

Development of spatial transition model and recovery scenarios in Fukushima

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- Development of spatial models for local analysis
- Progress of recovery from Nuclear Disaster
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 - A preliminary experimental population projection

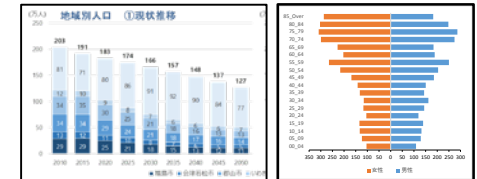
Research motivation

- For recovery of Fukushima
 - Showing quantitative roadmaps of ;
 - Reconstruction from Tsunami disaster
 - Recovery from radioactivity pollution
- Contribution for the other Japan municipalities
 - Local development strategy against demographic change
 - Aging, Population reduction, Migration
- Contribution to the sustainability of the world
 - Knowledge on risk and recovery process of nuclear accident
 - Analytical quantitative methodology of Societal-economic-environmental recovery process after large disaster

Progress of spatial modeling

1. Socio-economic Macro Model

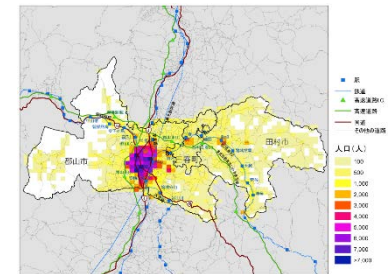
Population
GDP by industry
Employment
(City)



2. Spatial Distribution Model

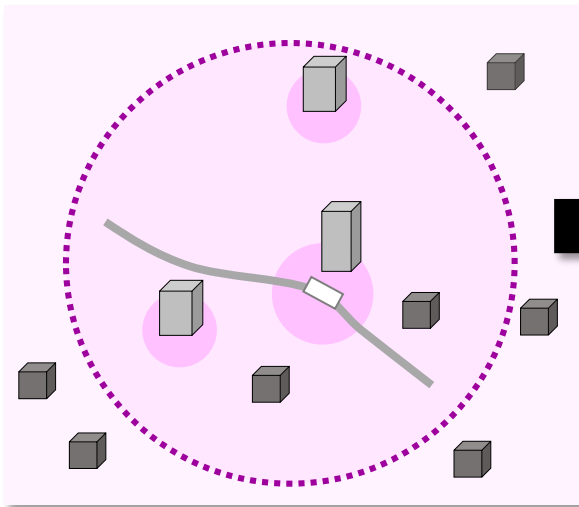
Urban core area
Fringe area
Building disposal rate
Migration rate

Population
Employment
Floor area
(500x500m)

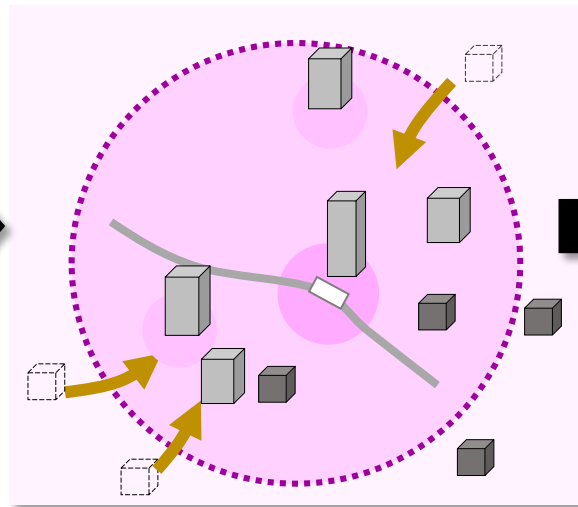


Spatial distribution scenarios

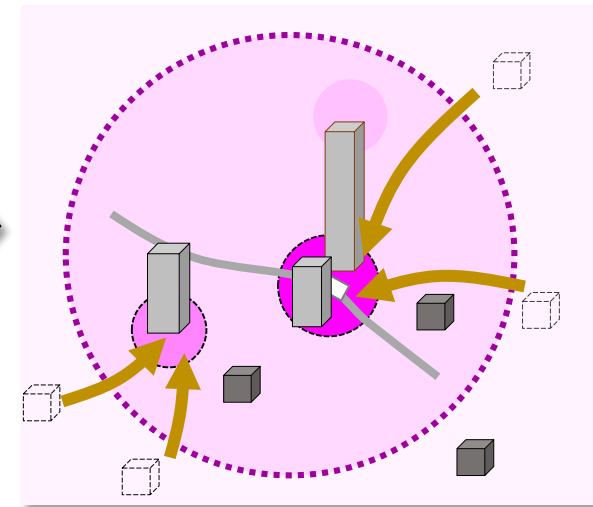
BAU



Compact-A



Compact-B



BAU

Current spatial pattern continues throughout the simulation period

Compact-A

Move activities from suburban to “urbanization area”

