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**Publication date**

2018

**Document Version**

Final published version

**Published in**

Conference papers of the European Network for Housing Research (ENHR 2018)

**Citation (APA)**

Jansen, S. (2018). The impact of earthquakes on residential wellbeing. In *Conference papers of the European Network for Housing Research (ENHR 2018): More together, more apart: Migration, densification, segregation* ENHR.

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# The Impact of Earthquakes on Residential Wellbeing

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## Abstract

*In the Netherlands, the extraction of natural gas from the ground has led to soil subsidence and the occurrence of earthquakes. These earthquakes cause physical damage to buildings and also lead to psychological problems and decreased housing satisfaction. Research on the impact of natural hazards has shown that there is a complicated relationship between perceived risk, place attachment and coping behaviour. The current study provides further insight into this relationship. The research questions are the following:*

- 1) What is the relationship between place attachment and risk perception?*
- 2) What is the relationship between risk perception and the intention to move?*
- 3) Is the relationship between risk perception and intention to move influenced by place attachment?*
- 4) What is the role of psychological distress in the interaction between place attachment, risk perception and the intention to move?*

*The results show that, in general, (1) residents with the highest level of attachment show the highest mean risk perception. Furthermore, (2) residents with a higher risk perception more frequently indicate that they intend to move. Moreover (3), there is an interaction between place attachment, perceived risk and the intention to move. Strongly attached residents show a high level of risk perception, but are less willing to move. Finally, (4) this finding cannot be explained by a low level of psychological distress in strongly attached residents as their level of psychological distress is relatively high.*

Keywords: place attachment, risk perception, wellbeing, earthquakes

## Introduction

The extraction of natural gas in the province of Groningen, the Netherlands, has led to soil subsidence and subsequently the occurrence of earthquakes. These earthquakes are relatively weak in terms of the Richter scale. The strongest one occurred in 2012 and was 3.6 on the Richter scale. However, the shallow depth at which they occur nevertheless causes much damage to dwellings, other buildings and the infrastructure. Mostly, this concerns (major) damage and not the total collapse of a dwelling. Residents can submit a claim for damage compensation by the NAM, the company that extracts the gas from the ground. But the process of claiming has turned out to be a very lengthy one and the objectivity of the NAM in evaluating the claims has been disputed. Recently, the damage compensation has been taken out of the hands of the NAM but a satisfactory solution has still not been found. This causes a large psychological burden for the residents of the area, aside from the stress that they already experience as a result of the threat of future earthquakes.

How do residents cope with such serious physical and psychological consequences of (future) earthquakes? As noted by Bonaiuto et al. (2016): What happens when one's own place – an environment the inhabitant would consider as familiar and secure - becomes a source of threatening events? Some research has been done into this topic. For example, Bonaiuto et al. (2016) performed a literature review into the relationship between place attachment, risk coping and risk perception for various types of risk, such as flooding, tornado's, earthquakes and volcanic activity.

