

Five years of change of the perimeter of the evacuated zones following the Fukushima accident

During and after the accident at the Fukushima nuclear power plant, Japanese local and national authorities implemented measures to protect the population. Three types of measure were taken:

- Shelter and evacuation (to minimise external exposure);
- Administration of iodine (to minimise the effect due to the inhalation of radioactive iodine isotopes);
- Restrictions on contaminated foods to limit internal exposure.

This document only concerns the first of these (shelter and, more specifically, evacuation) measures, which were - and still are for evacuation - applied to geographically defined zones. These zones changed first according to reactor status and, then, according to the results of measurements and predictions of radioactive doses to the population. This document provides a summary of how and why these zones have changed over time between March 2011 to the present day.

Three phases can be observed in how the different zoning systems were set up:

- The first phase covers the period from March to December 2011 when emergency protection measures were implemented. It lasted until the end of 2011 when the Japanese government and TEPCO announced that the conditions for cold shutdown of reactors 1 to 3 of the Fukushima plant had been met;
- The second phase extends over the period from December 2011 to the end of 2013 and led to the creation of zones based on estimated predicted doses over the year following the accident. These zones were the basis for a decontamination strategy aimed at securing conditions for the eventual return of evacuees to their homes;
- Lastly, the third phase, which began in 2014, during which decontamination operations were completed and some of the evacuation orders given by the government in spring 2011 were first lifted.

1) Zone changes from March 2011 to December 2011

This first phase corresponds to the emergency phase, in other words before the stricken reactors had reached a stable state. Starting on 11 March, the authorities implemented measures to shelter and evacuate the population from the areas closest to the Fukushima NPP. These measures were gradually extended as release measurements were carried out over a period of weeks and time was required to complete the characterisation of contamination levels. It was not until the end of 2011, when the authorities and TEPCO deemed that the reactors on the site had reached a stable state, that definitive evacuation zone boundaries were defined. Table 1 and Figure 1 give an overview of how zones changed over this period.

<i>Date</i>	<i>Protective measure</i>	<i>Area concerned</i>	<i>Figure</i>
11 March 2011, 20:50	Evacuation order (Fukushima Prefecture)	2 km radius around the Fukushima NPP	Figure 1a
11 March 2011, 21:23	Evacuation order Sheltering (Japanese government)	3 km radius 3-10 km radius	Figure 1b
12 March 2011, 05:44	Evacuation order	10 km radius	Figure 1c
12 March 2011, 18:25	Evacuation order	20 km radius (represents the evacuation of some 76,000 people from 9 municipalities)	Figure 1d
15 March, 11:00	Sheltering order	20-30 km radius	Figure 1e
25 March 2011	Voluntary evacuation recommendation	20-30 km radius	Figure 1f
11 April 2011	The Japanese government announces that a total predictive dose of 20 mSv per year as from the date of the accident will be used to determine the areas from which the population must be evacuated beyond the 20 km limit		
22 April 2011	Sheltering order lifted	20-30 km radius	
22 April 2011	Definition of a "Deliberate Evacuation Area" to be evacuated within a month	Katsuro, Namie, Iitate, part of Kawamata, part of Minamisoma (totalling about 10,000 people)	Figure 1g
22 April 2011	Definition of an "Evacuation Preparation Zone" where it is recommended for residents to remain sheltered or to evacuate the area voluntarily and by their own means.	All or part of five municipalities (Hirono, Naraha, Kawauchi, Tamura and Minamisoma). Represents a population of around 59,000	Figure 1g
22 April 2011	Definition of a "Restricted Area" (strict access control measures set up in this area)	20 km radius	Figure 1g
30 June 2011	The government defines specific hot spots outside the above areas, where the projected dose exceeds 20 mSv.		Figure 1h
30 September 2011	The evacuation preparation zone is abandoned (the related recommendations no longer apply)		Figure 1i

Table 1: Location of areas where sheltering and evacuation orders were issued between 11 March and 30 September 2011.