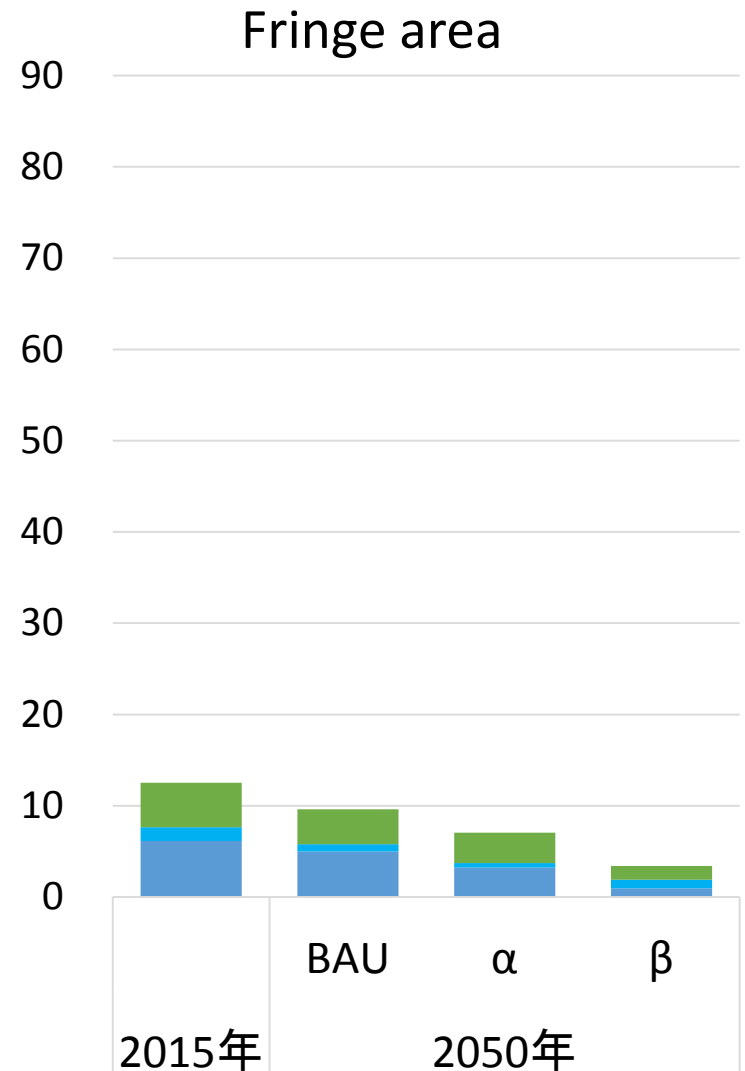
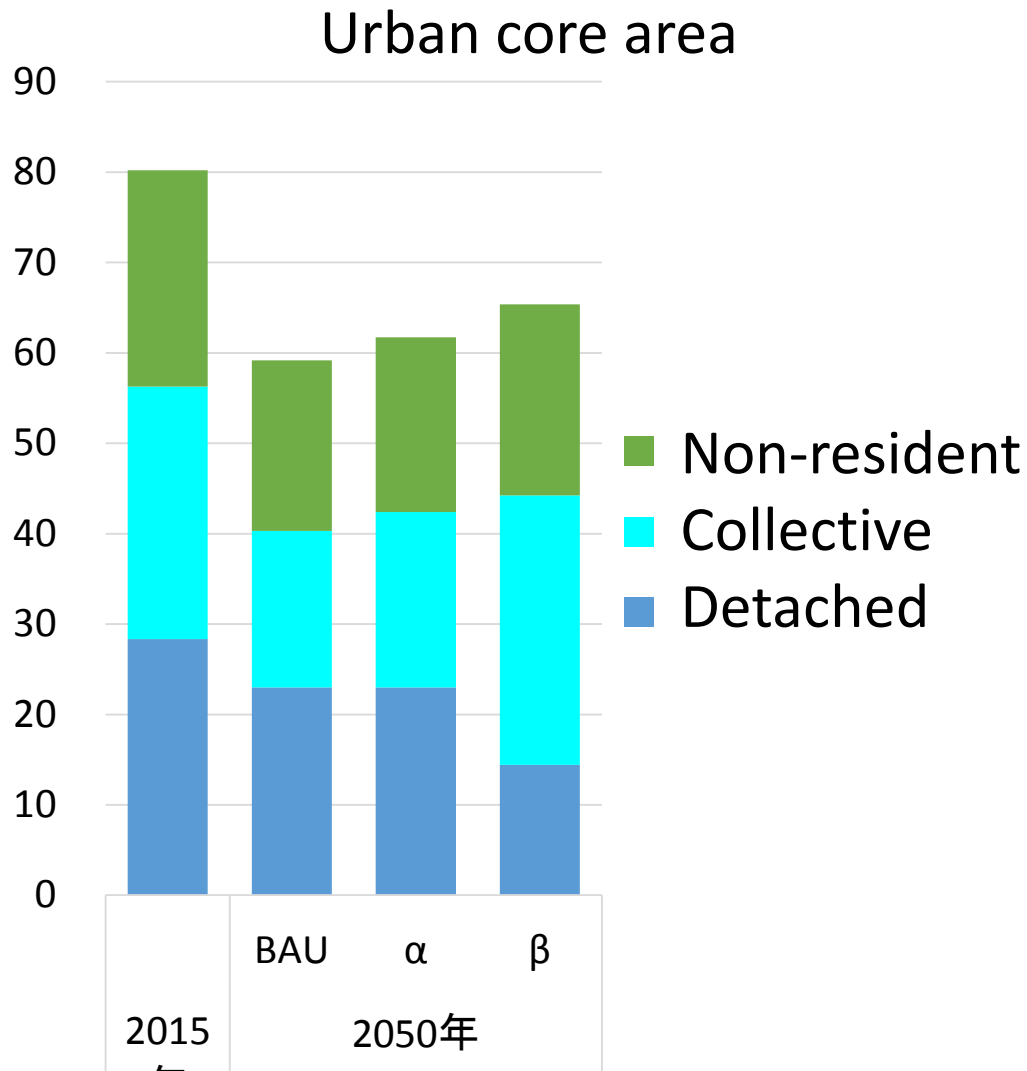
Compact-B1

Move activities from suburban area to “city core centers” determined in the official urban plans.

Compact-B2

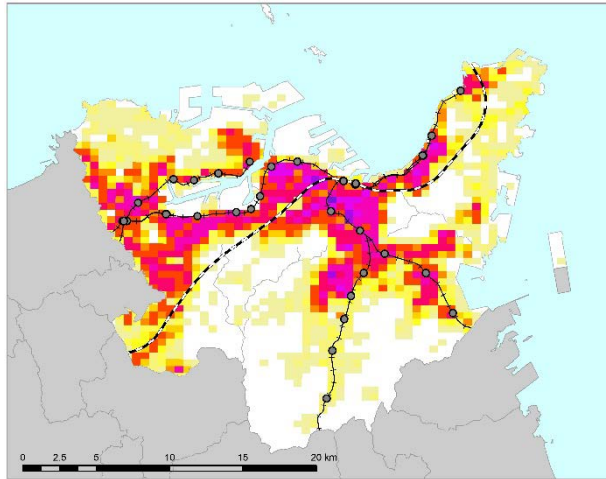
Move activities from suburban area to fewer number of “city core centers”. Detached house is reduced.

