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Environmental Sustainability of Earthquake Disaster Restoration
- Some Notes from Reconnaissance Studies -

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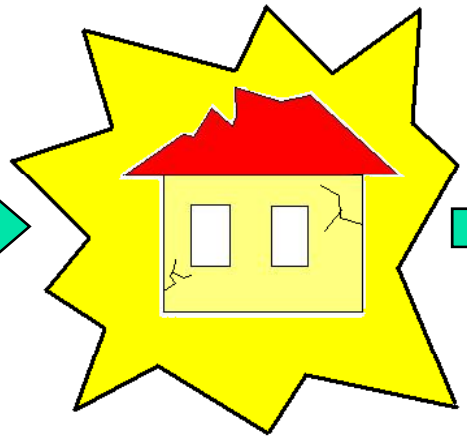
Contents

- In the 2004 Niigata Chuetsu earthquake, Japan, how many buildings were demolished?
- How decision making either to rebuild or repair a damaged dwelling were made?
- How can housing recovery support reduce environmental effects?

Objectives of the study

EQ occurs



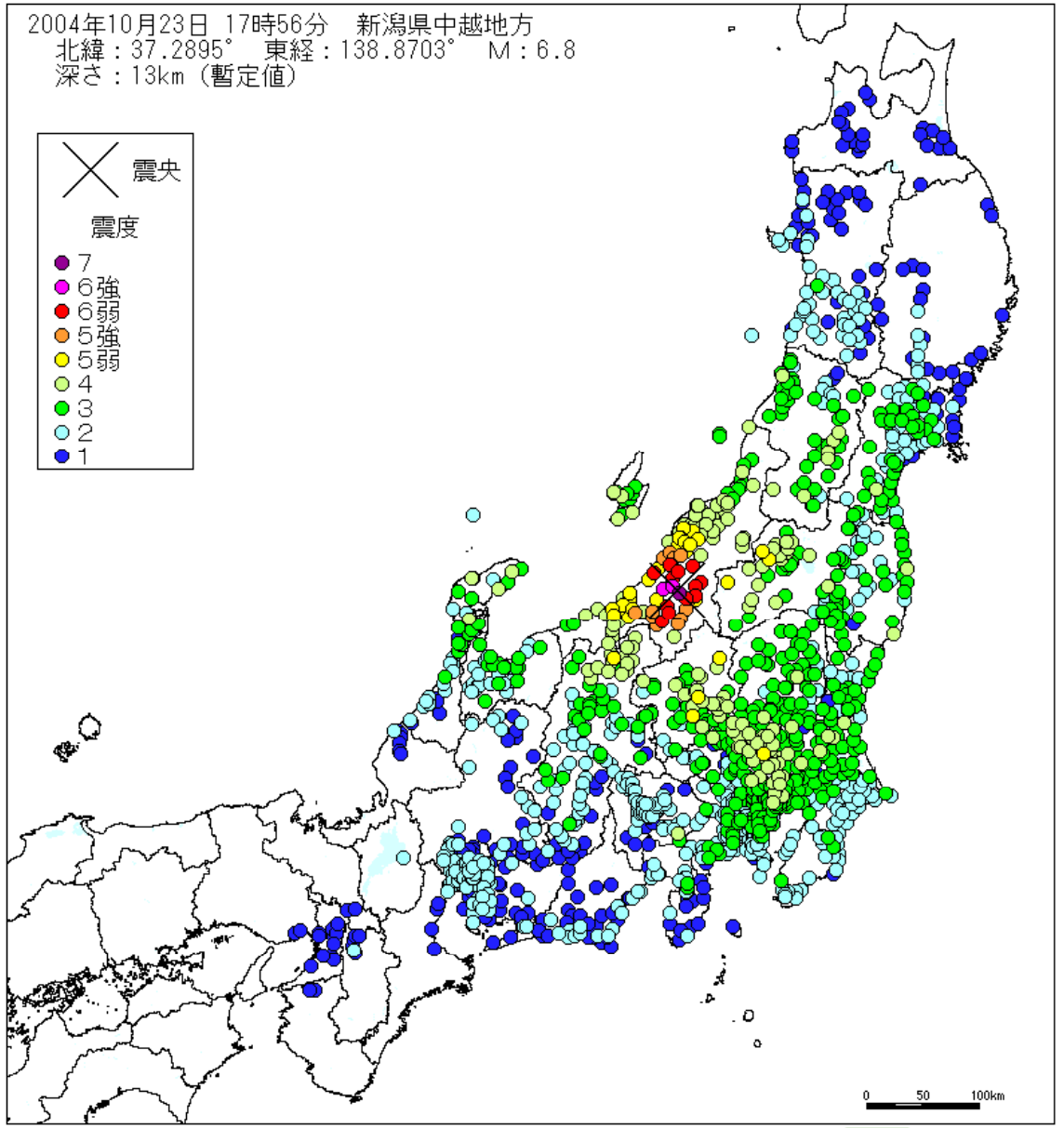
Decision making
Of inhabitants
Rebuild or repair i

Housing damage

This study made classification analysis how decision making of home owners were affected by damage conditions, using questionnaire data and discuss environmental problems of disaster restoration.

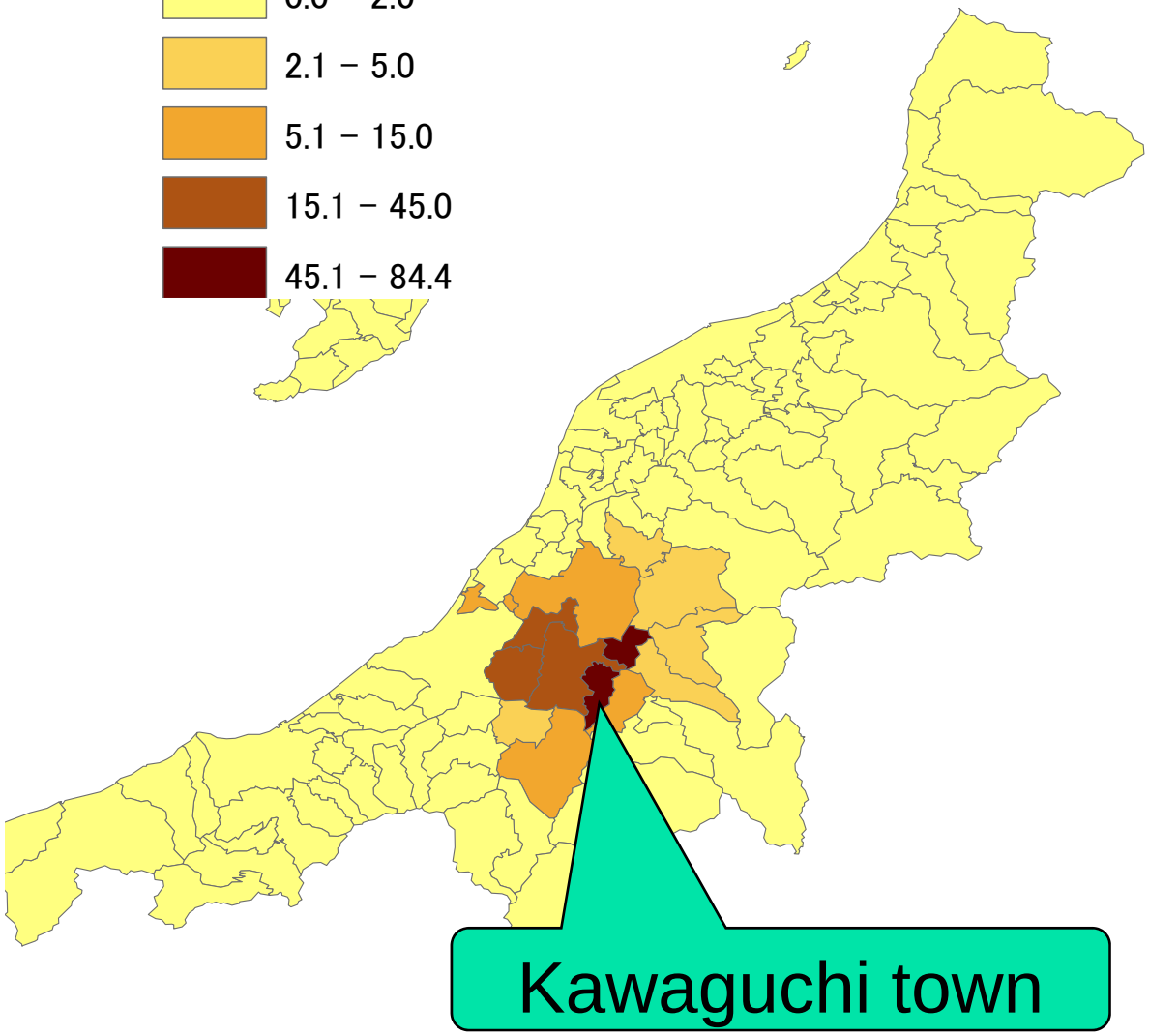
The 2004 Chuetsu, Niigata eq

- Oct. 23,
  17h 56m local time
  M=6.8
  focal depth 13km
- M=6.8
- JMA intensity 7 in Kawaguchi town



