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"Effects of the 3.11 Catastrophe:
Migration Patterns and Demographic Structure
in Tōhoku and Japan"

verfasst von / submitted by

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# 1. Introduction

In 2011 the Great East Japan Earthquake struck in Tōhoku and with the subsequent Tsunami and nuclear disaster lead to the devastation of the area around the reactor in Fukushima, which contributed to a further depopulation of a region which was already struggling with decreasing population levels.

Now, almost a decade later, the situation has improved, but the effects of the catastrophe are still apparent. As data on population changes from Japan become available, research on what impact the Great East Japan earthquake had on the internal migration in Japan can be quantified by considering the population movements that occurred as a result of the earthquake within Japan.

With many homes destroyed and emergency measures taken by the Japanese government after the nuclear reactor was compromised, many families had to relocate away from the zones around the power plant where the tsunami caused severe damage. It is therefore plausible that closer regions to the Fukushima Nuclear Disaster saw a higher depopulation than other regions. But how affected was the population of these regions really? Which municipalities faced a high depopulation of the natural disaster and did it also impact municipalities further away from the power plant?

In my thesis I will show, by means of demographic analysis, how the available data through the population census can give an indication on the effects of large scale catastrophes on the migration behavior of the population.

## 1.1. Background

On the 11th of March 2011 at 14:46 local time an earthquake hit Japan close to the coast of Eastern Tōhoku. The epicenter was close of the coast to Miyagi prefecture at a depth of 24 kilometers. The magnitude 9 earthquake and was one of the strongest levels in recorded history. Subsequently the earthquake produced a tsunami reaching a height of over 39 meters (Mimura *et al.* 2011:804–805). The tsunami hit the coastal regions of the three prefectures of Iwate, Miyagi and Fukushima in the region of Tōhoku the heaviest, with Miyagi facing the highest amount of fatalities and of those three Fukushima the least (Mori *et al.* 2011:1). However, the tsunami also damaged the Fukushima Nuclear Power Plants No.1, which led to a series of nuclear accidents and a large number of people being evacuated or fleeing from close areas, numbering over 350 thousand at one time (Mimura *et al.* 2011:804), with other sources giving a number of over a million refugees (Nomura *et al.* 2016:1). This nuclear accident led to an increase in health risks in the area, but the evacuation itself also poses an increased health risk for the evacuees, as it provides stress because of a change in socioeconomic status (Nomura *et al.* 2016:1–2).

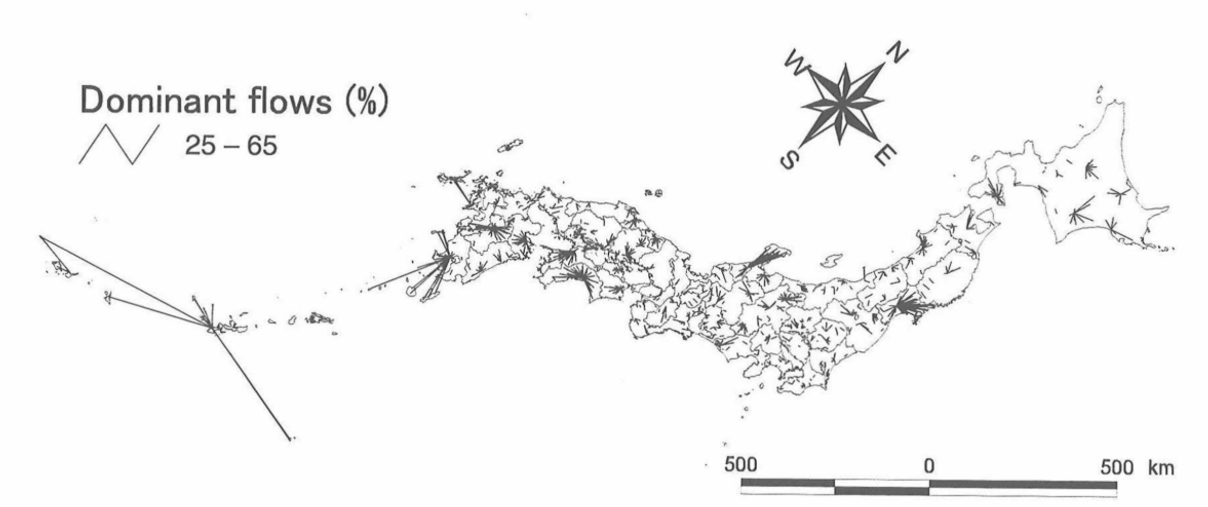
## 1.2. Literature Review

### *1.2.1. Studies on internal migration and population change in Japan*

In the 1970s studies have shown effects of migration on the Japanese population and the problems Japan might be facing due to the demographic shift (see Kuroda 1973 and Jinkō Mondai Shingikai 1974). The population fluctuates with a dropping birth rate and increasing internal migration. From the rural areas towards urban areas, especially in Tōkyō and Ōsaka (Kuroda 1973:38). In the postwar period, internal migration generally increased. Kuroda argues that this was a balancing of the population in rural areas with high reproductivity with those in urban areas with lower fertility (1973:55–56). Since most of those migrants were young adults, the rural areas faced labor force shortages and an enhanced ageing of the population (Kuroda 1973:67–69). By 2000, Tōhoku was one of the regions with the highest population ratio working in agriculture (Tsutsumi 2011:26–27). Tsutsumi (2011) gives more insight in migration patterns and reasons of migration with the help of surveys (78–86).

An earlier work by Yano *et al.* (2000) analyzes the internal migration in Japan based on demographic data of the 1990 population census. As opposed to prior works, this analysis is based on all the available inter-municipal migration data of the census, compared to only inter-prefectural analysis done elsewhere. Therefore it paints a more detailed picture of the migration flows within Japan. For analysis, the data is added to a Origin-Destination matrix with roughly eleven million possible dyads of migration between municipal units. This data then is described with the use of GIS software and dominant migration flows are shown. The migration flows can then be analyzed by spatial-interaction models, based on the Gravity model to give macro-economic reasoning for the migration. Given the dominant flows of migration, it is shown that those gravitate naturally towards the big population centers. See also figure 1.

Nishioka *et al.* (2010) give an analysis of the Sixth Migration Survey, conducted in 2006, about the personal reasons for migration. The survey aimed to understand those reason in light of the increasing migration of younger people from non-metropolitan to metropolitan regions. For one this survey showed that young people in their twenties and thirties are the most mobile and changed their residence within the last five years. Secondly, this group also had the largest share of inter-prefectural migration, while the older generation mostly mi-




Source: Yano *et al.* (2000:170)

Figure 1 Dominant Flows, 1980s

grated only intra-prefectural. Similarly, Ōtomo (1984) analyses the various personal reasons for internal migration in the beginning of the 1980s. As in the later study, the main reason for migration was employment, but also housing, schooling and family matters were important reasons. Generally the reasons changed over different life stages and there was a noticable difference between rural to urban migration in comparison with urban to urban migration.

Lützeler (2008) discusses the problems arising in Japan due to the uneven population distribution and analyses the migration flow on a prefectural level. He notes that the internal migration in Japan is centered towards Tōkyō, leading to over-crowding in certain areas and ultimately to an unbalanced population distribution in Japan (Lützeler 2008:63–64). Additionally, migration over longer distances is dominated by young adults. If older generations migrate, they do shorter distances. This behavior leads to even lower fertility rates in the prefectures mostly affected by the out-migration, and speeds up the population ageing in those areas (Lützeler 2008:68–69).

Ishikawa (2014) studies the effect of international migration to Japan and how it affects the population decline and regional differences in population. While foreigners helped in reducing the decline of population, it did not change the regional variation much, as most of those foreigners settled in the Tōkyō metropolitan area.

Hanaoka *et al.* (2015) investigate the destination choices of foreign immigrants to Japan and how this affects the regional population distribution. Based on the census data of 2010 (compared to the census of 2000) two approaches were used in their study: The destination choices of international inmigrants, and the migration patterns of the foreigners already living within Japan. They found that the destination choice of these people is influenced by labor-market conditions, and to a lesser degree also by co-ethnic communities for immigration. For internal migration both those factors were found to influence destination choice similarly. Other results were that the service industry had a larger pull than the manufacturing industry and that Chinese immigrants were more likely to disperse (Hanaoka *et al.* 2015:13).

Chen *et al.* (2018) provide information about how internal migration affects population ageing and resulting in regional differences by studying numerous cities in China. They show that less developed regions faced higher population ageing due to a higher out-migration. They conclude that internal migration is the driving force for population dynamics and fertility and mortality only play a minor role.

Nishioka *et al.* (2011) offer a view of the potential future population of prefectures in Japan from the year 2005 to 2035. These projections have been conducted before the Great East Japan Earthquake and therefore do not consider its effects. The results show that the prefectures of Tōhoku will all be affected by population decline, with Miyagi being somewhat of an outlier and the only prefecture in Tōhoku that will retain more than eighty percent of its 2005–population level by 2035 (Nishioka *et al.* 2011:11). While the prefectures still have an elderly population higher than average, it will be in line with the ageing of the rest of the country (Nishioka *et al.* 2011:22, 29).

Nakagawa (2017) argues that the popularity of migrating to rural areas has increased since the Great East Japan Earthquake. Furthermore, the study found various reasons for migration to rural areas. For one, migrants had lower self-determination to work and did not want to be self-employed (contrary to prior research in other countries). Other reasons include higher environmental awareness and high spiritual growth, as well as motives for better health, especially with the younger demographic (Nakagawa 2017:19–21). Two socioeconomic reasons for migration were found: higher financial affluence (in correlation with employment) and also a lower educational background (due to higher dissatisfaction with working conditions). The author then argues about the reasons for the increased migration to rural areas after 2011. According to the author, the accident increased the enviromental awareness and the understanding that renewable energy and safe food might be easier to access in rural areas, as well as the understanding of deeper social community ties in rural areas and the longing for those (Nakagawa 2017:22–23).

Similarly, Ishikawa (2011) argues about the change in internal migration within Japan. He points out that most prefectures of Japan face a constant population decline, and Tōhoku is one of the most affected. The three prefectures in the center of the Great East Japan Earthquake however, faced less decline than the western prefectures of Tōhoku (Ishikawa 2011:423). The decline of population in the rural regions is attributed to the migration of young people to the large urban areas, leading also to an increased ageing of the rural population. Notably this migration mainly consists of young men, while young women migrate more to the urban centers within their home prefecture (Ishikawa 2011:426–427). This gender imbalance in migration thus also leads to an imbalance of the sex ratio in different areas of Japan, as in western Japan the sex ratio is more equal, while in farming and mountainous areas there is a significant lack of young women. In urban areas, including prefectural capitals, the ratio of women is higher again (Ishikawa 2011:427–429). Mainly middle-aged people above 40 years old migrate to rural areas and often enter the agricultural sector (Ishikawa 2011:430–431). The sex ratio imbalance is partially compensated by international marriages of Japanese men with foreign women (Ishikawa 2011:437).

Kondo and Okubo (2015) find in a study based on interregional labour migration within Japan that wages determine migration. It is not just the nominal wage that factors into the decision making, but more so the relative real wage based on the price index of the region. However, since the migration data lacks economic data of the migrants, this study also has some limitations.

Research by Tanaka (2017) deals with the question of what attractions of the Greater Tōkyō area is. The author finds, by means of vector autoregression and the Granger causality test, that there is a causal relationship that the increase in interregional income disparities will increase the number of transferees to that region, and that there is no converse relationship. Tanaka infers that the reason for the continuous population influx lies within the maintenance of the high income in the area, supported by the industrial structure and the highly educated population. Usually, it is suggested, that higher income levels attracts migrants. However, this leads to a high supply of labor and thus a lowering of income. This situation cannot be observed in the Tōkyō region (Tanaka 2017:71). Additionally, the author remarks that the analysis does not come without problems. Research based on data has to acknowledge the shortcomings of said data, and that the migration data used is not always complete. Also for the analysis prefectural level data was used, whereas more fine-grained data could establish deeper insights (Tanaka 2017:72–73).

Shioji (2001) establishes the fact that migration has had a strong influence on the structure of the regional population. Ultimately this leads to the transfer of human capital to the migration receiving area. However, the authors argues that efforts are not enough to fully explain migration causes, and that there is a upper bound for the change in regional population composition and human capital transfer (Shioji 2001:47).

Hayashi Reiko (2015) compares migration mobility in the three East Asian nations, Japan, South Korea and China, and shows that especially the Tōkyō area has seen significant population increase since the early twentieth century, in comparison to the rest of Japan. While there was a significant rate of migration in the 1960s and 1970s within Japan, the migration activity has since decreased, and most of the migration is now focused on the large metropolitan areas of Tōkyō, Ōsaka and Nagoya (Hayashi R. 2015:2). The results show that there is a high mobility towards the large metropolitan areas in Japan, twice as high as in China, but also only half of the mobility than in South Korea (Hayashi R. 2015:10). Furthermore, the Japanese migration data shows that until around the age of fifty, household separation rate (i.e. living outside one's original household) is increasing in the population, and then decreasing, with a small bump at around the retirement age (Hayashi R. 2015:12–13).

There is a significant urban–rural disparity in Japan, which is a driving force of migration to urban areas. However, the migration from rural areas to urban areas has decreased since the 1990s and in recent years there is a trend of return migration from the urban areas to the rural areas. Based on neoclassical economic thinking, people would migrate to the urban areas for higher income opportunities, but rural areas have some pull factors contrary to that thinking, like better quality of life, or the need to take care of family (Hayashi T. 2015:261–262). Nonetheless, measuring the rural–urban disparity with the Genuine Progress Indicator, Hayashi Takashi still found the disparity to be increasing in the beginning of the twenty-first century, even considering the rural advantages, such as environmental conditions (2015:270).

Iguchi (2014) discusses recent migration trends in Japan, focused on international migration of foreigners to Japan. The author notes that after the Great East Japan Earthquake around half a million foreigners left Japan and henceforth gradually returned. 2011 was then also the year of the largest population decline for Japan after the Second World War. The distribution of the leaving foreigners was uneven, with mostly Brazilians and Koreans leaving the country (Iguchi 2014:32–33). Data also shows that the prefectures of Tōhoku have the lowest amount of foreign workers (Iguchi 2014:41–43).

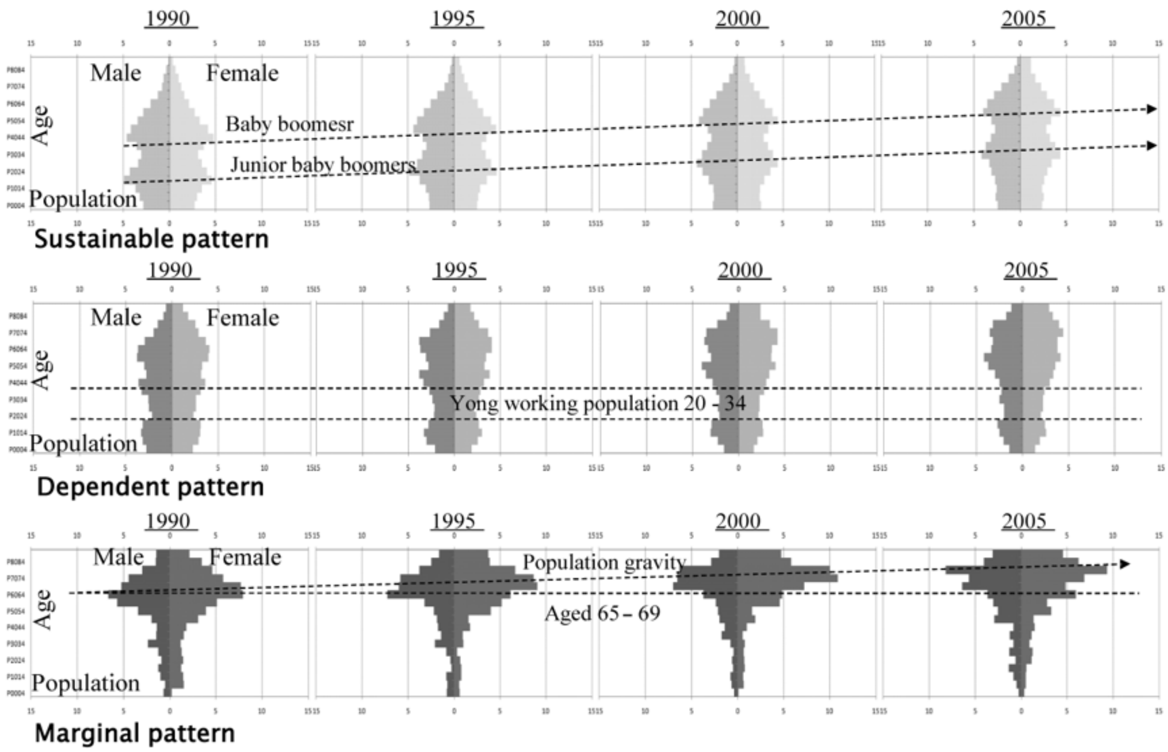
#### *1.2.2. Studies on disaster response migration*

The connection between natural disasters and migration in general is the main topic of interest for Belasen and Polachek (2013). By reviewing available literature they conclude that natural disasters certainly lead to an increase in short-term migration, but it is also possible that it has an effect on migration activity long-term. Additionally, migration tendencies are stronger within urban areas, while rural areas are more likely to remain when encountering natural disasters. This can be attributed to higher human capital in urban areas, making it easier for urban population to consider relocation. However, one key aspect among many points they make in their research is the lack of studies on what people migrate, meaning that it is not clear whether younger or older population migrate, as well as whether families move together or separated (Belasen/Polachek 2013:325). Therefore, my master thesis will focus in its core on the questions of how internal migration in Japan as a result of the earthquake looked in detail. This is possible because new data on migration from the Japanese government are now available for research.

Black *et al.* (2012) study if migration in response to natural disasters can be explained by simpler factors than other migration (e.g. migration for work). But they find the migration and displacement in response to natural disasters to be as complex as migration for any other reasons. Thus they argue that explanations of migration in response to disasters needs a similar approach as the study of migration in general.

Chen *et al.* (2014) draw parallels to the Great East Japan Earthquake by analysing the affects of two prior earthquakes (the 1995 Kōbe and 2004 Chūetsu earthquake) on population ageing in those areas using demographic characteristics pre-disaster and post-recovery. Older population has a direct impact on recovery after disaster and making it for those ageing regions more difficult to adapt to post-disaster times. Those two earthquakes showed that the affected areas kept their population ageing characteristics. However the authors argue that economic recovery can have the potential to allow for population recovery by means of purposely designed recovery projects. Population recovery is mainly determined by the demographic structure in those areas. When an area already has a high ratio of an aged population, the trend is amplified after disaster. However, if there was a sustainable population pattern before, the population of those areas would recover (compare Chen *et al.* 2014:293, see figure 2).

Okumura and Ito (2018) find in a study over forty years on internal migration in Japan that in response to large disasters, emigration from the afflicted regions increases and it has also more of a long-term effect due to ongoing recovery efforts. This also means that population increases in safe areas elsewhere in the country. However, the reverse is true for smaller dis-




SOURCE: Chen *et al.* (2014:293)

FIGURE 2 Demographic patterns for population recovery after disasters

asters, where immigration actually increases in those disaster-stricken areas. Big disasters and subsequent recovery can only be tackled by assistance from government and other organizations. Since the study only focused on prefecture-level data, the overall impact of even large disasters on the whole prefecture has been not as severe, while local communities might be destroyed. They further point out that it is clear that disasters affect migration, but since they lack demographic data, which demographic structures are more affected remains to be studied (Okumura and Ito 2018:1080).

Meybatyan (2014) gives an overview of the evacuation after the two large nuclear accidents, in Chernobyl and in Fukishima. The author points out that in both cases long term effects on the population can be observed, due to lack of information from the government and thus insecurities in the population on the situation (Meybatyan 2014:65).

The topic of Swanson *et al.* (2009) are the demographic effects of the Hurricane Katrina that occurred in August 2005 in the United States . They compare predicted population sizes in the affected areas to the reality after the hurricane to estimate the impact of it. The authors conclude that the demographic impact on the population of the catastrophe could be further reaching than the immediately affected areas.

One of the earlier nuclear disasters was the Three Mile Island nuclear power plant accident in March 1979 in the United States. A study on the evacuation behavior was conducted by Cutter and Barnes (1982), focusing on the spatial proximity of the populace to the nuclear power plant, as well as their social features. The results of a questionnaire showed that proximity to the accident location was the driving force in the decision to evacuate, no matter the social structure of the households. Furthermore, if the members of the households were younger, and especially when they had children, the people were more apt to evacuate. This also means that older people were more likely to remain after the accident (see Cutter/Barnes 1982:122–123).

Nakayama *et al.* (2017) gives an overview of return migration after various natural disasters, like Hurricane Katarina (2005) and Hurricane Sandy (2012) in the United States, the Great East Japan Earthquake of 2011, as well as the Great Indian Ocean Tsunami in 2004 and the Great Sumatra Island Earthquake in 2009. Based on several case studies, it is found that planning from the government for the return of evacuees is necessary, and that not all of those people are willing to return. Due to the life changing effects of such a big disaster, people themselves might change and not feel as welcome at their previous home.

Landry *et al.* (2007) examine the decisions of Hurricane Katarina evacuees to return to their previous home. The biggest determinants for the return decision were the household income (middle income households were more likely to return than low income households) and the real wage differential between the home place and the place of evacuation. However, a strong connection to their home place was not affecting the return decision. The cost of moving back also factored into the decision making.

Parker and Steenkamp (2012) investigate the economic impact of the Canturbury earthquakes in New Zealand in 2010 and 2011. They find that especially after the second earthquake in February 2011 there is a considerable out-migration not only to other places in New Zealand, but also to international locations. However, already in the following year there is a positive inflow of international migrants to the region. The statistics of New Zealand also show a large drop in the ratio of the working age population in Canterbury in the months after the earthquake (Parker/Steenkamp 2012:16).

### *1.2.3. Studies on migration after 3.11*

There are a few works directly concerned with changing migration after the 2011 natural disaster in Tōhoku. A work on the general recovery efforts in Tōhoku after five years is given by Santiago-Fandiño *et al.* (2018). It is not focused on the recovery of the population, but more so on governance and planning, as well as on community rebuilding. It shows that there are many requirements to reestablish such an affected region as viable living area for many people and to ensure the return of internally displaced people.

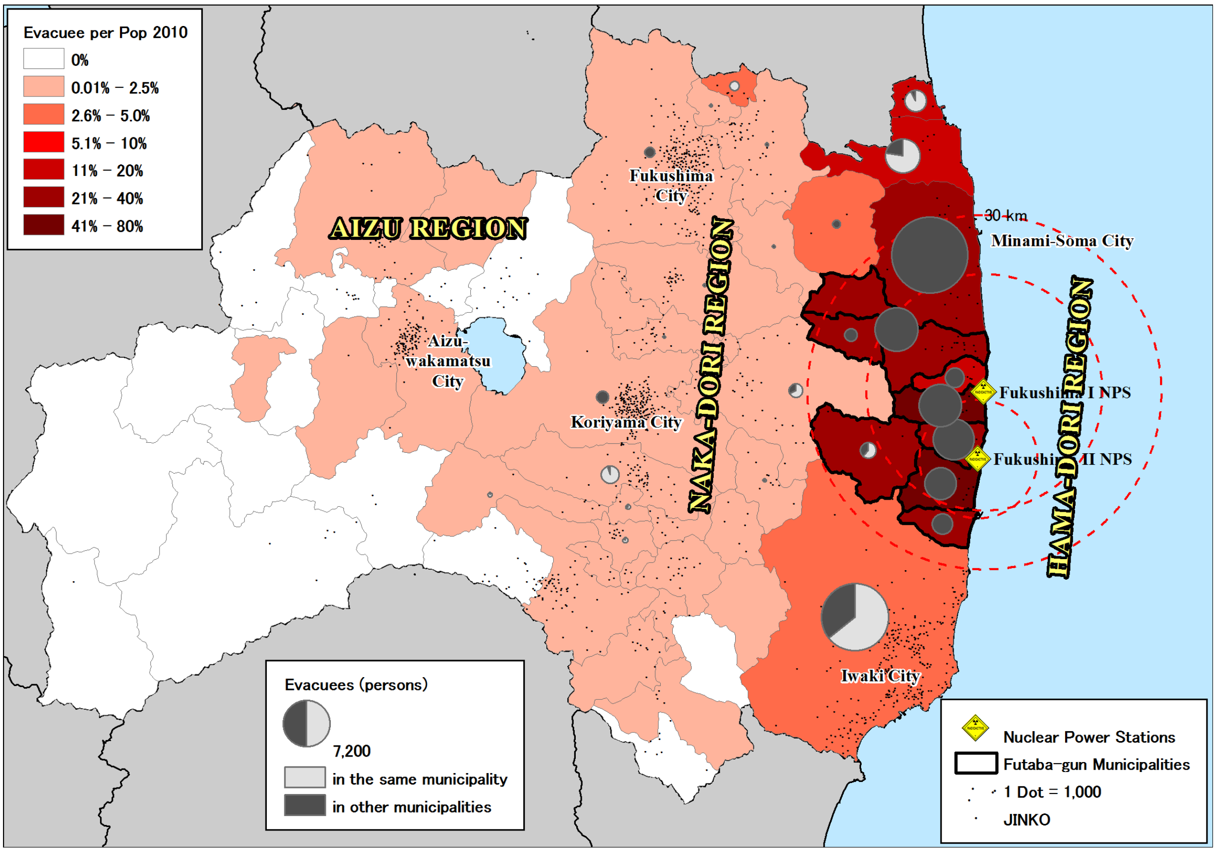
Soon after the disaster some 65,000 people from Fukushima prefecture, 15,000 from Miyagi prefecture and about 9,000 from Iwate prefecture had to abandon their homes and move away (Oda 2011:1). While the local governments of affected municipalities where relocated elsewhere in the prefecture, it was not clear which location the evacuees chose. However, the people who used to live in Fukushima went to prefectures in the vicinity, to Yamagata, Niigata or the Kantō area (Oda 2011:5).