Application in Kitakyushu City

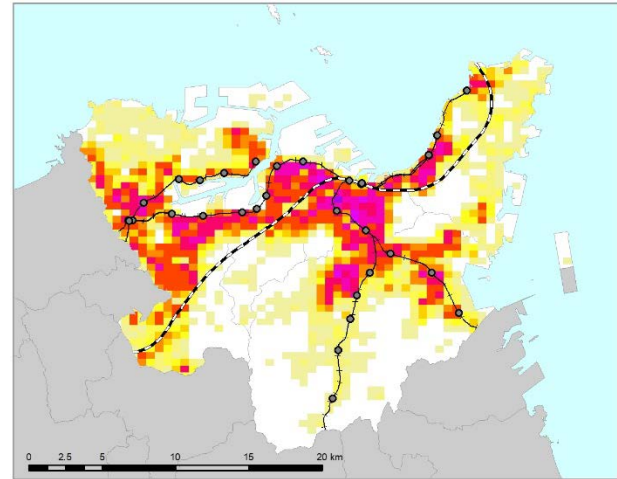


Population density

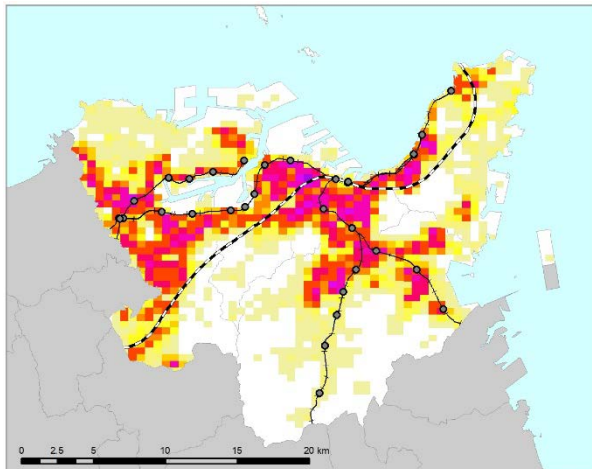
2015



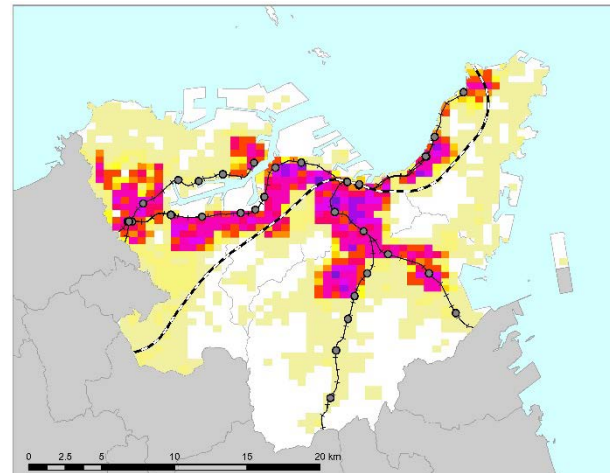
2050BAU



































































































2050 α



2050 β



Local Snapshot Model and SDGs

	 1 Poverty	 2 Hunger	 3 Health	 4 Education	 5 Gender	 6 Water	 7 Energy	 8 Economy	 9 Technology	 10 Inequality	 11 City	 12 C&P	 13 Climate	 14 Sea	 15 Land	 16 Justice	 17 Partnership			
	1 Poverty	2 Hunger	3 Health	4 Education	5 Gender	6 Water	7 Energy	8 Economy	9 Technology	10 Inequality	11 City	12 C&P	13 Climate	14 Sea	15 Land	16 Justice	17 Partnership	Total		
Assumptions	Birth/death rate																		5	
	Employment																		4	
	RE investment																		4	
	Industry location																		4	
	Urban core																		3	
	Transport structure																		2	
	Labor productivity																		3	
	Working time																			2
	Consumption																			7
	Energy tech. Waste management																			3 2
Socio-economic var.	Population																		4	
	Labor																		3	
	Industrial output																		3	
	Commuting																		5	
	Expenditure																		4	
	Transport volume																		2	
	Spatial distribution																		5	
Env. & Ent.	Energy demand																		3	
	Energy supply																		3	
	CO2 emissions																		1	
	CO2 sink																		2	
	Waste disposal																		3	
Total	4	5	4	2	4	2	6	8	7	3	9	6	13	0	4	0	0	77		

2011. 3. 11



18,455 people were killed.

2011.3.11



400,326 buildings were destroyed.

