5
口頭発表	Takumi Hayashida, Shinichiro Mori, Gülten Polat, Nurcan Meral Özel, Koji Hada, Masayuki Yamada, Hiroyuki Goto, Shigeto Ohsato, Tatsuro Chiba, Yasemin Korkusuz Öztürk, Maki Koyama、「Microtremor Array Survey at Strong Motion Stations Recording Significant Ground Motions du ring the 2023 Kahramanmaraş Earthquake (Mw7.8), Turkey, Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba, 2024.5
ポスター発表	Saki Yotsui, Hitomi Murakami, Maki Koyama, Nurcan Meral Özel, Dilek Kepekçi, Yasemin Korkusuz Öztürk, Hiroyuki Goto, Shinichiro Mori, Estimation of seismic intensity by questionnaire method in the 2023 Kahramanmaraş Earthquake (Mw7.8), Türkiye, Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba, 2024.5
口頭発表	Nurcan Meral OZEL, Shinichiro MORI, Hitomi MURAKAMI, Maki KOYAMA, Dilek KEPEKCI, Gulten POLAT, Yasemin Korkusuz Öztürk, Saki YOTSUI, Mayumi SAKAMOTO, 6 FEBRUARY 2023 KAHRAMANMARAS, TURKEY EARTHQUAKES: MICROTREMOR MEASUREMENT, EXTENSIVE FIELD SURVEY ON SEISMIC INTENSITY AND STRUCTURAL DAMAGE CORRELATIONS TO DEVELOP THE NEW INTENSITY FORMULA FOR THE REGION, The General Assembly 2024 of the European Geosciences Union (EGU), 2024.4
口頭発表	Shinichiro MORI, Hiroyuki GOTO, Nucan Meral ÖZEL, Gülten POLAT, Shigeto OSATO, Tatsuro CHIBA, Comparison of damage-based Modified Mercalli (MM) intensities and instrumental MM intensities during the 2023 Kahramanmaraş, Türkiye earthquake, 第43回日本自然災害学会学術講演会, Chiba, 2024.9

International Urgent Collaborative Projects
Regarding the 2023 Southeastern Türkiye Earthquakes within the J-RAPID Program

１．Title of the Project： Development of a new seismic intensity calculation formula based on seismic records and structural damage in the strong motion zone of the Kahramanmaraş earthquake and elucidation of the intensity in the damage concentration zone based on microtremor measurements and shaking questionnaire survey

２．Research/Investigation Period： 2023.8 ～ 2024.7

３．Main Investigators：

Japanese Team

	Name	Title	Affiliation	Project role
Principal Investigator	Mori Shinichiro	Endowed Chair Professor	Ehime University	General, damage assessment, microtremor measurement
Collaborator	Goto Hiroyuki	Professor	Kyoto University	Development of seismic intensity calculation formulas, elucidation of seismic intensity in areas of concentrated damage
Collaborator	Koyama Maki	Associate Professor	Gifu University	Questionnaire seismic intensity survey, elucidation of seismic intensity distribution in municipalities with seismographs
Collaborator	Yotui Saki	Associate Professor	Tokyo University	Seismic intensity estimation method based on questionnaire seismic intensity survey
Collaborator	Sakamoto Mayumi	Professor	Hyogo University	A Survey of Pre- and Post-Use of Seismic Intensity Information in Risk Management, Disaster Prevention Education, and Reconstruction in Turkey
Total Number of participating researchers in the project: 12				

Counterpart Team (up to 6 people including Principal Investigator)

	Name	Title	Affiliation	Project role
Principal Investigator	Nurcan Meral ÖZEL	Professor	Boğazici University	Damage data collection and analysis, microtremor measurement, and questionnaire seismic intensity survey in each municipality
Collaborator	Gulten POLAT	Associate Professor	Yeditepe University	Seismic intensity evaluation of damage concentration area by microtremors
Collaborator	Dilek KEPEKÇI	Former staff	Boğazici University	Questionnaire seismic intensity survey, utilization of seismic intensity information
Collaborator	Yasemin KORKUSUZ ÖZTÜRK	Associate Professor	Erzincan Binali Yıldırım University	Microtremor measurement, seismic intensity mapping, utilization of seismic intensity information
Total Number of participating researchers in the project: 4				

4. Objectives and Challenges

Since the establishment of the seismic observation network of Turkey, it has mainly experienced seismic intensity up to intensity 8 on the Modified Mercalli seismic intensity scale (MMI scale), and has only experienced intensity 9 or 10 on the MMI scale, which is equivalent to intensity 6- or 6+ on the Japan Meteorological Agency seismic intensity scale (JMAI scale), at five locations in two earthquakes, and the MMI of 11, which is equivalent to JMAI of 7, has not been experienced. The Kahramanmaraş earthquake caused unprecedented damage over a wide area, and strong earthquake ground motions were recorded over a wide area. The damage should be evaluated as MM seismic intensity 10, 11, or 12 in some municipalities, but the MM seismic intensity based on the damage (damage-based seismic intensity) has not yet been evaluated according to the seismic intensity definition of the MM seismic intensity scale.