Bonaiuto et al. (2016) first report the results with regard to studies into the relationship between place attachment and risk perception. Risk perception concerns the intuitive risk judgments concerning natural or technological hazards (Slovic 1987). Risk perception is mediated by social influences (e.g., friends, family), whether or not an activity is voluntarily and by mental strategies (heuristics) that people use to structure their view of the world (Slovic 1987). Risk perception can also be influenced by the situation that people face, individual characteristics (Lopez-Vazquez & Marvan, 2003) and previous experience (Tversky & Kahneman, 1973; Whitmarsh, 2008; Peters et al. 2012). Place attachment can be broadly defined as an emotional and cognitive experience linking people to places (Bonaiuto et al. 2016). Bonaiuto et al. (2016) report eight studies that showed a positive relationship between place attachment and risk perception, indicating that a heightened sense of place attachment is related to a higher awareness and perception of the occurrence of a natural disaster. For example, a high level of place attachment was related to a higher awareness of the risk of a volcanic eruption, the prospect of hurricanes and the occurrence of earthquakes and mud slides. Bonaiuto et al. (2016) also report four studies that showed a negative relationship. A higher level of place attachment was related to lower risk perception and awareness in the case of seismic risk exposure, volcano risk and beach pollution threat. The latter research result suggests that strongly attached residents may underestimate potential risk (Bonaiuto et al. 2016). Strongly attached people might feel safe and this could lead to neglect or denial of the potential hazard (De Dominicis et al. 2015). Such a finding might, for example, be explained by an optimism bias: individuals think that a disaster “will not happen to them” (De Dominicis et al. 2015, Bonaiuto et al. 2016). Another explanation for a negative relationship between place attachment and risk perception is psychological distance. People might believe that an environmental risk is less likely to occur in distant geographical regions or in the distant future (Bonaiuto et al. 2016 refer to Locke and Latham, 1990). It is also possible that the relationship between place attachment and risk perception is different, depending on the level of risk. For risks that are perceived to be less likely, place attachment might decrease risk perception whereas for risks that are perceived to be more likely, place attachment might increase risk perception (De Dominicis et al. 2015). This indicates that the (actual) level of risk should also be taken into account.

Bonaiuto et al. (2016) also studied the relationship between place attachment and coping with risk. Coping can be defined as a person’s cognitive and behavioural efforts to manage the demands of a stressful person-environment relationship (Folkman et al. 1986). Which coping strategie(s) will be applied depends upon the situation, personal characteristics and other processes, such as risk perception (Lopez-Vasquez, 2001). Bonaiuto et al. (2016) report to have found both positive and negative relations between the level of place attachment and coping activities. This varying result can be explained because it concerns different types of coping with risky situations. The positive relationships generally showed that a high level of place attachment was related to place-protective and pro-environmental behaviours (e.g., recycling, cleaning up beaches, collecting litter and planting trees). The negative relationships mostly concerned the relationship between place attachment and moving from a risky area. Strongly attached individuals are generally less willing to relocate and are more likely to return to risky areas after a natural environmental disaster.

Based on their findings, Bonaiuto et al. (2016) conclude that strongly attached individuals seem to perceive the risk from the natural disaster but might underestimate the potential effect for their personal situation. Furthermore, strongly attached individuals seem to be unwilling to relocate when facing natural environmental risks. Finally, the authors conclude that there is a lack of knowledge with regard to systematic scientific attention to the relation between place attachment, risk perception and coping (Bonaiuto et al. 2016). The current study will contribute to the accumulation of knowledge regarding this topic. The goal is to disentangle the relationships between place attachment, risk perception, coping behaviour and psychological distress.

Based on the literature described above, the following research questions were formulated:

- 1) What is the relationship between place attachment and risk perception, and is this relationship influenced by actual risk level?
- 2) What is the relationship between risk perception and the intention to move (a type of coping behaviour)?
- 3) Is the relationship between risk perception and the intention to move influenced by the level of place attachment? In other words, are strongly attached residents less inclined to move, irrespective of their perceived risk level?
- 4) What is the influence of psychological distress on this relationship?

## Methods

### *The respondents*

In June 2015, more than 19,000 residents who lived in one of nine “risk municipalities” in the province of Groningen, the Netherlands, were invited by letter to take part in an internet survey. Note that - if preferred - they could also fill in a written questionnaire. The nine municipalities combined have about 96,500 inhabitants aged 18 years or older and consist of almost 53,000 households. All 811 participants of the “Groninger Panel” who lived within the area were invited. The “Groninger Panel” is a representative sample of the inhabitants of the province of Groningen. The other 18,436 potential respondents were selected by having the nine municipalities take a random sample from their registry based on the following criteria: age  $\geq 18$ , one person per household, not part of the “Groninger Panel” and not living in an institution. The selection was partly stratified to obtain a sufficient number of respondents from smaller villages within the municipalities. The response rate was 65% ( $n = 529$ ) for participants from the “Groninger Panel” and 21% ( $n = 3,834$ ) for the randomly selected residents (total = 4,363) (Hoekstra, 2016). Some of the questionnaires were not usable, leading to a total of 4,260 valid responses.