Hino (2011) points out the ageing and depopulation all over Tōhoku in the years prior to the earthquake. The data presented shows that many municipalities within Fukushima and Miyagi were less affected by population decline than elsewhere in Tōhoku, but those regions were closer to the disaster area in March 2011. Hino conjectures that due to the destruction of the local economies, it will have an effect on the young working age population and measures have to be taken to ensure that part of the population does not migrate away.

Isoda (2011) shows which municipalities the people evacuated from and discusses which destinations they had. Naturally mostly people from the thirty kilometer evacuation zone moved, but people from nearby municipalities were affected too. See also figure 3. For the largest part they evacuated to within their home prefecture, but also the surrounding prefectures, like Akita, Niigata or the Kantō region. Isoda further acknowledges that the demographic structure of the evacuees is not equally distributed in their destinations. Children until the age of fourteen and women did evacuate further away from the Fukushima Nuclear Power Plant. It is suggested that mothers with children are more concerned about the radiation danger and move further away. Furthermore, the elderly people over seventy-five remained disproportionately close to the affected areas.

Evidence that especially women with small children living close to Fukushima were more likely to leave the area affected by the disaster is given by Yamamura *et al.* (2014). This result also leads back that women perceive risks differently than men.

Deguchi (2012) predicts the potential impact of the 3.11 triple disaster on further population development all over Japan. Based on early population changes in the year after the




Source: Isoda (2011)

Figure 3 Evacuations in Fukushima prefecture

catastrophe, Deguchi used a mathematical model to compare population changes after the disaster with a prediction if it would not have happened. The prediction showed that as opposed to the case without the disaster, the disaster would greatly amplify the population decline in the three prefectures Fukushima, Iwate and Miyagi. Vice versa, the population decline would be a lot less in the surrounding prefectures, like other prefectures Tōhoku and the Northern Kantō region. Nonetheless, the model Deguchi used still detects an impact of the disaster on the population decline on the Southern Kantō region (including Tōkyō).

Following one year after 3.11, Crimella and Dagan (2012) state that the recovery efforts for displaced people had not achieved enough for many of them to return, albeit various measures for return have been taken. Nonetheless, issues remained for the return, like the decontamination of the area to ensure safe radioactivity levels and the restoration of infrastructure and public facilitites.

Lee *et al.* (2017) add the relevance of networks in the decision making on migration after disaster struck. For victims of the disaster the destruction of their personal networks was a more significant factor to relocate than the economic loss.

Lee and Sugiura (2014) determine if residents of Noda in Iwate prefecture relocated after the Great East Japan Earthquake. The results show that higher income residents had less intentions to relocate from the area. Also young, female, and unmarried people showed greater intention to leave. Furthermore, neither damage to homes or loss of job had any significant effect. However, if personal or family networks got affected, this strengthened their intentions to seek a new home. Therefore, the results indicate that networks are the largest contributors for intention to relocate and should be included by considerations on disaster response (Lee and Sugiura 2014:164).

Abe (2014) showed that in Tōhoku the out-migration in the most affected prefectures increased clearly in 2011 after the earthquake and nuclear disaster compared to the year before. Also the destinations of the out-migrants have been further away from their main prefecture than before. Since mostly those migrants are from the younger generations, an even more over-aged society is expected in the Tōhoku region.

Munro and Managi (2014) study the intentions of evacuees in Fukushima and Miyagi prefectures to return to their home place. According to their research, almost 90% of their sample came from affected regions with only 38% having an intention to return to their original home. The majority, that is 58%, only moved within their municipality, a fact most prevalent in large cities and in Miyagi prefecture. Since many remained in the same town, where there is still higher radiation exposure, the authors argue that personal networks and connections might play a role in people's will to stay in the affected area (Munro and Managi 2014:3–4).

Ishikawa (2012) discusses the immediate response of refugees to the catastrophe. Right after 3.11, almost half a million people evacuated the coast and the close surroundings of the nuclear power plant. Within one month, the amount of evacuees dropped to around 100,000. However, those people did not migrate to a new home, but mostly housed in shelters (Ishikawa 2012:1–2). The destinations of the displaced people were mostly in the area and they remained in their prefectures but also to other nearby prefectures like Akita, Yamagata and Niigata. The larger the damage, the higher the intra-municipality evacuees. A further larger destination was the Tōkyō metropolitan area, but people moved even further south to the other large metropolitan areas of Nagoya and Ōsaka (Ishikawa 2012:6–7). The research notes the difficulty of returning to their original homes due to the large damage, which is especially notable for the coastal area of Fukushima. A few months later in 2011, the prefectures of Miyagi and Iwate already experienced a positive net migration and many people returned (Ishikawa 2012:9).

Aldrich and Sawada (2015) studied how exactly the tsunami affected the municipalities in Tōhoku. In a quantitative study researching the determinants for mortality, they find that not only the strength of the tsunami in a given location determins the scale of mortalities, but also further factors played a role. In municipalities where the social capital, the ties within the community was stronger, the mortalities rates were lower. They argue that a good system of connections plays a role in disaster response, thus leading to higher survival rates. Another determinant was the support of the municipality for the ruling Liberal Democratic Party. Municipalities with a higher LDP vote share had a better outcome. It is suggested that the LDP directly attracts rural voters by investing in their regions, thus those municipalities where better prepared for the disaster. Therefore the authors argue that in the future survival rate can be improved, especially by tackling social cohesion in the communities at risk (Aldrich/Sawada 2015:72–73).

Do (2019) analyses the distance people moved after the Fukushima Nuclear Disaster and why they choose their destination, by surveying evacuees from Minamisoma. The people evacuated not very far directly after the disaster, but the average distance increased after a while. Nonetheless, most people still remained in closer distance, with a bit less than fifty percent, each moving less than 100 km and between 100 and 300 km. The average evacuation distance then decreased over the next five years, when over half had returned to Minamisoma. Around thirty percent of the original evacuess were still living more than 100 km away (Do 2019:241). As has been postulated by other studies, the role of social networks was the most important determinant for destination choice (Do 2019:243).

Takabe and Inui (2013) give insight on the population movements after the Great East Japan Earthquake, showing a clear increase of emigrants in 2011, while in the years prior out-migration was actually a bit reduced.

Based on prefectural data, Hauer *et al.* (2019) aim to discern between the evacuation migration and the normal migration of people after the Great East Japan Earthquake and subsequent tsunami and nuclear catastrophe. Building upon data of before 3.11, during and after, they find evidence that evacuees migrate shorter distances, while migrants moved to location where they had ties. An important result of the study lies therein that the disaster did not change the exisiting migration patterns between prefectures in Japan (Hauer *et al.* 2019:15). Even in the three most affected prefectures, no major difference between the migration system before and after 3.11 was found.

According to Zhang *et al.* (2014) areas in the vicinity to the nuclear accident in Fukushima have been affected by further depopulation and ageing, which also includes areas with lower levels of radiation exposure. Several factors, such as the risk and effects of low radiation being unknown, psychological effects due to the disaster and loss of trust of government, as well as the lack of an exisiting economic strength of the area, have an effect on immigration patterns to Tōhoku. Studying Minamisoma, the authors find a higher drop in population in the younger age groups (up to forty years old), with a total reduction in population of around thirty percent three years after the disaster (Zhang *et al.* 2014:9291–9292, see also Ishikawa *et al.* 2012:2358). Hence, recovery is an issue due to the lack of labor force.

There are several possible problems following a disaster. One of them is the effect on the birth rate following the disaster. Suzuki *et al.* (2016) find that newborn children in the heavily affected regions had a lower birth weight than in previous times and unaffected regions, as well as the secondary sex ratio did decline if women experienced the earthquake, meaning less male children were born than normally (Suzuki *et al.* 2016:80). Therefore it is evident that a disaster does not only affect the demographic structure by migration and death, but also birth.

Thiri (2017) shows that there was a significant increase of out-migration in affected municipalities in Miyagi prefecture. The author, by statistical analysis, attributes an increase of up to 33% of outward migration activity to the disaster. Furthermore, there is empirical evidence that social vulnerability plays a role in migration increase, and it is also suggested that the disaster only had a strong influence in 2011 with no measurable impacts to later migration patterns.

For Ibaraki prefecture Tamura *et al.* (2013) find evidence that several factors impact the evacuation response time, mostly related to the knowledge of evacuation procedure and awareness of the threat potential. Nonetheless, many residents outside their homes did not evacuate immediately, but instead first went home to look after their family. The authors suggest that local disaster management plans need to be adapted for an improved disaster response of the residents.

In the three prefectures Iwate, Miyagi and Fukushima, the mortality was highest among the older generation, with most deaths occuring after sixty years old. While their percentage of population was roughly 30%, they accounted for around 65% of the casualities due to the disaster (Gender Equality Bureau 2014:2). Also studying the change in internal migration, the Gender Equality Bureau concluded that there were no siginificant changes in Iwate prefecture, but in Miyagi prefecture there was a clear increase of out-migration of residents in their twenties. In Fukushima prefecture the largest increase was children up to 14 years old, and in their parent generation of 25–44 year olds there were clearly more women migrating away than men (Gender Equality Bureau 2014:7). Similary Urano (2016) finds that people of old-age and handicapped people were most afflicted by the disaster due to difficulty for evacuation suggests that different long-term disaster mitigation and evacuation plans need to be considered in case another natural disaster hits.

Hasegawa (2015) argues that the evacuation behaviour and subsequent desire to return has been influenced by the insecurity whether low-doses of radiation have a health risk. As a result of this, some residents outside the evacuation area still decided to flee, even though the measured radiation was below a level considered harmful, and thus the risks for residents was assessed not to be high enough to warrant evacuation. Based on a survey of Naraha town within the evacuation area in Fukushima prefecture, only about 40% of the evacuees voiced a wish to return, and a quarter did not want to return (Hasegawa 2015:4–5).

Yamakawa (2017) and Horikawa (2017) focus on the conditions of evacuees. In the eight municipalities of Futaba district in Fukushima prefecture the reconstruction efforts are still in progress even five years after the disaster. The evacuees of those municipalities were mostly located in other areas of Fukushima prefecture, but also other prefectures close by and in the Kantō area. Based on a survey of those evacuees, there is a difference between men and women, as women in their forties cited concern over their children as evacuation reason, while for men it was mainly work related reasons (besides radioactivity concern for all evacuees). In this survey as well (similar to Hasegawa (2015)), also around a quarter had no desire to return. Similar as in other surveys, there is also an increasing distrust in the government (Yamakawa 2017:54–56). According to Horikawa (2017:66), three years after the disaster, still around 100,000 people were internally displaced as a result, and almost half of which still live outside their prefecture. Based on interviews, there were three main reasons people voluntarily evacuated: Safety of children, their own safety and governmental policy to provide free housing (Horikawa 2017:76).

In a study of the municipality Kawauchi in the vicinity of the Fukushima nuclear power plant, Orita *et al.* find that from the evacuees, more men than women decided to return after it was deemed safe to do so. Because the women had higher levels of anxiety about potential safety hazards of the effects of radiation on personal wellbeing and food consumption safety. Also women generally had lower levels of employment. However, there were no age differences in the surveyed population in their desire to return (Orita *et al.* 2013:384–385).

According to a study of Higuchi *et al.* (2012), the employment situation in the three prefectures Iwate, Miyagi and Fukushima was severly afflicted in the aftermath of the disaster. Especially the fishery sector, one of the main sectors of employment before the disaster, faced difficulties. Generally out-migration increased in those prefectures in the year following the disaster, especially in Fukushima prefecture the emigration of young people increased. This also posed a problem for the labor market. While in the beginning there was a job opportunity reduction, due to reconstruction efforts new jobs emerged. However, due to a mismatch between needed qualifications and those of the applicants, there was an issue filling open positions (Higuchi *et al.* 2012:19–20).

According to Soda (2013), the areas in the interior of Fukushima prefecture, more distant to the nuclear power plant, were affected by the catastrophe. Even in the inland there are insecurities due to the radiation effects (and also traumatizing of its main economic sectors, like tourism). The decision of whether or not to evacuate brought problems to families, as the opinions on evacuations differed (Soda 2013:194–195). The author further points out that due to an increased distrust in the government and nuclear power plants, as well as issues with potentially radioactive contaminated food, could influence the behaviour of people all over Japan (Soda 2013:197).

Nishimura and Oikawa (2017) choose a different approach, as they research the effect of the nuclear catastrophe on land prices in Fukushima prefecture and elsewhere in Japan close to Nuclear power plants. The results showed that land prices between thirty and sixty kilometers away from Nuclear power plants, which were at a distance of more than 300 kilometers to the Fukushima the nuclear power plant, had increased. This circumstance is explained by an increased in-migration of people from Fukushima prefecture to those areas.

Based on a survey, Kawase (2015) found that three years after 2011 of the surveyed evacuees who went to Miyazaki prefecture, about one quarter came from Tōhoku, and about two thirds evacuated from the Kantō area. Most of the evacuees went voluntary for radiation anxiety reasons. The results also showed that not all people immediately left after the disaster, but about half migrated only two years thereafter (Kawase 2015:5–6).

Nakagawa (2013) claims that the recovery efforts after the Great East Japan Earthquake are quite different to the large earthquake that hit Kōbe in 1995. Since in Kōbe a large urban area with a growing population was afflicted, recovery efforts had priority. While in Tōhoku, an area already faced with out-migration and ageing, recovery will not have a high priority. According to the author, it is more worthwhile to include migration in the recovery process and support the population willing to move elsewhere instead of focusing on rebuilding the region (Nakagawa 2013:75).

Matanle (2013) analysed problems that ageing rural communities may face through surveying two villages, directly hit by the tsunami in 2011. He concludes that communities in Tōhoku will continue to struggle with depopulation and an ageing society. While in over all it will not disappear completely, the recovery and reconstruction efforts after the disaster can provide an opportunity to rebuild in a more resilient way (Matanle 2013:73)

Not directly concerned with migration, but research of Suzuki *et al.* (2018) suggests that locals in the vicinity of Fukushima still have doubts about air and water quality and safety. Especially close to the nuclear power plant, the safety views of the people still have not recovered to the levels it had before 2011. Younger generations had higher safety anxiety levels than older generations, but no clear differences between the male and female population (Suzuki *et al.* 2018:ii34). The authors suggest the necessity to promote safety to younger people, so they are more willing to return and enhance recovery efforts (Suzuki *et al.* 2018:ii38).

Further looking at the effects of the nuclear accident on the well-being of people are Sung *et al.* (2017). The authors use a survey with also free-form replies to assess the people affected.

The findings include the thoughts of the people on the evacuation afterwards, and some of the surveyed people had evacuated and still resided in their new residence, while others wanted to evacuate, but were unable without the economic means, due to having jobs, loans to pay, etc. (Sung *et al.* 2017:106–107). Either way, people also voiced their insecurity about their choice of whether to evacuate or not (see Sung *et al.* 2017:106–110).

Tokunaga and Resosudarmo (2017) edited a book giving various approaches towards studying the economic impact of the Great East Japan Earthquake. In particular the chapter by Ishikawa (2017) focuses on the economic impact of the population decline caused by the disaster. It is shown that while the production in the affected regions decreased, in other areas, like the Kantō area, there was an increase in production output. Considering further population decline projections, Ishikawa estimates a prevailing long-term effect on the regional economy (Ishikawa 2017:256–257).

Hara (2014) compares population predictions of 2007 and 2013 to assess the impact of the Great East Japan Earthquake on the population of the prefectures Iwate, Miyagi and Fukushima. The author notes that for Miyagi the newly predicted population decrease for Miyagi is flatter than the one for Iwate and Fukushima, mostly due to Miyagi's largest city, Sendai. For instance, in Iwate the new projection forecasted a negative effect on the population demographics, amplified by the disaster, for at least the following five years (Hara 2014:3–4). Fukushima would be hardest hit by population ageing, for the fact that by 2040, its elderly population would increase by 1.9%. Iwate is forecasted to also have a slightly accelerated ageing, while Miyagi is supposed to age at about the same rate as given by the previous projection (Hara 2014:4–5). Based on those projections, the author argues that the demographic impact of the disaster, in terms of depopulation, will be limited. The projections were developed under the assumptions to have similar migration patterns as large previous earthquakes, like the Great Hanshin Earthquake of 1995 and the Hokkaidō Earthquake in 1993, where many people returned to their previous home areas. Due to the previous tendency of out-migration and ageing in the region, recovery and reconstruction plans have to consider that continuing trend of demographic shift (Hara 2014:6–7).

## 1.3. Research Question

In this thesis I will investigate the impact of the earthquake and tsunami on the migration patterns and demographics within Tōhoku and in Japan. I will focus primarily on the areas in closest geographical proximity to the epicenter of the earthquake, as those regions experienced the most severe damages in Japan. As measures were implemented by the Japanese government to deal with the nuclear catastrophe, and many residents were forced to relocate immediately after the tsunami. How did this situation develop in the years following and how did it result in a change of migration behaviours as a result of this?

To answer those questions, this entails a number of smaller questions on how internal migration in Japan was affected in relation to this event, which I have outlined below.

> *How did the Great East Japan Earthquake and the subsequent Tsunami and Nuclear Catastrophe in Fukushima impact the migration of locals in the area?*

- *To what spatial extent did it alter migration patterns?*
- *How was the demographic structure of those migrants?*
- *How was their destination choice affected?*
- *How did it compare to the migration pattern change of the rest of Japan?*

To a large extent, existing research on the migration flows within Japan has been concentrated on the prefectural level, or on specific flows to the larger population centers. This is in part due to a lack in the availability of suitable data for this this research. However, newer population censuses of Japan give data about the usual residence of five years prior, thus allowing a more detailed analysis. Therefore, I will make use of these newer sets of data in order to create a more detailed picture of the migration movements.

Even the more rural prefectures of Tōhoku vary in their population density; therefore it can be assumed the migration will be different between cities and villages in those areas. However, since most research focuses on the aggregate migration of the prefecture, it is not clear how the spatial distribution changes. This research aims to take a look at the smaller administrative levels within Japan, and analyses the migration flows and change in demographic structure within and between municipalities.

In the previous section I have outlined previous research on this question and some prominent opinions among researchers. With my research I will also aim to consider the validity of below mentioned hypotheses regarding migration patterns in light of the 3.11 catastrophe. I will focus on the following hypotheses:

- *The catastrophe lead to a further depopulation of a region already troubled by increasing out-migration.*
- *Women (especially with young children) migrated further away than men.*
- *The increased migration was by mostly younger people, while older inhabitants remained in the affected areas.*

# 2. Methodology

In this chapter I will outline and further dissect the methodology I used for the data analysis.

Firstly, the change in net migration, as well as in- and out-migration can directly be calculated out of the available census data. This is available for all municipalities, in the most recent census of 2015 for sex and five-year age groups, whereas in earlier census the division in age groups is not as detailed.

To answer the research question about the change in migration flows, first a Origin / Destination Matrix has to be constructed containing all the migration between any two places as given in the census data. Afterwards I will visualise the migration flows like in Yano *et al.* (2000:169–170) gives an overview and helps in making the data understandable. The authors construct a connectivity measure, given by $\frac{T_{ij}}{O_i} + \frac{T_{ji}}{O_j}$. The variables $T_{ij}$ and $T_{ji}$ denote migration from one place to another, and $O_i$ and $O_j$ denote the out-migration of a specific place. This means that the strength of migration is measured by the relative migration from one place to another. The more people migrate from one place to another in relation to all the out-migration of that place, the higher this connectivity measure will be.

With the same approach the age and sex structure of the migrants can be analysed. This should be put in the general context of the original demographic structure of the municipalities. Additionally, for further analysis on the relation of the average distance of migration of the different sexes and age groups, a comparison of the average migration distance of the migrants of Fukushima prefecture to the average migration distance to the surrounding prefectures will be made. Since prefectures further in the periphery of Japan (such as Hokkaidō or Okinawa) will have longer average migration distances, I will only consider the following prefectures for the comparison: Aomori, Iwate, Miyagi, Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata. The ratio is calculated by $\frac{avg_{fukushima}}{avg_{others}}$, and it is separated in men and women, and four age groups: 0–19, 20–44, 45–64, 65+. The same is repeated for the prefectures of Iwate and Miyagi, against the average of Aomori, Fukushima, Miyagi, Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata, respectively Aomori, Iwate, Fukushima, Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata.

I will use the statistical tool *R* for all the data manipulations and analyses in this thesis. Specifically the *R* library *sf* provides tools for the geographical analysis and visualisation of data (see Pebesma 2018).

## 2.1. Data

The Japanese government provides detailed migration data in the censuses. They are available every five years, so a short term observation in changes of migration patterns is not possible; only the longer term impact can be observed. Additionally, detailed data on the age of migrants is only available in the most recent census of 2015, hence the comparison to early data in that case is not possible. I will give a more detailed description of the individual data sets in the next sections.

Internal migration data between all cities, towns and villages in Japan is available through the census of the most recent years. There is also data on the recently merged municipalities, but in the last two census there was no change in the structure of those municipalities. The census, however, is slightly flawed on the municipality level that some municipalities can be too large that the exact distribution of where the internal migrants lived is not available. Nonetheless, the data on municipality level still allows for significant deeper insides than merely looking at the migration data between prefectures.

The *Population Census* has migration data with the *Tabulation on Internal Migration for Population*, where the migration is given by the population based on place of present residence, and by the population based on the place of usual residence five years ago. In addition to that, further data can be obtained from the *Report on Internal Migration* in Japan, also giving age and sex structure of the migrants, though in a limited way.

Specifically, in this thesis, I will use the *Population Census* of 2010 and 2015, as well as the *Report on Internal Migration* for the years from 2011 to 2014, to provide a rough overview of the migration movement between the two census (Statistics Bureau of Japan 2012a, 2012b, 2013, 2014, 2015b, 2017).

I will now describe the available data in more detail. To bring the data in a suitable form for analysis, the unnecessary information in the data files had to be removed first. This data editing process forms the basis for all the statistical analysis of chapters 3 and 4.

## 2.2. Population census (2010, 2015)

Detailed population census data is offered by the Japanese government every five years. Because the earthquake in Japan happened in 2011, this allows for a comparison of the population data in the year before the earthquake (2010) and its relatively long term effects on population migration four years later (2015). Assuming that many people had to relocate as an immediate response to the earthquake, this effect would have been seen in the years 2011 or 2012. As the census data is only updated every five years, the available data cannot offer the immediate impact of the earthquake.

What can be seen, is how the situation looked like about four years after the earthquake. If we approximate that the situation in 2010 is similar to when the earthquake happened, we can see the result after about four years with the population data of 2015. However, this does not allow a detailed description of how the four year period until 2015 exactly looked like. Therefore, additional data can help bridge the gap between 2011 and 2015. For this timeframe the *Report on Internal Migration* will be used.

The population data for the census is always taken at 0:00 am on the first of October of the surveyed year (Statistics Bureau of Japan 2015a). This means that the data from 2010 was recorded just a little over four month before the earthquake occurred, which provides a good starting point for analysis. Although this temporal gap between the collection of data and the event of the earthquake is present, the error it entails is negligible for the analysis of this paper.

The relevant data for the analysis of the migrations is provided through the *Tabulation on Internal Migration for Population* in the census. Therein the migration is recorded given the current place of living, as well as the place of living five years prior. This shows how many people stayed in their municipality over those five years, and how many people moved to a different municipality. It does not contain migrations within a municipality, nor would it have information of the migration of a person moving away and back within the five-year period. In both census, 2010 and 2015, this data is available for all municipality pairs where any migration happened, in total, but also separated by sex. Additionally, for the census of 2015 those tabulations also contain the migration data by age.

### 2.2.1. *Definitions*

Hereafter I will shortly define some terminology used throughout the thesis related to migration:

- *Internal migration*: Means only migration within the country, thus it is the opposite of international migration. In this thesis any migration out of Japan to any other country, as well as migration from other countries to Japan is not considered.

- *Intra-prefectural migration*: Migration from one prefecture to another. This differs to inter-prefectural migration, which is the migration between the municipalities of one prefecture.

- *In-migration*: When discussing a prefecture or municipality, the in-migration, or immigration, is the migration from other places to the prefecture or municipality.

- *Out-migration*: The opposite of in-migration, it contains all migration of people that left the specific prefecture or municipality.

- *Net migration*: The net migration is the difference of in-migration to out-migration. If it is positive, it means that more people migrated to the prefecture or municipality than those people that left.

- *Net migration rate*: The net migration rate is the net migration divided by the average population of the prefecture or municipality between the two years of observation. For example, in the calculation of the net migration for the census of 2015, the average of the population of the years 2010 and 2015 is used. Mathematically, the net migration rate is $n = \frac{i-o}{\frac{p_{2010}+p_{2015}}{2}}$, where $n$ is the net migration rate, $i$ is the total number of in-migrants, $o$ the total number of out-migrants, $p_{2010}$ and $p_{2015}$ the total population in the years of 2010 and 2015 respectively.