The objectives of this study are: (1) to develop instrumental MM seismic intensity calculation formulas using seismic ground motion records that can appropriately evaluate high damage intensity of 9 or higher on the MM seismic intensity scale based on the correspondence between the amplitude of earthquake motion recorded in a wide area and high density in this earthquake and the degree of structural and ground damage around the seismograph, and (2) to clarify the seismic intensity in the damage concentration area in each city by microtremor measurement and questionnaire seismic intensity survey around the seismograph sites, and (3) to investigate the current utilization of seismic intensity information in Turkey, and to propose how to utilize the information in future risk management, earthquake reconstruction, and disaster prevention education.

The European Macroseismic Intensity scale EMS-98, which corresponds roughly one-to-one with the MM seismic intensity scale, defines seismic intensity as a more objective scale based on building

type, vulnerability, and damage rate by damage grade. The instrumental MM seismic intensity is calculated for each region by mapping the seismic intensity of damage to the magnitude of seismic motion. The development of the MM seismic intensity formula is based on the JMA seismic intensity evaluation method in Japan, which has been verified over many years and is highly reliable.

The goals to be achieved in each of the research items in this study are as follows (1) To develop and present a new MM measured seismic intensity calculation formula based on seismic motion records and damage to structures around the seismograph. Estimate the seismic intensity at points distant from the seismograph by microtremor measurement. (2) Based on the structural damage situation around the seismograph and the questionnaire survey of seismic intensity and shaking revealed by microtremor measurement, establish a questionnaire seismic intensity calculation method, clarify high-density seismic intensity distribution, and present a seismic intensity distribution map of the damage concentration area. (3) Using the seismic intensity distribution map of the affected area, we will propose measures for risk management of seismic intensity information in Turkey, reflection in seismic resistance standards, disaster prevention education, and pre- and post-use of seismic intensity information in reconstruction.

5. Results of the research/survey activities

5-1. Results of joint research. Expected future development, ripple effect on society

(1) Development of the formula for calculating instrumental MM seismic intensity

Based on the relationship between the magnitude of the seismic motion recorded over a wide area with high density during the Kahramanmaraş earthquake and the degree of structural and ground damage around the seismographs, a formula for calculating instrumental MM seismic intensity using seismic motion records that can appropriately evaluate high damage-based seismic intensity of 9 or more on the MM scale was developed. The formula developed for the USGS (Wald et al. 1999, WQHK1999 formula) and the instrumental MM seismic intensity formula (Bilal and Askan 2014, BA2014 formula) used widely in Turkey were used as comparison targets for the formulae developed. In addition, in order to relate it to the JMA instrumental seismic intensity, which has been verified for its correspondence with structural damage at high seismic intensity, the formula developed by Kunugi (2000) (K2000 formula), which relates the instrumental JMA seismic intensity to the WQHK1999 formula, was also examined. Furthermore, we also added the equation for converting JMA seismic intensity to MM seismic intensity (SF2008 formula) developed by Sokolov-Furumura (2008), who derived the relationship between JMA seismic intensity and MM seismic intensity determined from the FAS (Fourier Amplitude Spectrum) level developed and verified by Chernov (1989), Chernov-Sokolov (1999), Sokolov (2002), and Sokolov-Wald (2002)) was also added. As a result of comparing the damage-based MM seismic intensity evaluated based on the EMS-98 at 31 seismograph sites and the various instrumental MM seismic intensities evaluated based on the earthquake ground motion acceleration records, it was found that the SF2008 formula best fit the damage-based MM seismic intensity. Therefore, in order to solve the problem of overestimation of seismic intensity due to large amplitudes of short-duration pulses, the modified JMA seismic intensity developed by Goto-Mori (2024) by introducing a rigid-plastic model was applied to the SF2008 formula. Consequently, it was confirmed that the SF2008-GM2024 formula also fitted the instrumental MM seismic intensity well, and that the overestimation had been improved. In other words, the SF2008 formula and the SF2008-GM2024 formula were presented as formulae for calculating instrumental MM seismic intensity that fitted the damage-based MM seismic intensity well.

(2) Microtremor measurements were taken at 80 locations in total, including 37 seismograph stations and 43 locations with concentrated damage, to investigate the relationship between microtremor characteristics and damage intensity. As a result, it was found that the differences in damage intensity were not reflected in the differences in microtremor characteristics and velocity characteristics at many of the locations, and that building characteristics were more dominant than ground characteristics in the areas that suffered significant damage from this earthquake. Therefore, it was found that there was

no need to consider ground amplification characteristics using microtremor measurements in order to evaluate the seismic intensity at locations without seismographs. The purpose of "estimating seismic intensity at locations far from seismographs using microtremor measurements" was based on the assumption that the amplification characteristics of seismic motion in the surface layer of the ground in Japan, the United States, and other countries would amplify the shaking and increase the seismic intensity. However, the results of measurements taken at many locations showed that the ground in the target area was mostly hard ground with a Vs30 of 400m/s or more, and that the amplification of the so-called surface ground was not expected in the majority of cases. This means that the amplification of the surface ground, which had been thought to be expected in the estimation of MM seismic intensity, does not have to be expected. This can be said to be a new discovery as a characteristic of the ground properties in the target area in Turkey.