Nuclear Accident

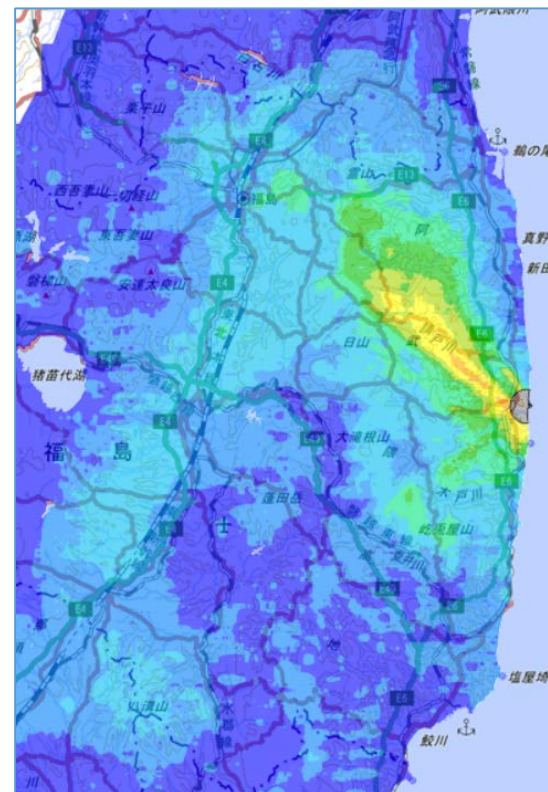
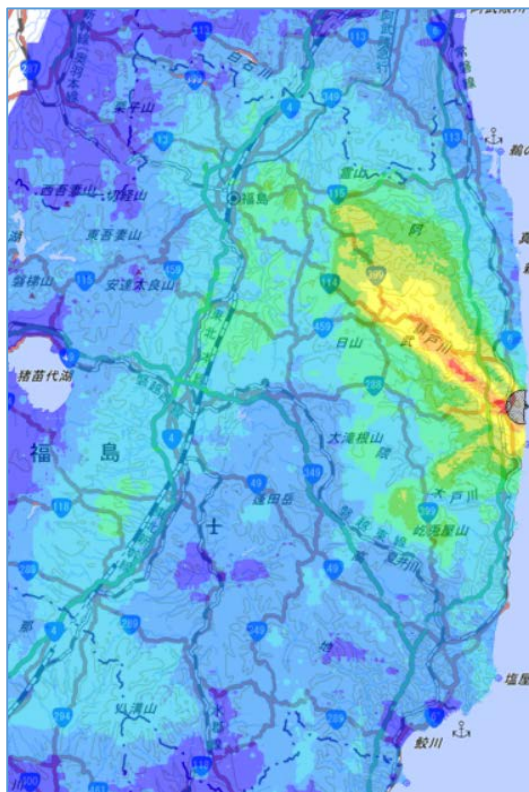
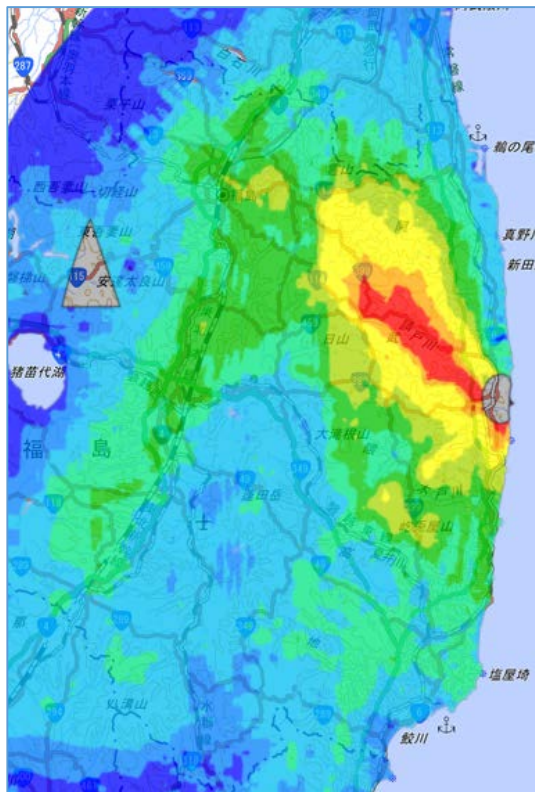


Radioactivity pollution overtime

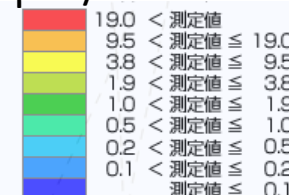
May 2011

Nov. 2014

Nov. 2017



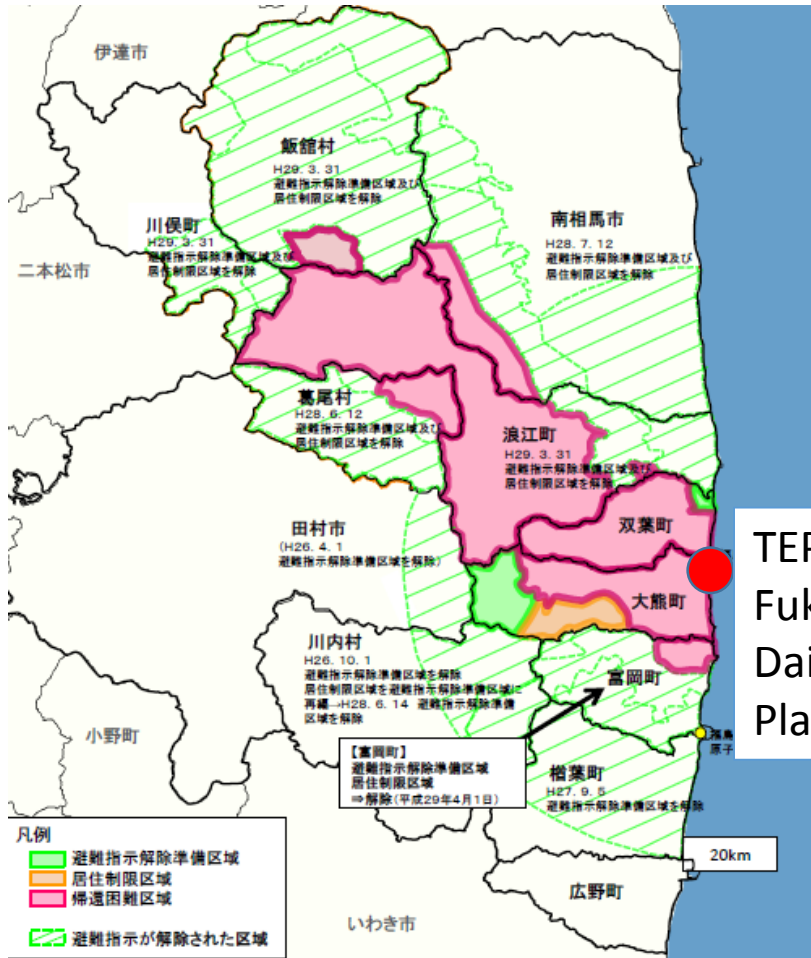
$\mu\text{Sv/h}$



Source

Nuclear Regulation Authority, Japan: Monitoring Information of Environmental Radioactivity Level, <http://radioactivity.nsr.go.jp/>