## 2.3. Merged municipalities

There are also some difficulties when comparing population data from two different population censuses. In this paper, the census data from the years 2010 and 2015 should be compared. The data is tabulated based on the official municipalities in the year of the census. However, the datasets of 2010 and 2015 do not completely overlap. This is because over the years municipalities in Japan can either merge or dissolve, which thus makes it more difficult to align the data of the two censuses.

To remedy this issue, it is necessary to manually correct the available data by aligning the entries that do not match up. Lists for all the mergers or dissolutions of municipalities during this five-year period are available online (Wikipedia 2020).

## 2.4. Map data

For map data I used the data set *Database of Global Administrative Areas* (GADM) that is provided for free for research purposes (GADM 2018). It includes spacial map data for Japan and all sub-divisions thereof. All the map data can be downloaded as shape-files from their server and then imported into statistical computing software like R.

As with the data of the municipalities, there are again some discrepancies between the data of the population census from 2010 and 2015 and the individual polygons for each Japanese region in the map data. Therefore, these two sets of data again need to be connected to be able to work with the available data correctly.

One visual way to quickly determine data that is not connected properly between the population and the map data is by color coding the map data based on some variable in the population data. For example, I chose a running index number that is distributed across Japan

Source: Own calculations, based on GADM data

Figure 4 Japanese areas coded by region with grey areas not correctly identified

from north to south. When applying a gradient based on the index number categorized in the 47 prefectures of Japan, they should show up on the map as a uniformly distributed gradient (The gradient goes from Hokkaido (orange) to Okinawa (red) and follows a rainbow colour gradient). However, for all the areas where the index is not correct in the data set, the correct colour can not be applied and the region thus shows up grey in the map (see figure 4).

After this has been done, the wrong entries need to be corrected by hand. Now it is possible to visualise the population data as maps.

Another useful feature of this approach is that all the individual polygons for the regions in Japan can now be used for calculating distances to other regions, which will be important to measure the relative distance that people migrated within Japan after the 3.11 earthquake. This is of course only an approximation of the total distances, because it can only measure the linear distance (based on the great circle distance) between the centres of two polygons as of now. It does not measure the distance of transport, as it does not account for the availability of roads and other forms of public transport. Nonetheless, a concern lies in the general geographical distance to the affected regions of the disaster, which this approach can provide. It also allows to see the difference in total migration distance between the years of 2010 and 2015.

## 2.5. Definition of urban areas

In this section I will define urban and rural areas in Japan. For calculations on migration patterns within Japan, it is important to classify certain migration movements. One possibility of classification is to subdivide areas in Japan into urban or rural, or somewhere along this spectrum. The general trend in recent years was that of urbanisation, where people favoured a move to urban centres. In this thesis, I would like to inspect the migration patterns based on demographic groups of people.

Population data can be used to group citizens by gender (male or female) and in age groups (youth, working-age, elderly). These groups can then be analysed in terms of all possible migration patterns (rural to urban, urban to rural, urban to urban, and so on).

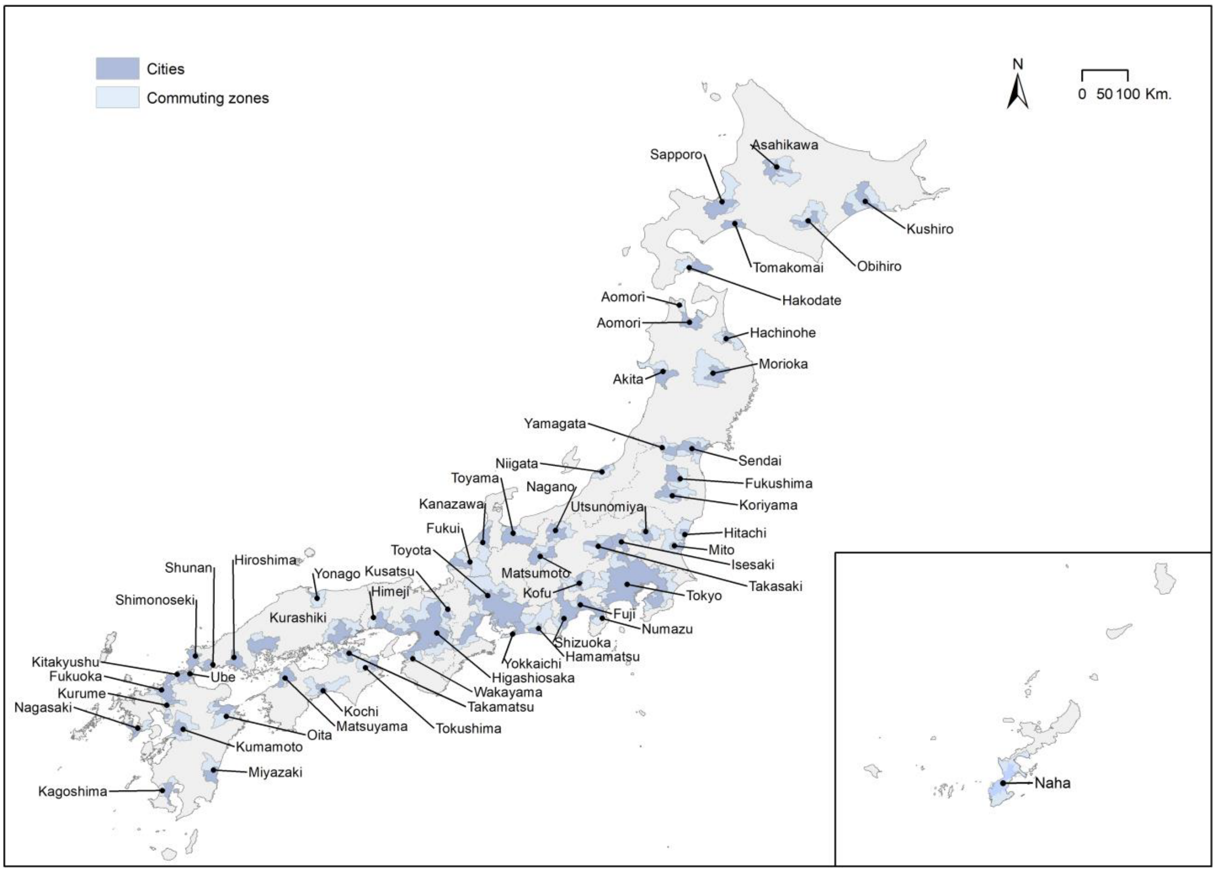
The classification of areas into urban and rural is somewhat arbitrary and several different methods for classification are possible. From the data available in hand there are generally two different approaches to classifying regions in Japan. One possible way is to base the classification on either the total amount of people living in a certain area, or the population density of an area. Then an arbitrary threshold for separating the two categories of urban and rural has to be chosen. This approach, however, does not factor in infrastructure and the geography of the area, which might influence these numbers. It also does not work well with large areas where the population is not distributed homogeneously (i.e. there may be a population concentration in part of the area while the rest is only sparsely populated).

Another possibility is to base the classification on the division of municipalities on the Japanese government, which can be seen through the suffixes of Japanese municipality names. These can thus be grouped into cities or villages. One problem is that there are many municipalities where the naming came about historically and does not reflect its present status.

This problem could be overcome by combining the two approaches outlined above, which would certainly be sufficient for the purposes of the analysis of this paper. However, in order to avoid possible inaccuracies of this approach, relying on classifications of previous research is can offer another way for grouping urban and rural areas.

The classification chosen for this paper is the data on 'functional urban areas' provided by the OECD (OECD 2020). It identifies urban centres around cities and commuting zones in the vicinity of these cities. The graphical representation of the urban areas, based on the OECD data, can be seen in figure 5. The OECD classifies a city as a urban area where at least fifty percent of the population live an urban centre, which is 'a cluster of contiguous grid cells of one square kilometer with a density of at least 1,500 inhabitants per square kilometer and a population of at least 50,000 inhabitants overall', and a commuting zone a 'local administrative units for which at least 15% of their workforce commute to the city' (OECD 2020:2).

For the purpose of this study, there will be three groups for classification: (1) urban (cities), (2) commute (commuting areas), and (3) rural (all areas not classified as 1 or 2). This allows for a more detailed description of migration pattern within Japan. Based on these three groups,




Source: OECD (2020)

Figure 5 Functional urban areas of Japan

there are nine possible migration patterns: (1) urban to urban, (2) urban to commute, (3) urban to rural, (4) commute to urban, (5) commute to commute, (6) commute to rural, (7) rural to urban, (8) rural to commute, and (9) rural to rural.

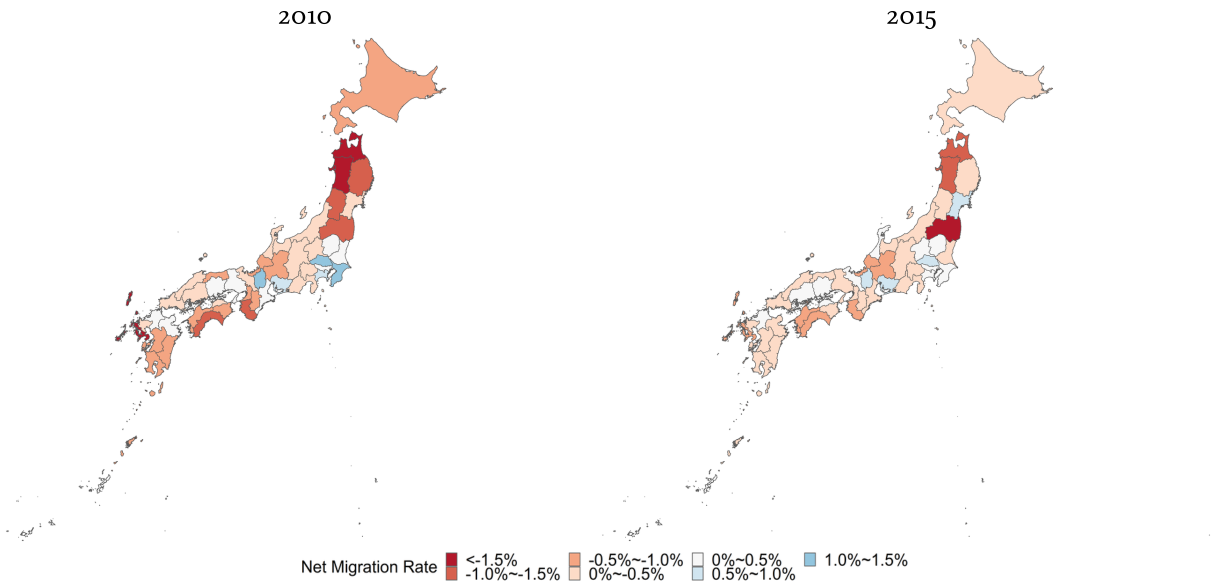
# 3. Overview of migration and population development between 2010 and 2015

In this chapter I will provide a description of internal migration within Japan between the years 2010 and 2015. This is meant to give a birds-eye view to better understand the population data in general.

This overview is divided into three sections. In the first section I will outline the data on the prefectural level and show a comparison of the migration between 2010 and 2015. The second section focuses on the municipality level, thus allows a deeper understanding of migration patters within the prefectures. This step is also important for understanding how, for example, differences in migration patterns between rural and urban areas looked like in the given time frame. Thirdly, I will look at the yearly trends based on the Report on Internal Migration to show how the net migration and differences between gender have changed over the five year period in question.

## 3.1. By prefecture

First, an overview of the migration changes on a prefectural level will be given. This part will also focus in particular on the prefectures of Tōhoku and the surroundings, as they have been most affected by the disaster. The illustration in figure 6 shows the net migration rate in 2010 and 2015. Negative numbers in red colours denote more out-migration than in-migration in a given prefecture, while positive numbers and blue colours show that more people migrated to a prefecture than people who migrated away from it.




Source: Own calculations, based on Census of Japan 2010 and 2015

Figure 6 Out-migration by prefecture 2010 and 2015

Notably, in 2010 much of Tōhoku had some of the highest out-migration within Japan. Particularly Aomori and Akita had the highest rate with 1.74% and 1.52% respectively. Only the southern prefectures of Nagasaki on Kyūshū, Kōchi on Shikoku and Wakayama also have a net out-migration of more than one percent. Among them, Nagasaki was the only prefecture with a similar net migration rate to those in Tōhoku with 1.68%. Within Tōhoku, Miyagi was at around zero percent, with a net out-migration of around 7,500 people. Nationwide, in-migration is mainly found in the metropolitan centres of Japan. Especially the Kantō region has a high net migration rate with a net plus.

Table 1 shows data of 2010 of the ten prefectures with the highest and lowest net migration respectively. It gives an overview of internal migration in Japan just a few months before the earthquake affected the regions of northern Japan. Since most of the areas in Tōhoku already had considerably more out-migration than in-migration (which is equal to a negative net migration rate), the numbers for 2015 should be considered accordingly. This means that

Table 1 Migrants in 2010 per prefecture

| Prefecture | Net migration rate | In-migrants | Out-migrants |
|---|---|---|---|
| Akita | -18.96% | 36197 | 53133 |
| Aomori | -18.84% | 52661 | 77116 |
| Nagasaki | -15.75% | 65383 | 89828 |
| Fukushima | -14.30% | 73168 | 97578 |
| Yamagata | -14.18% | 41852 | 55681 |
| Iwate | -13.25% | 53325 | 69618 |
| Wakayama | -13.21% | 34803 | 45393 |
| Kōchi | -13.00% | 28502 | 37017 |
| Tokushima | -11.51% | 30595 | 38553 |
| Hokkaido | -11.02% | 134386 | 167666 |
| ... | ... | ... | ... |
| Tochigi | 0.61% | 102568 | 101326 |
| Fukuoka | 0.71% | 287663 | 283611 |
| Okinawa | 1.07% | 54749 | 53590 |
| Tokyo | 1.68% | 966360 | 934426 |
| Ibaraki | 3.57% | 155250 | 144540 |
| Kanagawa | 7.37% | 633490 | 546569 |
| Aichi | 7.84% | 356149 | 304342 |
| Saitama | 8.70% | 468414 | 393454 |
| Chiba | 9.31% | 442626 | 367246 |
| Shiga | 11.69% | 91831 | 72610 |

Source: Own calculations, based on Census of Japan 2010

the relative change between the years 2010 and 2015 gives the best indication of the effects the earthquake had on the internal migration pattern within Japan.

Contrasting the data of 2010 and 2015 (see table 2), it reveals some interesting changes in the migration patterns across Japanese prefectures. It can clearly be seen that the situation had changed severely by 2015, especially in the regions that were close to the epicentre of the earthquake. Although prefectures facing considerable amounts of out-migration roughly remained the same, for many of those prefectures, out-migration rates were on a reduced level in comparison to 2010. This signals a general trend that internal migration across prefectural borders was much lower in 2015 as opposed to 2010 – with one significant exception. Naturally, after the disaster, Fukushima faced by far the biggest out-migration, with a net loss through migration of 2.54%, which is considerably higher than the top out-migration rate of 2010. Next

Table 2  Migrants in 2015 per prefecture

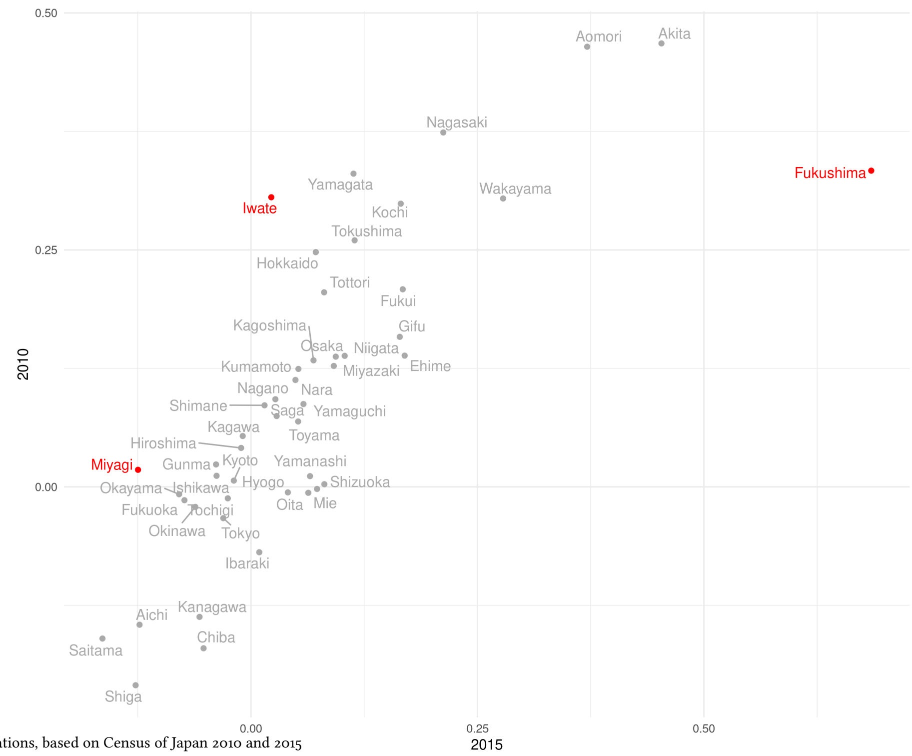
| Prefecture | Net migration rate | In-migrants | Out-migrants |
|---|---|---|---|
| Fukushima | -25.50% | 73041 | 123051 |
| Akita | -18.47% | 31914 | 46374 |
| Aomori | -15.65% | 48341 | 66282 |
| Wakayama | -12.22% | 31179 | 39856 |
| Nagasaki | -9.60% | 62370 | 75610 |
| Ehime | -7.82% | 51254 | 59948 |
| Fukui | -7.73% | 27034 | 31562 |
| Kōchi | -7.63% | 26452 | 30825 |
| Gifu | -7.59% | 75066 | 87394 |
| Tokushima | -5.41% | 28887 | 32191 |
| ... | ... | ... | ... |
| Gunma | 1.97% | 82537 | 79352 |
| Chiba | 2.69% | 366478 | 347295 |
| Kanagawa | 2.92% | 543781 | 512892 |
| Okinawa | 3.17% | 56326 | 52864 |
| Fukuoka | 3.81% | 271582 | 251628 |
| Okayama | 4.13% | 91721 | 84443 |
| Aichi | 6.55% | 323284 | 283513 |
| Miyagi | 6.65% | 149720 | 131047 |
| Shiga | 6.80% | 78658 | 68640 |
| Saitama | 8.93% | 432409 | 361507 |

Source: Own calculations, based on Census of Japan 2015

on the list were still Aomori and Akita, both still had an negative net migration rate, with 1.34% and 1.37% out-migration respectively. This is slightly less than the values of 2010. Also Yamagata and Iwate still had a net out-migration, but only 0.42% and 0.10%.

Comparing the data of 2010 and 2015 provides further details as to which prefectures were affected and how the migration pattern changed in the five-year time period. Interestingly, the net migration rate for the prefecture Miyagi changed quite drastically to a net plus, which is contrary to the trend we see in the prefectures of the Tōhoku region.

In 2015 Miyagi had become one of the prefectures with the highest net in-migration, and almost 19,000 more people migrated to Miyagi as opposed to migration away from it. Hence, it had a positive net migration rate of 0.80%. This situation is likely due to the increase in out-migration from the neighbouring Fukushima prefecture. Despite the gain in net migra-




Source: Own calculations, based on Census of Japan 2010 and 2015

Figure 7 Out-migration by prefecture 2010 (y-axis) and 2015 (x-axis) in percent

tion in Miyagi prefecture, between 2010 and 2015 the total population still dropped. It may be attributed to the changed circumstances after the 3.11 catastrophe, with lower birth rates and higher death rates. As mentioned before, Miyagi's and Iwate's net migration rates were actually higher compared to the other prefectures in Northern Japan.

Compared to the census of 2010, even in the urban prefectures which had higher net migration rates, their in-migration was somewhat reduced in 2015 percentage-wise, which is evident when viewing the Kantō area, where even the positive net migration rates are now lower than 1% and thus a higher balance etween in-migration and out-migration.

Within Tōhoku, most prefectures had more in-migration in 2015 than in 2010. The change in percentage points is shown in table 3. Only the migration rates for Fukushima changed considerably, but the prefectures of Iwate and Miyagi, which were also affected, showed the biggest net growth in migration rates in the years after the 3.11 disaster.

In the rest of Japan, the data also shows a bit of a reversal to the depopulation of the rural prefectures. Besides Fukushima, prefectures around the Kantō region also had relatively little in-migration, as well as other more metropolitan areas like Aichi and close prefectures and Hyōgo prefecture. Whereas the more rural prefectures in northern, western, and southern Japan reversed the trend of out-migration at least to some degree. For differences between rural and urban migration, a more detailed discussion is in the next chapter. The out-migration ratios of the prefectures are visualised in figure 7, showing that Fukushima prefecture has had high out-migration streams not only before the disaster, but even more so in 2015.

### *3.1.1. Sex ratio of internal migration*

Now that I have given a brief overview of the general migration patterns between the years 2010 and 2015, I would like to elaborate the prefectural migration patterns. One important aspect to internal migration in Japan are differences in how male and female citizens choose to migrate. Therefore, I will focus on the sex ratio of internal migrants in this section.

As a borderline for comparison, let me briefly explain the numbers for Japan in total, so that the numbers of the Tōhoku can be contextualized better in later paragraphs. Across all 47 prefectures of Japan, there were a total of 6,807,773 people who moved to another prefecture in 2010. In contrast, the number declined by 8.74% over the next five years, the total migration being 6,213,230 people in 2015. Therefore, in this section I will consider any change in migration between the years 2010 and 2015 over -8.74% as above average migration (meaning that prefectures where net migration is over -8.74% between 2010 and 2015 have increased internal migration relative to the average among prefectures).

Table 3 Net migration rate in 2010 and 2015 in Tōhoku

| Prefecture | 2010 | 2015 | Percentage Points Change |
|---|---|---|---|
| Fukushima | −1.18% | −2.54% | −1.35% |
| Akita | −1.52% | −1.37% | 0.15% |
| Aomori | −1.74% | −1.34% | 0.40% |
| Yamagata | −1.16% | −0.43% | 0.73% |
| Miyagi | −0.11% | 0.80% | 0.91% |
| Iwate | −1.20% | −0.10% | 1.10% |

Source: Own calculations, based on Census of Japan 2010 and 2015

The migration between prefectures in Japan is mostly driven by male migrants. In both censuses of the years 2010 and 2015, almost 55% of all migrants in Japan were male and about 45% female. Since the sex ratios remained about the same, this drop equally affected the entire population.

When focusing on the Tōhoku region in specific, it can be seen that between the years 2010 and 2015, Fukushima prefecture has experienced the greatest change in net migration. While all prefectures, except Miyagi, had a negative net migration in 2015 (see table 3), the relative amount of net migration improved. Fukushima is the only exception to this general trend. In the year 2010 the net migration rate was -1.18%, which then changed to -2.54% in 2015, showing the great impact of the earthquake. In total, it is a negative change of -1.35% percentage points over the five year period.

As for the sex ratio, Fukushima prefecture again is unique among prefectures in 2015. While for out-migration the sex ratio was almost equal, the people choosing to move to Fukushima between 2010 and 2015 were mostly men.

In the year 2010 there were a total of 73,168 inmigrants to the prefecture of Fukushima in the census data, 58.37% of them were male. In the year 2015, the numbers looked quite different. Although the total amount of inmigrants to Fukushima prefecture in 2015 was almost the same (73,041 people), the sex ratio changed drastically. Among the inmigrants recorded, 68.22 % (49,828) were male and only 31.78% (23,213) were female. As such, the number of male inmigrants had increased by 16.66% in those five years, while the number of female inmigrants decreased by 23.78%.

Opposed to that, the total out-migration from Fukushima prefecture did increase by 26.11% from 2010 to 2015 to a total of 123,051 (from formerly 97,578). In 2010, this was made up of 45.50% (44,395) female outmigrants, compared to 49.50% (60,905) in 2015.

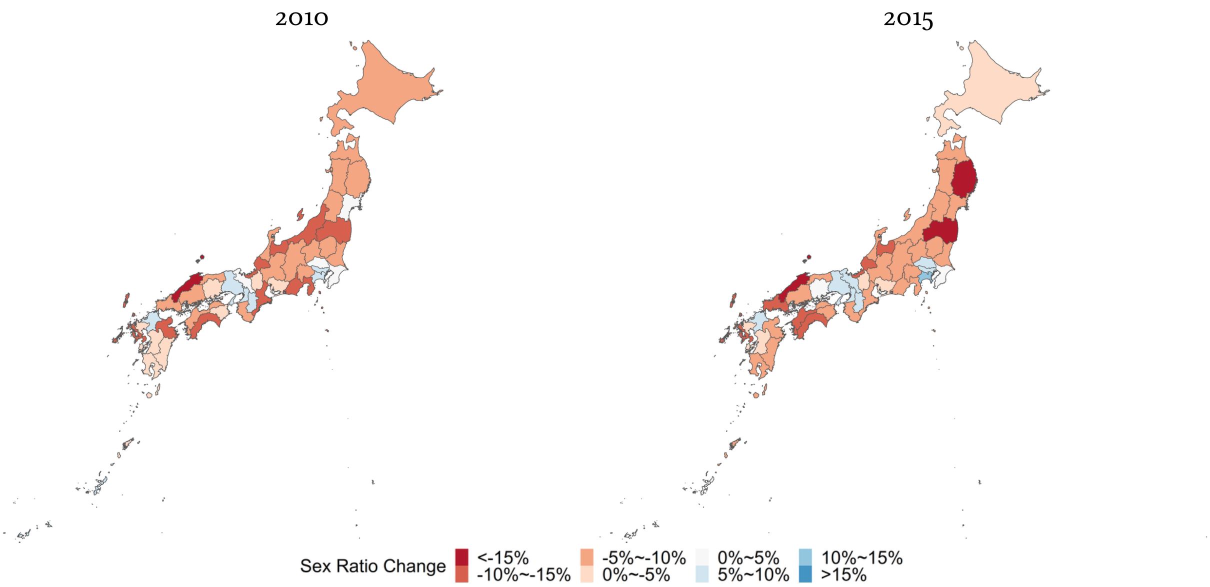
In turn, this means that the negative net migration rate in Fukushima prefecture changed from a minus of 25.02% in 2010 to a minus of 40.64% in 2015. This gives a birds-eye view of the impacts that the nuclear disaster had on the migration pattern in the most affected province.