(3) The questionnaire survey was conducted online with parents as respondents at schools in the seven provinces (Adıyaman, Gaziantep, Hatay, Kahramanmaraş, Malatya, Osmaniye, Şanlıurfa) that were hardest hit, with permission for the survey obtained through the directors of the National Education Agency. The questionnaire had 32 questions, including questions about where they were when the earthquake hit, sounds and shaking, the type of building, how people felt, the movement of furniture in the house, the damage to buildings, damage to roads, injuries and rescue, etc. As a result, 14,737 responses were obtained, and in the seven disaster-stricken prefectures, the number of responses in which the location could be identified as a prefecture, district, or residential area (mahalle) was 12,726. According to the survey results for Hatay Prefecture, the questionnaire seismic intensities in the residential area (mahalle) where the seismograph sites vary from 9.5 to 10 along the surface fault, and it was found that this corresponded well with the instrumental MM seismic intensity (WQHK1999 formula). Therefore, it was confirmed that the developed questionnaire-based seismic intensity survey is effective for estimating MM seismic intensity in areas without seismographs.

(4) As a result of the survey on the current state of utilization of seismic intensity information in Turkey, it was found that it is not used at all in any aspect, including risk management and disaster prevention education. Therefore, in the project, a pamphlet was created using the results of the seismic intensity survey of the earthquake, and a trial of disaster prevention education using seismic intensity was conducted at four schools.

5-2. Added Value from International collaborative work

・It can be said that the technical transfer of damage survey methods was achieved through the joint earthquake damage survey conducted by the Japanese members, who are accustomed to earthquake damage surveys, and the Turkish members, who are relatively less familiar with damage surveys due to the low frequency of damaging earthquakes in Turkey.

・As the survey sites were close to the earthquake fault that caused the earthquake, there were not many differences in the ground characteristics, and the influence of the ground characteristics did not appear much in this case. However, as the ground characteristics often appear as seismic amplification characteristics, it can be said that the transfer of technology and data sharing were achieved by conducting microtremor measurement surveys at many sites together.

Owing to the efforts of the Turkish researchers, we were able to carry out many surveys in a wide range of areas, and we were able to obtain a large amount of excellent data. In addition, it can be said that this led to the development of a reliable joint questionnaire seismic intensity calculation formula, based on the survey methods that have been cultivated in Japan over many years.

6. Organized workshops/seminars, presentations, papers and other deliverables

	・Organized workshop/seminar: Title, date ・Presentation: Presenters, title, conference ・Papers： Authors, title, journals、vol, page, publish year ・Other deliverables: ・Media
Oral Presentation	Shinichiro Mori, Shigeto Osato, Tatsuro Chiba, Nurcan Meral Özel, Gülten Polat, Seismic motions and structural damage in various locations during the 2023 Kahramanmaraş, Turkey, earthquakes. Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba,2024.5
Oral Presentation	Takumi Hayashida, Shinichiro Mori, Gülten Polat, Nurcan Meral Özel, Koji Hada, Masayuki Yamada, Hiroyuki Goto, Shigeto Ohsato, Tatsuro Chiba, Yasemin Korkusuz Öztürk, Maki Koyama、「Microtremor Array Survey at Strong Motion Stations Recording Significant Ground Motions du ring the 2023 Kahramanmaraş Earthquake (Mw7.8), Turkey, Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba, 2024.5
Poster Session	Saki Yotsui, Hitomi Murakami, Maki Koyama, Nurcan Meral Özel, Dilek Kepekçi, Yasemin Korkusuz Öztürk, Hiroyuki Goto, Shinichiro Mori, Estimation of seismic intensity by questionnaire method in the 2023 Kahramanmaraş Earthquake (Mw7.8), Türkiye, Japan Geoscience Union Meeting 2024 (JpGU 2024), Chiba, 2024.5
Oral Presentation	Nurcan Meral OZEL, Shinichiro MORI, Hitomi MURAKAMI, Maki KOYAMA, Dilek KEPEKCI, Gulten POLAT, Yasemin Korkusuz Öztürk, Saki YOTSUI, Mayumi SAKAMOTO, 6 FEBRUARY 2023 KAHRAMANMARAS, TURKEY EARTHQUAKES: MICROTREMOR MEASUREMENT, EXTENSIVE FIELD SURVEY ON SEISMIC INTENSITY AND STRUCTURAL DAMAGE CORRELATIONS TO DEVELOP THE NEW INTENSITY FORMULA FOR THE REGION, The General Assembly 2024 of the European Geosciences Union (EGU), 2024.4
Oral Presentation	Shinichiro MORI, Hiroyuki GOTO, Nucan Meral ÖZEL, Gülten POLAT, Shigeto OSATO, Tatsuro CHIBA, Comparison of damage-based Modified Mercalli (MM) intensities and instrumental MM intensities during the 2023 Kahramanmaraş, Türkiye earthquake, The 43th Annual Conference of Japan Society for Natural Disaster Science, Chiba, 2024.9