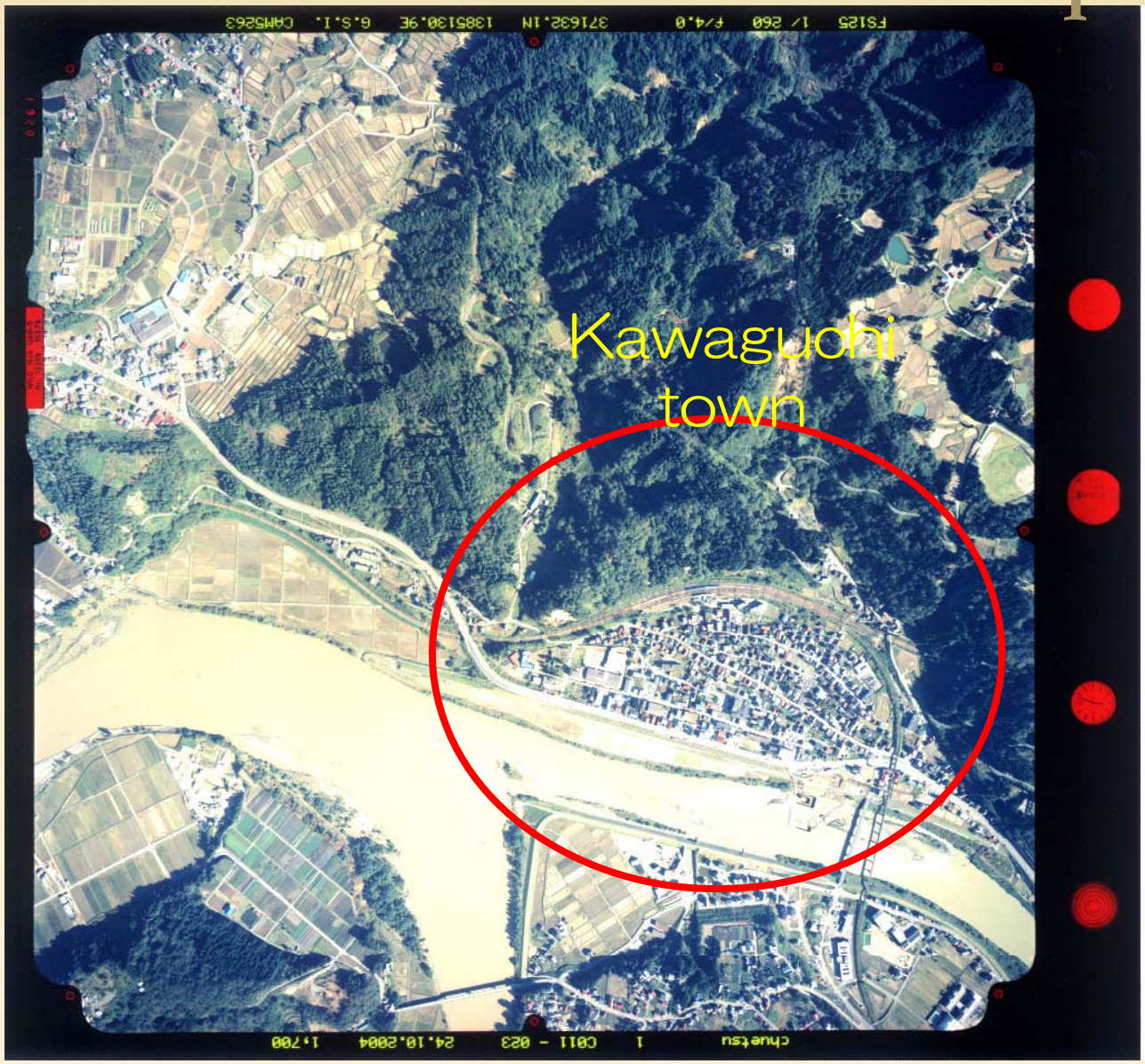
http://www.adep.or.jp/shindo/Screen/041023a.niigata.gif

Heavy, partial damage %



Nagaoka city, JMA intensity 6+ (Takamachi area, ground failure)

Areal photo of Kawaguchi town after the 2004 eq



「川口町」

Taken by Geographical Institute of Japan

国土地理院撮影の空中写真

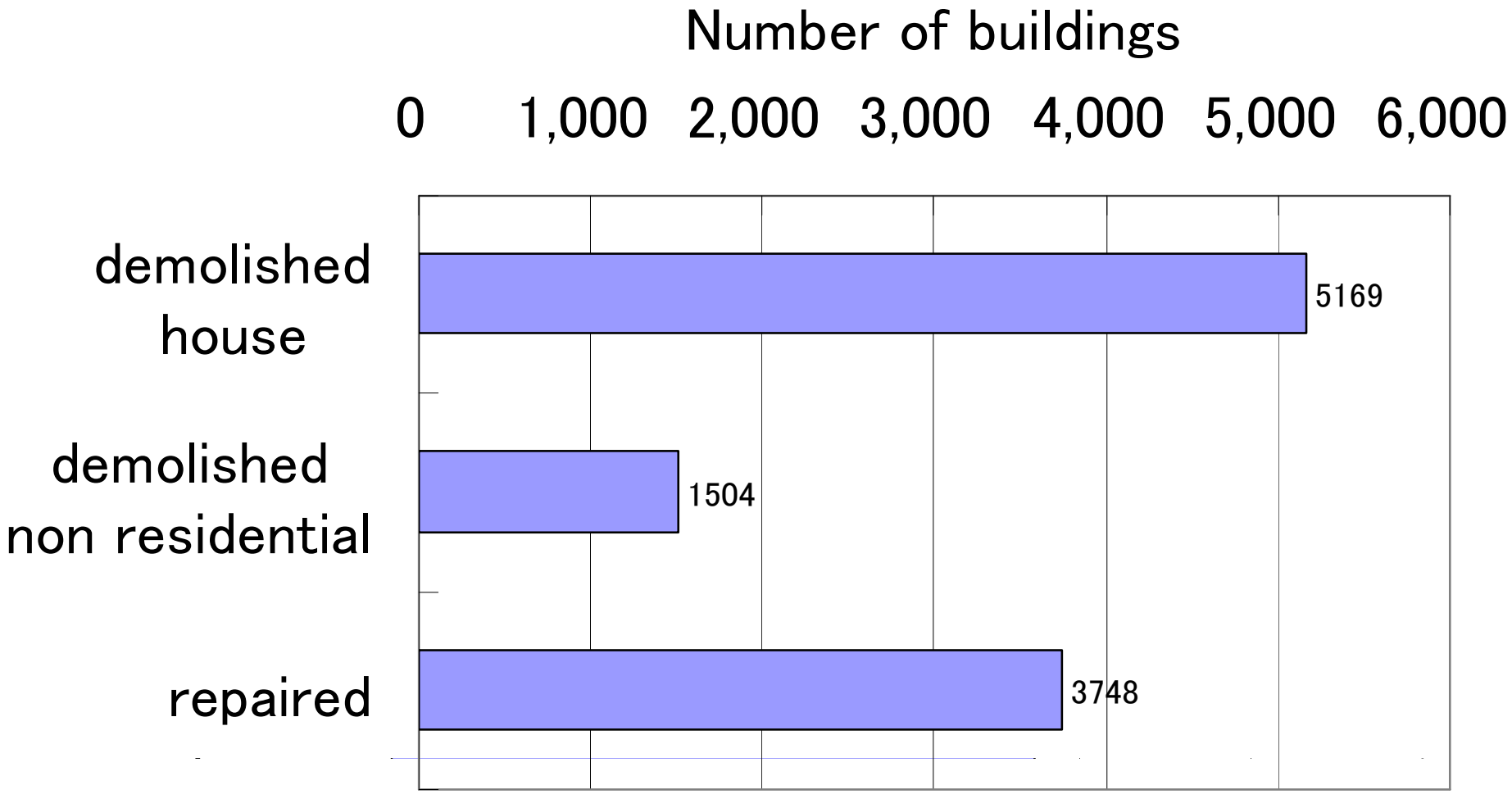
(撮影高度1700m)
(2004.10.24撮影)

撮影機関	国土交通省国土地理院	使用カメラ	RC－30
撮影実施機関	国土交通省国土地理院	画面距離	F＝153.76mm
撮影年月日	自 平成16年10月24日 至 平成16年10月24日	撮影高度	1,700m

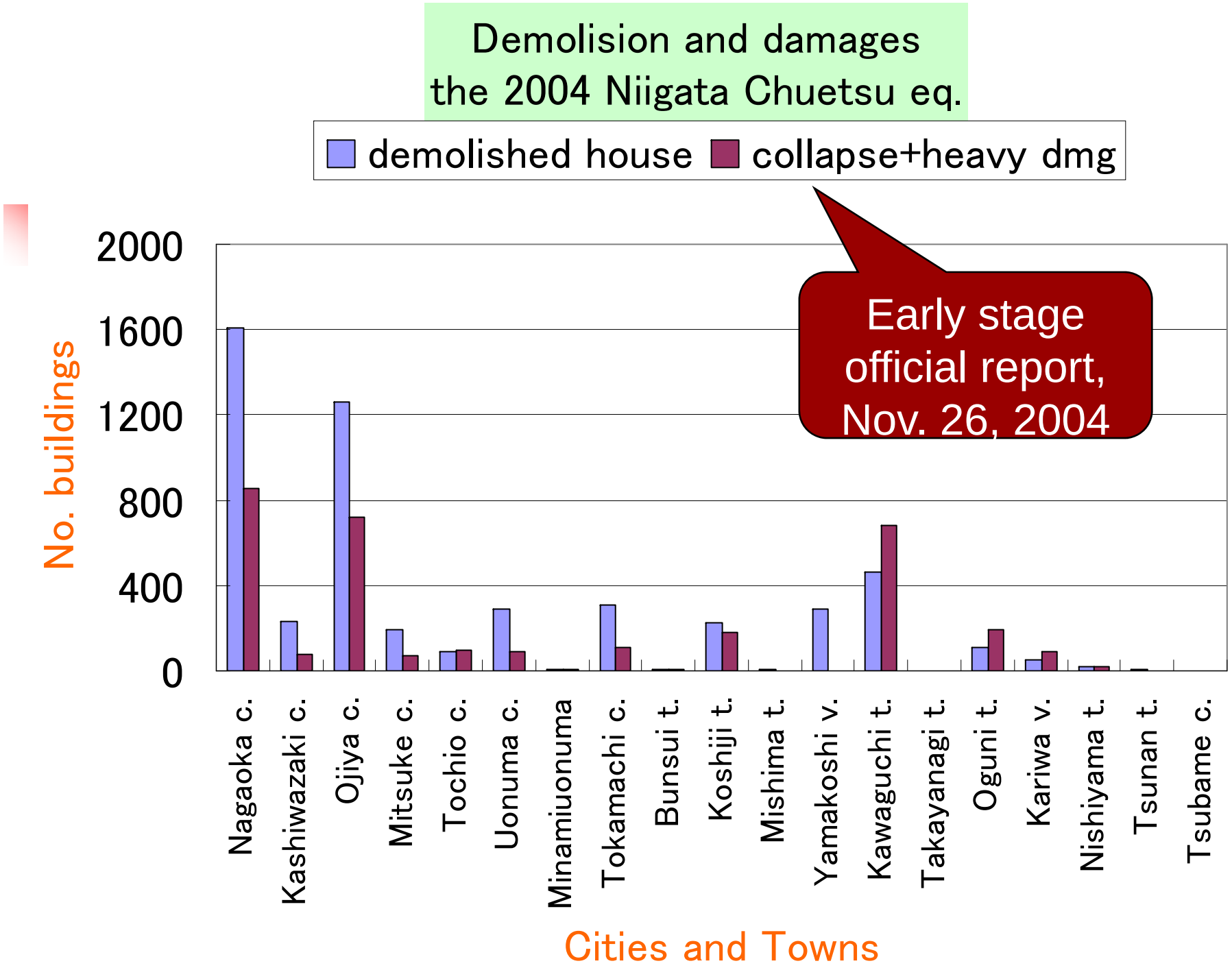
The number of houses damaged
by Niigata pref. report