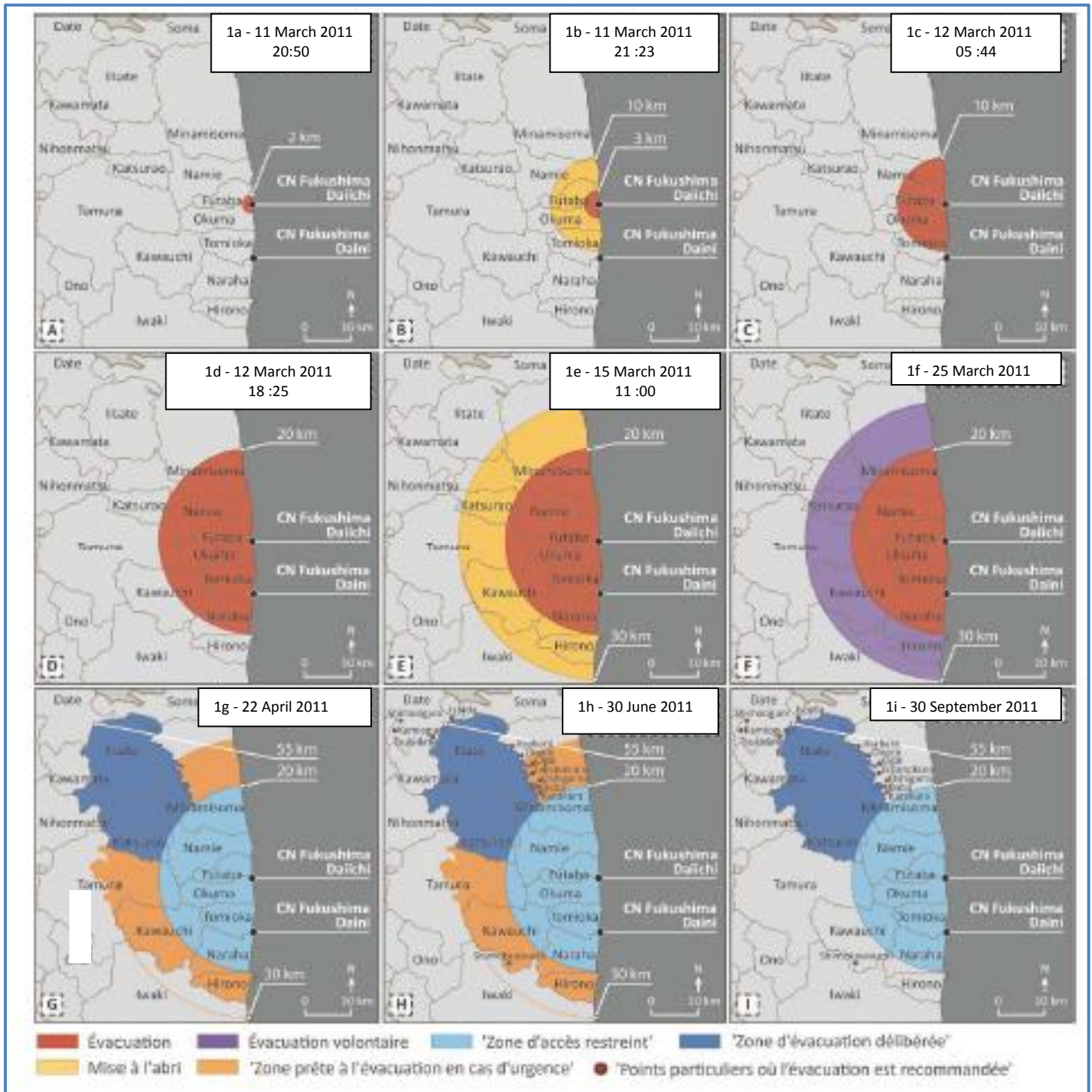


Figure 1: Time-related changes in the boundaries of sheltering and evacuation zones ordered by the Japanese government after the accident at the Fukushima Daiichi nuclear power plant from March to December 2011¹

¹ Modified from http://www-pub.iaea.org/books/IAEABooks/Supplementary_Materials/files/10962/100000/The-Fukushima-Daiichi-Accident.