### *Place attachment, risk perception, risk level, coping behaviour and socio-demographic characteristics*

The variables that have been used in this study are summarised in Table 1. Place attachment was operationalized with a question into the level to which the respondent felt attached to the region in which he/she currently lives. Risk perception was measured using four statements on feelings of unsafety and insecurity that were rated on a 5-point Likert scale (entirely agree to entirely disagree) (see Table 1). Respondents could also indicate: “I don’t know / not applicable”, which was coded as a missing answer. A Cronbach’s Alpha analysis yielded a value of 0.91, which is quite satisfactory ( $n = 3,565$ ). The four items were combined into one scale, which will be referred to as reflecting “Risk perception”. The mean score on the scale was calculated for respondents who had no missing or inconclusive answers on at least two of the four items ( $n = 3,988$ ). Higher scores indicate more perceived risk. Actual risk level was taken from the study by Hoekstra (2016) and was based on the percentage of officially acknowledged damage claims within a limited area (a postcode). Four regions are distinguished. The first region contains postcodes in which no more than 5% of residents has experienced officially acknowledged damage to the dwelling. For the second, third and fourth regions these percentages are 5-38.9%, 39.0-60% and  $> 60\%$ , respectively.

Psychological distress was determined with the use of three different statements that were rated on a 5-point Likert scale (entirely agree to entirely disagree) (see Table 1). A Cronbach's Alpha analysis yielded a value of 0.78, which is satisfactory ( $n = 3,211$ ). The three items were combined into one scale: "Psychological distress". The mean score on the scale was calculated for respondents who had no missing or inconclusive answers on at least two of three items ( $n = 3,878$ ). Higher scores indicate more psychological distress.

People can use many different strategies to cope with stressful situations. Possible coping behaviours that can be used to handle the threat of earthquakes are cognitions, such as accepting the situation or blaming others (for example, the company that extracts the gas from the ground and that handles the damage claims) and actions, such as making the dwelling earthquake resistant or moving out of the region. In the current paper we focus on the intention to move within two years.

The socio-demographic data that were collected include: age, education, household type, gender, monthly net household income, tenure and length of residence.

Table 1. Variables used in the study

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<i>Place attachment</i>
Do you feel an attachment to the region in which you live? (very strong; strong; moderate; weak or none)
<i>Risk perception</i>
Risk perception due to earthquakes (range 1 – 5; higher indicates higher perceived risk), based on the following statements:
I feel safe in my dwelling
I am worried about the safety of my family
I feel unsafe as a consequence of the earthquakes
The threat of future earthquakes makes me insecure
<i>Actual risk level</i>
The area is divided into four regions depending upon officially acknowledged damage to the dwelling (< 5%; 5-38.9%; 39.0-60%; > 60%).
<i>Psychological distress</i>
Psychological distress due to earthquakes (range 1 – 5; higher indicates more distress), based on the following statements:
I have psychological problems as a consequence of the earthquakes
I feel less happy as a consequence of the earthquakes
I feel that my worries about the earthquakes are not taken seriously
<i>Coping behaviour</i>
Do you intend to move within two years? (yes; maybe; no)
<i>Socio-demographic characteristics</i>
Age (< 46; 46-55; 56-65; > 65)
Education (low; middle; high; unknown)
Household type (single; couple; couple with children; single parent)
Gender (male; female)
Monthly net household income (low; middle; high; unknown)
Tenure (owner-occupied; rental)
Length of residence (< 6 years; 6-10 years; > 10 years)

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### 2.3. Statistical methods

Simple descriptive methods (means, frequency tables, cross-tables) are used to report results. An analysis of variance is used to examine relationships between numerical variables (e.g., perceived risk, psychological distress) and categorical variables (e.g., level of attachment and risk level). In the case of a statistically significant overall result, the Bonferroni post-hoc test is used to examine differences between various groups.

