What can be learned from permanent mass displacements?

Case of the largest peacetime emergency evacuations in human history: Chernobyl and Fukushima

Northern Institute, Charles Darwin University, 04.10.2016
Photo: Decoration on Lyuba’s house in city of Chernobyl. She moved back home to Chernobyl in July 1986 and she hasn’t left the city since that time.
1. Key questions
   Are they really the largest?
   How can they influence demography?
   Is the affected area a „frontier”? 

2. Fukushima and Chernobyl:
   disaster, evacuation, resettlement - a comparison
   Data sources, maps, results
   Census data results, micro-data results

3. Life after...?
   What is the future of these regions?

4. Summary

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Are Chernobyl and Fukushima really the largest?

Flooding, cyclones or volcano eruptions can cause even larger evacuations but these are usually temporary evacuations:

**Flooding:**
1998 Yangtze river flooding (China) ~ 14 million people
In Europe flooding can affect 1-200 000 people (Nederlands, Germany, Hungary)

**Cyclones:**
2005 Hurricane Rita (USA) ~ 3 million people (the largest ever in the US)
2007 Typhoon Kroosa (China: Zhejiang, Fujian) ~1.4 million people
2014 Typhoon Hagupit (Philippines) ~ 1 million people
2005 Hurricane Katrina (USA) ~ 500 000 people

**Bushfires, forest fires:**
2007 California, USA ~ 900 000 people

**Earthquakes:**
2008 Sichuan earthquake, China ~ 200 000 people

**War:**
Globally ~65 million people are displaced because of war. (2016, UNHCR)

**Industry:**
1984 Bhopal (India) ~ 4 000 deaths, ~560 000 injured
1986 Chernobyl (USSR) ~ 350 000 people (permanent)
2011 Fukushima (Japan) ~ 200 000 people, half of them permanent
They left only the Zones, large scares on the surface of the Earth where even the laws of Physics works in a different way. The authorities closed, fenced and made the area restricted, but they didn’t calculate with human’s curiosity…

Strugatsky brothers: Roadside Picnic, 1972
– 14 years before Chernobyl,
39 years before Fukushima

The entrances to the Zones of Fukushima (above) and Chernobyl (bellow)
Can disasters change demography?

Disasters, especially climate change induced disasters can cause mass displacement (Lavell, Ginnetti 2013), which is usually the most important demographic consequence of a disaster event along with the population decrease because of disaster casualties (death tolls).

The displacement can be permanent or temporary however, there are only few studies on the experiences about permanent resettlement (Oliver-Smith 2013).

Demographic shifts can be permanent in case of permanent resettlement.

Both Chernobyl and Fukushima are in the same time rapid-onset and slow-onset disasters, hyper complex, non-conventional event exceeding multiple thresholds. In both cases there were massive permanent population displacements: Emergency evacuation and later resettlement of vulnerable population to avoid future radiation risks.

Photo: Former village in the Chernobyl evacuation zone (Ukraine) – number of evacuated: 1114 persons date of evacuation: 03.05.1986
Can disaster change an entire region?

- Mass displacement not solves the problem itself, even it generates new challenges. Displacement during a disaster has also direct effects: death, injury, disease, and trauma (Robinson 2003).

- In many cases the resettlement ends up in a secondary disaster (Oliver-Smith 2013).

- In the new place appropriate settlement design, housing, services and economic base is needed to enable the community to restructure itself and achieve adequate level of resilience. Not only personal life within the community, but also relationships, networks and supporting structures (social capital) needs to be rebuilt.

Due to displacement: Destroyed links and social cohesion within the community. Tensions within the settlements receiving refugees, refugee communities (enviness), conflict between original population and newcomers: „Chernobiltsy” etc. Community conflicts, segregation, blame of the victims...
Can disaster change an entire region?

- **The place has a significant importance** in the construction of individual and community **identities**. Such place attachments mean that the loss or removal of a community from its ‘ground’ by disaster may be profoundly traumatic (Oliver-Smith 1996).

Displacement can **shake the foundations of** personal worldview and **identity** (Oliver-Smith 2013). Loss of personal identity and social integration and economic base: dependence on government support, social deviances like alcoholism/ addiction to pachinko etc.

- Loss of personal and community identities and cohesions means **also loss of the traditions, the former social structures, loss of an entire region**.

- **Those communities who able to reconstruct in situ**, even in much worse circumstances they **have better chance** during recovery.