An increased amount of males moving to Fukushima prefecture between the years 2010 and 2015 could be interpreted in light of the nuclear disaster and the amount of manual labour that was required to deal with the aftermath. The work required for the clean up of the destroyed areas might be carried out by the male population, which could explain the unusual migration patterns in relation to male/female ratio in Fukushima prefecture. Of course there may also be other explanations for this phenomenon, which could be further investigated in subsequent research on a more qualitative level, but this research is outside the scope of this study.

This stark contrast between the sex ratio of in-migration to the sex ratio of out-migration is peculiar for Fukushima in the census of 2015, but already in 2010 Fukushima was one of the prefectures, which had one of the largest differences in sex ratio. Data for 2015 also shows a large difference in the sex ratios for Iwate prefecture. Even though it did not face such a high out-migration of women as Fukushima, the in-migration in Iwate had a bigger imbalance. In total, 11,500 more men than women migrated to Iwate, while only 2,200 more men left Iwate.

However, unequal migration of men and women are not only a phenomenon in the Tōhoku region. Nationwide there are two other prefectures, Fukui and Shimane, which face a large sex imbalance in migration. The sex ratio of the migration across prefectural borders in those two prefectures persisted over both censuses that were subject of this thesis. One interpretation is that the migration pattern of sex imbalance in Fukui and Shimane is not related to the 3.11 disaster, as the pattern did not change too much between 2010 and 2015.

This further illustrated in figure 8, the trend of demographic change persisted between 2010 and 2015, although it has been amplified in the Tōhoku region. Mainly the urban areas in the Kantō, Kansai region and in Fukuoka had a female population increase due to migration. Notably Miyagi prefecture had a relative increase in female population, but this can be attributed to an increased out-migration of men, while there were about as many female inmigrants than outmigrants.




Source: Own calculations, based on Census of Japan 2010 and 2015

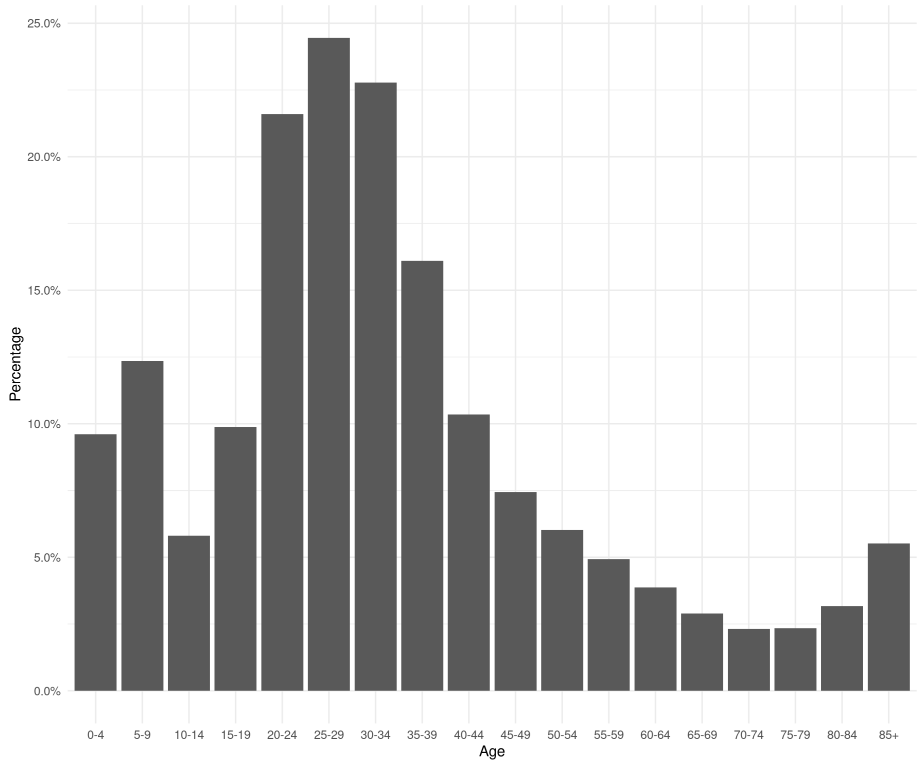
Figure 8 Sex ratio Difference between male and female by prefecture 2010 and 2015. Negative values are an increase of male population due to migration, positive is a female population increase.

### *3.1.2. Age groups of internal migrants*

Other interesting data can be obtained through the distribution of internal migrants among age groups (see figure 9). This allows for a description of how age influences the choices of migration patterns among the population.

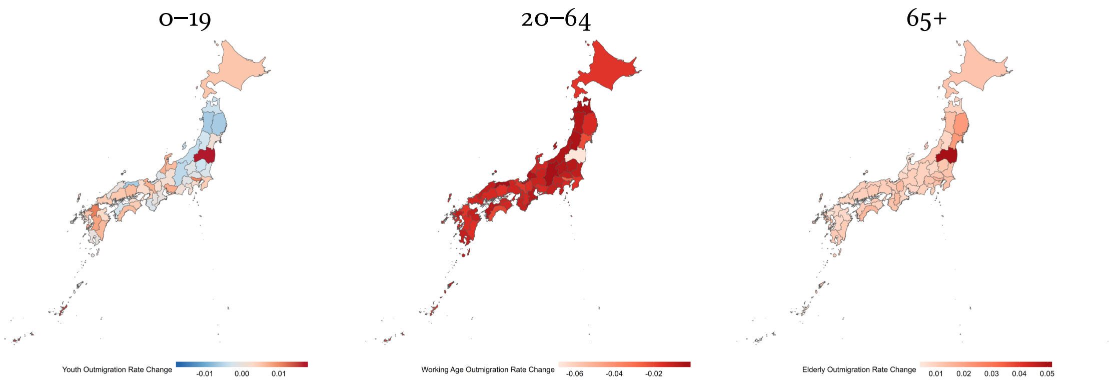
Looking at the age groups, all over the country the elderly (those over 65 years old) increased their willingness to migrate. This ratio is the percentage of the relevant age group to the total out-migration of that prefecture, but does not take into account the in-migration. The out-migration of the elderly then particularly increased in the affected regions of the 3.11 disaster (see figure 10).

However, for the young generation the picture is a little bit different. While there was a large increase in out-migration in Fukushima prefecture still, the situation changed less drastically




SOURCE: Own calculations, based on Census of Japan 2015

FIGURE 9 Percentage of out-migrants to the total population by 5-year age groups




SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 10 Change of out-migration in prefectures of different age groups. Youth is under 20 years old and elderly above 65 years old. Relative change etween the out-migration of the Census of 2010 and 2015

in Miyagi and Iwate. The changes are illustrated in figure 10, which shows the relative changes of out-migration among the age groups between 2010 and 2015 (note that does not contain absolute numbers, if the change is negative, still more people in total could have migrated in an age group, but the change was relatively less than with other age groups).

This illustrates also that in Fukushima prefecture the percentage of out-migration of people in their working age (20–64) is relatively the lowest compared to the other prefectures, relative to the age groups under 20 and over 65 years old. However, compared to the total population, it is still one of the highest out-migration ratios (percentage of out-migrants to total population) of the working age populace. Therefore, it is overshadowed by the drastic increase of out-migration of younger and older people in Fukushima prefecture. The working-age/student population tended to migrate less between those five years, in relation to the other two age groups.

Thus, this seems to show that age-specific migration as a result of 3.11 could have had two several effects. This is in addition to the obvious increase in out-migration of Fukushima prefecture. For example, elderly people were more inclined to move between prefectures in the whole country, which is contrasting the relative decline in migration across the whole population between 2010 and 2015 as shown in the previous sections. However, it is not clear whether this phenomenon can be attributed only to the earthquake, or the cause of this change may have other reasons as well. A more detailed study on migration movements on a five year based ovservation, for example 2015 and 2020, or 2005 and 2010, may provide a better context for interpreting this data.

In regards to the migration pattern change of people under 20 years old, there is a clear pattern, as seen in figure 10. People under 20 in the areas not directly affected by the nuclear catastrophe (mainly Fukushima and to some extent Miyagi prefecture) tended to leave their prefectures less. This is especially visible in the north of the Tōhoku region (see also table 4).

From the data alone it is difficult to explain this trend in migration movements, but there are some solutions one could entertain. For one, young adults (possibly together with their families) from the prefectures around Fukushima and Miyagi who may have planned to move to one of those two prefectures could have cancelled their move, thus staying in their home prefecture. Another possible solution could be that people moving away from Fukushima prefecture may have moved to relatives in surrounding areas (for example elderly people moving to their children). This could have been the reason for those families to be more likely not to move to other places.

Monetary reason may have also played a part in this, as families with young children may have not been able to afford moving after the effects of the tsunami. It would be possible that they either lost jobs or possessions, or that they were helping out family or friends who were more affected by the catastrophe.

As this is a quantitative study that aims to give a relatively broad picture, specific reasons for certain phenomena can not be known completely. A more qualitative investigation of these findings is necessary to make more concrete statements about the reasons for increased or decreased movement of people.

Table 4 Relative change of out-migrants per prefecture

| Prefecture | Total Youth (0–19) | Total Working Age (20–64) | Total Elderly (65+) | Male Youth (0–19) | Male Working Age (20–64) | Male Elderly (65+) | Female Youth (0–19) | Female Working Age (20–64) | Female Elderly (65+) |
|---|---|---|---|---|---|---|---|---|---|
| Hokkaido | −14.56% | −18.89% | 7.75% | −15.35% | −19.18% | 15.63% | −13.67% | −18.46% | 3.11% |
| Aomori | −16.36% | −15.37% | 9.95% | −16.24% | −14.97% | 25.44% | −16.48% | −15.92% | 1.34% |
| Iwate | −17.88% | −16.98% | 35.85% | −19.85% | −18.25% | 44.20% | −15.70% | −15.35% | 31.46% |
| Miyagi | −9.67% | −12.70% | 65.09% | −9.04% | −13.60% | 72.76% | −10.34% | −11.42% | 60.10% |
| Akita | −15.93% | −14.12% | 14.44% | −17.16% | −14.54% | 33.62% | −14.63% | −13.57% | 5.75% |
| Yamagata | −15.63% | −14.88% | 6.07% | −17.72% | −15.05% | 6.13% | −13.38% | −14.66% | 6.04% |
| Fukushima | 34.63% | 13.73% | 193.00% | 31.87% | 5.31% | 214.57% | 37.57% | 24.58% | 181.07% |
| Ibaraki | −7.51% | −7.33% | 20.54% | −6.58% | −6.52% | 21.85% | −8.55% | −8.38% | 19.56% |
| Tochigi | −12.00% | −11.14% | 16.71% | −12.23% | −11.14% | 19.51% | −11.75% | −11.13% | 14.85% |
| Gunma | −10.32% | −10.24% | 10.81% | −10.22% | −9.90% | 19.54% | −10.43% | −10.67% | 5.27% |
| Saitama | −9.77% | −9.95% | 9.41% | −9.10% | −9.49% | 12.27% | −10.51% | −10.51% | 7.09% |
| Chiba | −3.23% | −7.96% | 16.87% | −3.36% | −8.25% | 18.01% | −3.09% | −7.59% | 15.96% |
| Tokyo | 1.92% | −9.43% | 12.22% | 2.50% | −9.61% | 17.09% | 1.28% | −9.20% | 8.70% |
| Kanagawa | −5.10% | −8.33% | 13.97% | −4.17% | −9.08% | 17.95% | −6.10% | −7.29% | 10.65% |
| Niigata | −13.67% | −12.41% | 11.84% | −13.14% | −11.82% | 21.79% | −14.25% | −13.20% | 6.17% |
| Toyama | −10.36% | −14.40% | 5.78% | −11.11% | −14.76% | 11.61% | −9.56% | −13.90% | 2.35% |
| Ishikawa | −9.99% | −14.57% | 5.62% | −9.91% | −14.20% | 9.45% | −10.07% | −15.10% | 3.19% |
| Fukui | −14.96% | −14.75% | 4.43% | −16.07% | −13.75% | 19.01% | −13.65% | −16.13% | −4.13% |
| Yamanashi | −8.62% | −9.29% | 15.86% | −9.47% | −8.89% | 20.05% | −7.63% | −9.80% | 13.20% |
| Nagano | −15.32% | −13.92% | 7.74% | −15.59% | −13.71% | 13.47% | −15.03% | −14.18% | 4.36% |
| Gifu | −8.95% | −11.20% | 9.94% | −9.70% | −11.31% | 13.10% | −8.08% | −11.06% | 8.03% |
| Shizuoka | −8.86% | −10.58% | 10.60% | −9.19% | −10.33% | 16.32% | −8.49% | −10.90% | 6.81% |
| Aichi | −3.79% | −9.19% | 11.59% | −4.40% | −9.56% | 14.64% | −3.07% | −8.66% | 9.01% |
| Mie | −6.79% | −7.52% | 9.13% | −9.27% | −7.16% | 15.75% | −3.83% | −7.99% | 5.26% |
| Shiga | −5.22% | −8.17% | 21.49% | −2.47% | −8.78% | 22.48% | −8.45% | −7.32% | 20.76% |
| Kyoto | −6.91% | −13.62% | 5.70% | −6.85% | −12.55% | 10.35% | −6.97% | −14.84% | 2.75% |
| Osaka | −10.03% | −13.86% | −1.25% | −9.30% | −12.89% | 0.01% | −10.87% | −15.07% | −2.19% |
| Hyogo | −6.92% | −9.76% | 7.66% | −6.74% | −9.51% | 9.81% | −7.13% | −10.06% | 6.20% |
| Nara | −15.53% | −16.68% | 1.66% | −14.07% | −17.20% | 3.86% | −17.23% | −16.12% | 0.20% |
| Wakayama | −14.66% | −14.85% | 3.22% | −13.54% | −15.15% | 2.61% | −15.92% | −14.51% | 3.55% |
| Tottori | −17.28% | −15.26% | 10.14% | −15.49% | −14.72% | 16.74% | −19.07% | −15.95% | 6.47% |
| Shimane | −14.38% | −15.57% | 1.12% | −14.46% | −12.78% | 14.48% | −14.30% | −18.91% | −4.94% |
| Okayama | −10.66% | −15.17% | 9.24% | −11.62% | −14.97% | 14.34% | −9.53% | −15.42% | 6.24% |
| Hiroshima | −9.95% | −13.66% | 10.98% | −9.36% | −13.44% | 18.95% | −10.59% | −13.96% | 5.82% |
| Yamaguchi | −10.66% | −14.16% | 2.64% | −11.08% | −15.00% | 5.76% | −10.20% | −13.07% | 1.03% |
| Tokushima | −15.69% | −18.89% | 3.58% | −16.47% | −18.77% | 10.04% | −14.76% | −19.03% | 0.11% |
| Kagawa | −13.88% | −16.01% | 11.94% | −14.56% | −16.32% | 20.56% | −13.17% | −15.62% | 6.56% |
| Ehime | −12.77% | −12.50% | 8.73% | −12.52% | −13.25% | 15.29% | −13.06% | −11.55% | 5.51% |
| Kochi | −15.16% | −19.77% | 12.22% | −12.59% | −19.72% | 23.37% | −17.77% | −19.83% | 6.90% |
| Fukuoka | −6.62% | −13.93% | 4.84% | −5.91% | −13.89% | 10.55% | −7.44% | −13.98% | 1.37% |
| Saga | −9.20% | −12.56% | −0.88% | −9.61% | −13.01% | 10.18% | −8.71% | −12.04% | −6.30% |
| Nagasaki | −15.68% | −18.35% | 8.99% | −15.76% | −18.84% | 15.36% | −15.59% | −17.72% | 5.76% |
| Kumamoto | −9.31% | −14.38% | 4.60% | −9.17% | −15.07% | 15.00% | −9.46% | −13.46% | −0.34% |
| Oita | −8.44% | −10.87% | 5.26% | −8.28% | −10.57% | 13.50% | −8.63% | −11.25% | 1.38% |
| Miyazaki | −10.94% | −15.20% | 10.54% | −10.24% | −16.25% | 13.68% | −11.71% | −13.93% | 8.88% |
| Kagoshima | −14.06% | −15.19% | 5.48% | −14.18% | −16.26% | 11.90% | −13.93% | −13.82% | 2.60% |
| Okinawa | 3.28% | −5.67% | 30.26% | 4.04% | −6.10% | 40.80% | 2.46% | −5.14% | 21.29% |

Source: Own calculations, based on Census of Japan 2010 and 2015

## 3.2. By municipality

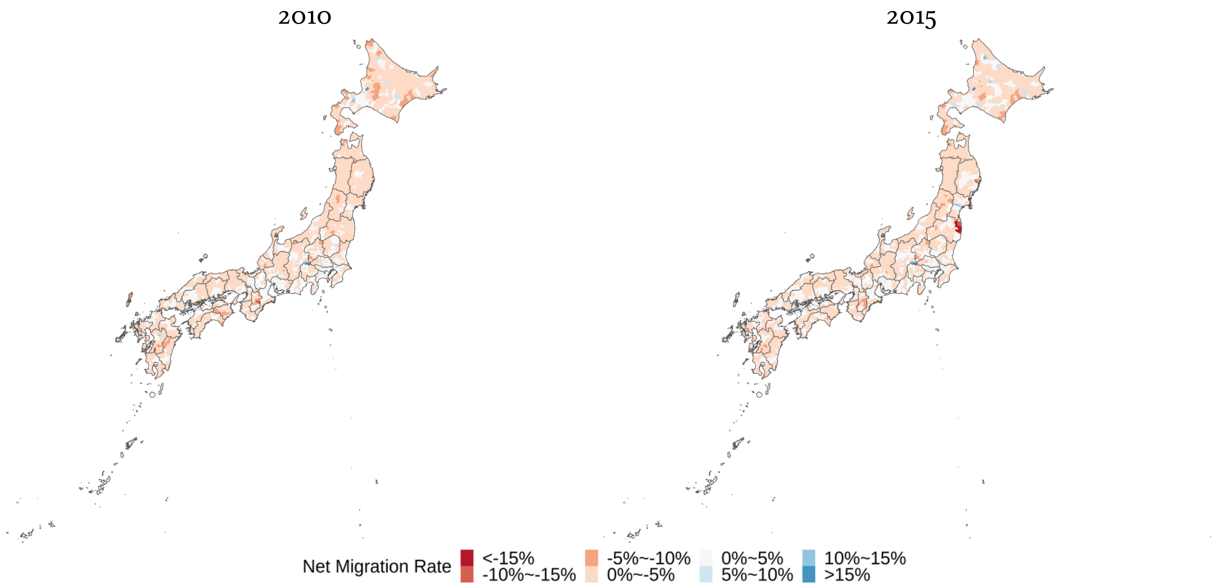
The previous section gave a broad overview on a prefectural level. However, as I stated in the introduction that the migration topic on municipality level was less explored in the literature. Before the dynamics of the migration between the municipalities in Japan will be given, this section will give another quick overview over the situation in all of Japan.

As can be seen in figure 11, the migration in 2010 and 2015 follows mostly the same pattern, rural areas have a higher out-migration, while many of the urban areas have a net in-migration.

The whole Tōhoku area was harshly stricken on the third of March 2011. Not only the surrounding area of the Fukushima nuclear power plant, but also the coastal regions in Miyagi and Iwate were impacted. However, as many migrants do not migrate far away, many of the safer inland municipalities have a lower out-migration rate, or, as is the case in Miyagi prefecture, their total migration even turned to a net in-migration.

For the census of 2010, detailed migration data by age is not available. On the municipality level only the sex of the migrants is in the data set, but not age is attainable. As seen in the section above, such data is only available for the whole prefectures. However, for the census of 2015 for each origin–destination migration pair, also the age groups are available. Due to those circumstances, it is not possible to analyse the change between 2010 and 2015, but it still allows a comparison throughout the country in 2015.

Migration data from the years 2010 and 2015 can also be analyzed in terms of how people decided to migrate. In this section I will be using the classification introduced in section 2.5 to group the migration movements within Japan into nine categories. The absolute numbers for all of Japan can be seen in table 5. The column to right shows the relative change of the number of migrants for any of the nine given migration pairs.




SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 11 Out-migration rate 2010 and 2015

TABLE 5 Migration between and within urban and rural areas in 2010 and 2015

| Migration | 2010 | 2015 | Relative change |
|---|---|---|---|
| Urban ⟶ Urban | 5638358 | 5038336 | -10.64% |
| Urban ⟶ Commute | 744698 | 656066 | -11.90% |
| Urban ⟶ Rural | 1608526 | 1542635 | -4.10% |
| Commute ⟶ Urban | 793653 | 713022 | -10.16% |
| Commute ⟶ Commute | 207827 | 189892 | -8.63% |
| Commute ⟶ Rural | 297437 | 295509 | -0.65% |
| Rural ⟶ Urban | 1924458 | 1806053 | -6.15% |
| Rural ⟶ Commute | 359931 | 358912 | -0.28% |
| Rural ⟶ Rural | 1177346 | 1167586 | -0.83% |

SOURCE: Own calculations, based on Census of Japan 2010 and 2015, and Functional Urban Area definition by OECD

In contrast to this are the numbers from the three prefectures of the Tōhoku region that my research focuses on. These can be seen in table 6. Comparing these two tables allows for a further understanding of how the tsunami determined the migration choices in the stricken regions.

While the general migration all over Japan decreased from 12.8 million to 11.8 million (-7.72%), migration in Fukushima, Iwate and Miyagi increased by 8.30%. This increase can

Table 6 Migration between and within urban and rural areas in 2010 and 2015 from Fukushima, Iwate and Miyagi

| Migration | 2010 | 2015 | Relative change |
|---|---:|---:|---:|
| Urban → Urban | 139737 | 126971 | -9.14% |
| Urban → Commute | 43549 | 36534 | -16.11% |
| Urban → Rural | 76243 | 74090 | -2.82% |
| Commute → Urban | 42930 | 42349 | -1.35% |
| Commute → Commute | 14838 | 13820 | -6.86% |
| Commute → Rural | 18784 | 18690 | -0.50% |
| Rural → Urban | 105233 | 128896 | +22.49% |
| Rural → Commute | 25577 | 36925 | +44.37% |
| Rural → Rural | 100950 | 136678 | +35.39% |

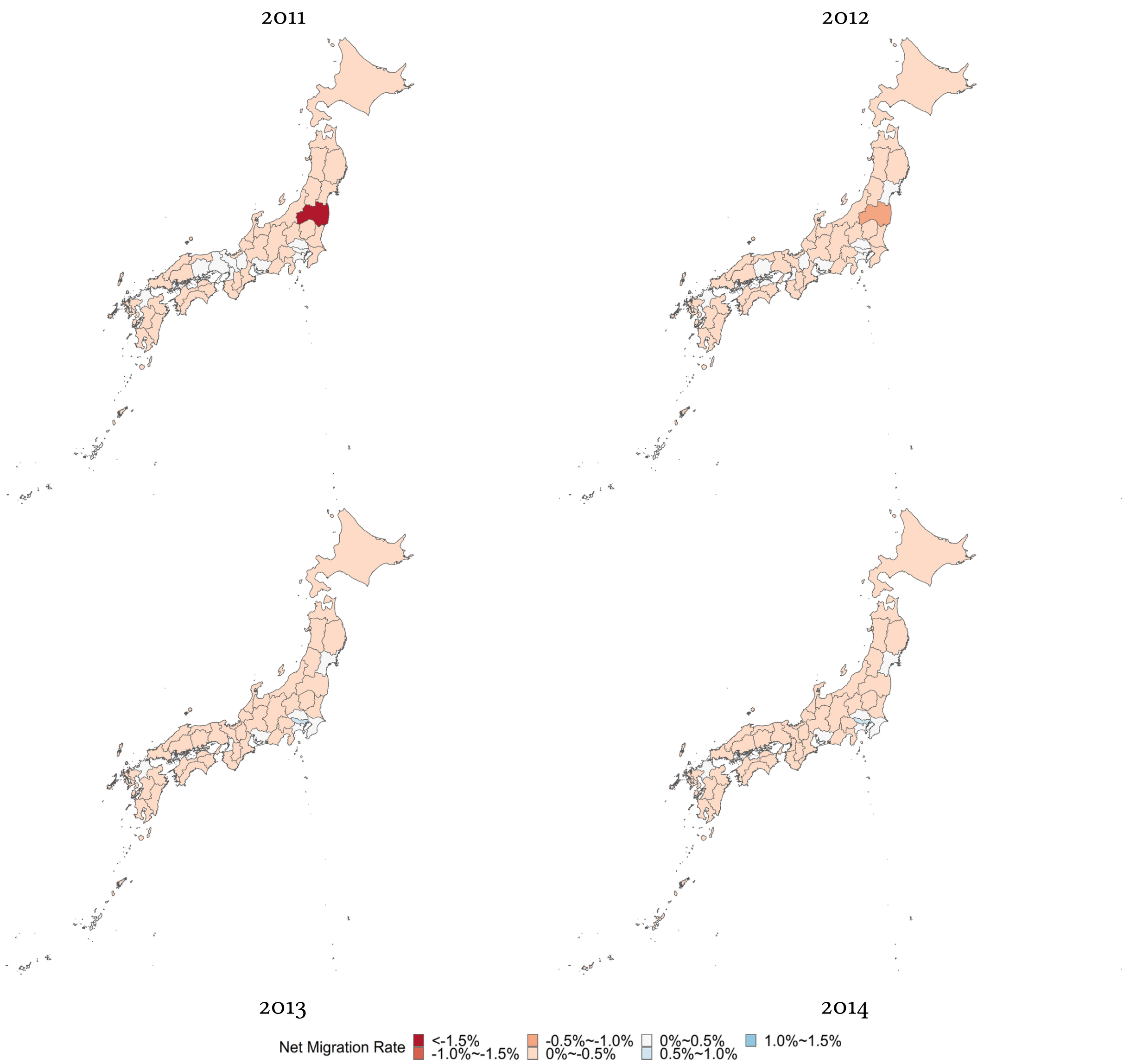
Source: Own calculations, based on Census of Japan 2010 and 2015, and Functional Urban Area definition by OECD

mostly be explained by people moving in rural areas. The relative increase of the number of people living in rural areas who moved away is far above average. 22.5% more than in 2010 moved from rural areas to urban areas, 44.4% more moved to commute regions and 35.4% more moved to another place in the countryside. This drastic increase in migration likely reflects the necessity to move house after the nuclear catastrophe forced them to abandon their houses and resettle.