Evacuation from Nuclear Accident



12 municipalities

Evacuation order was
lifted in 9 municipalities
since 2014
(at least partially)

Evacuees

164,865 (78%)

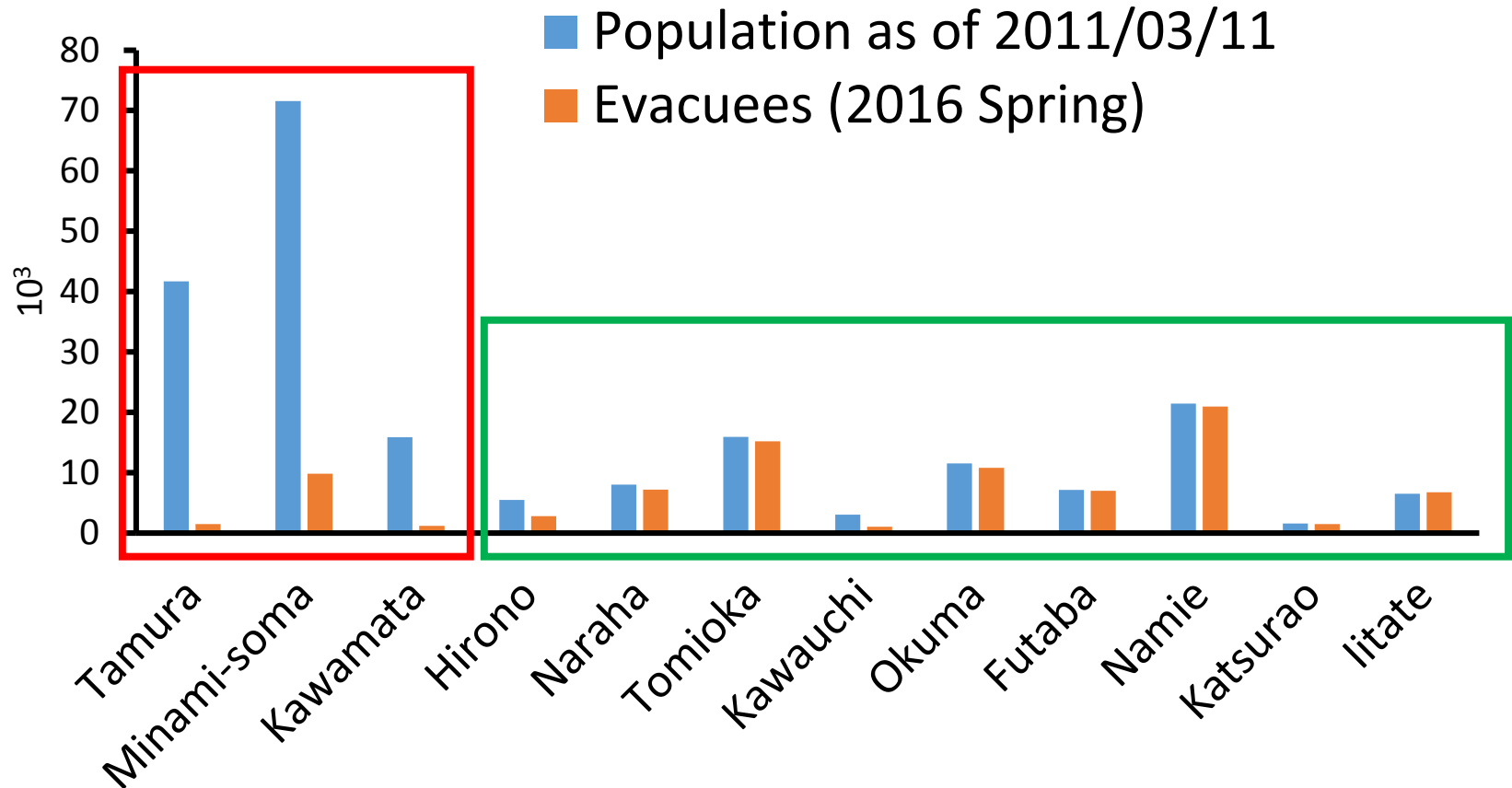
at maximum
(May, 2012)

44,878 (21%)

(Oct. 2018)