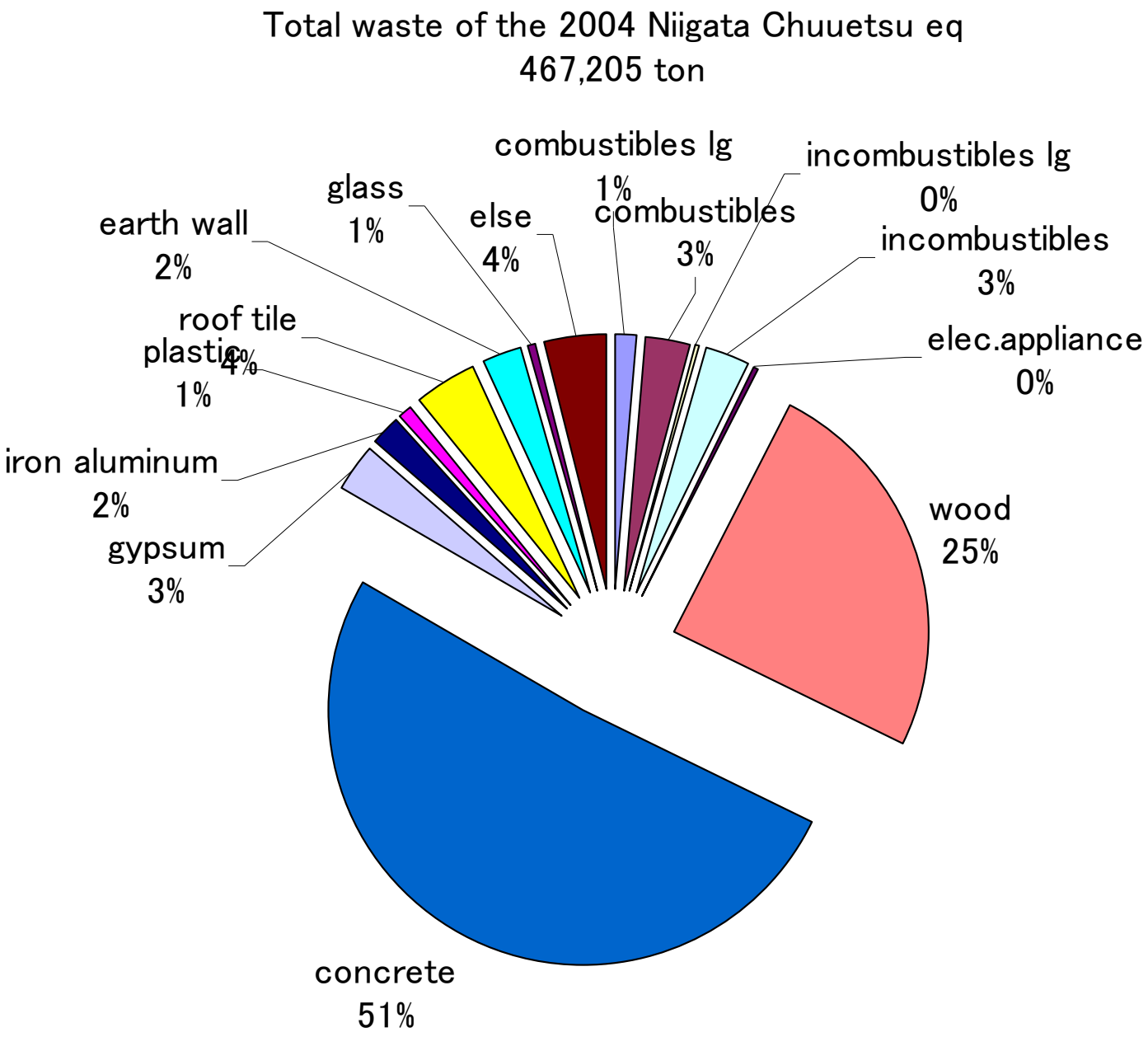
	2004.11.26 1 month after eq	2005.01.21 3 months after eq	2005.04.15 6 months after eq
Collapse 全壊	2,697	2,867	2,826
Heavy dmg 大規模半壊	571	1,664	1,993
Moderate dmg 半壊	6,041	9,349	10,870
Light dmg 一部破損	75,628	92,111	103,559

2004 Niigata Chuetsu eq, No of buildings demolished, as of Oct. 2006, Niigata pref.



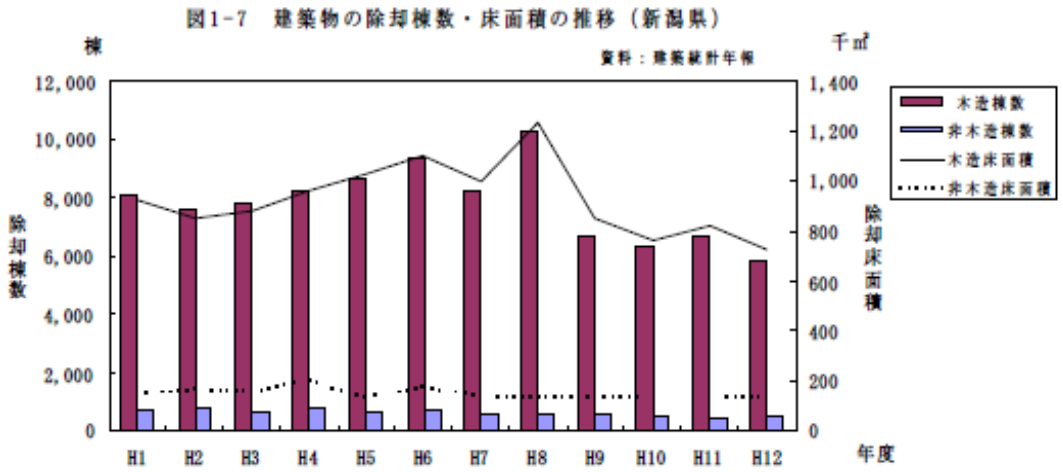
Source: Niigata pref. office, fund for disaster waste management, as of Oct. 30, 2006


Demolision and damages
the 2004 Niigata Chuetsu eq.
demolished house
collapse+heavy dmg
Early stage
official report,
Nov. 26, 2004
No. buildings
2000
1600
1200
800
400
0
Nagaoka c.
Kashiwazaki c.
Ojiya c.
Mitsuke c.
Tochio c.
Uonuma c.
Minamiuonuma
Tokamachi c.
Bunsui t.
Koshiji t.
Mishima t.
Yamakoshi v.
Kawaguchi t.
Takayanagi t.
Oguni t.
Kariwa v.
Nishiyama t.
Tsunan t.
Tsubame c.
Cities and Towns



Total waste, the 2004 Niigata Chuetsu eq: 467,205 ton

Annual demolition of buildings in Niigata pref. prior to the eq



- 5,838 wooden buildings and 477 non-wooden buildings were reported to be demolished in Niigata prefecture, in 2002.
- Population in the eq area is 1/7 of the pref.
- Post eq demolition is estimated as 7 year output.