## 3.3. Yearly trends in migration

Based on the Report on Internal Migration, much of the aforementioned migration happened shortly after the catastrophe. As is shown in figure 12, in 2011 there was a significant out-migration out of Fukushima. By 2012, Miyagi prefecture already had a net in-migration again. The origin of those migrants will be further discussed below with the analysis of migration flows.

A note to the calculation of the net migration rates of the Report on Internal Migration. Since it does not include the total population by year, the population of a prefecture is estimated by




Source: Own calculation, based on Report on Internal Migration 2011, 2012, 2013 and 2014

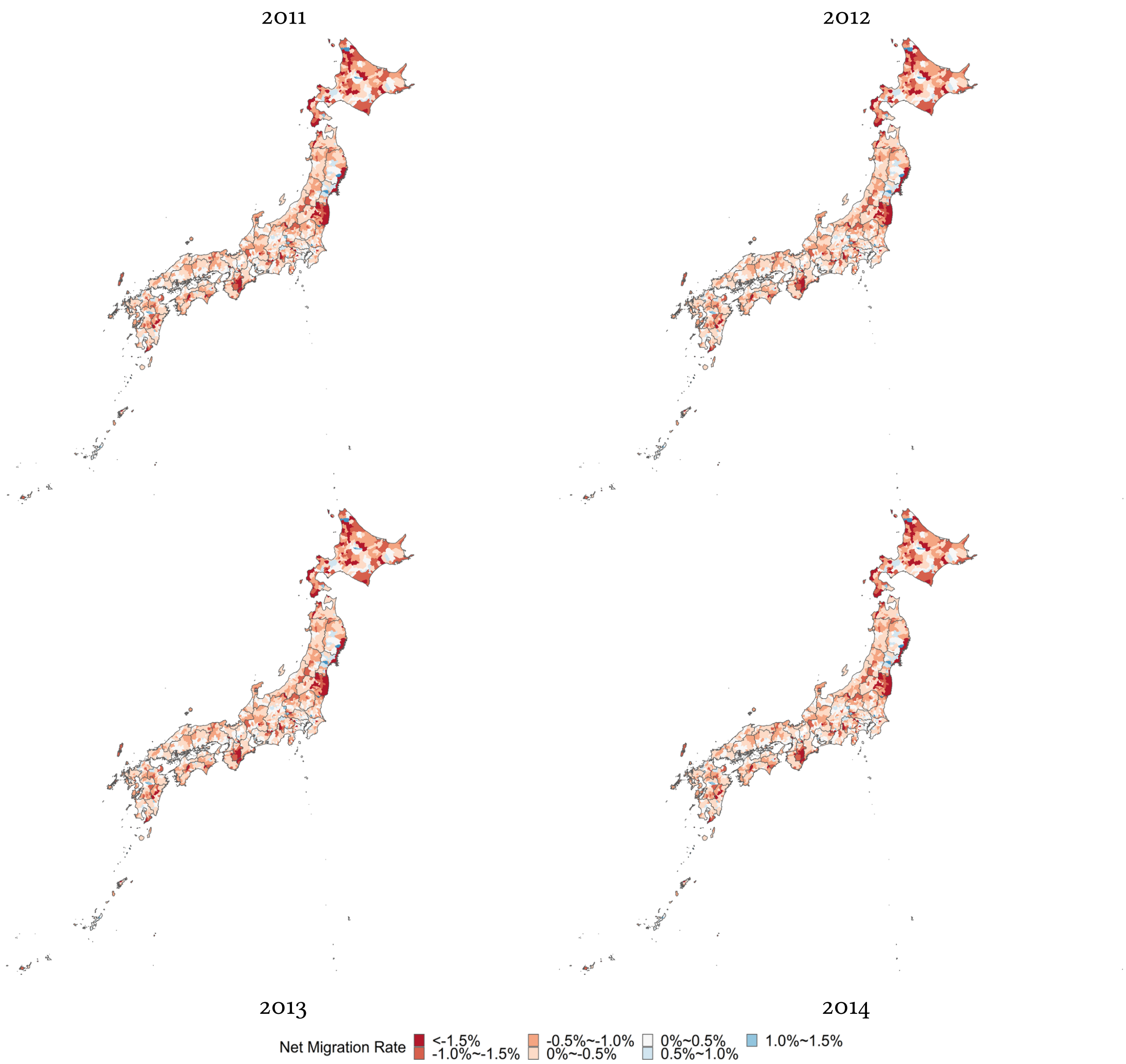
Figure 12 Yearly out-migration rate 2011–2014

taking the mean population of the census years 2010 and 2015 for the relevant area. Therefore, the shown net migration rate might not be entirely accurate. Nonetheless, it shows the trend of the migration, as it is calculated on the average population in each area between 2010 and 2015. Furthermore, if there was a net out-migration or a net in-migration will hold true regardless.

Clearly Fukushima prefecture saw a high out-migration in 2011 after the natural catastrophe, when it had by far the highest negative net migration rate (and thus a high out-migration compared to the in-migration). But also Iwate and Miyagi were high on that list in 2011, when the two prefectures had the third and fourth highest negative net migration rates of all prefectures in Japan. In 2012 this has already reversed somewhat. While Fukushima still had the highest negative net migration rate, Miyagi and Iwate did not have those issues anymore. Iwate still has some out-migration compared to in-migration, while Miyagi had one of the highest net migration rates in Japan. In the years 2013 and 2014 there was discernible difference to other prefectures. Even Fukushima did not have the highest negative net migration rate anymore.

This shows that when discussing the changes between the Census of 2010 and the Census of 2015 in terms of migration dynamics, much of it happened closely to the natural catastrophe – perhaps in the subsequent year – but after that the impact was not as high anymore.

The plots in figure 13 showcase the yearly variation of migration in the municipalities based on the Report on Internal Migration. By municipalities, there was a high negative net migration of several affected municipalites in Fukushima prefecture, as well as in Iwate and Miyagi prefecture in 2011. However, municipalities of those three prefectures did not in general have the highest negative net migration rates from 2012 onwards. Notably the towns of Onagawa and Yamamoto in Miyagi prefecture had some of the highest negative net migration rates from 2012 to 2014, even though Miyagi prefecture in general had a net in-migration in those years.




SOURCE: Own calculation, based on Report on Internal Migration 2011, 2012, 2013 and 2014

FIGURE 13 Yearly out-migration rate 2011–2014

# 4. In depth view on Fukushima, Miyagi and Iwate

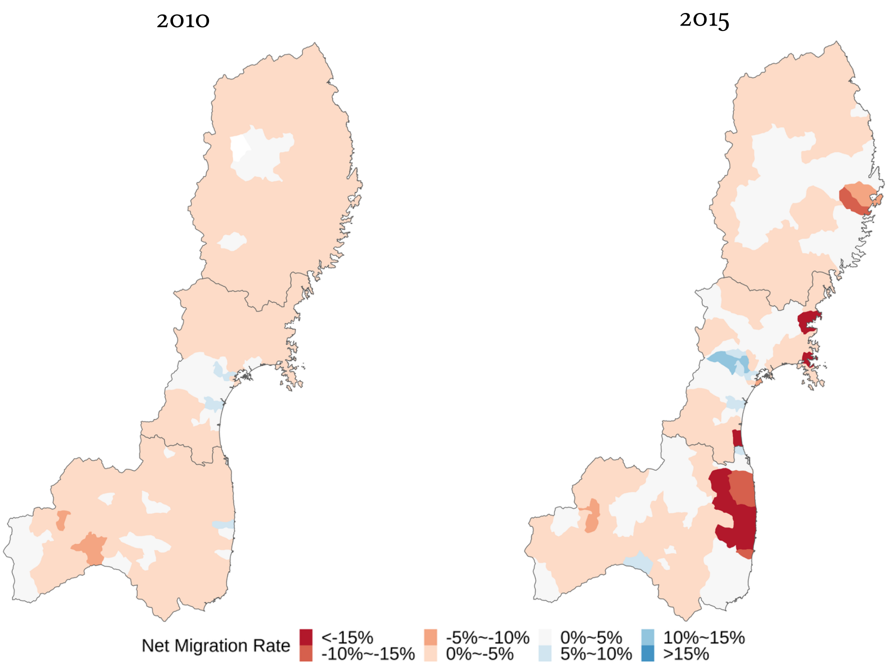
In the following sections I will take a closer look at the changing migration patterns within the most affected prefectures of Fukushima, Iwate and Miyagi. This part shall give an insight in how the catastrophe changed the structure within the prefectures, thus I will analyse the data on the level of the municipalities. In particular, the major emphasis will be put on the destination choice of the migrants, as well as the demographic structure of those migration flows.

As noted above, the data underlying this analysis is the Japanese census, which only introduced detailed information by age of the migration flows in the last census in 2015, therefore it limits the results in the analysis of the age of the migrants. However, the destination choices as well as the sex of the migrants between all municipalities are available for the last two census of 2010 and 2015.

In the literature review (Isoda 2011, Yamamura *et al.* 2014) a hypothesis was developed that especially women, with young children, would migrate further away in the face of danger. With the available migration data, an analysis can be conducted testing this hypothesis, which will be a substantial focus of the following sections. However, first I will describe the general structure of the migration flows and destination choices by migrants of the prefectures Fukushima, Iwate and Miyagi.

## 4.1. Changing in- and out-migration in Fukushima, Miyagi and Iwate

In the previous section I have given a brief glimpse at the changes between the census of 2010 and 2015 of the migrations in Japan. While prefecture-wise the three prefectures of Fukushima,



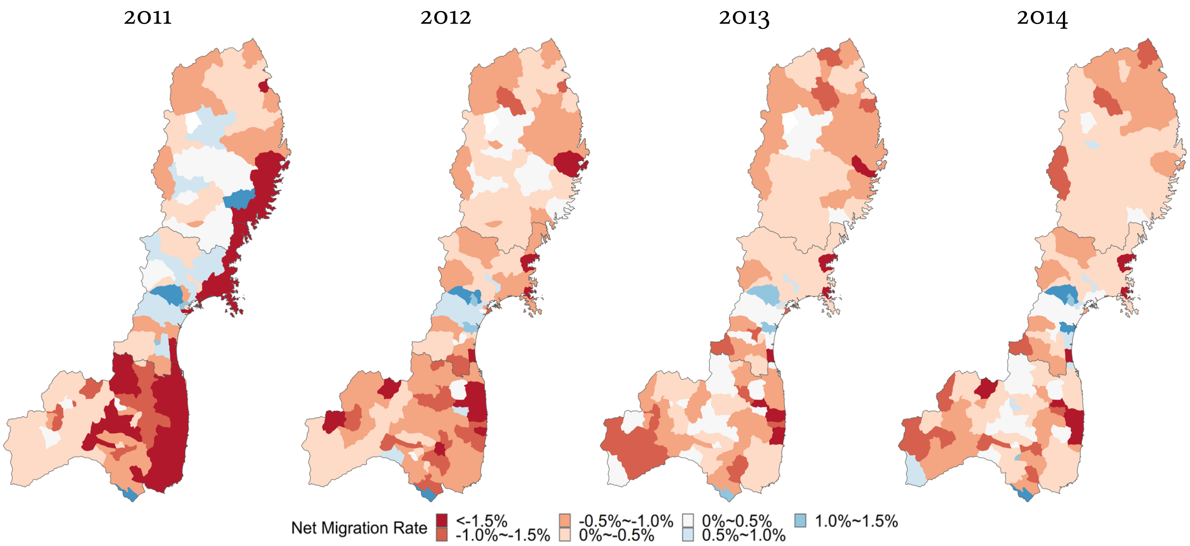

SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 14 Out-migration rate 2010 and 2015 of the prefectures Fukushima, Miyagi and Iwate

Iwate and Miyagi have been hit severly by increased out-migration, the picture within the prefectures is somewhat different.

As can be seen in figure 14, many of the municipalities close to the Fukushima nuclear power plant, as well as other coastal regions hit most severly by the tsunami have faced heightened out-migration in comparison to five years previously. It is prominent especially for the areas close to the nuclear power plant, since many of those were evacuated fully due to the nuclear risk.

However, a little bit further inland, the trend of out-migration of the previous census is somewhat reversed. Especially around Sendai, but also in many other municipalities, the in-migration increased and thus more of the municipalities have a net migration gain. It is entirely likely that this increase can be attributed to migrants and evacuees of the coastal regions close by, a point which will be further discussed below in the next section with the analysis of the destination choices.

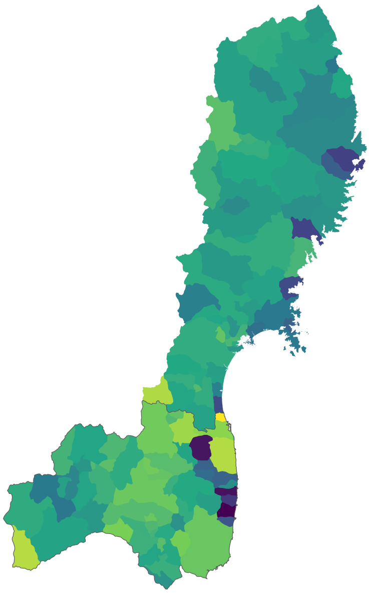



SOURCE: Own calculation, based on Report on Internal Migration 2011, 2012, 2013 and 2014

FIGURE 15 Yearly out-migration rate of Fukushima, Miyagi and Iwate 2011–2014

This shows that such disastrous events can also have rejuvenating effects to local communities, an idea which was also explored in Chen et al. (2014). Due to the influences of the migration after the event, some areas previously affected by a declining population might have an increased influx in younger generations and thus their demographic structure is changing, which allows for more development by a new productive work force. Nonetheless, the question if those disruptions will continue over the longer term still remains open.

Most of the out-migration is geographically closer to the catastrophic event, as can be seen from the *Report on Internal Migration* (see figure 15). But over the next couple of years, from 2011 to 2015, a significant reversal in many regions took place. In 2011 most of the coastal areas, as well as large parts of Fukushima prefecture, had a high out-migration rate. Additionally, the data of the *Report on Internal Migration* also shows the influx of migrants to Sendai and its surroundings over the years. It has to be noted that the calculation of the net migration rate for these years is not entirely perfect, as exact population data of the municipalities of



Source: Own calculations, based on Census of Japan 2010 and 2015

Figure 16 Change towards interprefectural migration. Lighter colour (yellow) means more interprefectural, darker (purple) means more intraprefectural migration

every year is not available. Thus the rate is calculated by the average of the population of each municipality between 2010 and 2015.

Hereafter the study will focus on more in-depth topics, such as the migration flows between the municipalities, as well as the demographic structures of those migration flows, seeking differences between different age groups and the sexes. Note that in the census of 2010 only male and female are given in the statistics, therefore this thesis will also only use the sex for the analysis for the year 2010, but not any age groups.

## 4.2. Changes in destination choice between the years of 2005–2010 and 2010–2015

The census holds data for the origin and destination of the migrants between those years. In the subsequent pages I will be scrutinizing the difference between the last two conducted census in terms of the migration behavior of the local population. Since several million origin–destination migration flows are possible, the study will concentrate on the major migration flows, and also observe them in two parts. There are the migration flows within each prefecture (here only the three mainly affected prefectures of Fukushima, Iwate, and Miyagi will be discussed) and then there are the migration flows of those three prefectures to other prefectures in Japan.

Additionally, to judge if any differences in migration flows only affect those three prefectures, the general migration trends will then be compared to the changing migration flows and patterns for all of Japan. Hence the affects of the natural disasters can be put better into context.

*Intraprefectural migration flows*

Whether most people migrate within the prefecture or migrate to a different prefecture might be largely determined by the structure of the prefecture they live in (e.g. attractive cities to migrate to, like Sendai). Hence some prefectures show a high level of interprefectural migration, while some have mostly intraprefectural migration. However, when comparing the population census of 2010 and 2015, the following observation is obtained: The three prefectures Fukushima, Iwate and Miyagi in Tōhoku all have the highest change towards interprefectural migration in 2015. This gives an indication that people in those prefectures might have increased the willingness to leave their prefecture due to the difficulties that arose with the natural disaster of 2010.

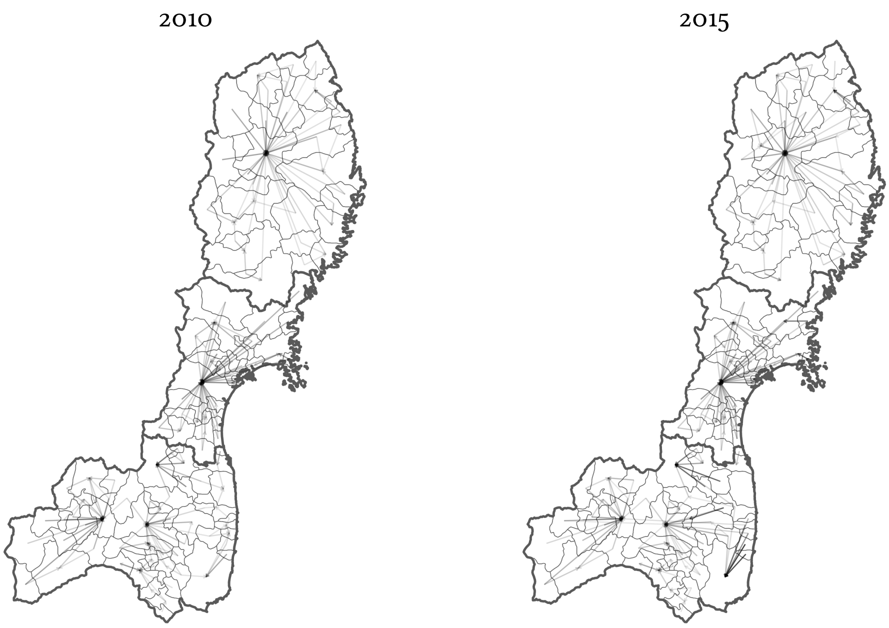
This point, however, applies to all of the migration from the outside and within the prefecture. Looking closer at the municipalities (see figure 16), it is clear, that the inhabitants of the affected municipalities along the coast and close to the Fukushima nuclear power plant actually migrated more within their prefectures. The increase in interprefectural migration thus came from other municipalities within the adjacent prefectures.

The migration within the prefectures Fukushima, Iwate and Miyagi remains similar between 2010 and 2015, with higher migration towards the population centres. This point is illustrated in figure 17.

*Interprefectural migration flows*

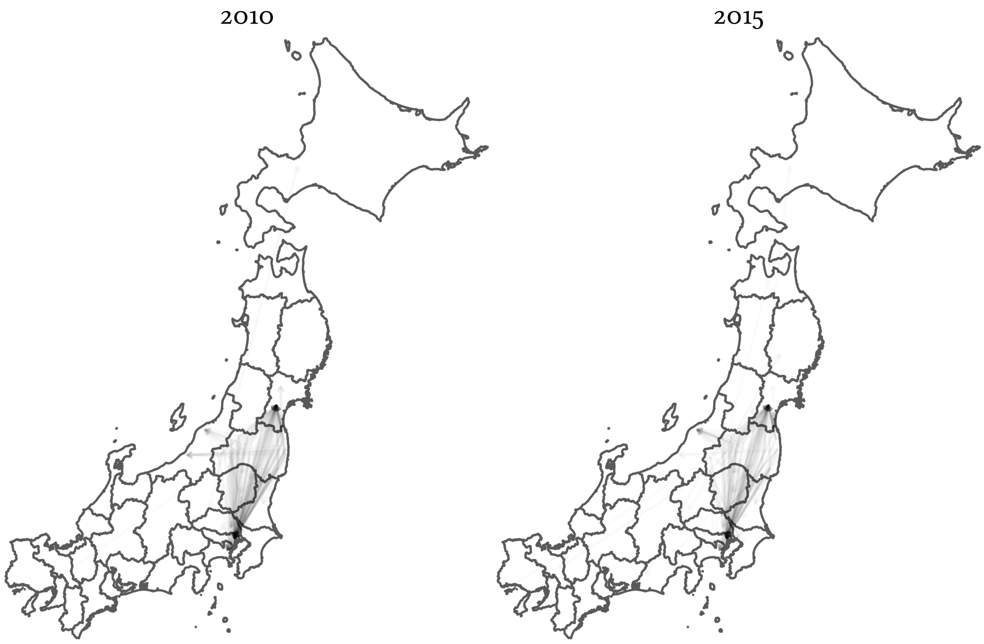
Looking at figure 18, it is evident that the main clusters of destination choices outside of the prefecture Fukushima remain the same, and are close to their origin. However, in 2015 the out-migration relatively increase to more destinations further away, and decreases to closer destinations.

Regardless, the pattern of the main destinations did not change between the time frames of 2005 to 2010 and 2010 to 2015 respectively. Still, the main destination choices remain the




Source: Own calculations, based on Census of Japan 2010 and 2015

Figure 17 Destination choices of migrants from Iwate, Miyagi and Fukushima prefecture within their respective prefecture, only major flows shown




SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 18 Destination choices of migrants from Fukushima prefecture, only major flows shown

same and large population centers bundle most of the regional migration. Moreover, this can be explained by the general increasing out-migration of the prefecture, thus the strength of the migration flows to several destinations is expected to increase.

In Iwate (figure 19) as well as in Miyagi (figure 20) the patterns of migration and the major migration flows in 2010 and 2015 largely remained largely unchanged. For residents of Iwate, the city Sendai in Miyagi prefecture is the main destination with Tōkyō being another, while the only main destination for residents of Miyagi outside of their prefecture is Tōkyō.

Hence the interprefectural migration of those three prefectures is shaped by the strong pull effect of the Kantō area, which gets most of the out-migration of Fukushima, Iwate and Miyagi. Additionally, the city of Sendai in Miyagi prefecture sees a high influx of migrants from Fukushima and Iwate.


SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 19 Destination choices of migrants from Iwate prefecture, only major flows shown


SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 20 Destination choices of migrants from Miyagi prefecture, only major flows shown

## 4.3. Differences between male and female migrants

One of the hypotheses posited in the literature was that women would migrate further away from potential risk than men (see Isoda 2011, Yamamura *et al.* 2014). Looking at the data from

Table 7 Average distance of total migration, based on ratio female/male avg. distance

| Prefecture | Male Migrants | Female Migrants | Avg. Distance Male (km) | Avg. Distance Female (km) | Ratio Female/Male Avg. Distance |
|---|---|---|---|---|---|
| Fukushima | 119,836 | 120,431 | 140.2 | 132.7 | 0.947 |
| Akita | 39,582 | 36,728 | 226.9 | 211.4 | 0.932 |
| Iwate | 64,355 | 61,189 | 191.8 | 174.6 | 0.910 |
| Ehime | 56,775 | 54,603 | 188.7 | 170.3 | 0.902 |
| Kagoshima | 89,418 | 86,742 | 286.4 | 256.0 | 0.894 |
| Miyagi | 129,372 | 119,655 | 194.8 | 169.2 | 0.869 |
| Tōkyō | 654,920 | 597,295 | 177.3 | 151.7 | 0.856 |
| Saga | 39,876 | 39,981 | 194.4 | 148.9 | 0.766 |

Source: Own calculations, based on Census of Japan 2015

the 2015 census, which gives all the pairs of migration between municipalities, the average distance of a migrant can be calculated. Although this is not entirely accurate, as for the distance calculations, the centroid of the administrative boundaries of a municipality is used, and also the straight distance (i.e. the great-circle distance, so actual roads and railways are not considered) is used. However, this error applies to all calculations the same, and the choice of the centroid of each municipality for the distance calculations should even out the error. Additionally, it is expected that due to the geographical shape of Japan, those living in the outskirts of Japan would migrate longer distances than those living closer to the metropolitan centers. Since the data does not contain the actual geographic spread of the population and the migrants in their respective municipality, the approximation is the only way to gauge the migration distances.