## Results

### *A short description of the respondents*

The total dataset consists of 4,260 respondents. The respondents' characteristics are shown in Table 2. One third of respondents (33%) is older than 65 years of age. About half of respondents (52%) lives as a couple without children at home. Thirty percent of respondents have children living at home. The respondent group is about equally distributed with regard to gender, education (lower, middle, higher) and monthly household income (low, middle, high and unknown). The majority of respondents is owner-occupier and lives more than 10 years in their current dwelling.

Table 2 Socio-demographic characteristics

	Frequency	%
<b>Age</b>		
=< 45	724	17%
46-55	874	21%
56-65	1230	29%
> 65	1394	33%
<b>Education</b>		
Unknown	138	3%
Lower	1292	30%
Middle	1347	32%
High	1483	35%
<b>Household type</b>		
Single	760	18%
Couple	2217	52%
Couple with kids	1127	27%
Single with kids	128	3%
<b>Gender</b>		
Male	2139	50%
Female	2121	50%
<b>Net monthly household income</b>		
Unknown	1194	28%
Low ( $\leq$ € 2000)	1026	24%
Middle (€2001 - €3000)	991	23%
High ( $>$ €3000)	1049	25%
<b>Tenure</b>		
Owner-occupied	3722	87%
Rental	538	13%
<b>Length of residence</b>		
< 6 years	561	13%
6-10 years	542	13%
> 10 years	3122	74%

The frequency tables with regard to the variables of interest (place attachment, risk perception, intention to move and psychological distress) are provided in Table 3. Sixty-eight percent of respondents feel a very strong (30%) or strong (38%) attachment to the region. Only seven percent reports no or only a weak attachment to the region. Ten percent of respondents definitely intend to move within two years and 26% of respondents probably intend to move. The mean level of perceived risk is 2.87 and the mean level of psychological distress is 2.71.

Table 3 Place attachment, risk perception, intention to move and level of psychological distress

	Frequency	%
Attachment to the region		
Very strong	1244	30%
Strong	1604	38%
Moderate	1052	25%
Weak or no attachment	300	7%
Wants to move within two years		
Yes	430	10%
Maybe	1097	26%
No	2732	64%
	Mean	Std
Level of risk perception (1-5) (n = 3988)	2.87	1.05
Level of psychological distress (1-5) (n = 3887)	2.71	1.02

*What is the relationship between place attachment and risk perception, and is this relationship influenced by risk level?*

The first research question explores whether there is a relationship between place attachment and risk perception. An analysis of variance shows that this is the case ( $F_{(3, 3943)} = 8.23, p < 0.01, n = 3,947$ ). The results are provided in Table 4. Post-hoc Bonferroni tests show that respondents who are very strongly attached to the region have higher mean risk perception than respondents with strong or moderate levels of attachment. The risk perception level of respondents with no or weak attachment is in between these levels, but does not statistically significantly differ from the other levels. Thus, the relationship between place attachment and risk perception is not linear and not even monotone.

Table 4 The relationship between level of place attachment and risk perception

	Risk perception		
	n	mean	std
Very strongly attached	1176	2.99	1.10
Strongly attached	1523	2.80	0.98
Moderately attached	970	2.81	1.05
Weakly or not attached	278	2.89	1.13
Total	3947	2.87	1.05



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To examine whether the relationship between place attachment and risk perception is different depending upon the actual risk level, two approaches are followed. For the first approach, the previously described analysis of variance is repeated for each level of actual risk. For the second approach, the actual risk level is included in the analysis of variance, next to place attachment.