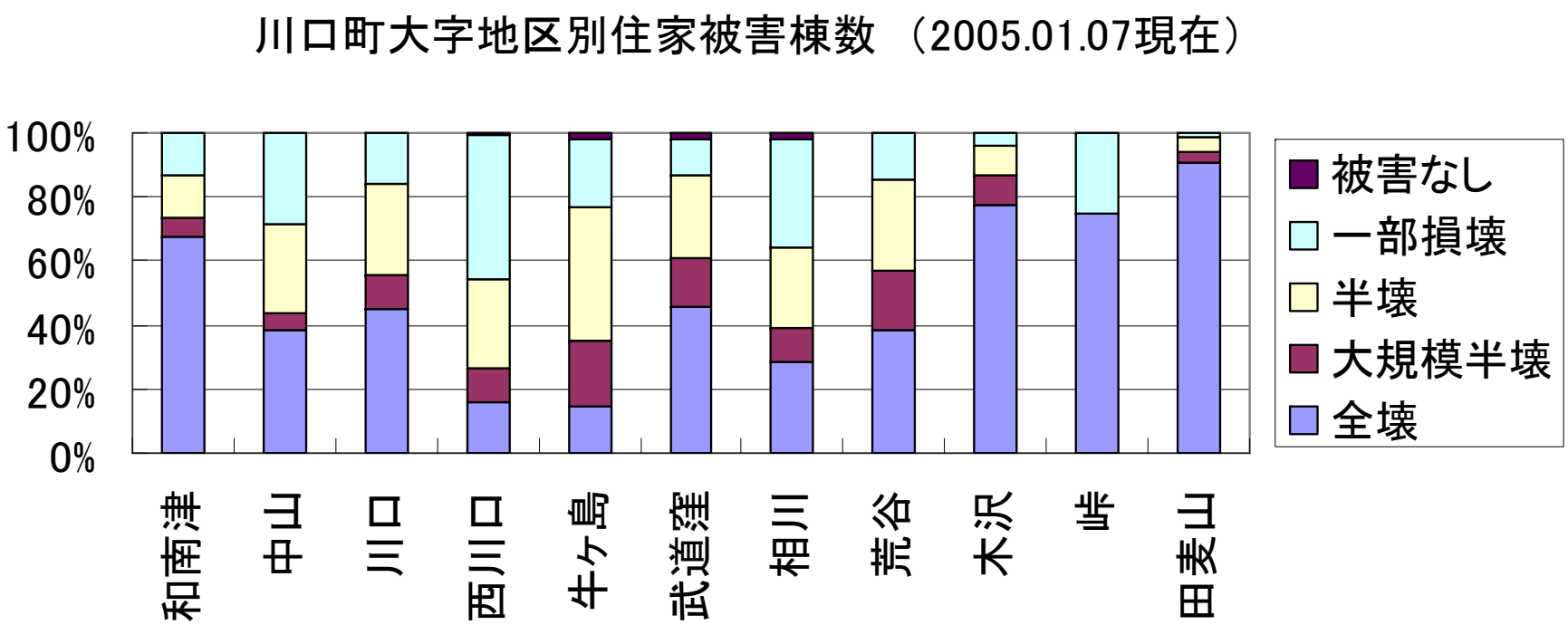
・外観あるいは、内部の被害から判断しても、
建て替えなくてもいい事例もある
・補修が可能で復旧費用に関しても安価であったのにもかかわらず、住宅の復旧方法として建て替えを選択してしまう

本研究では、
2004年新潟県中越地震の住宅復興アンケートを活用し、数量化Ⅱ類の手法により、補修か建て替えかの判別を分析し、補修可能性の推定を試みる

2. Questionnaire survey
Housing Restoration after the Niigata Chuetus Earthquake

- Kawaguchi Town (I-JMA=7)
  - Distributed 1533 cases
  - Collected 451 cases
  - Collection rate 29. 4%
- 28 questions
  - Type and age of a house, damage level, casualty, evacuation,
  - choice of restoration (rebuilding, reparing, or retrofit),
  - money for restoration, earthquake countermeasures, family conditions

Kawaguchi town, damage ratio for districts



Questionnaire on housing restoration

Q5. Damage levels for each building components

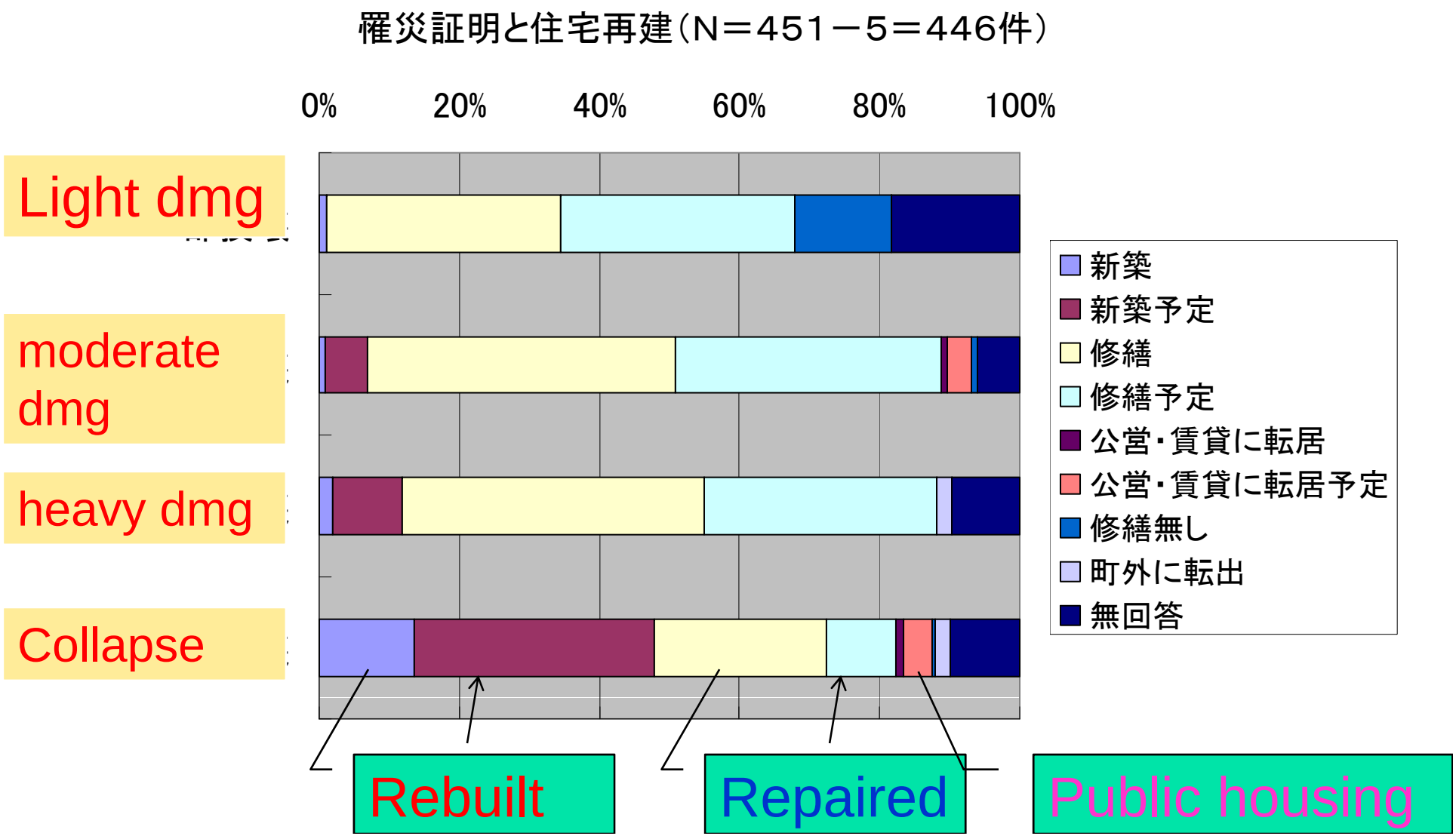
	Damage level category				
Compo-nents	1 no dmg	2 light	3 modereate	4 heavy	5 collapse
A. roof	被害無し	屋根材のズレ	屋根材の落下	小屋組破損	
B. Outer wall	被害無し	小さなキレツ	仕上げ材脱落	全面破損	
C. Columns, beams	被害無し	わずかな傾き	継ぎ目や材に損傷	大きな傾き	倒壊
D. foundation	被害無し	キレツ	傾斜・沈下	破壊・破断	
E ground, stone slope	被害無し	キレツ	傾斜・沈下	崩壊	

Questionnaire

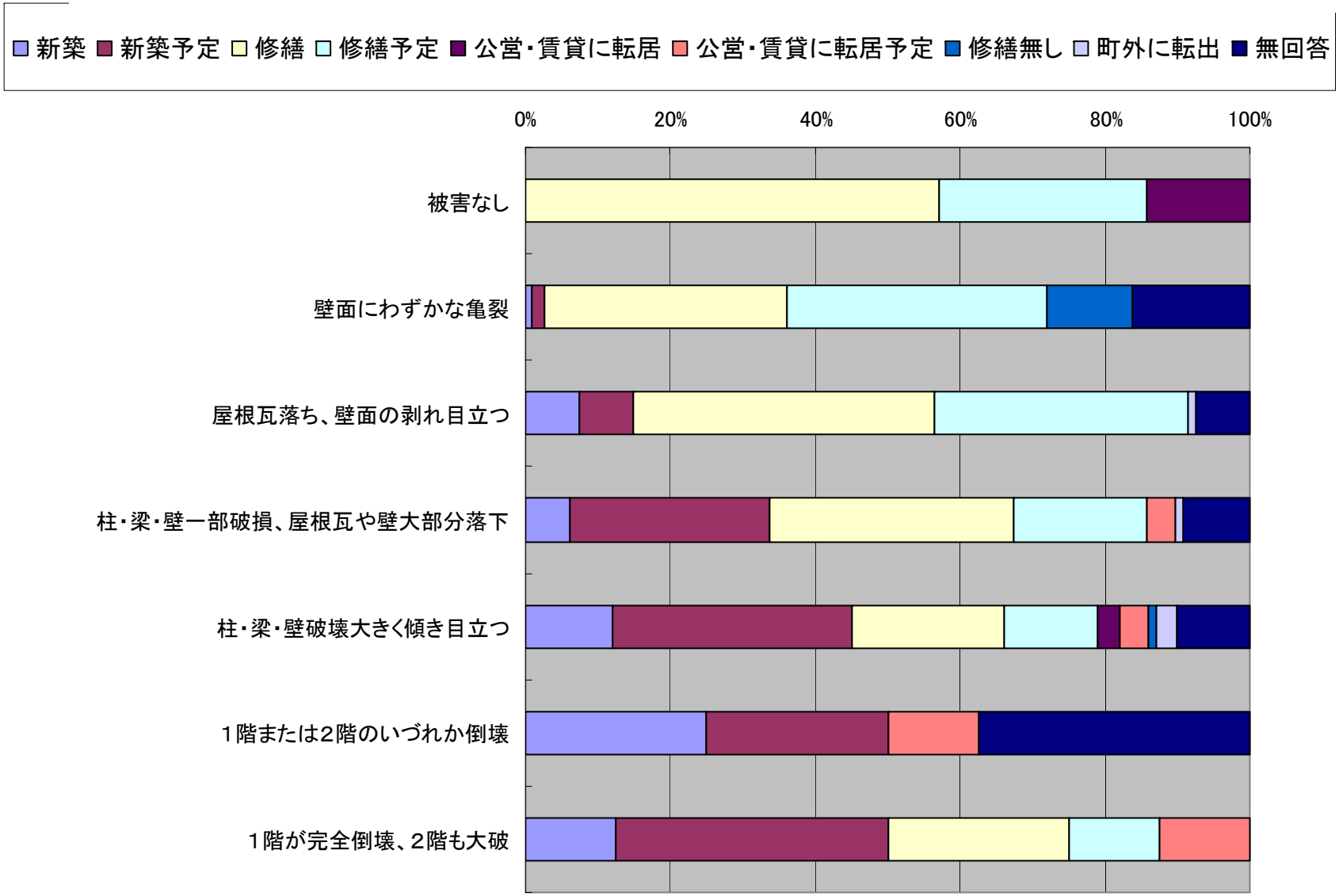
Q17. Housing restoration

1. Rebuilt
2. Planning to rebuild
3. Repaired
4. Planning to repair
5. Relocation to public post disaster apartments
6. Planning to relocate to public apartments
7. No repair (continue to live)
8. Moving out from the area