So disasters can change an entire region...
The Zone and around – Is it a „new frontier”?

Is it a „region”?
A region constructed by people’s identities and communities in a certain physical geographical area.

Is it a „dead region”?
People were evacuated, identities, traditions were lost, so the region was lost. But on the „frontier” of the Zone still people are living. Even within the Zone the society exist further: scientists, clean up workers, former residents or disaster tourists visits and temporarily inhabit the Zone. Even take back is on the agenda, especially in Japan and in Belarus.

Than what is it?
It is more like a frontier which changing all the time according to the current situation of the disaster cycle: evacuation, clean up, reconstruction, recovery, resettlement...

This is a region, product of modernity which failed: a „postmodern frontier”
## Development stages of the two „frontier” region

<table>
<thead>
<tr>
<th></th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional</strong></td>
<td>Polessye – entirely <strong>rural, peripheral area</strong>, marshland between Ukraine</td>
<td>Tohoku – the <strong>north-eastern frontier of Japan</strong>, Hamadori, the coastal road to the Japanese far-north</td>
</tr>
<tr>
<td></td>
<td>and Belarus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low population density, <strong>traditional ethnic/religious/social groups</strong> because of periphery location. Traditional lifestyles.</td>
<td></td>
</tr>
<tr>
<td><strong>Modern</strong></td>
<td><strong>Large industrial investment</strong> as part of regional development policy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction of the first large <strong>commercial nuclear power plants</strong> in regions characterised by <strong>low population density</strong>, underdevelopment but relatively close to large urban areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The <strong>modern society</strong> (engineers, highly skilled workers), <strong>urban lifestyle</strong> arrives to the rural-agricultural traditional periphery.</td>
<td></td>
</tr>
<tr>
<td><strong>Post-disaster (Post-modern?)</strong></td>
<td>The <strong>death of safety myth, death of believe in modern technical society</strong>. <strong>Post-apocalyptic shock</strong> within the society – fear and depression. Role of arts help to process the shock event. Huge economic loss, population loss, displacements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reconstruction, recovery, take back the area – <strong>new forms of land use</strong>: forestry, catastrophe tourism etc.</td>
<td></td>
</tr>
</tbody>
</table>
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Photo: Decoration on Lyuba’s house in city of Chernobyl. She moved back home to Chernobyl in July 1986 and she hasn’t left the city since that time.
## Fukushima and Chernobyl – a comparison

<table>
<thead>
<tr>
<th></th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time</strong></td>
<td>30 years ago</td>
<td>5 years ago</td>
</tr>
<tr>
<td><strong>1 reactor</strong></td>
<td>(245 tons of radioactive fuel)</td>
<td>(1852 tons of radioactive fuel)</td>
</tr>
<tr>
<td><strong>Steam and chemical explosions, damage of the reactor due to explosions, grafite fire for 10 days</strong></td>
<td>Earthquake and tsunami, cooling system fail, gas explosions, core melting, containment damage due to melting</td>
<td></td>
</tr>
</tbody>
</table>

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**Diagram:**

The diagram illustrates the geographical locations of Chernobyl and Fukushima, highlighting the affected areas in Japan and Ukraine.

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### Environmental Consequences of the Chernobyl Accident and Their Remediation: Twenty Years of Experience

**INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA, 2006**

<table>
<thead>
<tr>
<th>Relocated population (thousand)</th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>„Closed” area</th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>~4 700 km²</strong></td>
<td>~2 100 km² in Belarus ~2 600 km² in Ukraine</td>
<td>600 km²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affected area</th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137 &gt;37kBq/m² &gt;0.25 µSV/h</td>
<td>191 560 km²: 57 900 km² in Russia 46 500 km² in Belarus 41 900 km² in Ukraine 45 260 km² in other countries</td>
<td>29 400 km²</td>
</tr>
</tbody>
</table>

>185 kBq/m² >1 µSV/h 29 400 km² 1 700 km²

<table>
<thead>
<tr>
<th>Closed Zone/Polluted area</th>
<th>Chernobyl</th>
<th>Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td>16%</td>
<td>35%</td>
<td></td>
</tr>
</tbody>
</table>

* The exact number is unknown.
Fukushima and Chernobyl: Available data and statistics

Chernobyl data frame (30 years ago): 1979-1986-2010
Fukushima data frame (5 years ago): 2005-2010-2011-2015