2) Zone changes from December 2011 to end of 2013

At the end of 2011, the Japanese authorities, drawing on the "Act on special measures concerning the handling of radioactive pollution", defined new predictive doses (i.e. doses calculated over the first year after the accident, based on conservative assumptions) to divide the contaminated region into two large areas (see Figure 2):

- the Special Decontamination Area (SDA), which groups together all the evacuation areas defined in September 2011 (the 20 km evacuation area and the deliberate evacuation area). It is considered that the annual dose in this area could reach or exceed 20 mSv (calculated as from the date of the first releases). The government is responsible for decontaminating these areas;
- the Intensive Contamination Survey Area (ICSA), lying beyond the SDA, which includes municipalities where it is estimated that the annual dose may be between 1 and 20 mSv (dose plus radiological background) over all or some of their territory. The municipal authorities are responsible for conducting measurement campaigns to identify areas that require decontamination and then carrying out the decontamination operations, with technical and financial support from the national government.

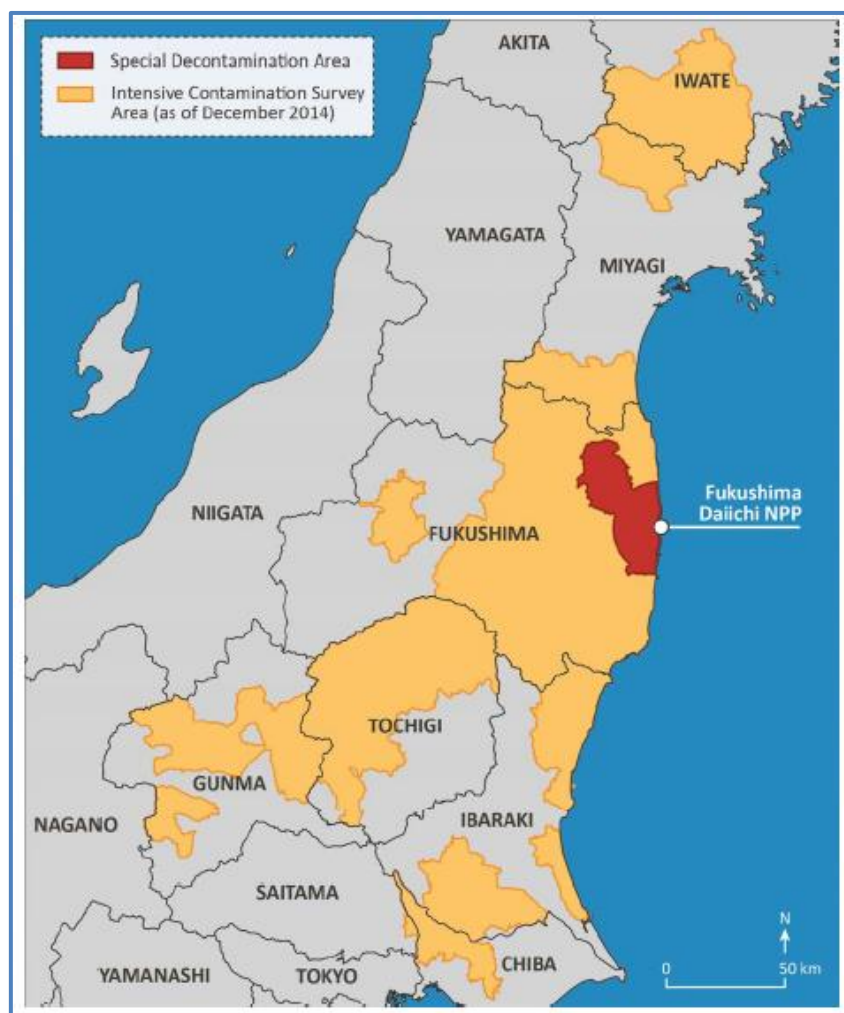


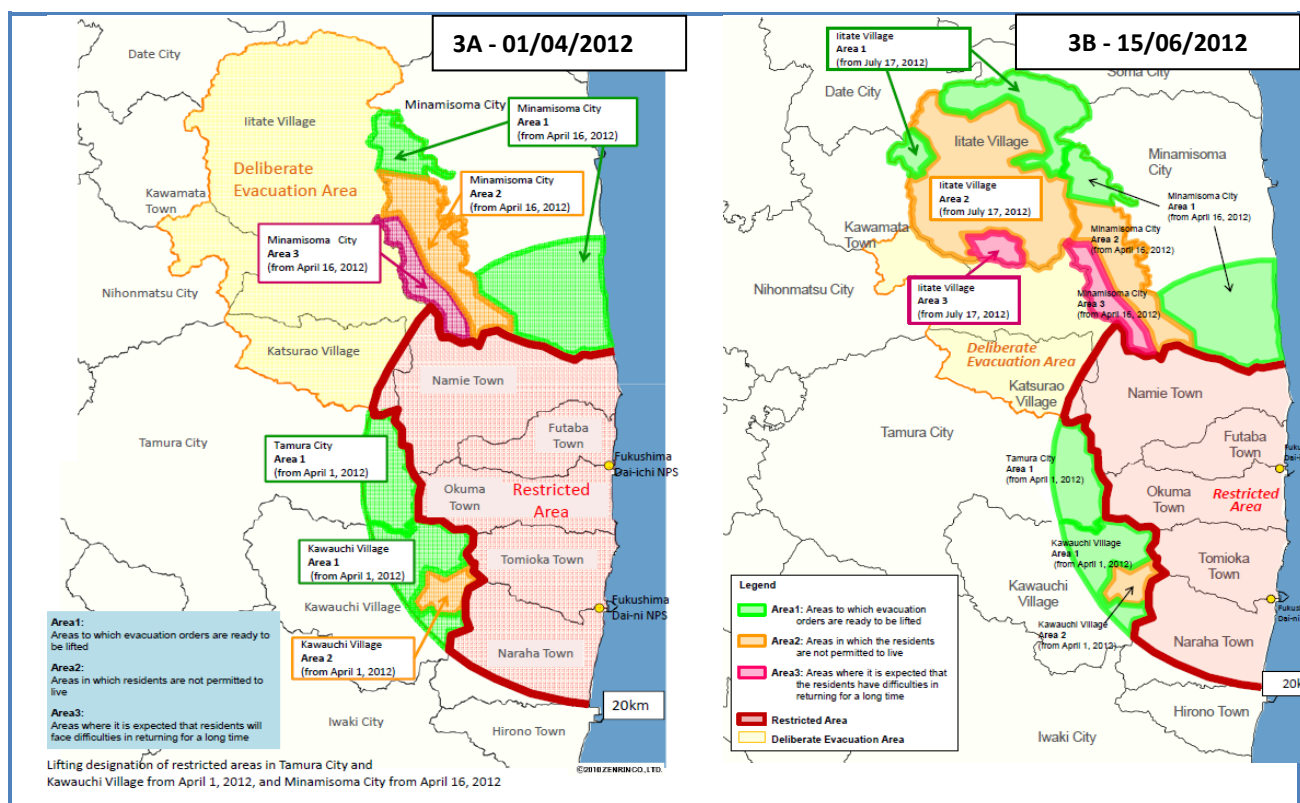
Figure 2: Location of the Special Decontamination Area (SDA) shown in red, and the Intensive Contamination Survey Area (ICSA) set up by the Japanese authorities at the end of 2011.²