The results of the four separate analyses show that the relationship between place attachment and risk perception differs for the four actual risk levels. The relationship is not statistically significant for the two lowest actual risk levels. In the group with the lowest actual risk (<5%), the mean score is highest for the very strongly attached respondents, followed by the moderately, not/weakly and strongly attached respondents ( $F_{(3,69)} = 0.14$ ,  $p = 0.93$ ,  $n = 73$ ). In the group with intermediate risk (5-38.9%), the mean score is highest for the not/weakly attached respondents, followed by the very strongly, strongly and moderately attached respondents ( $F_{(3,862)} = 1.66$ ,  $p = 0.17$ ,  $n = 866$ ). For the 39-60% risk level group, the effect is highly statistically significant ( $F_{(3,1979)} = 7.24$ ,  $p < 0.01$ ,  $n = 1983$ ). As was found for the whole group, the respondents who are very strongly attached perceive in general more risk than strongly or moderately attached respondents. The mean score for the respondents who are not or only weakly attached is between those with a strong or moderate level of attachment. For the highest risk level (> 60%), the effect is also statistically significant ( $F_{(3,1021)} = 2.92$ ,  $p = 0.03$ ,  $n = 1025$ ). Here, the respondents who are very strongly attached perceive in general more risk than strongly attached respondents. The mean scores of the other groups are in between.

For the second approach, the actual risk region is included in the analysis of variance. The results show that the mean level of perceived risk differs statistically significantly between the four levels of actual risk ( $F_{(3, 3931)} = 10.0$ ,  $p < 0.01$ ,  $n = 3,947$ ). The lowest risk perception (mean = 2.61) is seen for the region with the lowest risk (<5% damage). For the region with 5-38.9% damaged dwellings a mean risk perception of 2.81 is found and for the region with 39-60% damaged dwellings the mean is 2.82. The mean risk of 3.03 in the region with the highest risk (> 60%) differs statistically significantly from the other three regions, using the Bonferroni post-hoc test. The overall test also shows that place attachment is not statistically significant ( $F_{(3, 3931)} = 1.49$ ,  $p = 0.22$ ,  $n = 3,947$ ) and that the interaction effect between place attachment and risk level is also not statistically significant ( $F_{(9, 3931)} = 1.18$ ,  $p = 0.30$ ,  $n = 3,947$ ).

With regard to the first research question the conclusion is that there is no clear relationship between place attachment and risk perception. There is a trend that respondents with the highest level of attachment show the highest mean level of risk perception; but respondents with no or weak attachment also show relatively high mean risk perception. The relationship between place attachment and risk perception is not linear and not even monotone. The assumption mentioned in the Introduction section that in a situation of low risk place attachment is negatively related to risk perception whereas in a situation of high risk place attachment is positively related to risk perception cannot be supported. However, it was found that the relationship between place attachment and risk perception is more prominent for the two highest risk levels.

*What is the relationship between risk perception and the intention to move?*

Next, it is explored whether there is a relationship between risk perception and the intention to move within two years. An analysis of variance shows that there is a statistically significant relationship between these two variables ( $F_{(2,3984)} = 152.84$ ,  $p < 0.01$ ,  $n = 3,987$ ). The results are provided in Table 5. The mean risk perception differs statistically significantly between the three groups, according to Bonferroni post-hoc tests (all  $p < 0.01$ ). It can be concluded that higher risk perception is related to a stronger intention to move within two years.

Table 5 The relationship between risk perception and the intention to move

	Risk perception		
	n	mean	std
Yes, definitely intends to move	409	3.39	1.08
Probably intends to move	1045	3.17	1.04
No	2533	2.66	0.99
Total	3987	2.87	1.05

*Is the relationship between risk perception and the intention to move influenced by the level of attachment? In other words, are strongly attached residents less inclined to move, irrespective of their perceived risk level?*

The next research question explores whether the relationship between risk perception and the intention to move is influenced by the level of place attachment. In other words, does a high level of place attachment prevent respondents with a high perception of risk to intend to move out of the region? To examine this relationship, two approaches are followed.

