

Electronic supplementary material (ESM2) – Hydrogeology Journal

Report on questionnaire survey on water security after earthquake
(Welfare facilities for aged people in the city of Kumamoto, Kumamoto Prefecture, Japan)

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1. Background

This survey was supported by “Efficient Securing of Water Resources” project under the Enhancement of National Resilience against Natural Disaster, Cross-ministerial Strategic Innovation Promotion Program, controlled by the Cabinet Office of the Government of Japan (Project leader: Professor OKI Taikan, University of Tokyo). This research project was launched within the context of frequent occurrence of natural disasters in Japan. The overall aim is to construct a “groundwater utilization system for emergency situations” by investigating the availability of groundwater resources in times of crisis, without causing substantial negative impacts on the environment and by considering the institutional arrangements that underpin such a system.

The research target is welfare facilities for aged people in the city of Kumamoto, Kumamoto Prefecture, Japan. The purpose of this questionnaire survey is to collect information on how these facilities obtained water (including groundwater) and how they used it. The city of Kumamoto was struck by the Kumamoto Earthquake in 2016. The reason why such facilities is set as the research target is that they are likely to be vulnerable in an emergency. Special attention regarding the vulnerable is critical when thinking of the institutional design of Disaster Emergency Wells (DEWs).

A DEW is a local well registered with the local government that could be used as a supplementary water supply in the event of occurrence of an earthquake. While some wells are constructed by the local government, most are privately owned by local factories and shopping malls. Registered DEWs are supposed to be accessible by the local population as a source of water for drinking or other domestic purposes in an emergency. However, it is not mandatory and accessibility is at the discretion of well owners. Although Kumamoto did not have DEWs in operation at the time of the Kumamoto Earthquake (DEWs were registered the year following the earthquake), private wells were used as a source of water supply.

This survey was conducted in conjunction with an initial survey whose research target was DEW registrants in the city of Kumamoto. The objective of the initial survey is to reveal how groundwater was used following occurrence of an earthquake by focusing on the behavior of those who supplied the groundwater. The objective of this survey is to establish how groundwater was used by focusing on the actions of those who were in need of water. Integration of the results obtained from these two surveys enables more comprehensive understanding of groundwater utilization following occurrence of an earthquake.

2. Method

2-1. Research target

The research target comprised 328 facilities in the city of Kumamoto. These facilities were selected from GIS attribute data compiled by the Ministry of Land, Infrastructure, and Transport of Japan. The data can be found at <https://nlftp.mlit.go.jp/ksj/>. (accessed on 22 January 2021).

2-2. Questionnaire survey method

An online questionnaire survey was used.

2-3. Timespan

The questionnaire was distributed on 10 February 2021 and the deadline for response was as 1 March 2021.

2-4. Results of replies

Replies were obtained from 118 of 328 facilities (reply rate: 36.0%).

3. Questions and answers

Q1 Please let us know name and postal address of facilities.

Replies to this question are omitted.

Q2 How did you obtain a water supply when the earthquake occurred? Please select from the following choices. Selection of multiple answer choices is allowed. If you include [1] in your answer, please then move to question 3. If you do not include [1], please then move to question 4.

Answer Choices	Responses	
1. We used groundwater from our own well.	12.82%	15
2. We used tap water supplied directly from the waterworks.	31.62%	37
3. We used tap water stored in a water receiving tank.	16.24%	19
4. Not sure how we obtained water when the earthquake occurred.	11.97%	14
5. Other (free descriptive answer).	35.04%	41
Answered		117
Skipped		1

Q3 Only those who included [1. We used groundwater from our own well.] in answering question 2 should reply to this question. For what purposes did you use groundwater? Please select one from the following choices.

Answer Choices	Responses	
1. Drinking purposes (including cooking purposes).	0.00%	0
2. Domestic purposes (toilet, laundry, and bathing).	60.00%	9
3. Fire protection.	0.00%	0
4. Drinking and domestic purposes.	26.67%	4
5. Drinking and fire protection purposes.	6.67%	1
6. Domestic and fire protection purposes.	0.00%	0
7. Drinking, domestic, and fire protection purposes.	6.67%	1
8. Although we had a well, we did not use it.	0.00%	0
9. Other (free descriptive answer).	0.00%	0
Answered		15
Skipped		103

Q4 When the earthquake occurred, was the water supply cut off? Please select one from the following choices. If you select [1], please then move to question 5. If you select [2], please then move to question 6.