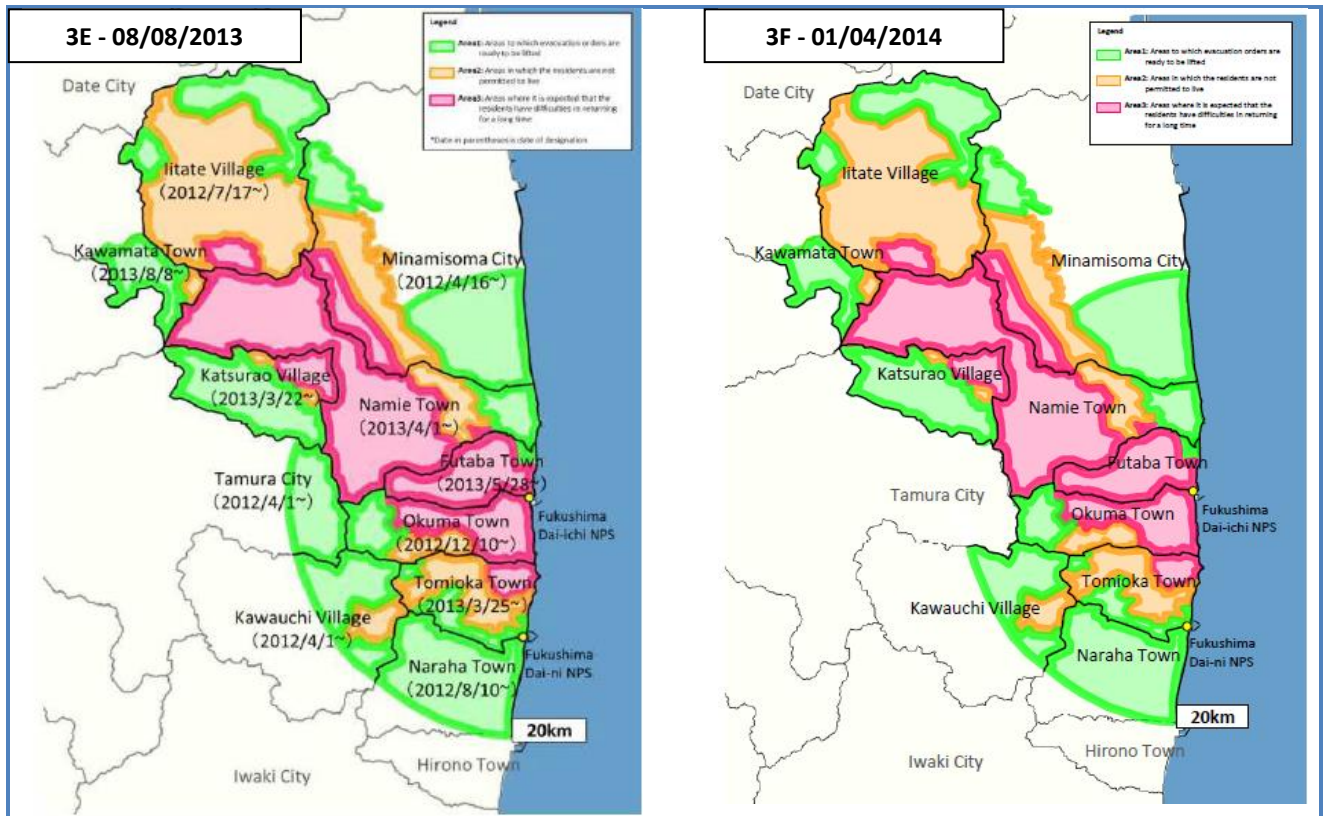
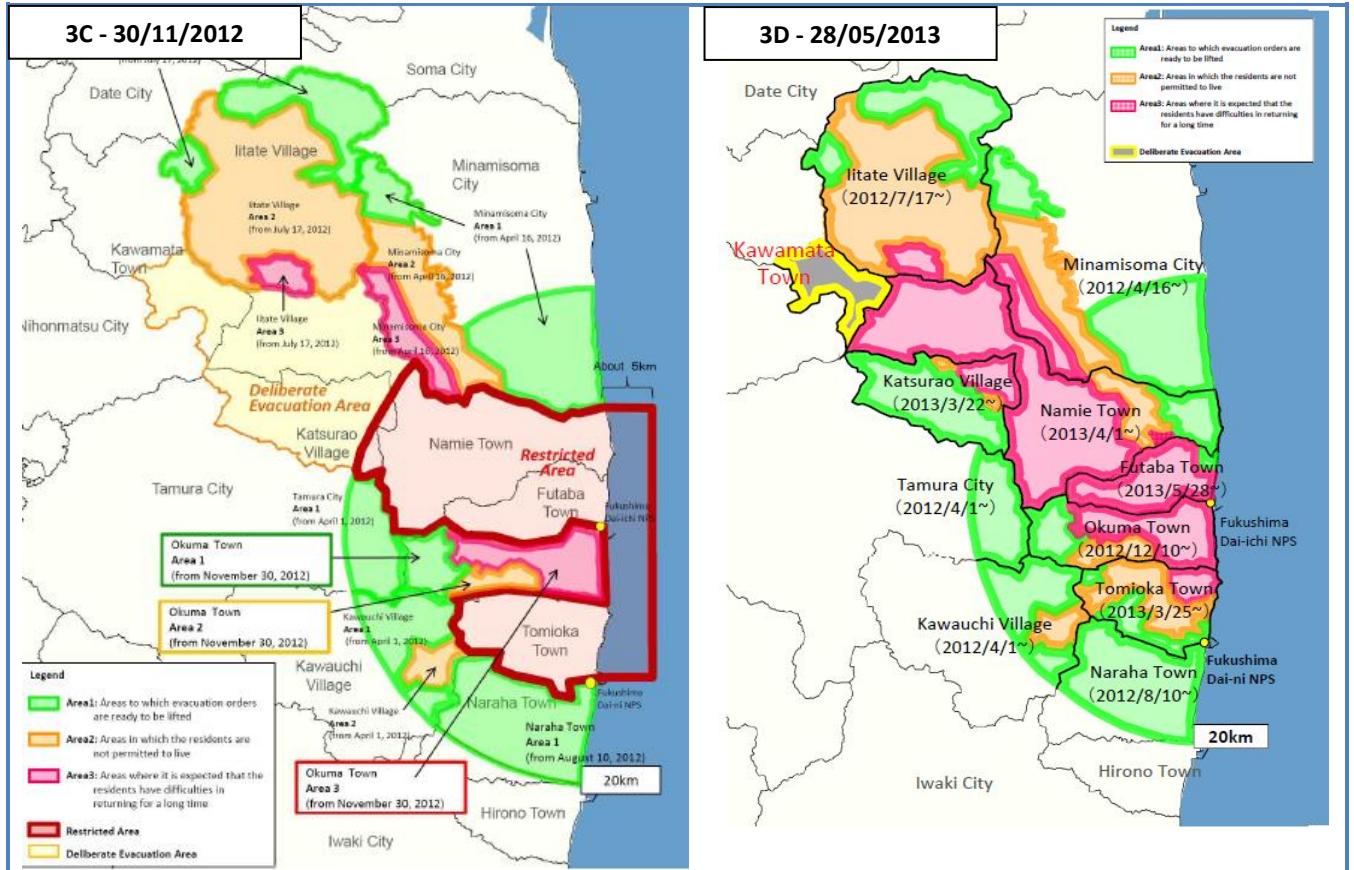
² Taken from http://www-pub.iaea.org/books/IAEABooks/Supplementary_Materials/files/10962/100000/The-Fukushima-Daiichi-Accident.