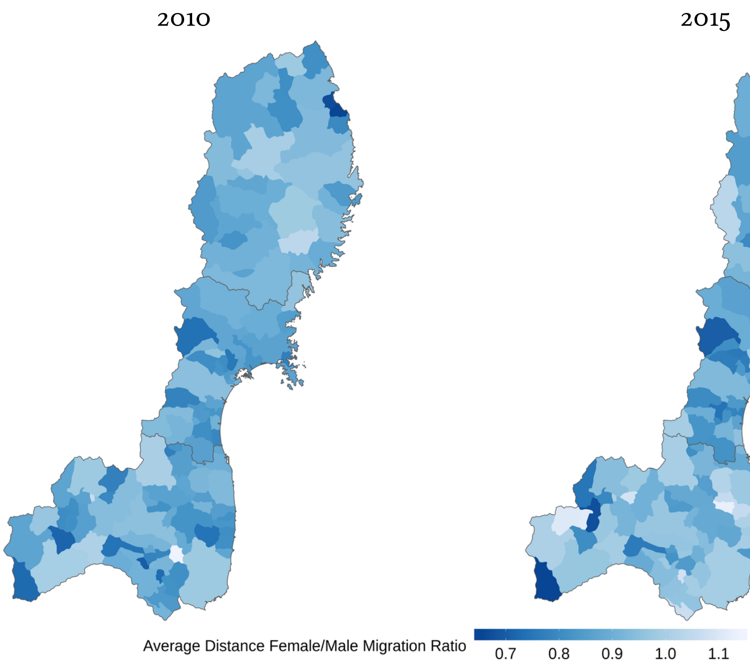
Looking at the data on a prefecture level, the hypothesis that women would migrate further away from potential risk than men is found not to be entirely true. This analysis only consider the interprefectural migration flows but failed to observe the migrations within the prefecture.

In all prefectures, the men migrated a higher average distance than women. A selection of the data by prefectures is given in table 7. Examining the data closer, there is a clear variation in the results. For example, the ratio of average female migration distance to the average male migration distance highest in Fukushima prefecture. The same holds true for Iwate prefecture, which has the third highest ratio within Japan. Only the prefecture Akita lies in between, and all of those prefectures have a ratio higher than 90%. In comparison, Miyagi does not have such high levels, having the fifteenth highest ratio among the prefectures of Japan. As shown above, Miyagi has not been affected as badly as Fukushima and Iwate in terms of out-migration, thus the difference is to be expected.

In terms of average distance by migrant, due to the relatively large distance to major population centres in mainland Japan, the northern and southern prefectures have naturally the longest distances. Those include the prefectures in the north: Hokkaidō, Aomori and Akita, as well as the their counterparts in the south: Okinawa, Kagoshima and Miyazaki.

Another point of note is that the people in the prefectures affected by the catastrophe do not have a considerably higher average distance migrated than those which were not affected. For instance, Fukushima has one of the lowest average distances in Tōhoku, only about the same as Yamagata. This is partly expected, because those are the southernmost prefectures of Tōhoku. However, the comparison with Yamagata shows that the people of Fukushima did not considerably migrate further away than without the disaster.

At the municipality level, the affected areas close in the three coastal prefectures of Tōhoku do not have higher levels than other municipalities within Japan. Notably, since the municipalities are smaller and less people migrate, there are significantly higher variance in the migration numbers. As illustrated in figure 21, the municipalities especially around the Fukushima




SOURCE: Own calculations, based on Census of Japan 2015

FIGURE 21 Average distance of migration, female/male ratio

nuclear power plant have a higher female/male ratio in migration distance than those municipalities further inland. But in the prefectures of Miyagi and Iwate, there is no clear difference between the coastal municipalities affected by the tsunami and those further inland. The ratio means that if it is above 1, women migrate longer distances than men, and if it is below it is the other way around.

As in the previous section, the migration destinations of the Fukushima emigrants are visualised in figure 22. However, in these figures only those migration flows are shown that are least 55% dominated by a given sex, i.e. the specific migration flow has at least 55% of either male or female migrants, and less than 45% for the other sex.

In general, males show a higher migration activity in 2010, but they do not dominate the migration flows as much in 2015. Women's migration flows cluster more either to close major destinations, or to the the Tōkyō area. However, there is no distinct difference in terms of destination choice in 2010 and 2015 for either sex. Some close bigger cities in nearby prefectures have an increased influx of migrants, like Niigata or Yokohama. Nonetheless, most migrants stay within their Fukushima prefecture. Besides Tōkyō also Sendai is a major destination of migration. For men it appears they are migrating shorter distances and more so stay within Fukushima prefecture.

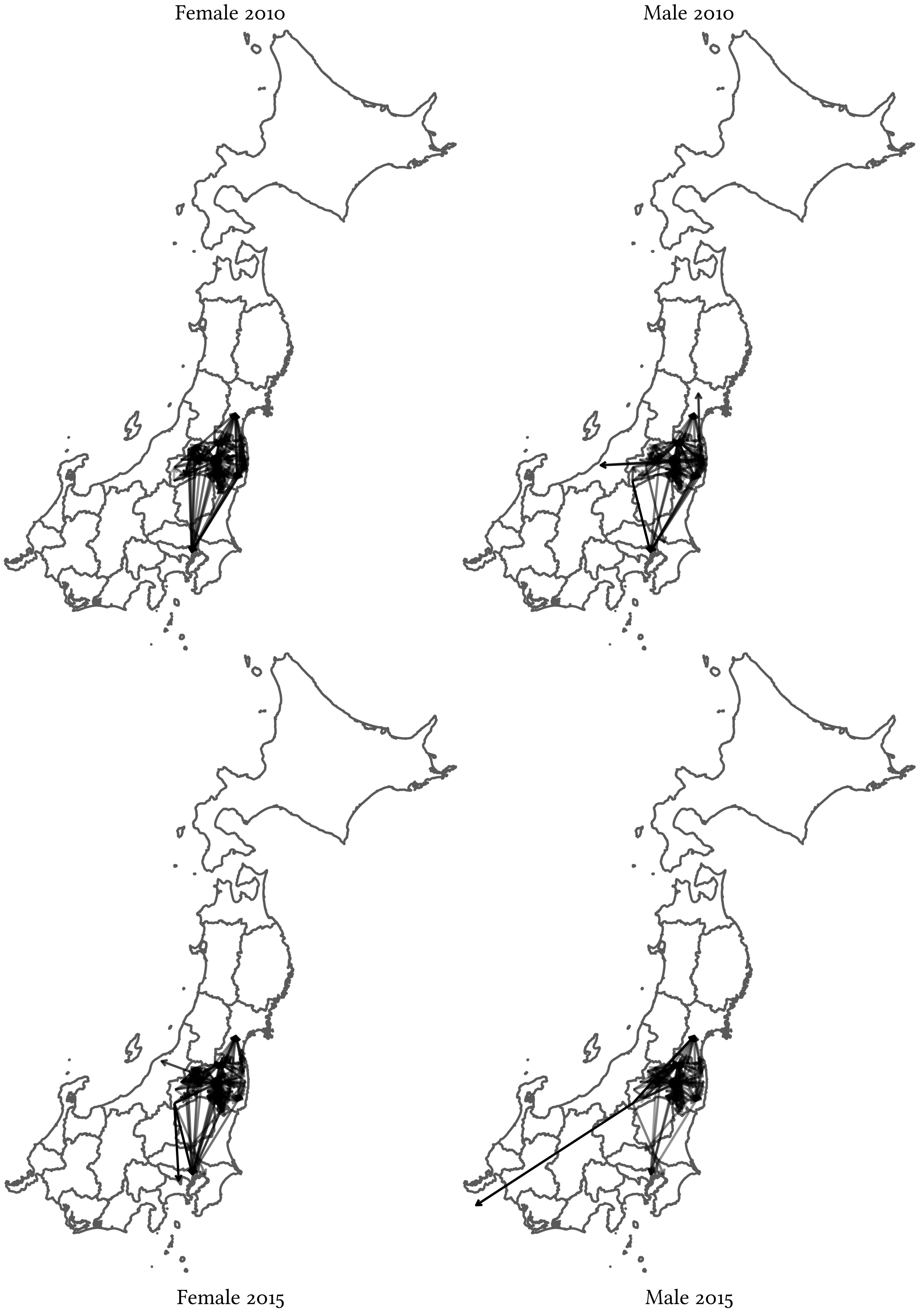
The situation in Iwate prefecture is similar, as is shown in figure 23. Unlike in Fukushima prefecture, the pattern for both sexes in Iwate is quite the same. In contrast, migration increases within the prefecture, while destinations outside of the prefecture are less popular. A major destination for residents of Iwate prefecture is also the city Sendai in Miyagi.

Lastly, the situation in Miyagi prefecture is visualised in figure 24. Major migration patterns for either sex remains the same over the last two censuses. Most migrants stay within Miyagi prefecture, as Tōkyō is the major destination outside the prefecture.

However, looking at the average migration distances of the migrants, it can be seen that in Fukushima prefecture the ratio of male to female in terms of migration distance has changed the most (see table 8). The table summarises the average migration distance in each prefecture and for each sex. The last column holds a comparison of the changes in average migration distance between men and women. This ratio is calculated for both years, and then the difference between the ratio of 2015 and 2010 is taken. This means that women migrated further away in Fukushima then in any other prefecture, in contrast to the men and to the data of 2010.

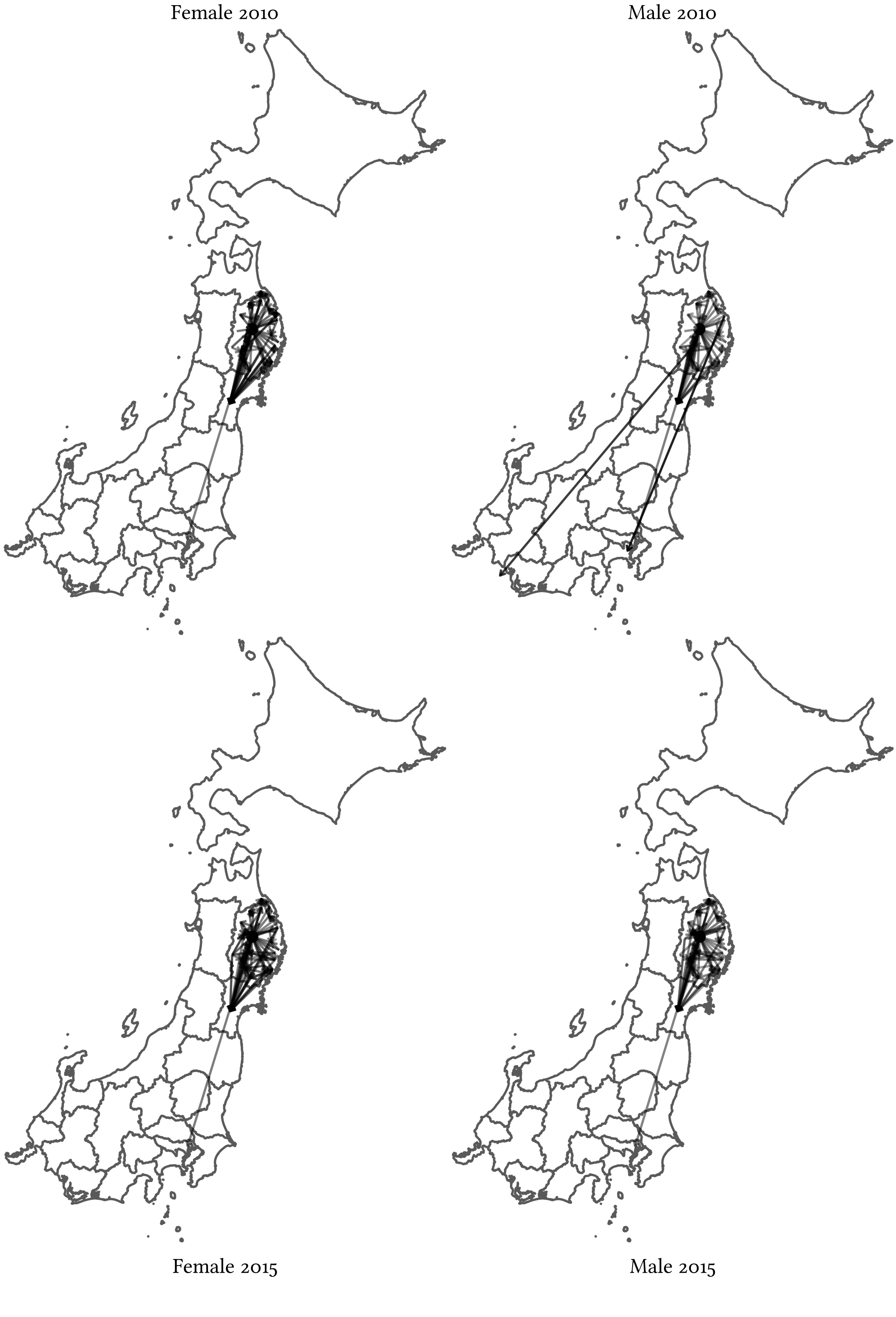
This change is amplified by another reason. On average, men in Fukushima prefecture migrated shorter distances between 2010 and 2015 than between 2005 and 2010. Also in Iwate and Miyagi the male to female ratio shifted in the same direction, however less so than in Fukushima. Additionally, both men and women migrated less in the last census than in the previous one in Iwate and Miyagi. This means that the majority of migrations were shorter distance, therefore it can be explained that most of the additional migrants after the disaster stayed closer to their origin.

This descriptive analysis gives some indications about the migration behaviour between women and men. In general, men nonetheless migrate longer distances, but it appears that in Fukushima prefecture, especially closer to the Fukushima nuclear power plant, women increased their average migration distance. This gives some slight support to the aforementioned hypothesis that women tend to migrate further in case of threat of radiation. This needs some further study, as the data does not contain a differentation of women with and without children, and the ages of those children (Isoda 2011, Yamamura *et al.* 2014).



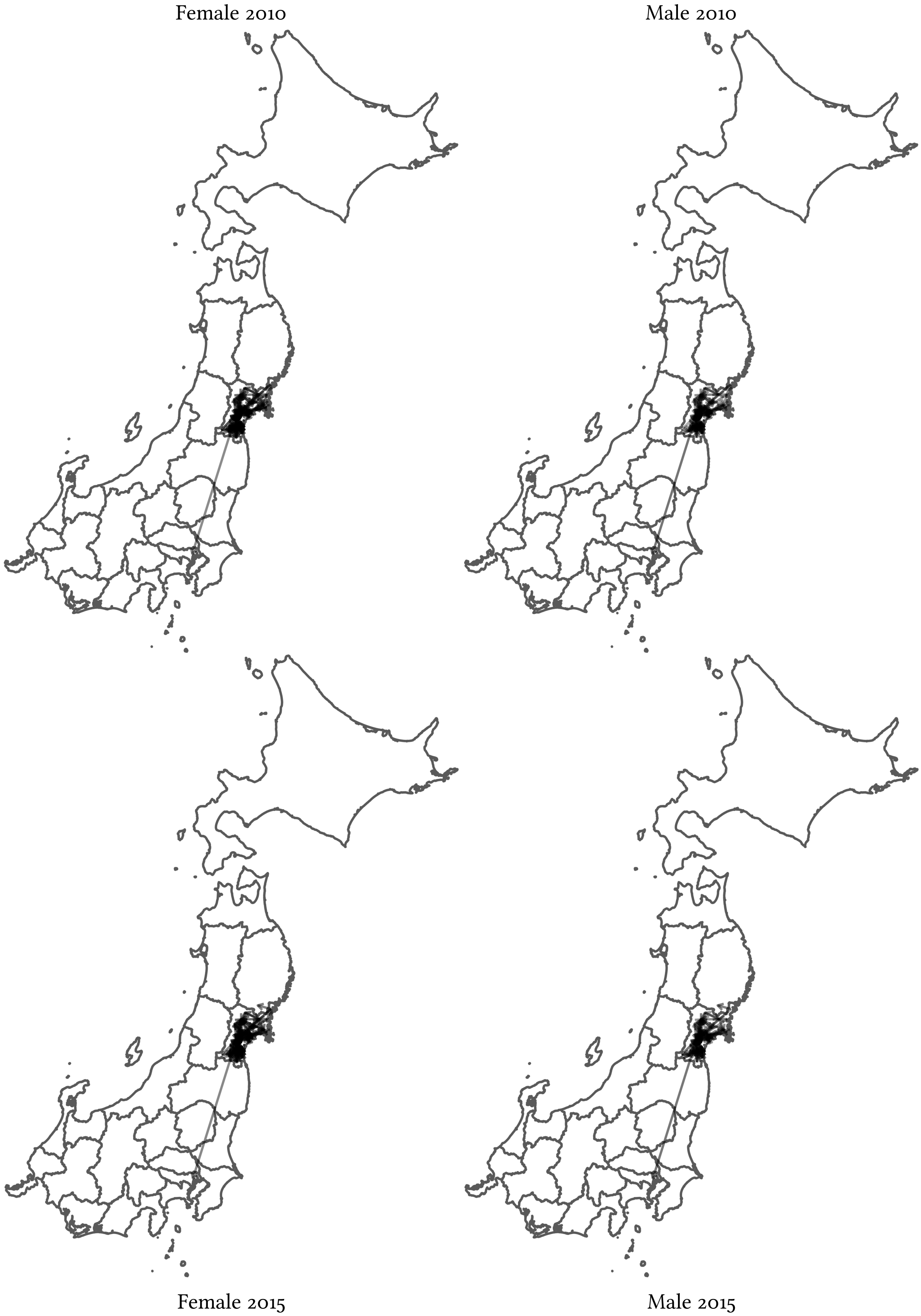

SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 22 Destination choices of female and male migrants from Fukushima prefecture, only major flows shown




Source: Own calculations, based on Census of Japan 2010 and 2015

Figure 23 Destination choices of female and male migrants from Iwate prefecture, only major flows shown



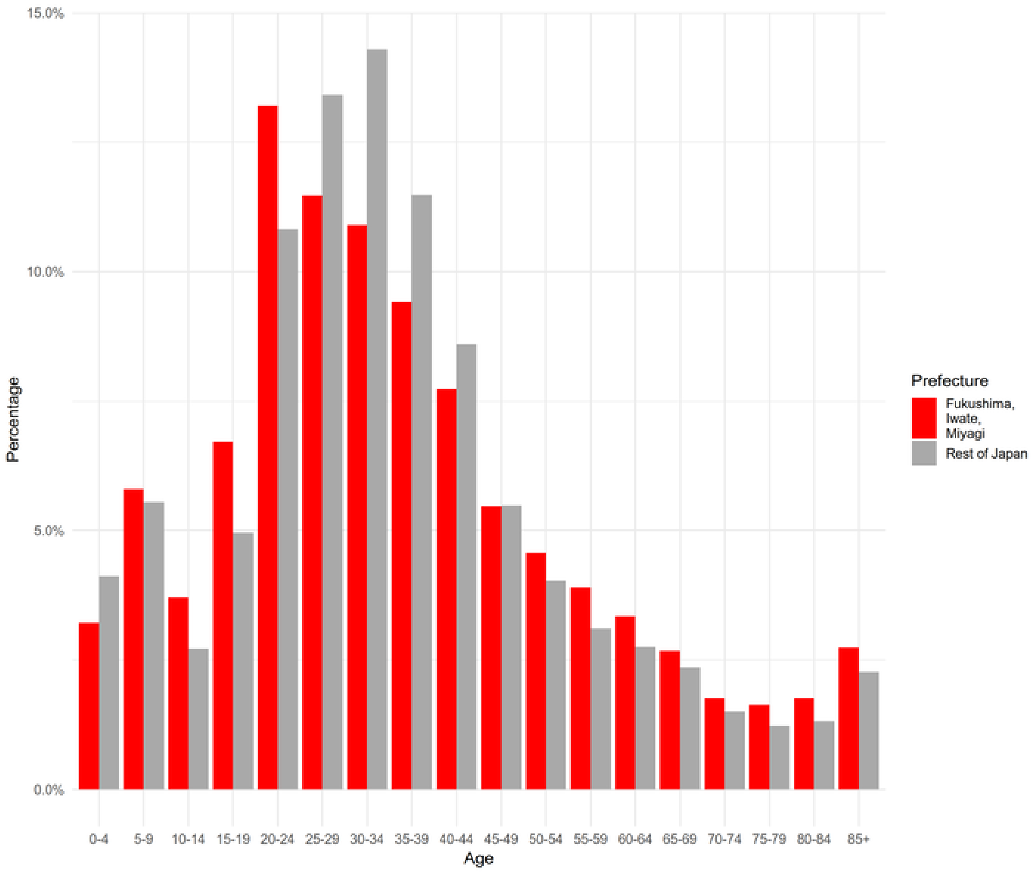

SOURCE: Own calculations, based on Census of Japan 2010 and 2015

FIGURE 24 Destination choices of female and male migrants from Miyagi prefecture, only major flows shown

Table 8 Changes in average migration distance between 2010 and 2015

| Prefecture | Average distance change (km) | | | Male to Female ratio change |
|---|---|---|---|---|
| | Total | Male | Female | in percentage points |
| Fukushima | 0.30 | −4.34 | 5.63 | 6.74% |
| Toyama | −4.74 | −8.05 | −1.45 | 3.68% |
| Akita | −3.62 | −7.69 | 0.81 | 3.40% |
| Kumamoto | −8.69 | −13.56 | −3.93 | 3.01% |
| Yamagata | −4.87 | −7.29 | −2.31 | 2.62% |
| Iwate | −19.72 | −22.57 | −16.25 | 2.00% |
| Hokkaido | −6.24 | −9.26 | −2.69 | 1.68% |
| Miyazaki | −8.12 | −10.80 | −5.35 | 1.58% |
| Kagoshima | −12.13 | −15.01 | −9.06 | 1.44% |
| Aomori | −6.89 | −9.30 | −4.24 | 1.30% |
| Tochigi | 3.12 | 2.65 | 3.68 | 1.21% |
| Miyagi | −6.87 | −8.30 | −4.83 | 1.17% |
| Tokyo | 16.22 | 16.56 | 15.97 | 1.12% |
| Saga | −10.80 | −13.03 | −8.57 | 0.68% |
| Okinawa | 6.32 | 5.14 | 7.09 | 0.54% |
| Gunma | 2.49 | 2.55 | 2.38 | 0.33% |
| Chiba | 8.81 | 9.55 | 8.11 | 0.29% |
| Aichi | −0.59 | −0.66 | −0.40 | 0.12% |
| Kanagawa | 9.42 | 10.36 | 8.55 | 0.04% |
| Kagawa | −2.58 | −2.63 | −2.49 | −0.13% |
| Yamaguchi | −6.09 | −6.16 | −5.78 | −0.17% |
| Ibaraki | 6.00 | 6.71 | 5.02 | −0.22% |
| Naoasaki | −8.21 | −8.24 | −8.13 | −0.48% |
| Niigata | −1.37 | −1.05 | −1.74 | −0.50% |
| Hiroshima | −3.49 | −2.92 | −4.14 | −0.72% |
| Nagano | −1.4 | −0.99 | −1.77 | −0.78% |
| Fukuoka | −6.62 | −5.89 | −7.23 | −0.92% |
| Oita | −0.51 | 0.48 | −1.56 | −0.96% |
| Ehime | 3.36 | 4.58 | 2.22 | −1.04% |
| Fukui | 1.11 | 1.85 | −0.02 | −1.14% |
| Mie | 2.24 | 3.29 | 1.17 | −1.22% |
| Ishikawa | −11.26 | −11.12 | −11.45 | −1.24% |
| Wakayama | 1.92 | 3.07 | 0.94 | −1.27% |
| Okayama | −0.55 | 0.57 | −1.59 | −1.27% |
| Saitama | 8.85 | 10.65 | 6.90 | −1.43% |
| Gifu | 1.44 | 2.36 | 0.55 | −1.46% |
| Shizuoka | 3.98 | 5.26 | 2.53 | −1.46% |
| Shiga | 1.13 | 2.22 | −0.04 | −1.48% |
| Kochi | −7.74 | −6.49 | −8.93 | −1.80% |
| Nara | 0.78 | 2.11 | −0.39 | −1.91% |
| Tokushima | −3.32 | −2.13 | −4.41 | −1.99% |
| Kyoto | 3.52 | 5.33 | 1.44 | −2.00% |
| Hyōgo | 2.23 | 4.18 | 0.17 | −2.21% |
| Osaka | 5.95 | 8.23 | 3.500 | −2.44% |
| Shimane | −5.09 | −1.66 | −9.05 | −4.03% |
| Tottori | −1.72 | 2.04 | −5.56 | −4.11% |
| Yamanashi | 8.05 | 11.64 | 4.40 | −5.01% |

Source: Own calculations, based on Census of Japan 2010 and 2015




SOURCE: Own calculations, based on Census of Japan 2015

FIGURE 25 Percentage of out-migrants by 5-year age groups, 2015

## 4.4. Variation in migration by age

The literature has shown a particular curve of the age of migrants. In general, most migrants are people in working age, between the ages of twenty and fifty. The same holds true for Japan in the most recent census, however, as is shown in figure 25, there is a slight difference in the age structure of the migrants of Fukushima, Iwate and Miyagi to the rest of Japan. In relation to the absolute amount of migrants, the younger people as well as the older people are a larger part of the migrants in those three prefectures.