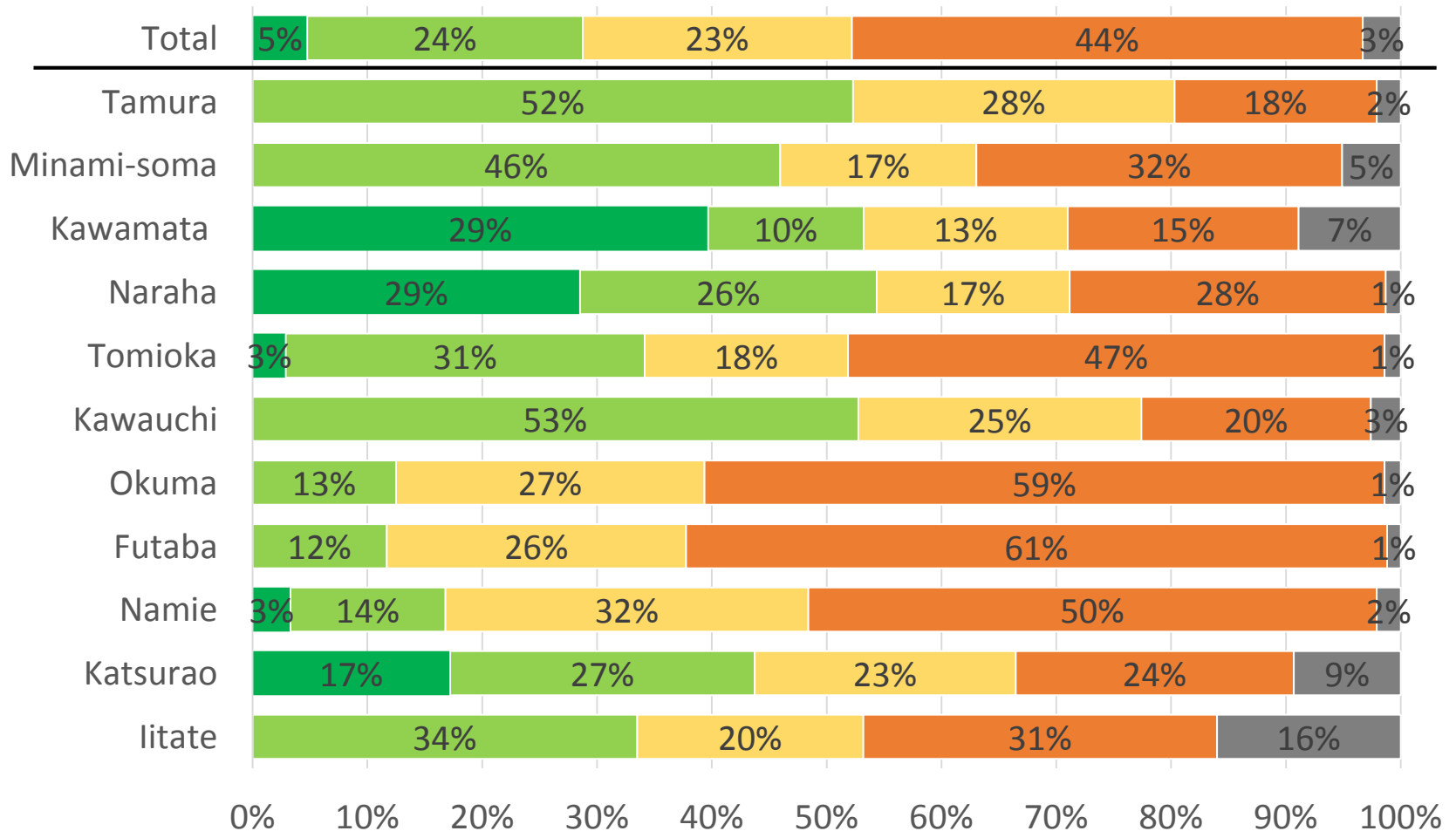
Source: Fukushima prefecture website
<http://www.pref.fukushima.lg.jp/site/portal/list271.html>

12 Municipalities



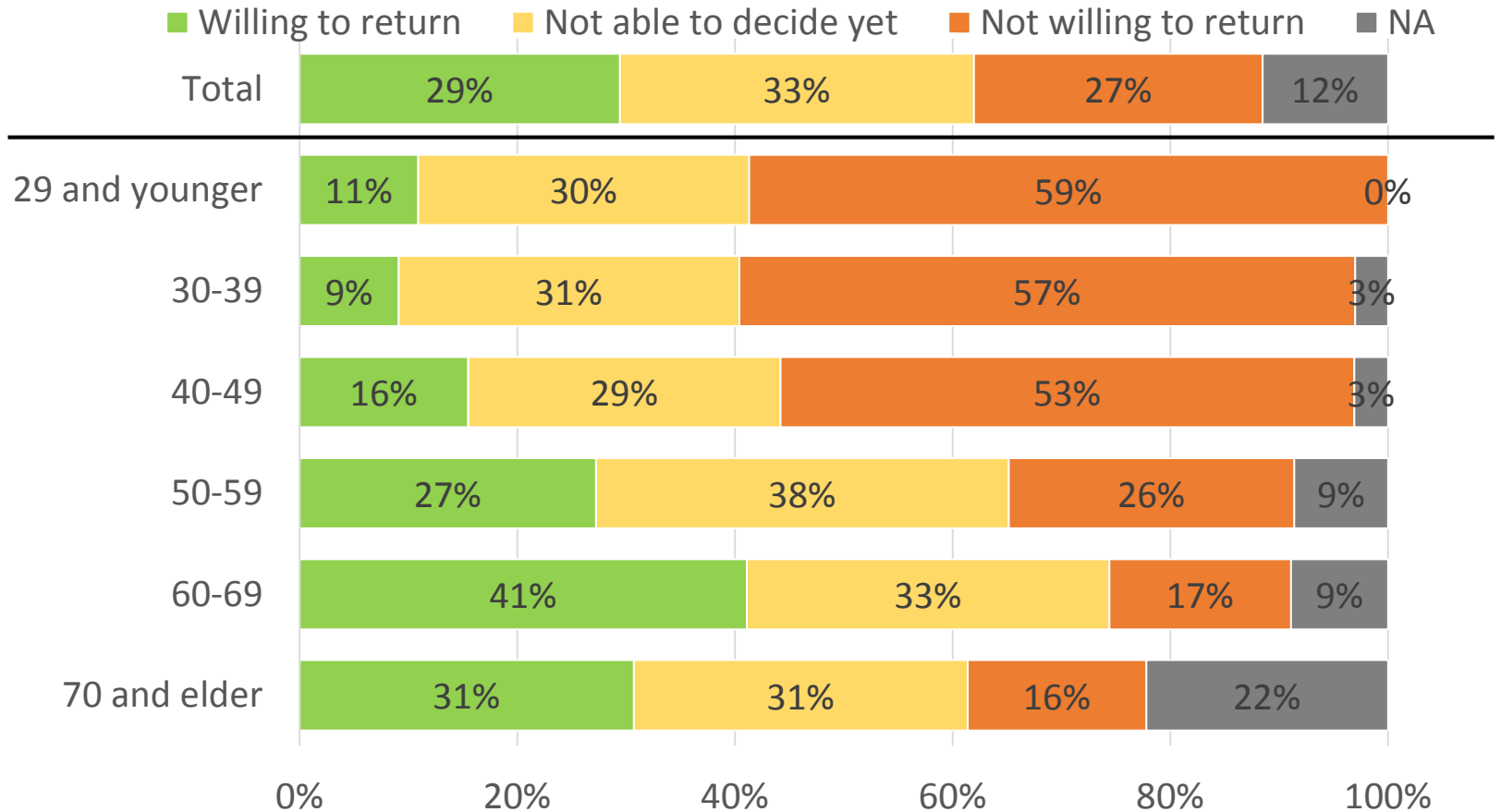
Willingness to return by municipalities

■ Returned
 ■ Willing to return
 ■ Not able to decide yet
 ■ Not willing to return
 ■ NA