On 26 December 2011 and following the declaration by the Japanese authorities that the situation of the Fukushima NPP had stabilised (in terms of safety), the Japanese government issued a document entitled *Basic Concept and Issues to be challenged for Rearranging the Restricted Areas and Areas to which Evacuation Orders have been issued*, in which it defines new criteria for defining areas within the SDA. Three types of area are defined:

- **Zone 1 (or green zone)** where the estimated dose during the first year is below 20 mSv (based on actual measurements and conservative assumptions). This zone is considered as an "area in which evacuation orders are ready to be lifted".
- **Zone 2 (or orange zone)** where the predictive dose for the first year is between 20 and 50 mSv. This zone is also referred to as an "area in which residents are not permitted to live".
- **Zone 3 (or red zone)** where the predictive dose for the first year is greater than 50 mSv and referred to as an "area where it is expected that residents will face difficulties in returning for a long time".

The Japanese government initially intended to carry out this zoning throughout the SDA between December 2011 and March 2012 so that decontamination and infrastructure revitalisation and reconstruction work could begin as soon as possible. Owing to a number of factors, however, such as characterisation of contamination, the need to reach a local consensus on the implementation of decontamination operations, and the search for temporary waste storage sites, it was not until August 2013, about a year and a half later, that the entire SDA was divided up according to the three types of defined area. During that period, several versions of SDA zoning (see Figures 3A to 3E) were issued reflecting the progress of characterisation work and negotiations at the local level. The beginning of August 2013 saw the first complete version of the SDA breakdown into green, orange and red zones (see Figure 3E).