Answer Choices	Responses	
1. Water supply was cut off.	82.20%	97
2. Water supply was not cut off.	17.80%	21
Answered		118
Skipped		0

Q5 Only those who selected [1. Water supply was cut off.] at question 4 should answer this question. How long did it take for the water supply to be restored? Please select one from the following choices.

Answer Choices	Responses	
1. 1 day.	4.35%	4
2. 2–6 days.	66.30%	61
3. 7–13 days.	17.39%	16
4. 14 days to less than 1 month.	9.78%	9
5. 1 month or longer.	2.17%	2
Answered		92
Skipped		26

Q6 The city in which your facility is located has introduced an institution where households and private firms voluntarily register their wells in advance as open to the public in case of disaster. Although these wells are generally called “Disaster Emergency Wells,” the name differs according to location. A disaster Emergency Well is called a “private firms’ cooperative well in disaster” in the city of Kumamoto. Are you aware of such wells now? Please select one from the following choices.

Answer Choices	Responses	
1. Yes, we know.	25.22%	29
2. No, we do not know.	74.78%	86
Answered		115
Skipped		3

Q7 When the preceding earthquake occurred, did you obtain water from a Disaster Emergency Well? Please select one from the following choices. If you select [1] or [2], please then move to question 8. If you select [3], please then move to question 12.

Answer Choices	Responses	
1. We obtained water from local wells and we knew that they were registered in the Disaster Emergency Well system.	0.86%	1
2. We obtained water from local wells although we were unsure whether they were registered in the Disaster Emergency Well system.	37.07%	43
3. We did not obtain water from local wells.	62.07%	72
Answered		116
Skipped		2

Q8 For what purposes did you use water from the local well? Please select one from the following choices.

*Only those who selected [1. We obtained water from local wells and we knew that they were registered in the Disaster Emergency Well system.] or [2. We obtained water from local wells although we were unsure whether they were registered in the Disaster Emergency Well system.] at question 7 should answer this question.

Answer Choices	Responses	
1. Drinking purposes (including cooking purposes).	18.18%	8
2. Domestic purposes (toilet, laundry, and bathing).	50.00%	22
3. Fire protection.	0.00%	0
4. Drinking and domestic purposes.	27.27%	12
5. Drinking and fire protection purposes.	0.00%	0
6. Domestic and fire protection purposes.	2.27%	1
7. Drinking, domestic, and fire protection purposes.	2.27%	1
8. Other (free descriptive answer).	0.00%	0
Answered		44
Skipped		74

Q9 Who owned the well? Please select from the following choices. Selection of multiple answer choices is allowed.

*Only those who selected [1. We obtained water from local wells and we knew that they were registered in the Disaster Emergency Well system.] or [2. We obtained water from local wells although we were unsure whether they were registered in the Disaster Emergency Well system.] at question 7 should answer this question.

Answer Choices	Responses	
1. Resident of detached house.	52.08%	25
2. Resident of apartment house.	4.17%	2
3. Factory.	8.33%	4
4. Shopkeeper.	4.17%	2
5. Shopping complex.	0%	0
6. Local firm.	0%	0
7. Community center.	0%	0
8. School.	2.08%	1
9. City government.	10.42%	5
10. We do not know who owned the well.	2.08%	1
11. Other (free descriptive answer).	16.67%	8
Answered		48
Skipped		74

Q10 What is the distance from your facility to the well? Please select one from the following choices. If you used multiple wells in various locations, please select the furthest.

*Only those who selected [1. We obtained water from local wells and we knew that they were registered in the Disaster Emergency Well system.] or [2. We obtained water from local wells although we were unsure whether they were registered in the Disaster Emergency Well system.] at question 7 should answer this question.

Answer Choices	Responses	
1. Less than a 5-minute walk.	43.48%	20
2. A 5–10-minute walk.	13.04%	6
3. A 10–20-minute walk.	17.39%	8
4. More than a 20-minute walk.	26.09%	12
	Answered	46
	Skipped	72

Q11 How did you learn of the location of the well? Please select from the following choices.