Available Census data

<table>
<thead>
<tr>
<th>Census</th>
<th>Ukraine</th>
<th>Belarus</th>
<th>Russia</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>1979</td>
<td>1979</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>1989</td>
<td>1989</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>1999</td>
<td>2002</td>
<td>2005</td>
<td></td>
</tr>
<tr>
<td>-*</td>
<td>2009</td>
<td>2010</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2015</td>
</tr>
</tbody>
</table>

*postponed in 2011

Available other population data

Chernobyl: Hoyniki raion (Belarus), register of evacuated individuals (only one district, 1986-2007)

Fukushima: mobile phone location data, 2015
People living in affected areas
Scale, affected area and population, on district and municipality level

People living in admin. units, where radioactive contamination higher than 0.25 μSv/h*

(*eating a banana: 0.1 μSv, dental X-ray 5 μSv, 0.4 μSv/h average background dose)

<table>
<thead>
<tr>
<th></th>
<th>Population (2010)</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BELARUS</td>
<td>60 463 (1)</td>
</tr>
<tr>
<td></td>
<td>2 388 700</td>
<td>(46,3%)</td>
</tr>
<tr>
<td>2</td>
<td>JAPAN¹</td>
<td>9 812 (4)</td>
</tr>
<tr>
<td></td>
<td>1 875 210</td>
<td>(7,5%)</td>
</tr>
<tr>
<td>3</td>
<td>UKRAINE</td>
<td>33 860 (2)</td>
</tr>
<tr>
<td></td>
<td>1 407 811</td>
<td>(25,9%)</td>
</tr>
<tr>
<td>4</td>
<td>RUSSIA²</td>
<td>26 400 (3)</td>
</tr>
<tr>
<td></td>
<td>1 281 781</td>
<td>(20,2%)</td>
</tr>
<tr>
<td></td>
<td>Total:</td>
<td>130 535</td>
</tr>
<tr>
<td></td>
<td>6 973 502</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

¹ – approx. population before the evacuation (03.2011)
² – only Chernobyl affected area
Fukushima and Chernobyl – a compare:
Scale, affected area and population

Ratio of admin. units, where radioactive contamination higher than 0,25 μSv/h

<table>
<thead>
<tr>
<th></th>
<th>From total population of the country (%)</th>
<th>From total area of the country (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BELARUS</td>
<td>25,1</td>
</tr>
<tr>
<td>2</td>
<td>UKRAINE</td>
<td>3,1</td>
</tr>
<tr>
<td>3</td>
<td>JAPAN&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1,5</td>
</tr>
<tr>
<td>4</td>
<td>RUSSIA&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0,9</td>
</tr>
</tbody>
</table>

Population density of admin. units, where rad. contamination higher than 0,25 μSv/h

<table>
<thead>
<tr>
<th></th>
<th>Persons / sq. km</th>
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</thead>
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<td>1</td>
<td>JAPAN&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>RUSSIA&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>UKRAINE</td>
</tr>
<tr>
<td>4</td>
<td>BELARUS</td>
</tr>
</tbody>
</table>

<sup>1</sup> – approx. population before the evacuation (03.2011)
<sup>2</sup> – only Chernobyl affected area
Great East Japan Earthquake and Fukushima

In compare with Chernobyl, Fukushima was not only a nuclear accident, it was part of series of disaster events during the Great East Japan Earthquake (03.2011).

R – districts affected by radiation from Fukushima accident (0,25 μSv/h)

T – districts affected by the tsunami

E – districts affected by the earthquake (6 and over)
Great East Japan Earthquake and Fukushima – The Earthquake

Districts affected by EARTHQUAKE during the Great East Japan Earthquake (11.03.11)
Great East Japan Earthquake and Fukushima – The Tsunami

Kesennuma city “center” after the clean up

Municipalities hit by TSUNAMI minutes after Great East Japan Earthquake (11.03.11)
Minamisanriku town – remains of the former disaster management and shelter building

Land fill up in Minamisanriku town

Cut off hills on the Sanriku coast

New housing on top of the hills
Temporary market on Sanriku coast

Monument of „re-start” or „re-birth” near Sendai on the coast

Main street in Minamisanriku – people returned, reconstruction on going
Great East Japan Earthquake and Fukushima

Municipalities affected by RADIATION from the tsunami damaged Fukushima Daiichi NPP (during March 2011 and after)
Great East Japan Earthquake and Fukushima