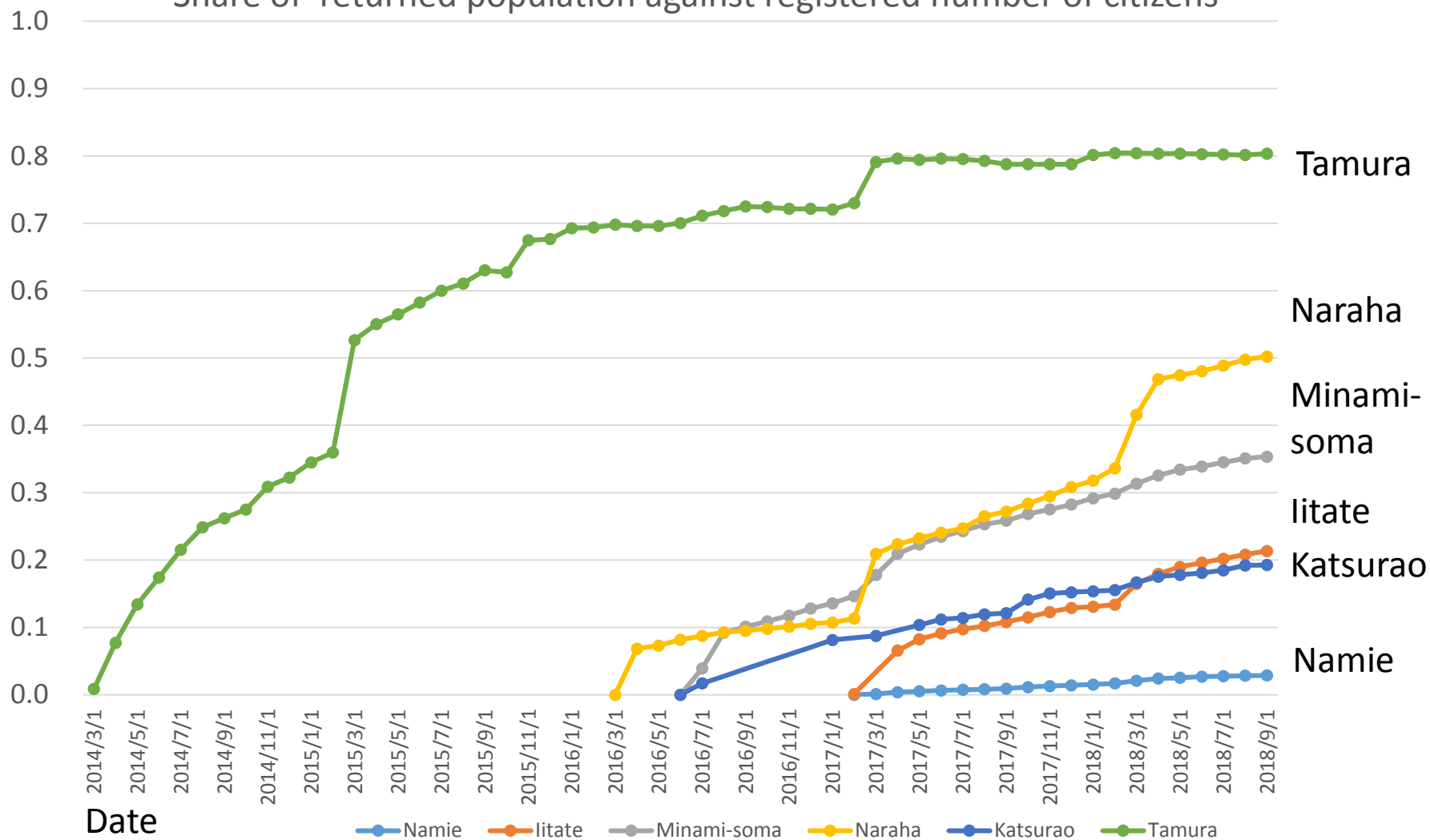
Source: "Willingness Survey" conducted by Reconstruction Agency and each municipal governments. Latest available results were aggregated by the presenter.