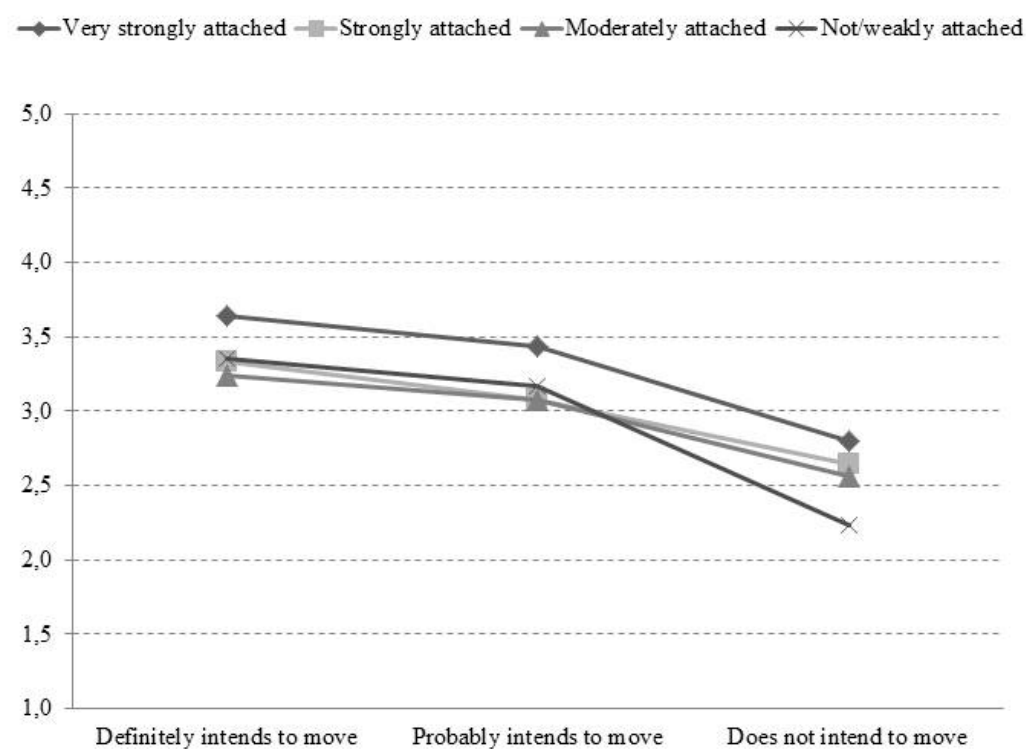
The first is to compare, for different levels of attachment, the percentages of respondents that intend to move as well as the mean levels of risk perception. The results are shown in Table 6 and Figure 1. The percentage of respondents that definitely intends to move is 10% in the whole sample. Table 6 shows that this percentage is 7% in respondents who are very strongly attached. The percentage increases to 8% for respondents who are strongly attached, 12% for respondents who are moderately attached and 27% for respondents who are weakly or not attached. Furthermore, the percentage of respondents that probably intends to move is 26% in the whole sample and 20%, 23%, 25%, 33% and 37% for respondents who are very strongly, strongly, moderately and weakly/not attached, respectively. Similarly, the percentage of respondents that does not intend to move decreases with decreasing level of attachment. All of these results point into the direction of an effect of place attachment on the intention to move. Respondents that are very strongly or strongly attached less frequently intend to move. It also becomes clear from the table and figure that the mean level of risk perception is relatively high for very strongly attached respondents.

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Table 6 The percentages of respondents who definitely, probably or do not want to move, divided according to the level of risk perception and the level of place attachment

		Count	%	Mean risk perception	std
Overall	Yes, definitely intends to move	403	10%	3.38	1.09
	Probably intends to move	1034	26%	3.17	1.04
	No	2509	64%	2.66	0.99
Very strongly attached	Yes, definitely intends to move	88	7%	3.64	1.05
	Probably intends to move	238	20%	3.43	1.04
	No	850	72%	2.80	1.06
Strongly attached	Yes, definitely intends to move	126	8%	3.33	1.02
	Probably intends to move	375	25%	3.08	1.02
	No	1021	67%	2.64	0.92
Moderately attached	Yes, definitely intends to move	113	12%	3.24	1.18
	Probably intends to move	317	33%	3.07	1.01
	No	540	56%	2.56	0.98
Weakly/not attached	Yes, definitely intends to move	76	27%	3.35	1.07
	Probably intends to move	104	37%	3.17	1.05
	No	98	35%	2.23	0.96