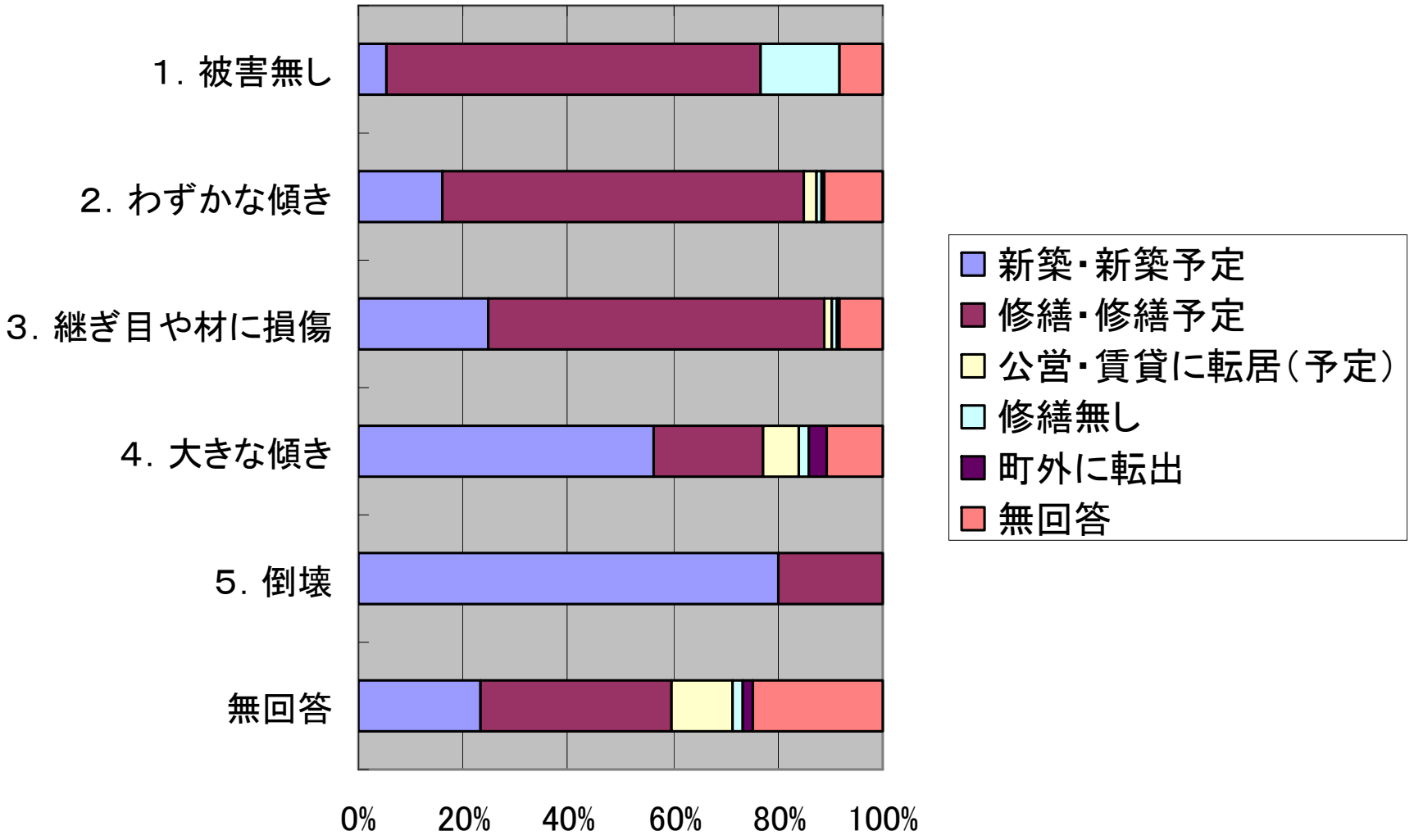
Official damage certificate and choice of restoration