Municipalities affected by RADIATION from the tsunami damaged Fukushima Daiichi NPP (during March 2011 and after)
Radioactive pollution and zoning in the Fukushima area

Air Dose Rate

- No entry
- Short visit only (over 20 mSv per year)
- Rehabilitation (less than 20 mSv per year)

Air dose rate (μSv per hour)
- 0.1 - 0.2
- 0.3 - 1.0
- 1.1 - 2.0
- 2.1 - 4.0
- 4.1 - 6.0
- 6.1 - 8.0
- 8.1 - 10.0
- 10.1 - 62.0

Evacuation Zoning

Municipality boundary
- Inner City boundary

Weekday population is the average of daily population including temporary stays during weekdays in June.
Fukushima affected area – as „periphery“ before the nuclear disaster

Administrative status, 2010

Mostly rural peripheries…
Fukushima affected area – as „periphery” before the nuclear disaster

Relatively low population density in compare to other parts of Japan…
Fukushima affected area – as „periphery” before the nuclear disaster

Ratio of 65-x population, 2010

Elderly population
Fukushima affected area – as „periphery” before the nuclear disaster

Population change 2005-2010

Rural peripheries with outmigration and elderly population – except the area close to the NPP (immigration and differences in society with engineers and other high skilled workers)
Fukushima affected area – as „periphery” after the nuclear disaster

Population change 2010-2015
Population change 2005-2010
Population change 2010-2015
Population change 2010-2015
Change of population dynamics after 2011

(difference between population change of 2005-2010 and 2010-2015)
Chernobyl – the affected area
Average annual population change, 1979-1989

Data source: regional statistical yearbooks of Belarus, Russia and Ukraine,
Author: Dávid Karácsonyi
Average annual population change, 1989-2000

Data source: regional statistical yearbooks of Belarus, Russia and Ukraine,
Author: Dávid Karácsonyi
Average annual population change, 2000-2009

Data source: regional statistical yearbooks of Belarus, Russia and Ukraine,
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Photo: Decoration on Lyuba’s house in city of Chernobyl. She moved back home to Chernobyl in July 1986 and she hasn’t left the city since that time.
## Change of population in the most affected rayons, 1979-2000

<table>
<thead>
<tr>
<th>Location</th>
<th>Country</th>
<th>total population loss, %</th>
<th>total population loss, persons</th>
<th>urban population loss, %</th>
<th>rural population loss, %</th>
<th>ratio of contaminated area, % over 0.25, 1 and 4 μSv/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polisske</td>
<td>Ukraine</td>
<td>-80</td>
<td>-29,748</td>
<td>-100</td>
<td>-69</td>
<td>70, 51, 27</td>
</tr>
<tr>
<td>Narodichi</td>
<td>Ukraine</td>
<td>-64</td>
<td>-20,554</td>
<td>-58</td>
<td>-66</td>
<td>96, 28, 23</td>
</tr>
<tr>
<td>Brahin</td>
<td>Belarus</td>
<td>-61</td>
<td>-27,365</td>
<td>-26</td>
<td>-69</td>
<td>100, 56, 30</td>
</tr>
<tr>
<td>Hoyniki</td>
<td>Belarus</td>
<td>-57</td>
<td>-24,476</td>
<td>-1</td>
<td>-68</td>
<td>100, 79, 57*</td>
</tr>
<tr>
<td>Vetka</td>
<td>Belarus</td>
<td>-52</td>
<td>-22,812</td>
<td>-11</td>
<td>-62</td>
<td>100, 97, 63</td>
</tr>
<tr>
<td>Naroulja</td>
<td>Belarus</td>
<td>-48</td>
<td>-16,449</td>
<td>-13</td>
<td>-75</td>
<td>100, 94, 47</td>
</tr>
<tr>
<td>Ivankiv</td>
<td>Ukraine</td>
<td>-46</td>
<td>-50,251</td>
<td>-17</td>
<td>-63</td>
<td>100, 28, 19</td>
</tr>
<tr>
<td>Novozubkov</td>
<td>Russia</td>
<td>-32</td>
<td>-26,327</td>
<td>-16</td>
<td>-56</td>
<td>100, 100, 76</td>
</tr>
</tbody>
</table>

*31% of the total area of Hoyniki raion is over 8 μSv/h.