Figure 1 The mean level of risk perception of respondents who definitely, probably or do not intend to move, divided according to level of place attachment



The second approach is to perform an analysis of variance with the level of attachment and the intention to move as independent variables and the risk perception as dependent variable. The results show a statistically significant effect for both place attachment ( $F_{(3, 3934)} = 13.9, p < 0.01, n = 3,946$ ) and the intention to move ( $F_{(2, 3934)} = 144.8, p < 0.01, n = 3,946$ ). For place attachment a monotone relationship with risk perception is observed in that strong place attachment is related to a high level of risk perception. The mean risk perception in the group of respondents that is very strongly attached is considerably higher than the means of the other three groups. For the intention to move also a monotone relationship is observed, the stronger the intention to move, the higher the perceived risk. Besides from main effects, also an interaction effect between place attachment and risk perception is observed ( $F_{(6, 3934)} = 2.52, p = 0.02, n = 3,946$ ). The interaction effect points to the fact that the mean risk perception of the group that is not or weakly attached is second highest in the group that definitely intends to move but lowest in the group that does not want to move. Apparently, respondents with weak or no place attachment that (probably) intend to move have relatively high risk perception. In conclusion, the combined results seem to indicate that a high level of attachment decreases the probability of moving out, but does not seem to have an influence on the level of risk perception.

#### *What is the influence of psychological distress?*

The previous results have shown that respondents with a high level of place attachment less frequently have the intention to move, despite their relatively high level of risk perception. The final analysis shows whether this result might probably be explained by the level of psychological distress that might be lower for strongly attached individuals. The mean scores for psychological distress for each of the levels of place attachment are provided in Table 7. To examine the relationship, an analysis of variance is performed. The results show that the relationship is highly statistically significant ( $F_{(3, 3840)} = 6.4, p < 0.01, n = 3,844$ ). Post-hoc Bonferroni tests show that the group of respondents that is very strongly attached has statistically significantly higher psychological distress than respondents who are strongly or moderately attached. As can be seen from Table 7, the respondents who are not/weakly attached have a mean level of psychological distress that is in between the other groups. Taken everything into account, the conclusion is that the level of psychological distress does not explain the effect of place attachment on the relationship between risk perception and the intention to move.

Table 7 The relationship between level of place attachment and psychological distress

	Psychological distress		
	n	mean	std
Very strongly attached	1151	2.81	1.05
Strongly attached	1484	2.65	0.98
Moderately attached	937	2.67	1.02
Weakly or not attached	272	2.77	1.11
Total	3844	2.71	1.02

## Conclusion

This study examined the relationships between place attachment, risk perception, the intention to move and psychological distress in respondents living in a region with a relatively high earthquake risk in the Netherlands.

The first research question examined the relationship between place attachment and risk perception, and the influence of risk level. The results showed that there is a statistically significant relationship between place attachment and risk perception. But the relationship is more complicated than just being negative or positive. Respondents who are very strongly attached show the highest mean level of perceived risk. The respondents who are strongly and moderately attached have about the same mean level of perceived risk. Finally, the group of respondents with the lowest level of attachment has a mean level of perceived risk that is in between these two levels. It is not clear what causes this complicated relationship, but it is not uncommon. Dominicis et al. (2015) report that the results of some studies on the relationship between place attachment and risk perception seem to be contradictory. They stress the importance of taking into account the influence of place attachment on both cognition and action and to examine the influence of areas with different levels of risk. The latter has been done in the current research. It has, however, not provided any clarification nor has it provided strong evidence for the assumption that the relationship between place attachment and risk perception could be different for different levels of risk. Note that the actual risk levels in our study are based on the percentages of officially acknowledged damage claims (see Hoekstra 2016) and not on actually calculated earthquake risk levels. This might have influenced the results.