Selection of multiple answer choices is allowed.

*Only those who selected [1. We obtained water from local wells and we knew that they were registered in the Disaster Emergency Well system.] or [2. We obtained water from local wells although we were unsure whether they were registered in the Disaster Emergency Well system.] at question 7 should answer this question.

Answer Choices	Responses	
1. Word-of-mouth communication.	58.70%	27
2. Public relations by the well owner (e.g., poster, signboard, social media, and homepage).	2.17%	1
3. Public relations by the city government (e.g., social media, homepage, bulletin, and hazard map).	6.52%	3
4. Someone other than those mentioned in choices [1]–[3] (e.g., social media of other affected people).	26.09%	12
5. Newspaper.	0.00%	0
6. Radio.	2.17%	1
7. Television.	2.17%	1
8. Other (free descriptive answer).	13.04%	6
	Answered	46
	Skipped	72

Q12 From now, please let us ask about the ways other than using wells in which you secured a water supply following the earthquake. How did you secure a water supply for drinking and cooking purposes? Please select from the following choices. Selection of multiple answer choices is allowed.

Answer Choices	Responses	
1. From the facility's own water supply systems (e.g., water receiving tank and elevated water tank).	19.47%	22
2. From the facility's own stock of bottled water.	37.17%	42
3. From the city government's water trucks.	29.20%	33
4. From supportive action of an external private aid organization.	16.81%	19
5. Other (free descriptive answer).	27.43%	31
	Answered	113
	Skipped	5

Q13 Please let us ask once again about the ways other than wells in which you secure a water supply following the earthquake. How did you secure a water supply for domestic purposes (toilet, laundry, and bathing)? Please select from the following choices. Selection of multiple answer choices is allowed.

Answer Choices	Responses	
1. From the facility's own water supply systems (e.g., water receiving tank and elevated water tank).	30.70%	35
2. From the facility's own stock of bottled water.	25.44%	29
3. From the city government's water trucks.	24.56%	28
4. From supportive action of an external private aid organization.	7.89%	9
5. Other (free descriptive answer).	39.47%	45
	Answered	114
	Skipped	4

Q14 Please let us ask about your efforts following the earthquake. Have you taken additional countermeasures to secure a water supply for drinking and cooking purposes in an emergency? Please select from the following choices. Selection of multiple answer choices is allowed.

Answer Choices	Responses	
1. We improved or increased our own water supply system such as a water receiving tank and elevated water tank.	4.27%	5
2. We increased our own stock of bottled water.	47.86%	56
3. We drilled our own well.	2.56%	3
4. We confirmed the location of an adjacent well.	22.22%	26
5. We consulted the city government regarding an emergency water supply.	3.42%	4
6. We consulted private organizations such as firms and non-profit organizations regarding an emergency water supply.	8.55%	10
7. We have not taken additional countermeasures.	27.35%	32
8. Other (free descriptive answer).	13.68%	16
	Answered	117
	Skipped	1

Q15 Please let us ask you once again regarding your efforts following the earthquake. Have you taken additional countermeasures to secure a water supply for domestic water purposes (toilet, laundry, and bathing) in an emergency? Please select from the following choices. Selection of multiple answer choices is allowed.

Answer Choices	Responses	
1. We improved or increased our own water supply system such as a water receiving tank and elevated water tank.	1.71%	2
2. We increased our own stock of bottled water.	33.33%	39
3. We drilled our own well.	1.71%	2
4. We confirmed the location of an adjacent well.	23.93%	28
5. We consulted the city government regarding an emergency water supply.	3.42%	4
6. We consulted private organizations such firms and NON-PROFIT ORGANIZATIONs regarding an emergency water supply.	11.11%	13
7. We have not taken additional countermeasures.	37.61%	44
8. Others (free descriptive answer)	7.69%	9
	Answered	117
	Skipped	1

Q16 Please let us know what you found difficult or what required your ingenuity in securing an emergency water supply following the earthquake (free descriptive answer).

Replies to this question have been omitted.

Q17 Please let us know your thoughts regarding the use of groundwater following the earthquake (free descriptive answer).

Replies to this question have been omitted.