This perhaps shows that facing a natural disaster, people in the main working age are bound more to their homes than those younger and older, given them relatively more migration flexibility. The major working force might be bound to their place of living due to economic necessity and therefore the desire to uphold ones current place of work. While those younger could change their place of education perhaps more easily, and those older at least relocate temporarily without fear of losing their economic means.

Nonetheless, looking at the various age groups and genders specifically, there is no clear difference between the affected prefectures and the other prefectures. So no particular age group, for example in Fukushima, migrates further than the average in Japan. Only those in their thirties migrate slightly further in relation to other age groups in Fukushima and in comparison to all other prefectures. Those migration behaviours exist for both men and women in a similar fashion. Additionally, Iwate and Miyagi are not out of the ordinary as well (see table 10, table 11 and table 12).

On the contrary, Fukushima prefecture exhibits small differences compared to Iwate and Miyagi. While men in general still migrate further distances, the difference is the smallest of all prefectures between men and women in the working age. Specifically, for women between the ages of twenty and forty-four has the slightest difference of all prefectures, while for women between forty-five and sixty-four the second smallest. For young people under twenty and those over sixty-five, Fukushima prefecture does not have any specific greater difference than among other prefectures. Once again, in Iwate and Miyagi, such a phenomenon can not be observed. Since many municipalities are rather small, there is a bigger variation between the age groups in each municipality, thus no clear comparison can be made.

Table 9 gives a ratio of average migration distance of the migrants from Fukushima in comparison to the average migration distance of the migrants of Aomori, Iwate, Miyagi, Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata, as well as the average migration distance of the migrants from Iwate and Miyagi, against the average of Aomori, Fukushima, Miyagi,

Table 9 Ratio of average migration distance per age group and sex, Fukushima relative to surrounding prefectures

| | Fukushima | | Iwate | | Miyagi | |
|---|---|---|---|---|---|---|
| Age group | Male | Female | Male | Female | Male | Female |
| 0–19 | 106.65% | 112.95% | 112.25% | 112.10% | 172.73% | 175.51% |
| 20–44 | 73.95% | 86.13% | 111.04% | 117.81% | 193.79% | 193.15% |
| 45–64 | 91.84% | 135.10% | 98.03% | 106.65% | 217.29% | 211.05% |
| 65+ | 173.42% | 178.80% | 109.76% | 129.72% | 164.71% | 169.14% |

Source: Own calculations, based on Census of Japan 2015

Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata, respectively Aomori, Iwate, Fukushima, Akita, Yamagata, Ibaraki, Tochigi, Gunma and Niigata. It can be seen that in Fukushima prefecture there is a clear difference in average migration distance between men and women, but also that young adults migrate relatively shorter distances. Furthermore, people from Miyagi prefecture migrate on average larger distances than migrants from other prefectures in the area.

Based on those analysis results, it cannot be confirmed that women in the face of danger would significantly migrate further away than men, especially those that would have younger children. However, this comes with the caveat that the census does not tabulate women with children and without separately, so such an effect could be offset by a reverse behaviour by women without children.

Table 10 Migration distance per age group relative to average migration distance in the prefecture, total

| Prefecture | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hokkaidō | 94.47% | 97.08% | 104.50% | 92.83% | 114.93% | 114.40% | 102.50% | 101.39% | 104.06% | 109.02% | 98.85% | 91.79% | 78.82% | 82.26% | 74.51% | 68.07% | 61.07% | 49.17% |
| Aomori | 89.85% | 89.89% | 100.59% | 107.86% | 126.74% | 100.94% | 89.17% | 91.79% | 98.64% | 106.90% | 99.60% | 93.21% | 87.87% | 88.97% | 83.35% | 64.79% | 56.35% | 41.69% |
| Iwate | 79.64% | 83.54% | 97.19% | 112.98% | 135.05% | 102.03% | 84.78% | 87.02% | 95.30% | 103.63% | 96.24% | 87.62% | 89.63% | 87.07% | 87.20% | 76.10% | 73.88% | 64.60% |
| Miyagi | 90.48% | 100.90% | 119.37% | 106.87% | 110.96% | 103.85% | 90.70% | 95.74% | 112.29% | 121.87% | 112.45% | 101.55% | 83.49% | 75.38% | 67.38% | 62.74% | 56.92% | 48.30% |
| Akita | 80.77% | 84.63% | 96.74% | 114.59% | 126.80% | 104.12% | 84.37% | 83.30% | 89.35% | 98.95% | 97.30% | 90.68% | 90.37% | 90.85% | 96.92% | 83.90% | 79.93% | 64.07% |
| Yamagata | 83.29% | 87.40% | 107.40% | 118.61% | 132.94% | 97.19% | 77.92% | 85.50% | 95.51% | 110.63% | 101.72% | 94.34% | 94.25% | 92.00% | 85.53% | 74.88% | 61.26% | 50.67% |
| Fukushima | 82.17% | 112.07% | 118.23% | 113.47% | 114.78% | 91.64% | 96.86% | 103.48% | 110.27% | 111.98% | 98.70% | 88.00% | 84.05% | 87.42% | 83.40% | 75.92% | 64.65% | 64.25% |
| Ibaraki | 88.57% | 104.32% | 136.49% | 112.18% | 104.33% | 90.78% | 84.06% | 91.84% | 107.28% | 123.99% | 127.33% | 123.26% | 130.60% | 114.92% | 86.72% | 68.52% | 58.25% | 43.12% |
| Tochigi | 89.70% | 104.42% | 137.82% | 114.63% | 103.01% | 86.24% | 84.29% | 92.12% | 109.73% | 124.46% | 125.76% | 134.14% | 115.66% | 115.76% | 79.58% | 79.84% | 60.49% | 46.57% |
| Gunma | 83.88% | 94.33% | 129.55% | 125.99% | 119.97% | 91.63% | 82.32% | 88.60% | 104.43% | 124.15% | 125.25% | 119.63% | 126.26% | 101.46% | 78.20% | 64.69% | 55.47% | 38.73% |
| Saitama | 98.55% | 118.47% | 150.66% | 111.12% | 97.89% | 88.76% | 82.80% | 88.33% | 104.82% | 122.12% | 126.67% | 134.09% | 141.02% | 121.62% | 89.09% | 65.62% | 53.51% | 42.86% |
| Chiba | 101.91% | 124.36% | 155.73% | 102.96% | 85.87% | 85.65% | 80.37% | 89.07% | 110.28% | 124.53% | 125.07% | 133.19% | 144.67% | 122.77% | 86.40% | 69.71% | 57.63% | 45.33% |
| Tōkyō | 103.11% | 121.26% | 137.31% | 101.66% | 92.97% | 97.35% | 90.14% | 93.72% | 105.85% | 117.55% | 119.97% | 121.03% | 126.54% | 107.30% | 81.05% | 64.74% | 53.69% | 42.13% |
| Kanagawa | 100.59% | 118.55% | 144.28% | 106.90% | 94.36% | 91.79% | 82.28% | 87.29% | 102.13% | 115.80% | 123.27% | 131.96% | 142.82% | 123.94% | 96.34% | 75.81% | 61.71% | 48.02% |
| Niigata | 87.30% | 96.90% | 118.88% | 111.84% | 114.13% | 93.67% | 84.15% | 88.36% | 105.67% | 117.79% | 114.73% | 109.55% | 104.50% | 99.07% | 93.79% | 75.60% | 71.50% | 56.12% |
| Toyama | 84.92% | 95.40% | 120.35% | 123.08% | 128.07% | 89.97% | 80.43% | 82.03% | 96.65% | 121.04% | 119.37% | 114.73% | 109.36% | 88.80% | 81.36% | 74.16% | 56.65% | 49.80% |
| Ishikawa | 88.25% | 98.84% | 131.79% | 115.19% | 119.33% | 100.12% | 80.60% | 88.89% | 103.43% | 121.59% | 117.96% | 108.48% | 105.95% | 84.86% | 71.65% | 61.82% | 58.10% | 46.22% |
| Fukui | 85.22% | 87.20% | 115.36% | 118.44% | 123.65% | 94.28% | 79.08% | 86.64% | 105.89% | 120.31% | 119.85% | 120.61% | 113.47% | 104.14% | 79.43% | 64.13% | 55.42% | 43.68% |
| Yamanashi | 82.65% | 93.23% | 120.62% | 115.02% | 115.54% | 103.23% | 83.79% | 86.66% | 105.69% | 121.03% | 128.51% | 123.36% | 118.74% | 100.70% | 85.68% | 70.63% | 52.12% | 37.98% |
| Nagano | 82.89% | 92.87% | 108.74% | 121.61% | 127.02% | 95.25% | 85.21% | 88.37% | 98.28% | 111.69% | 110.26% | 110.51% | 105.96% | 102.64% | 85.99% | 65.52% | 54.66% | 41.01% |
| Gifu | 84.54% | 86.89% | 125.96% | 133.39% | 131.19% | 92.23% | 80.33% | 85.96% | 101.59% | 119.61% | 122.46% | 113.70% | 113.36% | 106.10% | 94.69% | 74.41% | 57.85% | 49.49% |
| Shizuoka | 91.22% | 106.17% | 127.71% | 115.30% | 111.68% | 86.39% | 84.94% | 92.85% | 106.03% | 116.47% | 117.28% | 113.94% | 116.47% | 105.26% | 82.10% | 71.46% | 62.43% | 48.61% |
| Aichi | 86.28% | 98.05% | 136.15% | 126.52% | 116.86% | 88.87% | 81.09% | 86.05% | 105.38% | 127.26% | 131.52% | 134.62% | 142.65% | 124.24% | 93.13% | 73.22% | 60.12% | 45.57% |
| Mie | 91.91% | 107.12% | 130.97% | 112.53% | 108.87% | 87.78% | 87.25% | 95.37% | 108.09% | 121.67% | 119.08% | 121.67% | 120.93% | 105.28% | 84.83% | 75.45% | 57.94% | 48.05% |
| Shiga | 87.03% | 88.91% | 126.38% | 114.03% | 117.43% | 106.71% | 80.17% | 87.09% | 101.27% | 115.76% | 125.08% | 122.32% | 123.34% | 116.13% | 84.66% | 73.56% | 63.76% | 51.10% |
| Kyōto | 88.27% | 93.40% | 105.82% | 96.80% | 117.73% | 121.75% | 91.04% | 89.46% | 96.63% | 105.52% | 104.41% | 101.40% | 97.50% | 90.14% | 74.72% | 63.30% | 58.41% | 47.02% |
| Ōsaka | 94.52% | 100.21% | 128.65% | 117.23% | 119.37% | 106.04% | 90.06% | 89.48% | 103.66% | 118.14% | 114.93% | 115.00% | 108.17% | 91.10% | 73.62% | 63.39% | 55.93% | 47.80% |
| Hyōgo | 92.25% | 100.57% | 127.93% | 108.79% | 113.34% | 98.75% | 84.06% | 90.53% | 106.62% | 123.30% | 126.26% | 117.24% | 108.95% | 94.88% | 77.41% | 67.98% | 62.07% | 55.34% |
| Nara | 81.74% | 90.46% | 114.18% | 117.90% | 140.35% | 117.25% | 84.19% | 82.43% | 99.28% | 114.12% | 120.58% | 108.97% | 107.90% | 99.35% | 78.87% | 66.56% | 50.49% | 40.28% |
| Wakayama | 85.35% | 90.29% | 113.62% | 119.73% | 133.64% | 98.32% | 84.73% | 86.30% | 103.02% | 111.85% | 114.09% | 99.64% | 101.61% | 94.19% | 79.89% | 72.59% | 57.47% | 45.22% |
| Tottori | 85.31% | 87.70% | 98.00% | 107.03% | 123.68% | 105.49% | 90.84% | 88.96% | 101.32% | 116.79% | 106.05% | 96.95% | 84.81% | 95.14% | 86.19% | 67.37% | 53.18% | 43.07% |
| Shimane | 86.20% | 87.26% | 94.93% | 96.25% | 120.82% | 103.91% | 90.00% | 92.43% | 97.85% | 111.85% | 97.82% | 92.69% | 95.08% | 102.73% | 96.37% | 96.52% | 85.07% | 72.10% |
| Okayama | 87.87% | 91.81% | 110.34% | 102.28% | 115.43% | 100.48% | 88.12% | 93.38% | 105.85% | 126.20% | 128.89% | 116.97% | 97.54% | 90.01% | 85.13% | 73.81% | 62.55% | 49.13% |
| Hiroshima | 89.50% | 96.53% | 119.03% | 98.42% | 111.71% | 96.16% | 90.03% | 97.65% | 109.67% | 122.85% | 121.05% | 111.41% | 88.29% | 77.45% | 76.23% | 70.05% | 64.34% | 51.31% |
| Yamaguchi | 83.64% | 89.93% | 108.03% | 103.24% | 121.95% | 106.56% | 88.66% | 88.71% | 97.72% | 115.06% | 105.85% | 98.30% | 86.26% | 90.17% | 84.98% | 88.11% | 73.58% | 65.27% |
| Tokushima | 88.34% | 88.61% | 120.85% | 115.43% | 131.35% | 108.57% | 83.08% | 87.69% | 102.29% | 123.95% | 112.72% | 101.94% | 84.02% | 79.79% | 65.99% | 56.68% | 52.76% | 37.81% |
| Kagawa | 87.11% | 96.16% | 122.51% | 112.39% | 122.86% | 91.79% | 85.46% | 89.10% | 107.12% | 124.02% | 118.77% | 112.44% | 91.66% | 79.46% | 72.10% | 64.47% | 58.10% | 43.89% |
| Ehime | 81.99% | 84.63% | 104.57% | 111.46% | 122.85% | 98.88% | 89.18% | 90.18% | 98.07% | 111.07% | 106.35% | 98.43% | 87.20% | 86.05% | 82.15% | 85.62% | 81.95% | 70.90% |
| Kōchi | 76.72% | 83.61% | 95.12% | 110.07% | 147.09% | 110.71% | 86.18% | 86.89% | 95.98% | 104.50% | 93.45% | 89.50% | 80.26% | 86.59% | 81.55% | 60.14% | 56.70% | 45.80% |
| Fukuoka | 87.32% | 89.90% | 114.48% | 110.86% | 129.55% | 110.33% | 89.24% | 91.26% | 108.56% | 125.59% | 116.84% | 98.71% | 71.92% | 63.79% | 58.73% | 55.22% | 53.74% | 40.84% |
| Saga | 77.58% | 73.52% | 89.71% | 126.89% | 154.75% | 101.17% | 83.12% | 83.15% | 96.11% | 106.16% | 104.56% | 93.71% | 77.56% | 67.62% | 67.78% | 57.60% | 58.11% | 44.48% |
| Nagasaki | 82.30% | 80.94% | 89.35% | 108.04% | 135.88% | 104.36% | 92.20% | 89.71% | 92.95% | 97.55% | 95.68% | 91.55% | 76.86% | 89.42% | 86.97% | 89.77% | 80.41% | 59.99% |
| Kumamoto | 80.73% | 81.29% | 94.43% | 112.17% | 148.64% | 101.84% | 84.55% | 88.14% | 99.90% | 110.22% | 110.81% | 92.07% | 74.46% | 71.16% | 77.62% | 69.66% | 59.92% | 47.50% |
| Ōita | 87.65% | 87.77% | 99.06% | 105.83% | 124.19% | 105.80% | 91.89% | 91.30% | 96.94% | 113.32% | 106.81% | 98.55% | 86.73% | 76.96% | 81.65% | 83.58% | 69.58% | 58.49% |
| Miyazaki | 80.49% | 81.24% | 88.16% | 113.79% | 141.62% | 101.34% | 87.45% | 87.87% | 95.25% | 103.41% | 89.79% | 84.49% | 80.30% | 82.68% | 79.51% | 86.60% | 71.50% | 49.79% |
| Kagoshima | 80.73% | 83.66% | 89.55% | 109.61% | 141.13% | 98.10% | 87.96% | 88.51% | 96.54% | 100.26% | 90.60% | 83.22% | 81.98% | 87.55% | 104.83% | 94.91% | 89.65% | 80.45% |
| Okinawa | 86.36% | 83.12% | 99.73% | 138.51% | 174.03% | 99.77% | 86.70% | 91.41% | 95.01% | 99.42% | 95.27% | 79.49% | 67.57% | 57.64% | 50.92% | 33.13% | 26.79% | 20.28% |

Source: Own calculations, based on Census of Japan 2015

Table 11 Migration distance per age group relative to average migration distance in the prefecture, male

| Prefecture | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hokkaidō | 88.37% | 91.89% | 99.96% | 87.47% | 117.22% | 120.09% | 102.05% | 97.50% | 99.68% | 107.92% | 98.15% | 90.77% | 78.19% | 80.83% | 70.35% | 65.53% | 57.49% | 47.52% |
| Aomori | 83.90% | 85.95% | 95.33% | 101.78% | 123.37% | 104.85% | 94.34% | 92.87% | 98.80% | 107.21% | 96.20% | 91.09% | 87.11% | 84.88% | 75.61% | 61.87% | 50.74% | 40.65% |
| Iwate | 76.72% | 78.29% | 95.23% | 106.95% | 135.73% | 107.71% | 86.87% | 85.61% | 92.83% | 104.63% | 95.09% | 89.53% | 87.17% | 81.33% | 82.09% | 71.60% | 66.40% | 63.02% |
| Miyagi | 85.01% | 95.59% | 110.95% | 99.37% | 110.44% | 109.38% | 90.38% | 90.89% | 105.11% | 120.43% | 115.54% | 106.01% | 85.36% | 71.49% | 65.50% | 56.74% | 53.93% | 45.01% |
| Akita | 79.56% | 81.87% | 89.59% | 109.83% | 125.44% | 113.72% | 87.14% | 82.74% | 87.34% | 96.59% | 94.87% | 84.90% | 88.94% | 90.17% | 90.46% | 78.58% | 68.85% | 61.96% |
| Yamagata | 80.52% | 82.34% | 99.87% | 110.67% | 132.30% | 103.03% | 78.96% | 83.91% | 93.86% | 110.32% | 102.07% | 93.12% | 90.32% | 93.02% | 73.94% | 65.78% | 44.03% | 43.55% |
| Fukushima | 79.54% | 108.78% | 114.59% | 111.41% | 115.80% | 96.49% | 96.61% | 101.21% | 105.05% | 110.23% | 100.32% | 88.74% | 81.57% | 83.94% | 79.57% | 72.48% | 62.19% | 63.85% |
| Ibaraki | 79.96% | 95.14% | 122.46% | 102.86% | 106.03% | 94.01% | 85.06% | 87.12% | 101.95% | 124.18% | 133.09% | 124.66% | 129.87% | 113.02% | 85.62% | 65.26% | 55.93% | 46.11% |
| Tochigi | 82.06% | 93.44% | 124.62% | 108.56% | 104.62% | 89.80% | 84.24% | 87.97% | 104.64% | 122.61% | 132.71% | 135.12% | 117.46% | 116.05% | 73.11% | 80.83% | 57.36% | 42.13% |
| Gunma | 73.28% | 84.47% | 121.44% | 119.82% | 119.92% | 92.64% | 80.25% | 83.62% | 100.26% | 128.01% | 134.07% | 125.23% | 127.43% | 97.86% | 74.55% | 62.65% | 51.40% | 35.01% |
| Saitama | 89.25% | 106.83% | 137.83% | 107.53% | 104.95% | 92.31% | 79.08% | 82.02% | 98.84% | 124.98% | 137.64% | 137.43% | 139.31% | 122.94% | 89.09% | 64.10% | 48.49% | 37.92% |
| Chiba | 90.84% | 112.67% | 143.37% | 97.11% | 90.04% | 90.30% | 78.83% | 81.92% | 104.70% | 127.76% | 135.15% | 134.50% | 144.12% | 124.71% | 86.64% | 69.91% | 55.43% | 42.97% |
| Tōkyō | 93.64% | 113.61% | 129.36% | 97.88% | 95.56% | 99.14% | 87.18% | 88.15% | 101.56% | 119.27% | 127.30% | 125.54% | 125.58% | 107.93% | 80.11% | 64.43% | 51.37% | 40.39% |
| Kanagawa | 94.38% | 109.25% | 136.54% | 104.20% | 101.67% | 94.73% | 79.61% | 81.21% | 96.59% | 117.53% | 129.89% | 133.05% | 141.42% | 126.47% | 96.26% | 75.64% | 60.28% | 46.68% |
| Niigata | 84.84% | 90.32% | 113.66% | 106.78% | 113.15% | 98.22% | 84.53% | 86.82% | 102.49% | 115.42% | 112.91% | 108.31% | 102.62% | 95.01% | 87.74% | 67.23% | 64.95% | 56.24% |
| Toyama | 78.69% | 86.58% | 109.82% | 111.05% | 120.96% | 93.94% | 82.56% | 81.36% | 96.72% | 120.70% | 120.49% | 119.57% | 116.78% | 91.76% | 75.55% | 69.75% | 57.83% | 48.33% |
| Ishikawa | 83.42% | 92.43% | 120.02% | 107.06% | 118.53% | 103.70% | 80.74% | 85.01% | 100.46% | 121.72% | 120.10% | 110.60% | 107.11% | 80.67% | 65.19% | 53.62% | 43.46% | 43.10% |
| Fukui | 75.62% | 81.44% | 105.67% | 108.45% | 119.93% | 99.45% | 81.16% | 83.84% | 103.90% | 117.27% | 119.37% | 121.57% | 110.28% | 103.89% | 77.31% | 48.10% | 51.08% | 38.87% |
| Yamanashi | 74.79% | 88.71% | 106.24% | 109.77% | 113.75% | 101.07% | 81.82% | 81.49% | 103.83% | 123.87% | 135.62% | 130.40% | 121.45% | 100.36% | 88.06% | 65.43% | 47.60% | 32.79% |
| Nagano | 78.44% | 84.57% | 107.38% | 115.31% | 124.64% | 100.11% | 85.02% | 83.89% | 94.81% | 111.85% | 111.88% | 112.68% | 104.61% | 99.11% | 81.77% | 59.57% | 51.39% | 40.02% |
| Gifu | 76.15% | 76.42% | 115.02% | 125.97% | 133.61% | 93.10% | 78.58% | 81.15% | 97.17% | 122.44% | 129.78% | 119.52% | 111.37% | 102.40% | 84.66% | 65.00% | 53.85% | 46.78% |
| Shizuoka | 86.40% | 96.29% | 119.09% | 111.47% | 113.40% | 88.60% | 83.21% | 88.92% | 102.11% | 117.00% | 120.07% | 118.00% | 118.04% | 104.34% | 82.46% | 71.18% | 56.32% | 48.32% |
| Aichi | 79.44% | 90.27% | 124.76% | 121.11% | 118.82% | 91.11% | 78.84% | 80.78% | 100.27% | 127.38% | 137.32% | 139.46% | 146.52% | 127.52% | 93.08% | 70.87% | 61.30% | 43.40% |
| Mie | 83.46% | 98.34% | 124.29% | 104.40% | 107.55% | 90.23% | 86.97% | 90.94% | 103.20% | 125.51% | 121.67% | 121.87% | 123.93% | 100.35% | 81.45% | 70.30% | 52.91% | 48.39% |
| Shiga | 79.09% | 81.60% | 116.77% | 106.47% | 119.05% | 110.43% | 76.43% | 81.86% | 95.34% | 118.04% | 132.07% | 127.59% | 122.48% | 114.39% | 80.94% | 76.90% | 57.50% | 54.57% |
| Kyōto | 82.59% | 86.34% | 99.20% | 95.21% | 119.88% | 122.22% | 87.37% | 84.72% | 93.37% | 108.92% | 110.93% | 103.74% | 95.23% | 89.67% | 73.27% | 59.36% | 54.67% | 44.39% |
| Ōsaka | 86.25% | 91.30% | 116.33% | 117.85% | 122.71% | 107.45% | 84.75% | 82.52% | 98.83% | 122.53% | 126.24% | 122.74% | 109.40% | 91.22% | 72.34% | 61.30% | 50.17% | 45.89% |
| Hyōgo | 84.88% | 92.48% | 118.39% | 105.89% | 116.02% | 100.16% | 79.80% | 83.44% | 101.43% | 126.86% | 135.61% | 123.66% | 108.63% | 93.26% | 74.13% | 63.06% | 57.76% | 51.46% |
| Nara | 74.70% | 77.62% | 107.72% | 118.81% | 143.50% | 116.02% | 76.08% | 73.25% | 93.96% | 121.16% | 134.05% | 117.18% | 103.04% | 95.09% | 73.26% | 66.98% | 46.00% | 41.75% |
| Wakayama | 74.21% | 84.25% | 105.94% | 114.13% | 135.89% | 100.57% | 80.86% | 77.90% | 94.51% | 112.12% | 114.94% | 103.73% | 99.95% | 84.86% | 69.62% | 65.12% | 46.42% | 50.15% |
| Tottori | 83.31% | 82.88% | 93.14% | 102.95% | 125.25% | 109.13% | 90.15% | 85.64% | 97.31% | 111.15% | 102.72% | 96.63% | 80.86% | 93.50% | 71.26% | 57.95% | 45.21% | 38.73% |
| Shimane | 83.78% | 84.13% | 88.10% | 89.99% | 124.21% | 108.91% | 89.20% | 91.55% | 95.51% | 110.35% | 98.64% | 94.53% | 91.73% | 100.96% | 86.61% | 94.53% | 65.75% | 69.70% |
| Okayama | 80.34% | 83.90% | 102.98% | 95.41% | 117.82% | 103.57% | 85.99% | 88.45% | 103.45% | 125.07% | 132.84% | 118.57% | 98.11% | 86.24% | 79.81% | 61.27% | 54.19% | 43.38% |
| Hiroshima | 83.62% | 91.17% | 111.90% | 91.43% | 115.49% | 99.77% | 88.61% | 93.65% | 103.28% | 120.87% | 123.53% | 117.06% | 88.65% | 73.07% | 70.55% | 63.44% | 55.27% | 48.71% |
| Yamaguchi | 76.23% | 88.81% | 101.29% | 97.07% | 122.15% | 114.69% | 87.59% | 84.08% | 93.01% | 114.32% | 107.46% | 99.90% | 83.22% | 85.29% | 73.46% | 80.57% | 68.02% | 63.06% |
| Tokushima | 83.22% | 82.32% | 118.28% | 105.44% | 130.90% | 110.50% | 81.70% | 81.51% | 100.40% | 121.67% | 114.96% | 106.13% | 86.38% | 75.94% | 67.60% | 51.12% | 39.66% | 32.94% |
| Kagawa | 81.95% | 90.65% | 113.07% | 103.81% | 124.95% | 93.93% | 83.65% | 84.98% | 101.71% | 122.22% | 120.51% | 115.65% | 92.12% | 80.17% | 61.73% | 62.81% | 53.98% | 43.76% |
| Ehime | 80.17% | 79.15% | 102.56% | 107.45% | 125.23% | 101.92% | 88.37% | 87.21% | 96.29% | 111.68% | 103.97% | 99.91% | 85.50% | 82.43% | 70.56% | 74.81% | 67.99% | 62.32% |
| Kōchi | 75.12% | 84.39% | 89.56% | 104.11% | 147.15% | 115.01% | 82.42% | 81.76% | 89.61% | 106.89% | 95.04% | 92.83% | 76.62% | 77.09% | 66.52% | 56.38% | 47.99% | 40.26% |
| Fukuoka | 80.39% | 82.26% | 105.55% | 104.14% | 131.24% | 116.58% | 84.53% | 84.74% | 101.05% | 126.48% | 123.99% | 107.97% | 73.94% | 57.99% | 48.41% | 48.41% | 43.41% | 38.11% |
| Saga | 68.25% | 63.75% | 77.27% | 121.71% | 159.03% | 105.95% | 77.94% | 76.31% | 91.54% | 109.43% | 108.81% | 99.57% | 77.47% | 59.62% | 55.43% | 40.96% | 48.57% | 31.58% |
| Nagasaki | 75.13% | 74.58% | 78.23% | 107.36% | 141.50% | 108.56% | 91.31% | 86.63% | 88.16% | 99.54% | 95.13% | 90.23% | 73.07% | 79.65% | 69.98% | 75.42% | 73.39% | 56.79% |
| Kumamoto | 70.87% | 74.12% | 85.70% | 111.66% | 151.01% | 106.37% | 79.55% | 82.88% | 94.76% | 111.87% | 115.05% | 96.52% | 69.61% | 66.17% | 64.81% | 54.86% | 47.83% | 41.12% |
| Ōita | 82.52% | 81.56% | 88.28% | 103.56% | 126.56% | 109.21% | 91.70% | 87.57% | 94.54% | 112.08% | 110.27% | 100.11% | 85.43% | 73.91% | 69.27% | 67.60% | 57.50% | 57.67% |
| Miyazaki | 78.04% | 73.70% | 81.11% | 114.66% | 143.28% | 104.26% | 86.72% | 87.07% | 91.48% | 102.67% | 89.36% | 84.21% | 81.07% | 70.95% | 66.07% | 74.15% | 66.22% | 42.39% |
| Kagoshima | 77.78% | 80.39% | 85.33% | 108.85% | 146.80% | 104.55% | 85.98% | 84.77% | 92.71% | 100.83% | 90.17% | 83.54% | 75.65% | 76.79% | 87.79% | 75.02% | 75.23% | 70.35% |
| Okinawa | 81.93% | 78.35% | 95.75% | 131.05% | 172.49% | 103.02% | 85.09% | 86.48% | 91.65% | 103.78% | 104.16% | 87.11% | 72.04% | 57.32% | 47.24% | 32.77% | 20.70% | 20.36% |