The second research question examined the relationship between risk perception and the intention to move. It was clear from the results that respondents with a high risk perception more frequently intended to move out of the region.

Thirdly, it was examined whether the relationship between risk perception and the intention to move was influenced by the level of place attachment. The results showed that this was the case. For each level of risk perception, the percentage respondents that intended to move increased with decreasing level of place attachment. Strongly attached residents turned out to be less willing to move, irrespective of their perceived risk level. This result agrees with other studies that argue that the effect of place attachment can be different for cognitions and actions. Place attachment might not influence the perception of the risk (cognition) but might negatively affect the action level, in this way acting as a barrier variable for enacting preventive behaviours (De Dominicis et al. 2015). In the current study, the action would refer to the intention to move out of the risk area within two years. De Dominicis et al. (2015) argue that the action level is negatively affected. However, whether or not in this study “not moving” is a negative effect of a high level of place attachment is open for discussion. Residing in the risk area indeed increases the risk of future earthquake experience. However, leaving the risk area involves financial and non-financial costs, such as losing money, relationships with close neighbours and having to get acquainted to a new neighbourhood. Besides from that, massive out-migration will further deteriorate liveability in the area due to uninhabited houses and, eventually, a decrease in the supply of facilities and services.

Finally, the influence of psychological distress on this relationship was examined. The results showed that the level of psychological distress was relatively high in respondents who are very strongly attached. The conclusion was that the level of psychological distress probably does not explain the effect of place attachment on the relationship between risk perception and the intention to move.

One of the limitations of the current paper is that the results are not corrected for the influence of socio-demographic characteristics, such as age and household type, that will have an influence on the intention to move. A multivariate analysis is needed that includes all relevant socio-demographic characteristics. A related limitation is that for various analyses the risk perception was used as the dependent variable (using analysis of variance), whereas the intention to move might seem to be more suitable. In that case, a multinomial regression analysis seems to be the correct approach. This

approach was not followed in the current paper because the results from a multinomial regression analysis are difficult to interpret and including interaction effects is complicated. Besides from that, a multinomial regression analysis uses a reference category for both dependent and nominal independent variables against which all other groups are compared. In contrast, an analysis of variance makes it possible to compare each group against all other groups at the same time.

## References

- Bonaiuto M, Alves S, De Dominicis S, Petrucci I (2016). Place attachment and natural hazard risk: Research review and agenda. *Journal of Environmental Psychology*, 48, 33-53.
- De Dominicis S, Fornara F, Ganucci Cancellieri U, Twigger-Ross C, Bonaiuto M (2005). We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *Journal of Environmental Psychology*, 43, 66-78.
- Folkman S, Lazarus RS, Gruen RJ, DeLongis A (1986). Appraisal, coping, health status and psychological symptoms. *Journal of Personality and Social Psychology*, 50(3), 571-579.
- Hoekstra JSCM (2016). *Wonen en aardbevingen in Groningen. Een onderzoek in negen gemeenten*. Delft: TU Delft.
- Lopez Vazquez E (2001). Risk perception interactions in stress and coping facing extreme risks. *Environmental Management and Health*, 12(2), 122-133.
- Lopez-Vazquez E, Marvan ML (2003). Risk perception, stress and coping strategies in two catastrophe risk situations. *Social Behavior and Personality*, 31(1), 61-70.
- Peters E, Kunreuther H, Sagara N, Slovic P, Schley DR (2012). Protective measures, personal experience, and the affective psychology of time. *Risk Analysis*, 32(12), 2084-2097.
- Slovic P (1987). Perception of risk. *Science*, 236, 280-285.
- Tversky A, Kahneman D (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5, 207-232.
- Whitmarsh L (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research*, 11(3), 351-374.