Structural damage levels and choice of restoration

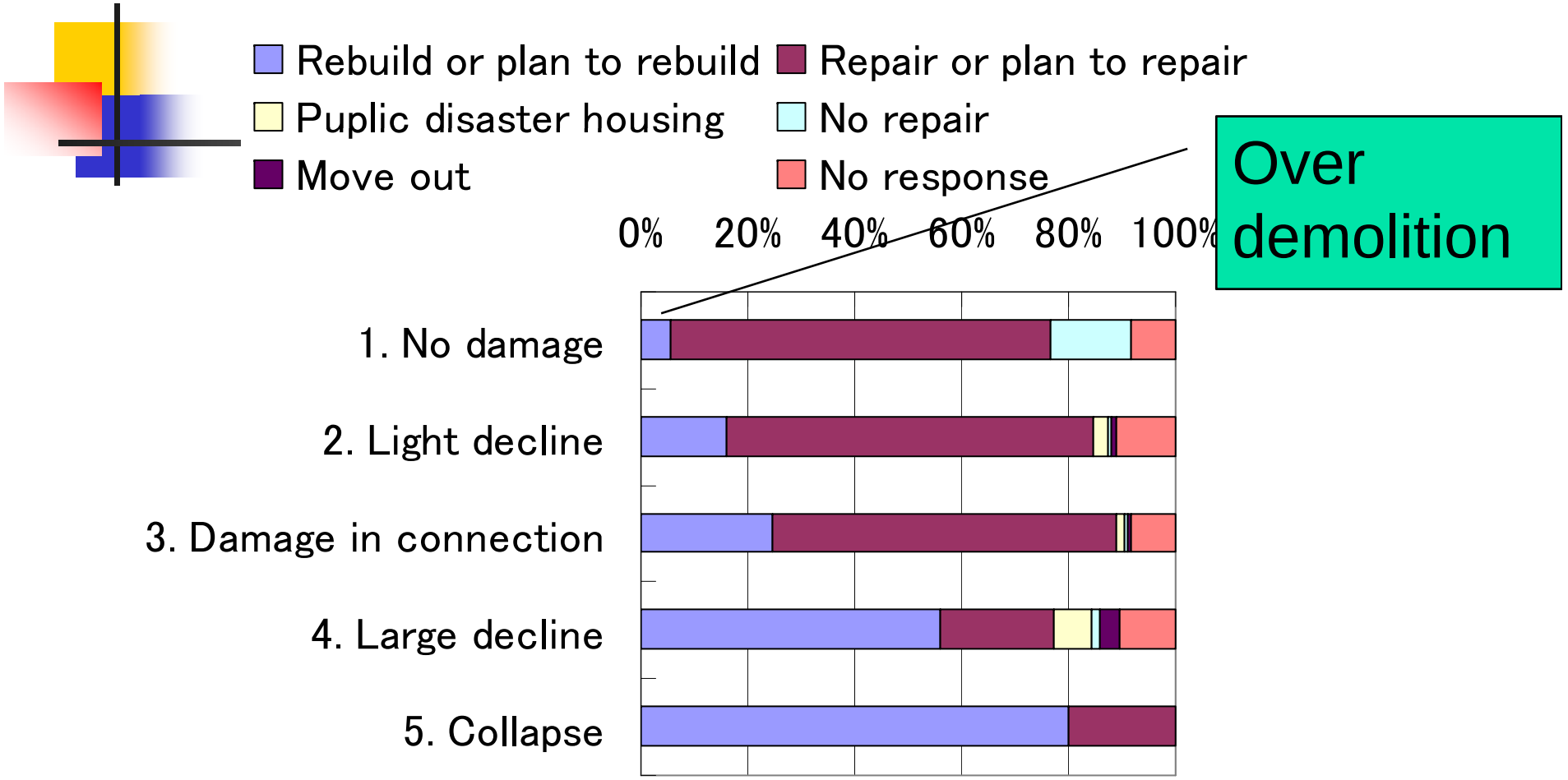


Q5C柱・梁の被害程度とQ17住宅再建に関する選択



・被害程度が増すと、新築・予定が増える・他の部位でも同じ傾向

Q5C Column beam damage and Q17 choice of housing restoration, N=399cases



As damage level gets greater, more dwellings rebuilt

Classification analysis by quantification theory II

- Independent variables

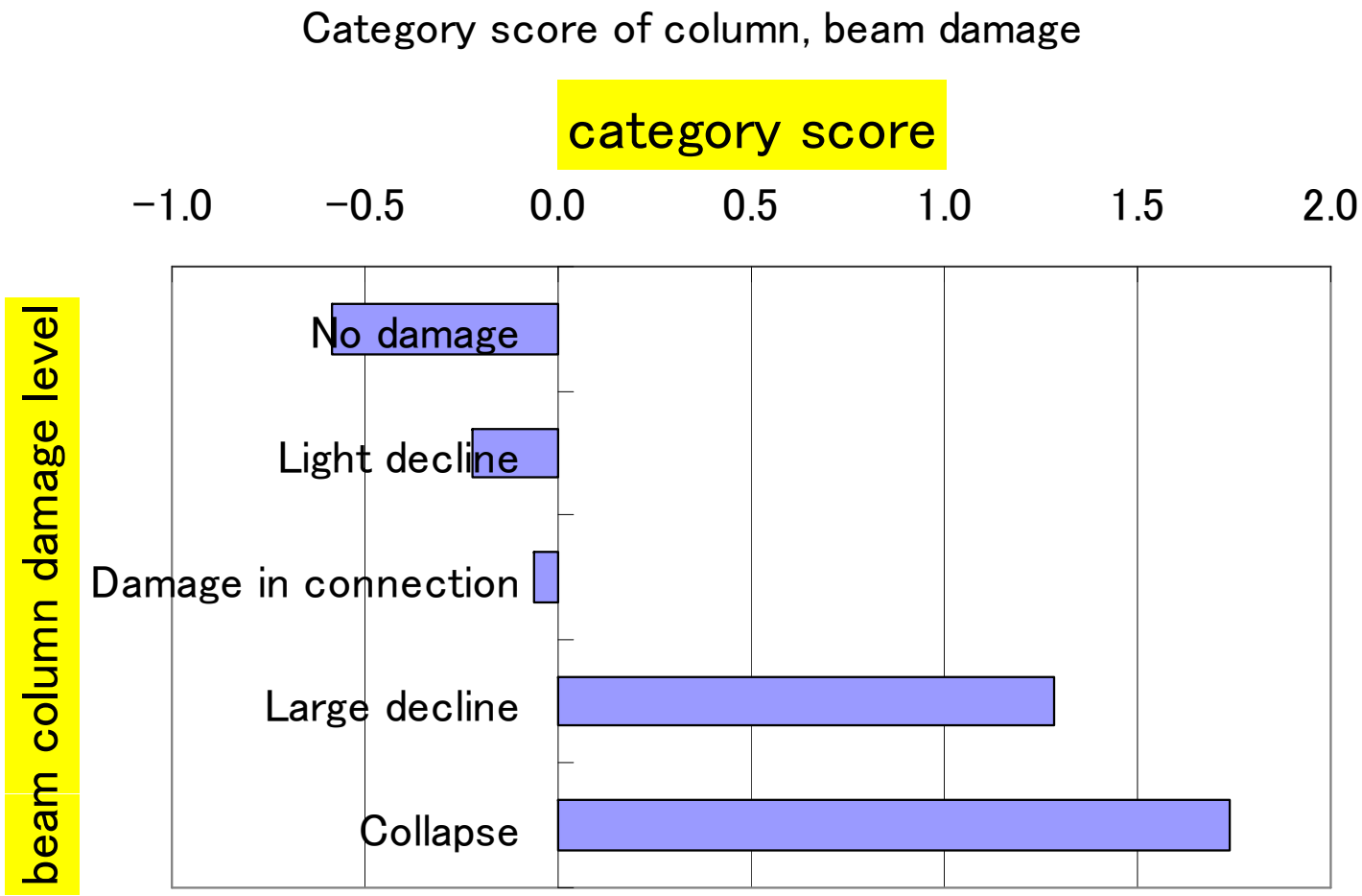
  Q5　damage levels of each building components; roof, outer walls, column and beam, foundation, ground

- Objective variable:　either to rebuild or repair

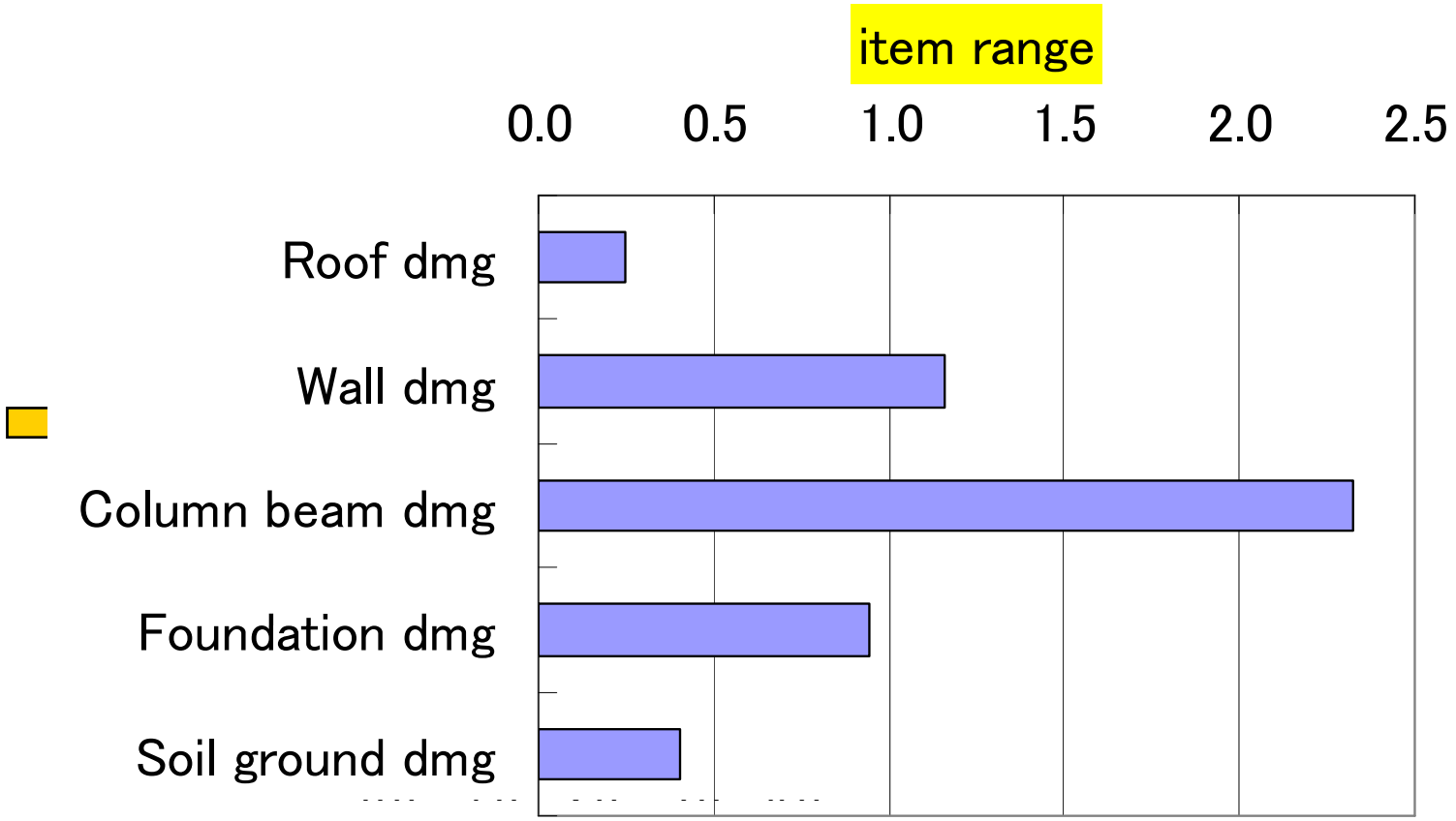
  Q17　Decision making for restoration rebuild or repair

Effective data: 272 cases out of 451 collected

Category score of the quantification analysis II
column, beam damage



Item range for classifying rebuilding or repair



３．数量化Ⅱ類（判別式）

$$
\begin{aligned}
Y = &-0.084X_{11} + 0.044X_{12} + 0.127X_{13} + 0.162X_{14} \\
&- 0.300X_{21} - 0.151X_{22} + 0.164X_{23} + 0.857X_{24} \\
&- 0.586X_{31} - 0.222X_{32} - 0.064X_{33} + 1.283X_{34} + 1.741X_{35} \\
&- 0.201X_{41} - 0.294X_{42} + 0.302X_{43} + 0.648X_{44} \\
&+ 0.211X_{51} - 0.190X_{52} + 0.092X_{53} - 0.098X_{54}
\end{aligned}
$$