Data source: regional statistical yearbooks of Belarus, Ukraine and Russia and own calculation
RADIATION POLLUTION CAUSED BY CHERNOBYL

Author: UNSCEAR, Karácaonyi, D., H.A.S.R.C.A.E.S. Geographical Institute, Budapest, 2016
Cartography: KJAM-LÉRT, Budapest, 2016

RADIATION POLLUTION CAUSED BY CHERNOBYL
Surface ground deposition of Cesium-137 after Chernobyl disaster, 1986

- 37 – 185 kBq/m²
- 185 – 555 kBq/m²
- 555 – 1,480 kBq/m²
- 1,480 – 3,700 kBq/m²

Fig. 4.1
RURAL POPULATION CHANGE (1986-2007)

Persons

%  

1000  
0  
-1000  
-2000  
-3000  
-4000  
-5000  
-6000  
-7000  
-8000  
-9000  
-10000  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  

rural population change (%)  
rural population change (person)
Rural population distribution in Khoyniki Raion, Belarus, 2007

- Main road
- Raion boundary
- Chernobyl evacuation zone
- Urban settlement
- Cs-137 pollution over 40 Ci/sq.km
- Cs-137 pollution 15-40 Ci/sq.km

Rural settlements:
- No evacuation
- Evacuation

Population size (people):
- Empty
- 1 - 50
- 51 - 200
- 201 - 500
- 501 - 1000
- Over 1000

Chernobyl NPP
Photo: Decoration on Lyuba’s house in city of Chernobyl. She moved back home to Chernobyl in July 1986 and she hasn’t left the city since that time.

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Life after?

Not only signs of death:

On the right: the kanji means „human” – number of death people find after the tsunami in the house.

On the left: „Here lives owner of the house” sign in Chernobyl town.
Newly opened highway on the Hamadori coast – instead of temperatures radiation levels
„Imázs” javítás – Japán útikalauz – Fukusima prefektúra

Map of Fukushima Prefecture with radiation levels

<table>
<thead>
<tr>
<th>Radiation Levels</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 μSv/h or more</td>
<td>these areas are likely to remain off-limits for many years</td>
</tr>
<tr>
<td>below 9.5 μSv/h</td>
<td>these areas are likely to remain off-limits for a few years</td>
</tr>
<tr>
<td>below 3.8 μSv/h</td>
<td>radiation increased by more than 10 times from before, but poses no threat to the health of short term visitors</td>
</tr>
<tr>
<td>below 1.0 μSv/h</td>
<td>radiation increased somewhat, but is comparable to regular levels in other places around the world, e.g. Denver</td>
</tr>
<tr>
<td>below 0.2 μSv/h</td>
<td>radiation increased slightly, but is similar to natural levels in most other places around the world</td>
</tr>
</tbody>
</table>

Radiation levels are shown in micro-Sieverts per hour (μSv/h) and are as of November 2013
"Dark tourism in Japan" (Akire Ide 2014)

Nagasaki – "ground zero"
Pripjat „dark tourism”
Cultural heritage sites and pilgrims

Orthodox Oldbelievers

Hasidi Jews
Summary

- The Zone and the surrounding area is more like a *frontier*, „product” of modern industrial society. It is a *changing region* according to the disaster-recovery cycle.

- It is possible to take back and use these areas but the *economic profile* will change *gradually* – new industries arrives (forestry, eco and catastrophe tourism, high tech industries etc.) old industries (food and agriculture) will disappear.

- The *entire society* will change both in the disaster affected area and in the refugee receiving area. In the receiving areas *conflicts and segregation* can occur. *Evacuated communities are disintegrating*, it is rarely possible to keep them together. An *entire region can disappear* with its people and traditions.

- Migration shifts are significant 5-10 years after the *disaster*, when clean areas receiving large number of new permanent population. The population trends can be entirely different for this decade in certain areas *challenging local housing market* and government policy. Later on this shifts are less and less significant. Some of the people (mostly elderly) remain or return, there are spontaneous and organized return migration, but *majority of the people (mostly young families) start a new life in other area*. The negative image of the region will less and less influence the migration in the future.

- There is a *strong spatial shift* towards urbanization: towns and medium urban centres provides *better chance for social re-integration* (job opportunities, social capital) even for village people. On the other hand *towns are easier to clean up, maintain and recover* than a fragmented countryside under permanent disaster pressure.
Thank you for attention!

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