Source: Own calculations, based on Census of Japan 2015

Table 12 Migration distance per age group relative to average migration distance in the prefecture, female

| Prefecture | 0-4 | 5-9 | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hokkaidō | 102.18% | 103.73% | 110.43% | 99.75% | 110.97% | 107.47% | 104.02% | 106.49% | 109.50% | 108.20% | 95.92% | 89.70% | 78.37% | 84.56% | 79.76% | 72.03% | 65.43% | 52.17% |
| Aomori | 97.35% | 95.02% | 107.28% | 115.54% | 131.13% | 97.56% | 83.99% | 90.45% | 97.02% | 102.01% | 101.52% | 92.70% | 86.71% | 94.09% | 92.13% | 69.11% | 61.60% | 44.40% |
| Iwate | 83.00% | 89.61% | 99.37% | 120.04% | 134.31% | 96.92% | 83.20% | 88.67% | 97.80% | 99.85% | 95.30% | 81.57% | 91.95% | 93.79% | 92.76% | 80.75% | 79.74% | 67.46% |
| Miyagi | 97.29% | 107.58% | 129.81% | 116.25% | 111.45% | 96.98% | 92.03% | 101.85% | 121.26% | 120.21% | 101.28% | 89.28% | 79.66% | 80.32% | 70.38% | 69.12% | 61.06% | 52.18% |
| Akita | 82.23% | 87.83% | 104.93% | 120.09% | 128.29% | 94.62% | 82.17% | 83.96% | 91.45% | 101.10% | 99.35% | 99.77% | 91.05% | 91.51% | 103.59% | 88.47% | 86.23% | 66.51% |
| Yamagata | 86.58% | 93.32% | 116.08% | 128.03% | 133.52% | 91.64% | 77.43% | 87.28% | 96.52% | 107.53% | 96.71% | 92.72% | 98.33% | 90.24% | 97.76% | 83.34% | 72.42% | 55.53% |
| Fukushima | 84.95% | 115.54% | 122.07% | 115.60% | 113.54% | 87.04% | 97.31% | 105.85% | 116.04% | 113.46% | 95.26% | 86.05% | 86.71% | 91.16% | 87.24% | 79.10% | 66.86% | 65.63% |
| Ibaraki | 100.57% | 117.17% | 155.98% | 124.58% | 101.50% | 87.76% | 84.29% | 98.48% | 113.49% | 116.15% | 107.88% | 112.09% | 126.12% | 116.42% | 89.56% | 74.67% | 64.41% | 46.42% |
| Tochigi | 99.76% | 118.68% | 155.15% | 122.29% | 101.08% | 83.06% | 85.00% | 97.54% | 115.61% | 122.03% | 105.32% | 123.72% | 106.61% | 114.50% | 88.18% | 82.36% | 66.23% | 51.92% |
| Gunma | 97.70% | 107.39% | 139.96% | 133.52% | 119.29% | 91.41% | 85.65% | 95.25% | 108.93% | 110.10% | 97.25% | 101.53% | 120.90% | 106.05% | 83.80% | 69.33% | 61.64% | 43.52% |
| Saitama | 111.34% | 134.45% | 168.47% | 114.62% | 87.06% | 85.09% | 88.60% | 96.94% | 111.97% | 110.52% | 98.59% | 121.86% | 140.21% | 118.59% | 90.18% | 69.95% | 60.64% | 49.01% |
| Chiba | 116.79% | 140.19% | 172.68% | 110.41% | 79.53% | 80.12% | 83.24% | 98.75% | 117.13% | 112.51% | 99.97% | 125.60% | 141.61% | 118.85% | 87.69% | 72.25% | 62.81% | 50.20% |
| Tōkyō | 115.12% | 131.12% | 147.53% | 105.82% | 89.02% | 95.05% | 94.28% | 100.86% | 110.91% | 110.61% | 102.56% | 111.04% | 125.69% | 105.45% | 82.82% | 66.78% | 57.61% | 45.42% |
| Kanagawa | 109.58% | 131.67% | 155.85% | 109.87% | 82.64% | 87.75% | 86.54% | 95.87% | 109.47% | 107.43% | 103.55% | 124.73% | 142.18% | 119.31% | 98.32% | 78.97% | 66.64% | 52.59% |
| Niigata | 90.43% | 105.03% | 125.58% | 118.09% | 115.56% | 88.91% | 84.47% | 90.49% | 108.99% | 117.08% | 111.39% | 104.96% | 104.48% | 103.84% | 101.15% | 84.07% | 77.98% | 58.98% |
| Toyama | 92.53% | 106.03% | 132.85% | 137.69% | 136.51% | 86.26% | 79.20% | 83.09% | 95.46% | 116.68% | 110.34% | 96.46% | 93.31% | 84.05% | 88.28% | 79.65% | 59.12% | 53.16% |
| Ishikawa | 94.49% | 107.23% | 146.89% | 125.72% | 119.54% | 94.89% | 81.58% | 94.13% | 106.31% | 117.06% | 107.04% | 98.83% | 101.70% | 90.18% | 79.81% | 70.41% | 69.00% | 50.60% |
| Fukui | 98.38% | 95.15% | 128.58% | 131.69% | 126.78% | 89.65% | 79.11% | 91.05% | 106.45% | 120.42% | 110.06% | 106.96% | 112.15% | 102.19% | 83.86% | 81.43% | 62.28% | 49.84% |
| Yamanashi | 93.06% | 99.18% | 139.65% | 120.70% | 117.40% | 107.21% | 87.28% | 93.40% | 105.97% | 107.97% | 106.37% | 100.56% | 110.73% | 99.77% | 84.98% | 78.59% | 58.87% | 43.84% |
| Nagano | 88.20% | 102.88% | 110.26% | 129.05% | 129.53% | 90.74% | 86.15% | 93.78% | 101.80% | 107.33% | 101.37% | 101.07% | 105.06% | 106.37% | 91.36% | 71.94% | 58.83% | 43.76% |
| Gifu | 94.87% | 99.79% | 139.42% | 140.92% | 125.94% | 92.86% | 83.30% | 91.88% | 105.73% | 109.50% | 102.23% | 97.46% | 113.54% | 110.25% | 106.75% | 84.81% | 63.70% | 54.45% |
| Shizuoka | 97.64% | 118.98% | 139.05% | 119.58% | 108.43% | 84.95% | 87.73% | 98.00% | 110.48% | 111.11% | 106.38% | 102.04% | 111.54% | 106.17% | 83.05% | 74.43% | 69.16% | 52.04% |
| Aichi | 95.65% | 108.72% | 151.69% | 132.78% | 112.49% | 87.02% | 84.67% | 93.30% | 111.79% | 121.09% | 112.50% | 120.26% | 132.15% | 118.52% | 94.70% | 78.07% | 63.08% | 49.89% |
| Mie | 103.15% | 118.87% | 140.20% | 122.95% | 109.23% | 86.24% | 88.67% | 101.15% | 113.44% | 107.86% | 105.31% | 112.78% | 111.64% | 111.17% | 90.83% | 83.26% | 64.70% | 52.13% |
| Shiga | 98.45% | 99.48% | 140.44% | 123.25% | 113.15% | 101.31% | 86.57% | 94.76% | 108.78% | 104.29% | 101.80% | 104.74% | 119.29% | 118.30% | 91.32% | 74.88% | 72.93% | 55.30% |
| Kyōto | 95.34% | 102.21% | 114.08% | 97.22% | 113.71% | 120.43% | 96.14% | 95.52% | 100.12% | 96.24% | 88.99% | 94.90% | 99.63% | 90.62% | 77.25% | 68.58% | 63.50% | 51.11% |
| Ōsaka | 105.07% | 111.56% | 144.35% | 111.59% | 112.31% | 104.63% | 97.17% | 98.39% | 109.22% | 105.93% | 90.07% | 97.60% | 104.14% | 90.56% | 76.42% | 67.46% | 62.56% | 52.21% |
| Hyōgo | 101.47% | 110.72% | 139.91% | 110.05% | 107.40% | 98.17% | 89.92% | 99.49% | 112.62% | 111.79% | 101.89% | 101.59% | 106.62% | 96.29% | 82.27% | 74.57% | 68.17% | 60.95% |
| Nara | 89.98% | 105.98% | 121.71% | 109.98% | 130.92% | 119.61% | 93.97% | 93.39% | 104.89% | 98.72% | 93.49% | 92.72% | 112.71% | 103.97% | 85.99% | 68.95% | 56.23% | 43.17% |
| Wakayama | 99.04% | 97.17% | 122.80% | 124.02% | 126.61% | 96.49% | 90.23% | 96.49% | 113.00% | 107.44% | 108.20% | 87.65% | 100.75% | 105.48% | 91.96% | 81.64% | 67.17% | 47.83% |
| Tottori | 87.83% | 93.75% | 104.63% | 112.22% | 121.65% | 100.42% | 92.92% | 93.32% | 105.45% | 121.36% | 104.58% | 89.38% | 88.41% | 96.06% | 104.63% | 76.75% | 60.54% | 47.91% |
| Shimane | 89.44% | 91.27% | 103.33% | 104.03% | 116.61% | 99.48% | 91.72% | 93.72% | 99.99% | 110.13% | 89.96% | 80.82% | 97.83% | 103.35% | 107.70% | 101.07% | 98.98% | 76.50% |
| Okayama | 96.97% | 101.44% | 119.26% | 110.46% | 111.35% | 98.37% | 91.43% | 99.40% | 107.88% | 123.20% | 114.15% | 107.87% | 94.34% | 94.15% | 91.72% | 85.27% | 69.78% | 54.06% |
| Hiroshima | 96.87% | 103.32% | 128.01% | 107.60% | 106.23% | 92.24% | 92.40% | 102.82% | 117.85% | 122.74% | 111.46% | 95.94% | 86.05% | 83.05% | 83.06% | 76.91% | 71.40% | 54.72% |
| Yamaguchi | 92.58% | 91.29% | 116.24% | 110.81% | 120.79% | 97.26% | 90.69% | 94.41% | 103.31% | 113.15% | 97.99% | 91.26% | 89.04% | 96.14% | 97.67% | 95.86% | 79.32% | 69.37% |
| Tokushima | 94.39% | 96.13% | 123.95% | 127.70% | 130.75% | 106.69% | 85.38% | 95.11% | 103.80% | 123.42% | 104.45% | 91.16% | 79.28% | 84.28% | 65.45% | 62.94% | 62.85% | 41.97% |
| Kagawa | 93.42% | 102.89% | 133.91% | 122.91% | 119.27% | 90.34% | 88.33% | 94.27% | 113.50% | 122.83% | 109.52% | 98.78% | 87.09% | 77.72% | 83.75% | 67.56% | 62.91% | 46.53% |
| Ehime | 84.04% | 90.99% | 106.98% | 115.87% | 119.40% | 96.22% | 90.88% | 93.73% | 99.66% | 107.12% | 106.88% | 92.39% | 88.39% | 90.18% | 93.75% | 94.03% | 90.72% | 76.47% |
| Kōchi | 78.55% | 82.39% | 101.41% | 116.80% | 146.04% | 106.54% | 90.56% | 92.69% | 103.28% | 98.70% | 87.54% | 79.86% | 84.19% | 97.56% | 96.66% | 64.22% | 63.10% | 49.60% |
| Fukuoka | 96.15% | 99.63% | 125.86% | 118.57% | 125.21% | 102.76% | 95.74% | 99.65% | 117.92% | 119.03% | 98.03% | 78.58% | 67.17% | 71.22% | 70.47% | 62.59% | 62.16% | 44.87% |
| Saga | 89.76% | 86.33% | 105.98% | 130.37% | 144.18% | 97.80% | 90.88% | 92.32% | 100.61% | 94.39% | 90.47% | 76.07% | 75.48% | 78.05% | 82.33% | 74.09% | 68.62% | 54.13% |
| Nagasaki | 91.45% | 89.06% | 103.55% | 107.12% | 126.04% | 101.03% | 94.30% | 93.98% | 98.84% | 91.14% | 92.02% | 89.87% | 81.36% | 102.12% | 104.30% | 103.89% | 88.87% | 65.52% |
| Kumamoto | 93.36% | 90.48% | 105.59% | 110.40% | 142.65% | 97.71% | 91.44% | 94.96% | 105.67% | 103.28% | 95.46% | 78.87% | 80.11% | 77.47% | 92.43% | 84.34% | 70.76% | 53.96% |
| Ōita | 93.91% | 95.35% | 112.30% | 108.00% | 120.42% | 102.27% | 92.97% | 96.01% | 99.19% | 112.04% | 95.50% | 91.87% | 86.64% | 80.71% | 94.48% | 97.05% | 78.61% | 62.13% |
| Miyazaki | 83.36% | 90.20% | 96.42% | 111.08% | 138.80% | 99.31% | 89.05% | 89.10% | 99.43% | 102.29% | 87.42% | 82.40% | 77.75% | 95.98% | 93.43% | 97.64% | 76.92% | 54.57% |
| Kagoshima | 84.07% | 87.40% | 94.41% | 109.18% | 133.10% | 92.27% | 90.75% | 92.93% | 100.86% | 97.76% | 89.05% | 80.31% | 90.12% | 100.38% | 122.13% | 111.11% | 99.85% | 87.08% |
| Okinawa | 91.49% | 88.72% | 104.47% | 147.00% | 175.56% | 96.76% | 89.05% | 97.27% | 98.73% | 91.56% | 80.22% | 66.53% | 60.12% | 57.32% | 55.22% | 33.75% | 31.96% | 21.35% |

Source: Own calculations, based on Census of Japan 2015

# 5. Discussion and conclusion

Was there a measurable impact on the migration patterns after 2011 the natural disaster? As shown in section 3, there was indeed an increased out-migration in the three worst impacted prefectures, Fukushima, Miyagi and Iwate. However, this out-migration happened mostly closer to the catastrophe, with the largest changes in 2011 and some additional migration in 2012 (figure 13).

In this thesis I have shown that additional migration remains in the prefecture and the disaster indeed affects the migration dynamics of some of the municipalities in the prefectures. Such population centres, like the city of Sendai in Miyagi prefecture, actually saw a reversal of the migration trends in 2010 towards a higher influx of migrants in 2015.

In general, the main impact on migration patterns was limited to the less damaged municipalities in Fukushima coastal area, Fukushima nuclear power plant surroundings, Miyagi and Iwate. Outside those areas there is no clear evidence that there was a major influence on the migration patterns.

Looking at the difference between the different age groups and sexes, there was some increase in migration activity among young people (under the age of twenty), and those within retirement age above sixty-five. Working age people though, did not see a pronounced increase in migration activity.

Additionally, limited to Fukushima prefecture, women in working age (between the ages of twenty and sixty-four) appear to have increased their average migration distance. However, this change can hardly be assessed accurately, as no detailed age data on migration from the census of 2010 is available.

This master thesis set out to find answers to the following questions:

- *To what spatial extent did it alter migration patterns?*
- *How was the demographic structure of those migrants?*
- *How was their destination choice affected?*
- *How did it compare to the migration pattern change of the rest of Japan?*

Certainly the data available and provided by the census of Japan came with some limitations. Neither was data on the ages of migrants available for the census of 2010, nor could the migration movements month by month or year by year be accurately recorded by the census.

Nonetheless, the data uncovered some changes a few years after the natural disaster impacting the prefectures of Fukushima, Miyagi and Iwate. In regard to the questions listed above, it can be seen that the impact on migration patterns was limited and in its spatial extent also restricted to those municipalities close to the disaster at the Fukushima nuclear power plant, as well as further coastal regions affected by the tsunami.

Furthermore, migration mobility was therefore increased, especially among the younger and older cohorts, which in general migrate less than those in the working age. This did not lead to migrations further away and the main destinations of migrants from those areas remained similar. Moreover, many of those people remained close-by, which led to some influx of migrants in bigger population centres of those prefectures (notably Sendai in Miyagi).

Based on the existing literature, the following hypotheses were introduced, and some indication for them can be given, although the analysis can not ascertain their validity.

- *The catastrophe lead to a further depopulation of a region already troubled by increasing out-migration.*
- *Women (especially with young children) migrated further away than men.*

- *The increased migration was by mostly younger people, while older inhabitants remained in the affected areas.*

The first hypothesis stated that those regions would face even bigger depopulation. However, this situation seems to be even reversed, especially in Miyagi prefecture. Beside, people from coastal areas were indeed heavily affected. While most people migrated shorther distances within their prefecture, some parts of those prefectures reversed the migration trends of 2010 and had even an increase towards a positive net-migration. However, migration from rural areas has indeed increased, albeit it seems most of those migrants stayed close to their origin and moved to bigger population centres. Since several areas in Miyagi prefecture, and also Fukushima prefecture saw a reversal of their out-migration, it might give some weight to the points made by Nakagawa (2017) about an increase of popularity of rural areas.

The second hypothesis cannot be clearly verified. Certainly, the average distance of female migrants did not drastically differ from their male counterparts. However, the difference in average migration distance in Fukushima prefecture in particular was the lowest for men and women in working age. Since this data is not available for the previous census though, it can not be ascertained if such a dynamic developed after 2011, or if it already existed like this before in Fukushima prefecture. However, it shows evidence for the research by Do (2019) that most people stayed within the vicinity of their origin. Additionally, the data confirms the population predictions in Hara (2014), as Miyagi was the least affected of the three prefectures, and even saw some increase in in-migration.

Lastly, the third hypothesis also did not show entirely true. Interestingly, while relatively more younger people under the age of twenty-five migrated in Fukushima, Miyagi and Iwate compared to other prefectures of Japan, the same holds true for those over fifty years old.

Especially in Fukushima prefecture, young adults migrated on average a shorter distance than other age groups and migrants in other prefectures.

This thesis has added some evidence that a large-scale natural disaster might have an impact on the migration behaviour of humans, but not necessarily influence a wider region negatively. Since regions in the area which were not directly affected by the natural disaster saw an increase in net migration, the argument made by Chen *et al.* (2014) that a natural disaster can rejuvenate regions struggling with depopulation, can indeed happen. Although further research would be needed to so what impact those changing migration patterns have long term. With such an event having an effect on the whole population, those that are not bound to their place of life by work might be more willing to migrate. In essence, younger, as well as people of higher age (perhaps already retired), tend to be more likely to migrate as a response to natural disaster.

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## Summary

In this master's thesis I focus on the changes in internal migration patterns and its demographic structure after the 3.11 Great East Japan earthquake, and subsequent tsunami and nuclear disaster. Prior to the event, the regions in Tōhoku highly affected by the tsunami have already faced depopulation and an ageing population. Based on the data of the *Census of Japan*, this thesis gives first a descriptive overview of the migration situation in the timeframes of 2005 to 2010 (from the census of 2010) and 2010 to 2015 (from the census of 2015), and then an analysis, if certain social groups (sex, age and location of their life) migrate differently when facing a natural disaster. Previous research has postulated the hypothesis that women with children would migrate larger distances away than other members of society in such a case. The results of this thesis cannot confirm this hypothesis, and in comparison to the past, especially the youth and the elderly increased their migration behaviour. Another hypothesis brought up by this thesis is that for regions already fighting depopulation and ageing of society, such a catastrophe could amplify that change. However, many of the people in their working age remained close to their place of life, and several municipalities in the prefectures of Fukushima, Iwate and Miyagi actually saw a reversal of that trend by 2015.

## Zusammenfassung

Das Tōhoku-Erdbeben im Jahre 2011 konfrontierte die Bevölkerung Japans mit einem Tsunami sowie einer Atomkatastrophe. Diese Ereignisse führten zu Mustern in der Binnenmigration und der demographischen Struktur, die in dieser Masterarbeit untersucht werden. März 2011 im Mittelpunkt. Vor diesem Tag sahen sich die stark betroffenen Regionen in Tōhoku mit einer zunehmenden Entvölkerung und Alterung der Bevölkerung konfrontiert. Diese Arbeit gibt, basierend auf Daten des *Zensus von Japan*, zunächst einen deskriptiven Überblick über die Migrationssituation in den Zeiträumen 2005 bis 2010 (aus der Volkszählung von 2010) und 2010 bis 2015 (aus der Volkszählung von 2015) und anschließend eine Analyse, ob bestimmte soziale Gruppen (Geschlecht, Alter und Ort ihres Lebens) bei einer Naturkatastrophe unterschiedlich migrieren. Frühere Forschungen haben die Hypothese aufgestellt, dass Frauen mit Kindern in einem solchen Fall größere Entfernungen als andere Mitglieder der Gesellschaft abwandern würden. Die Ergebnisse dieser Masterarbeit können diese Hypothese nicht bestätigen, und im Vergleich zur Vergangenheit haben insbesondere die Jugend und die älteren Menschen ihr Migrationsverhalten verstärkt. Eine andere Hypothese, die in dieser Masterarbeit aufgestellt wird, ist, dass für Regionen, die bereits gegen Entvölkerung und Alterung der Gesellschaft kämpfen, eine solche Katastrophe diesen Wandel verstärken könnte. Viele der Menschen im erwerbsfähigen Alter blieben jedoch in der Nähe ihres Lebensortes, und in mehreren Gemeinden der Präfekturen Fukushima, Iwate und Miyagi kam es bis 2015 tatsächlich zu einer Umkehr dieses Trends.