サンプルスコア

例：Aさん

屋根被害無し：X_{11}

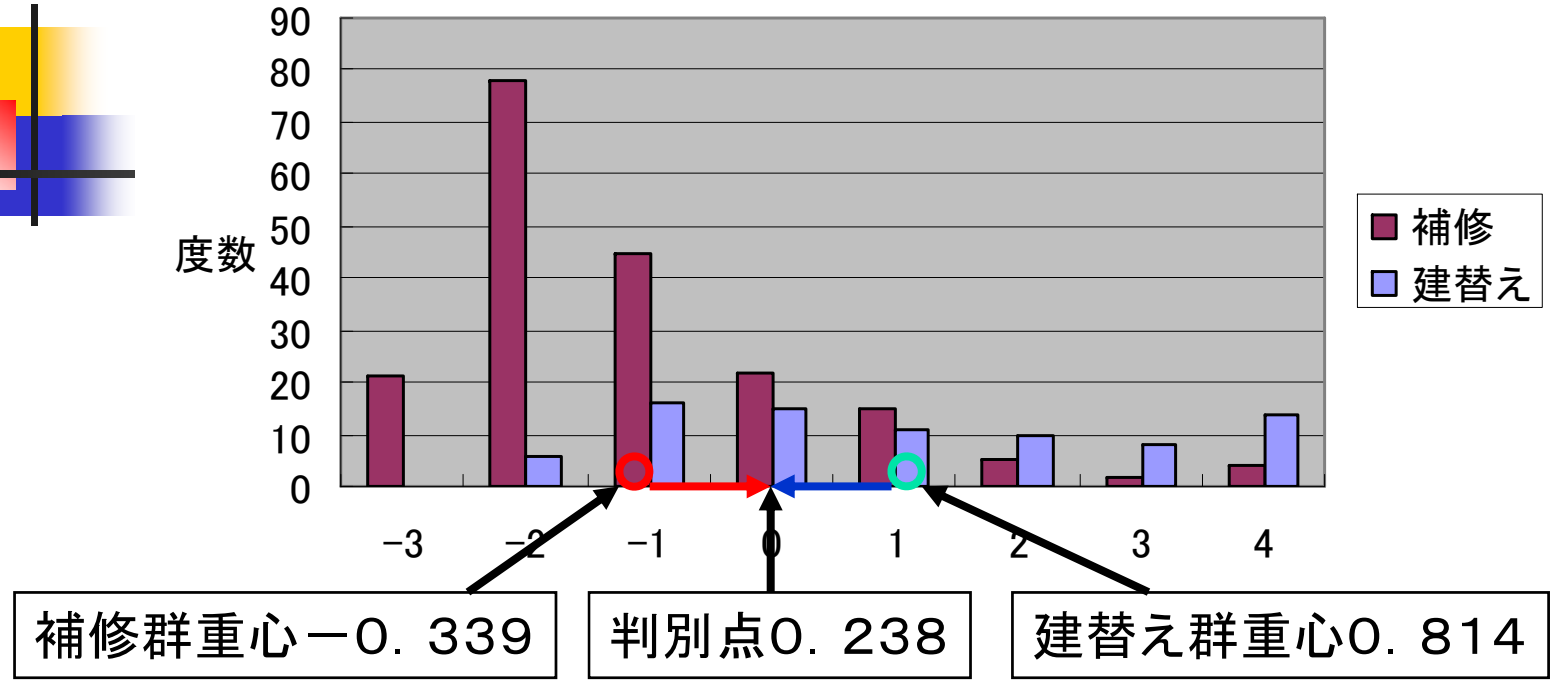
外壁小さなキレツ：X_{22}

柱・梁わずかな傾き：X_{32}

基礎・土台被害無し：X_{41}

地盤・石垣被害無し：X_{51}

サンプルスコアの分布



- 補修か建替えか判別するために判別点をもとめる
- 判別点より大きいと建替え、小さいと補修に判別

Classification results, by Quantification Theory II

Over demolition?

Under repair?

		Estimated		
		rebuilt	repaired	total
Observed	rebuilt	48	32	80
	repaired	33	159	192
	total	81	191	272

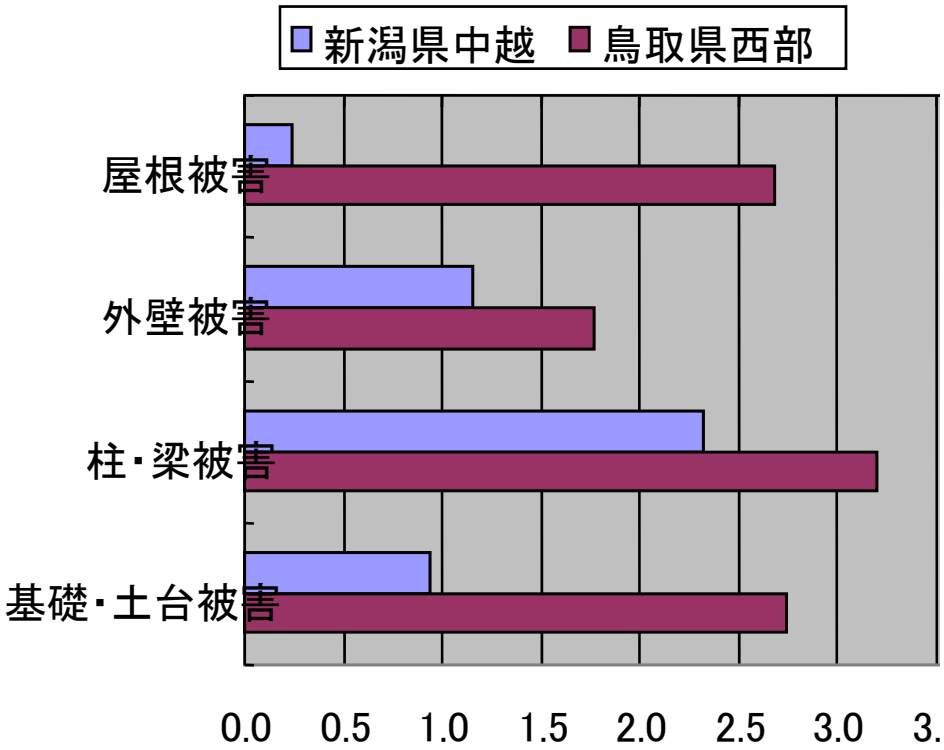
Rate of collect estimate＝(48＋159)／272＝76．1%

Comparison with the 2004 West Tottori earthquake results

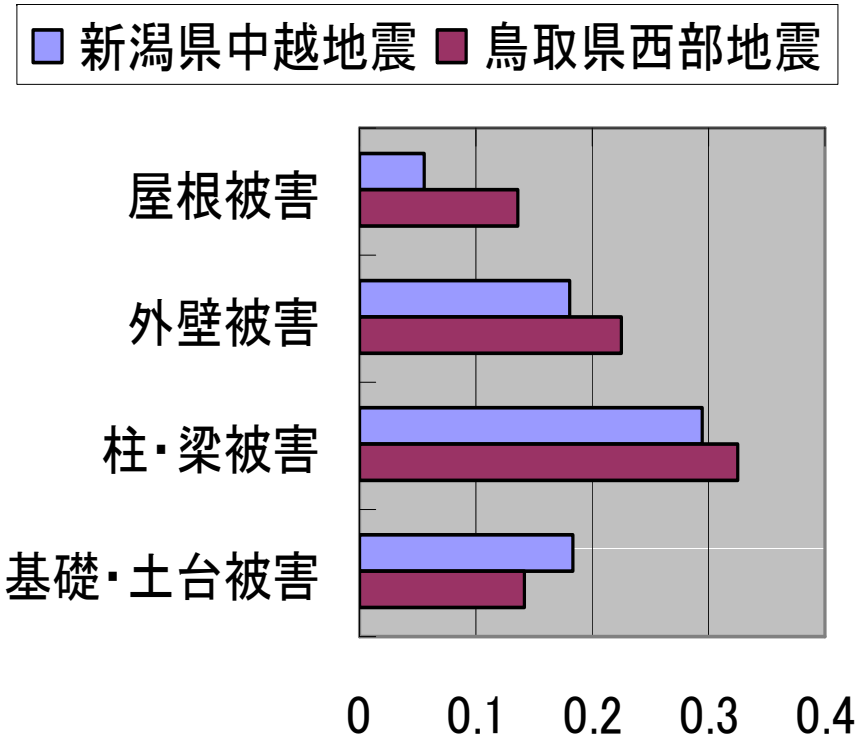
- Murakami and Hashimoto（2006）
  - Database of housing damage and decision making either to rebuild or to repair were analysed by quantification theory II
  - Database based on field survey for reserch purpose, and no. of data was 323 cases (26 rebuildings and 297 repairs)

4. 鳥取県西部地震(村上・他、2006)との比較

アイテムレンジ

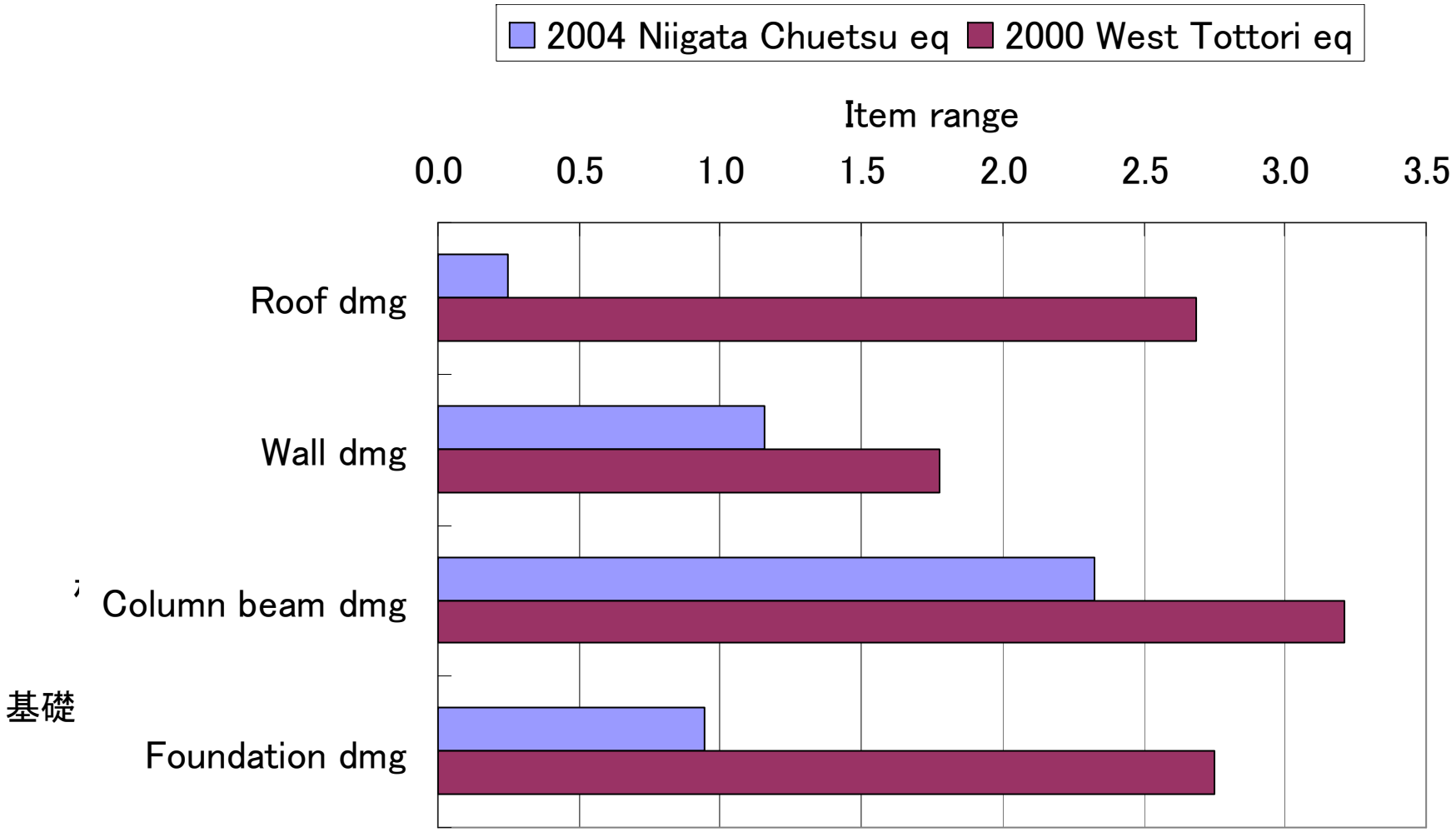


偏相関係数



中越地方は多雪地域、軽量屋根が多い
鳥取県西部・・・伝統的軸組木造、瓦屋根、屋根の影響大

Item range to classify rebuilding or repairing



Niigata pref. heavy snowfall, light metal roof
Tottori pref, traditonal Japanese wooden houses, heay tile roofs are common