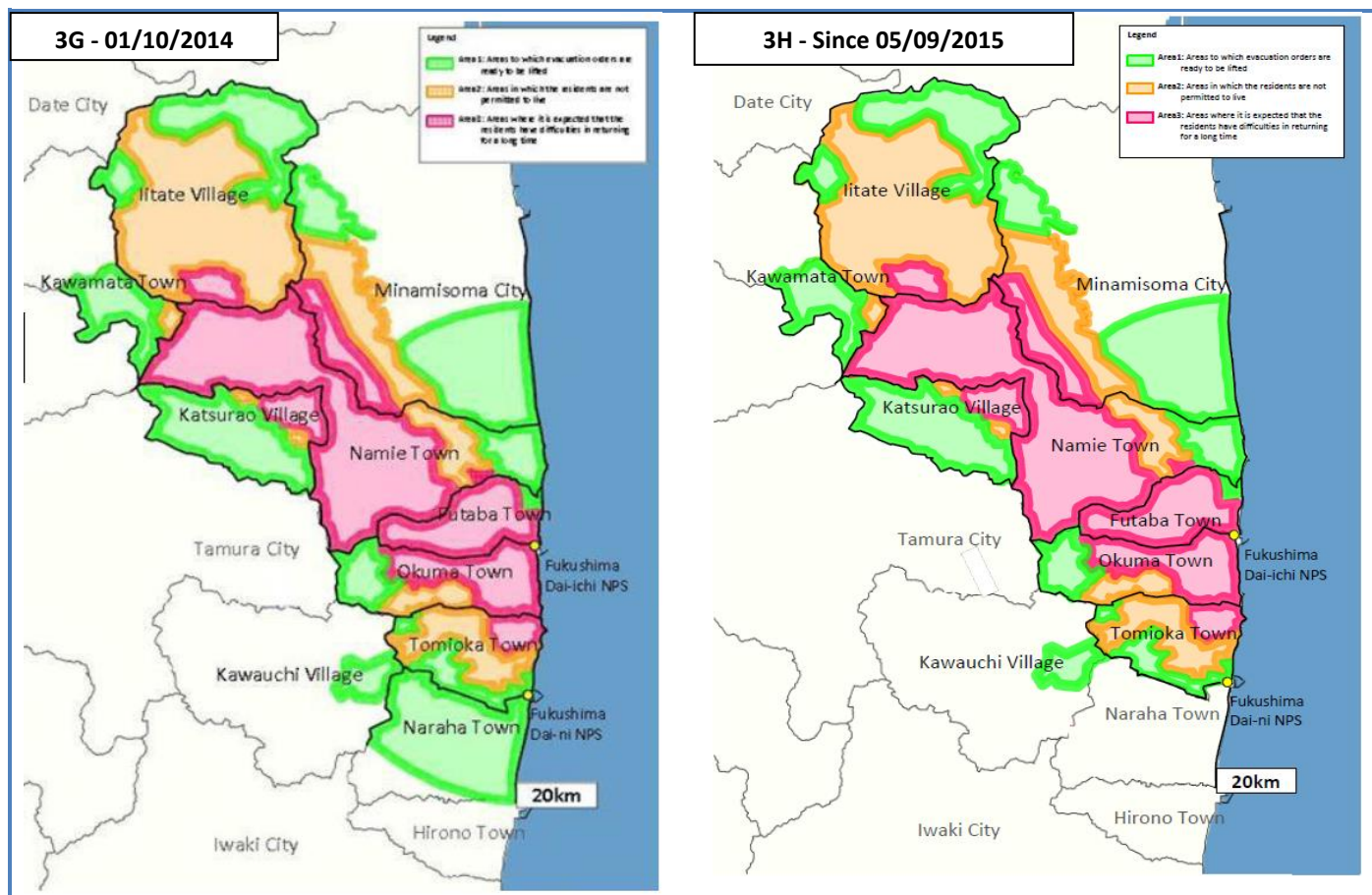


Figure 3: Zone changes in the Special Decontamination Area between April 2012 and September 2015.

3) Zone changes from December 2013 to end of 2015

In July 2011, the Japanese government defined the conditions to be met for lifting evacuation orders in a document entitled *Basic policy for emergency response on decontamination work*. The document defines three conditions:

- Confirmation that the annual dose will not exceed 20 mSv;
- Confirmation that sufficient progress has been made in restoring essential facilities, especially those frequented by children;
- Confirmation that structures are in place to allow dialogue between local and regional authorities (municipal councils and prefectures) and residents.

These conditions were met in early 2014 following the completion of decontamination work, allowing the evacuation order to be lifted in three municipalities (or in certain areas within them):

- on 1 April 2014 in Tamura;
- on 1 October 2014 in Kawauchi;
- and on 5 September 2015 in Naraha.

As a result, these municipalities are no longer in the green zone as shown in Figures 3F, 3G and 3H.