Summary

- In the 2004 Niigata Chuetsu earthquake;
  - Housing demolition in the 2004 Niigata Chuetsu earthquake amounted to 7 year normal output in the disaster region.
  - Decision making either to rebuild or to repair depends most on column beam damage level, though significant cases of over demolition and under repair existed.
  - Factor affecting in the West Tottori earthquake is roof damage reflecting regional housing shapes
  - Recovery subsidies and consultation system should be designed to support suitable choice to rebuild or repair those.

榊原・村上・他（2006)

- 地震後の住宅再建に関する世帯の意思決定要因の分析

はじめに

- 鳥取県西部地震（2000）
- 宮城県北部地震（2003）
- 新潟県中越地震（2004）

（被災住宅再建のための支援制度導入）

- コミュニティ維持の観点からの評価
- 再建方法（建て替え（新築）か，補修か）に影響を与えた可能性
- 事前のミティゲーション（耐震補強，地震保険加入など）へのインセンティブ低下の懸念
- より広域的・大規模な地震の際の実行可能性

- アンケート調査を実施（2003～2005年）
- 住宅再建に関して，世帯の選択モデルを構築

集計概要（新潟県）

図2.7：罹災証明(新潟県)

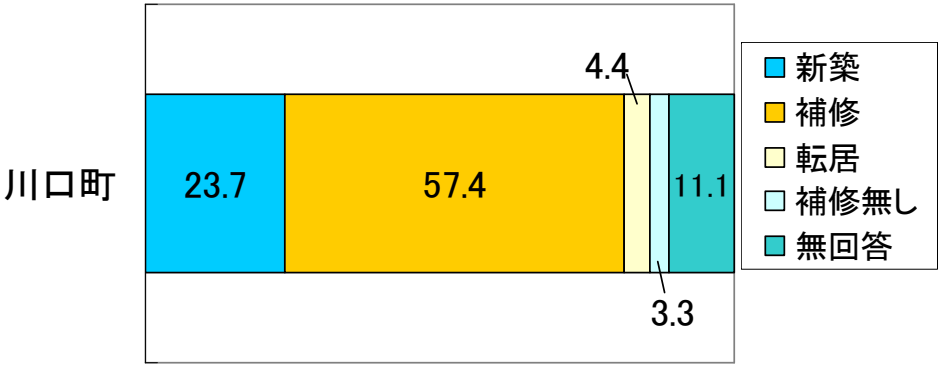


図2.8：実際の再建方法(新潟県)

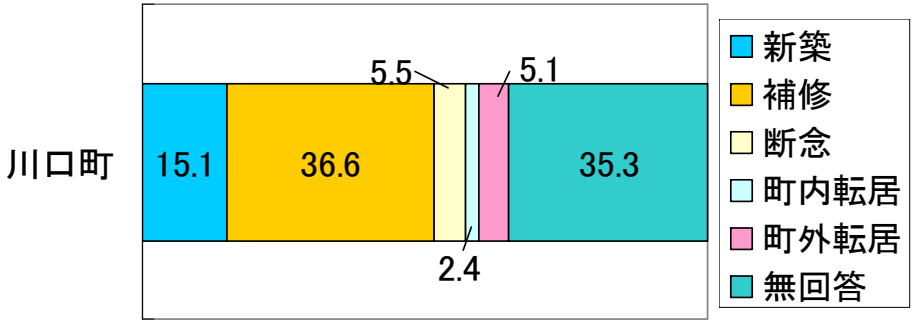
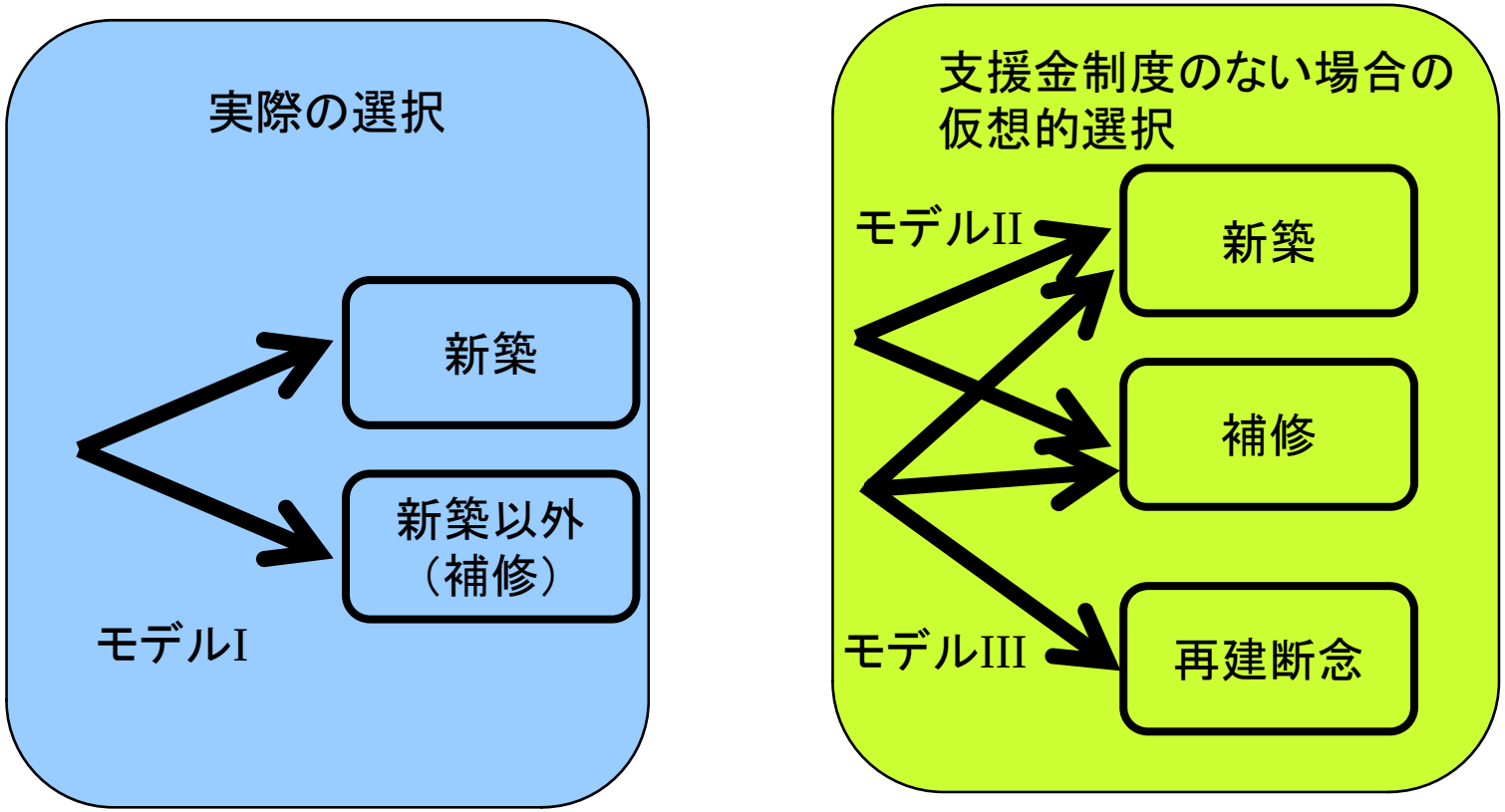


図2.9：支援金が無い場合の再建(新潟県)

選択モデルの構成

二項・多項ロジットモデルを使用



パラメータ推定結果（モデルI）

	説明変数名	パラメータ推定値	t値
θ1	定数項	−3.964	−9.142**
θ2	築年数	0.027	6.820**
θ3	地震保険・JA共済への加入	0.199	0.829
θ4	避難生活の有無	1.240	4.082**
θ5	罹災証明が全壊	3.501	14.694**
θ6	構造的破損	0.510	1.809*
θ7	付帯的破損	−0.122	−0.409
θ8	子供のいる世帯	0.621	2.355**
θ9	高齢者世帯	−1.762	−5.641**
θ10	過疎地域ダミー	−1.273	−4.237**

*：10%有意，**：5%有意

的中率：87.1%，尤度比：0.566

- 物理的被害を表す変数のパラメータ（「全壊」θ5，「避難生活」θ4が有意）
- 「子供のいる世帯」のパラメータθ8は正で有意（建て替え促進の要因）
- 「高齢者のみの世帯」のパラメータθ9は負（建て替え抑制の要因）
- 「過疎地域ダミー」のパラメータθ10は負（建て替え抑制の要因）