Willingness to return by age



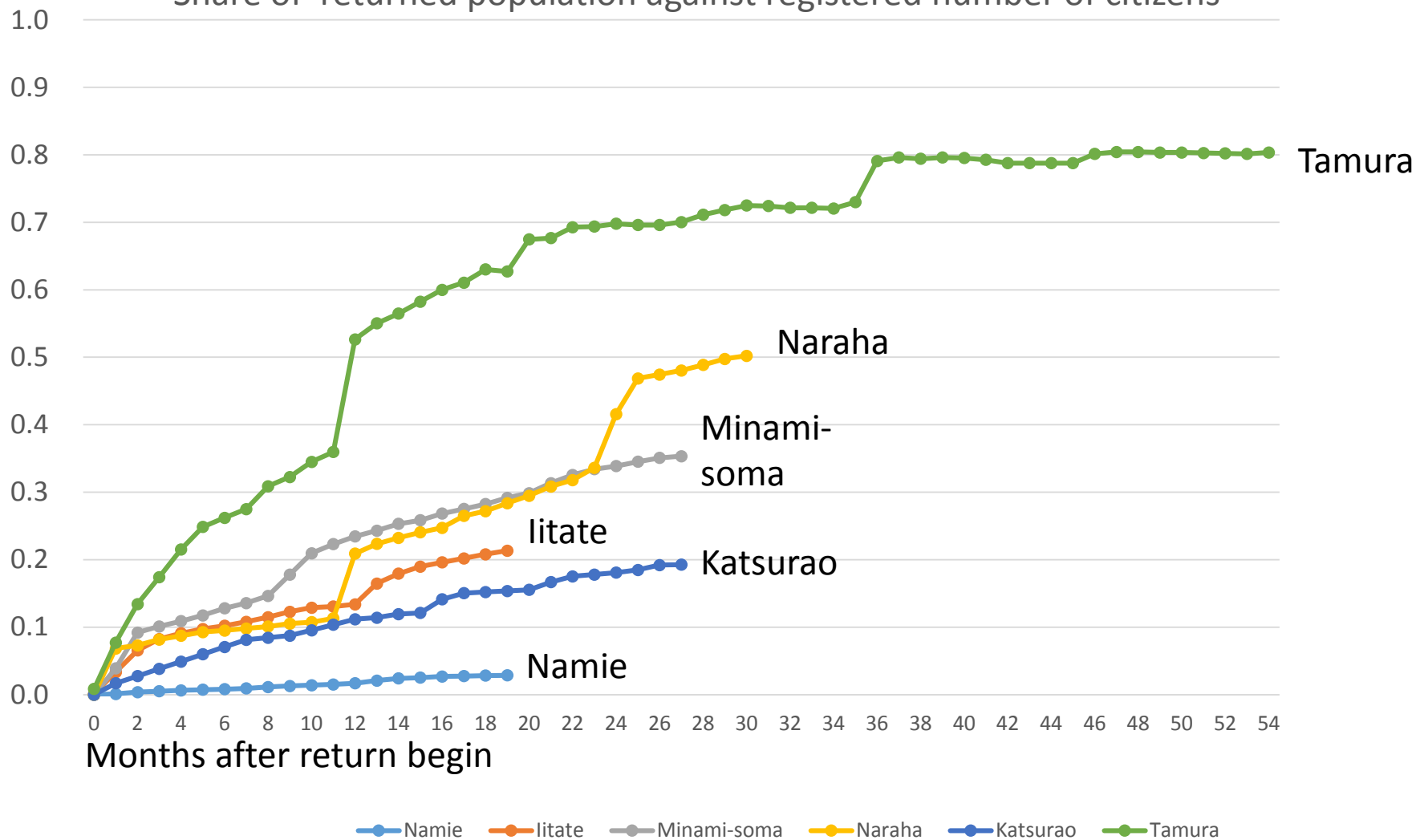
Population after returning begin

Share of returned population against registered number of citizens

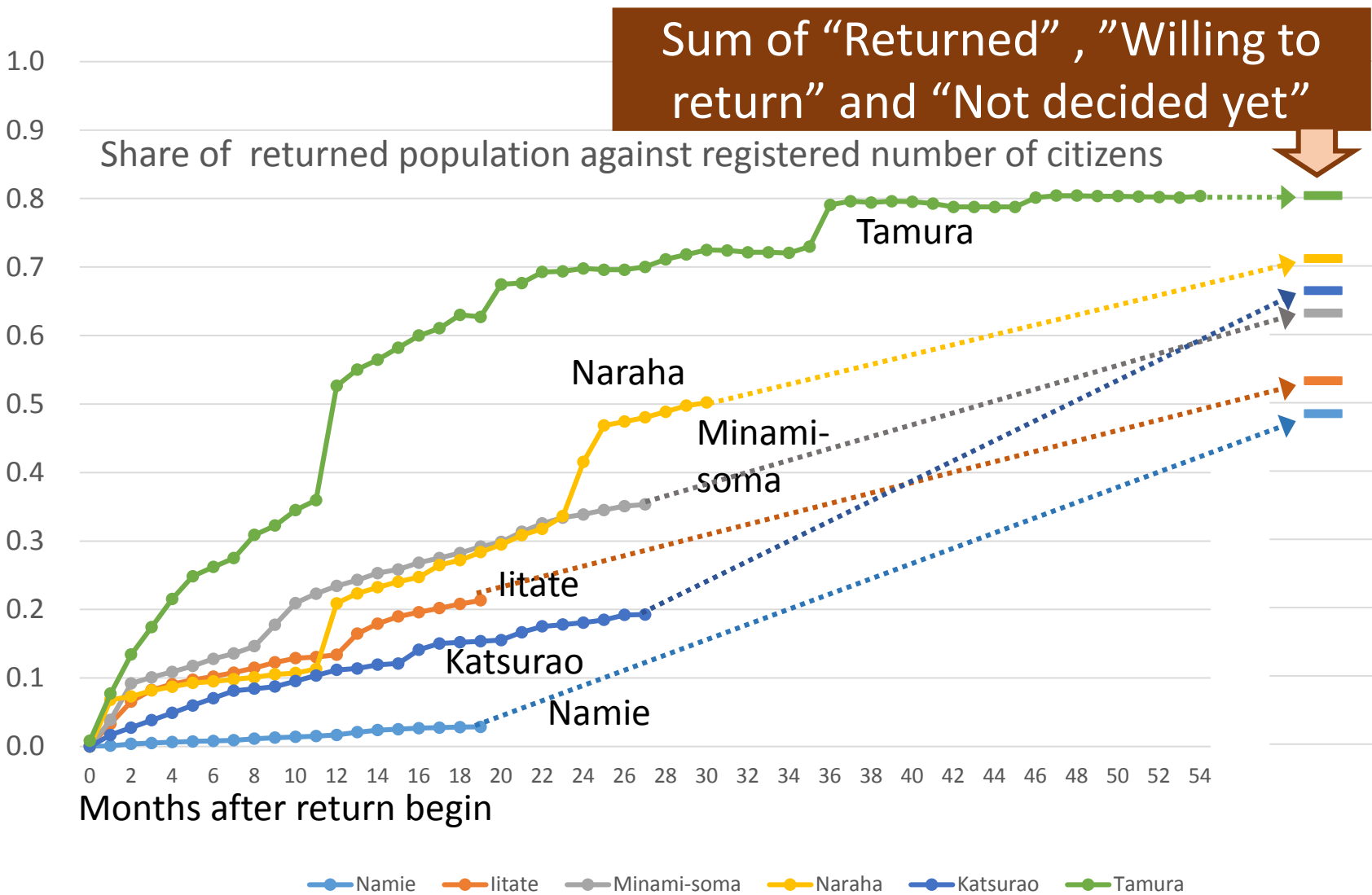


Population after returning begin

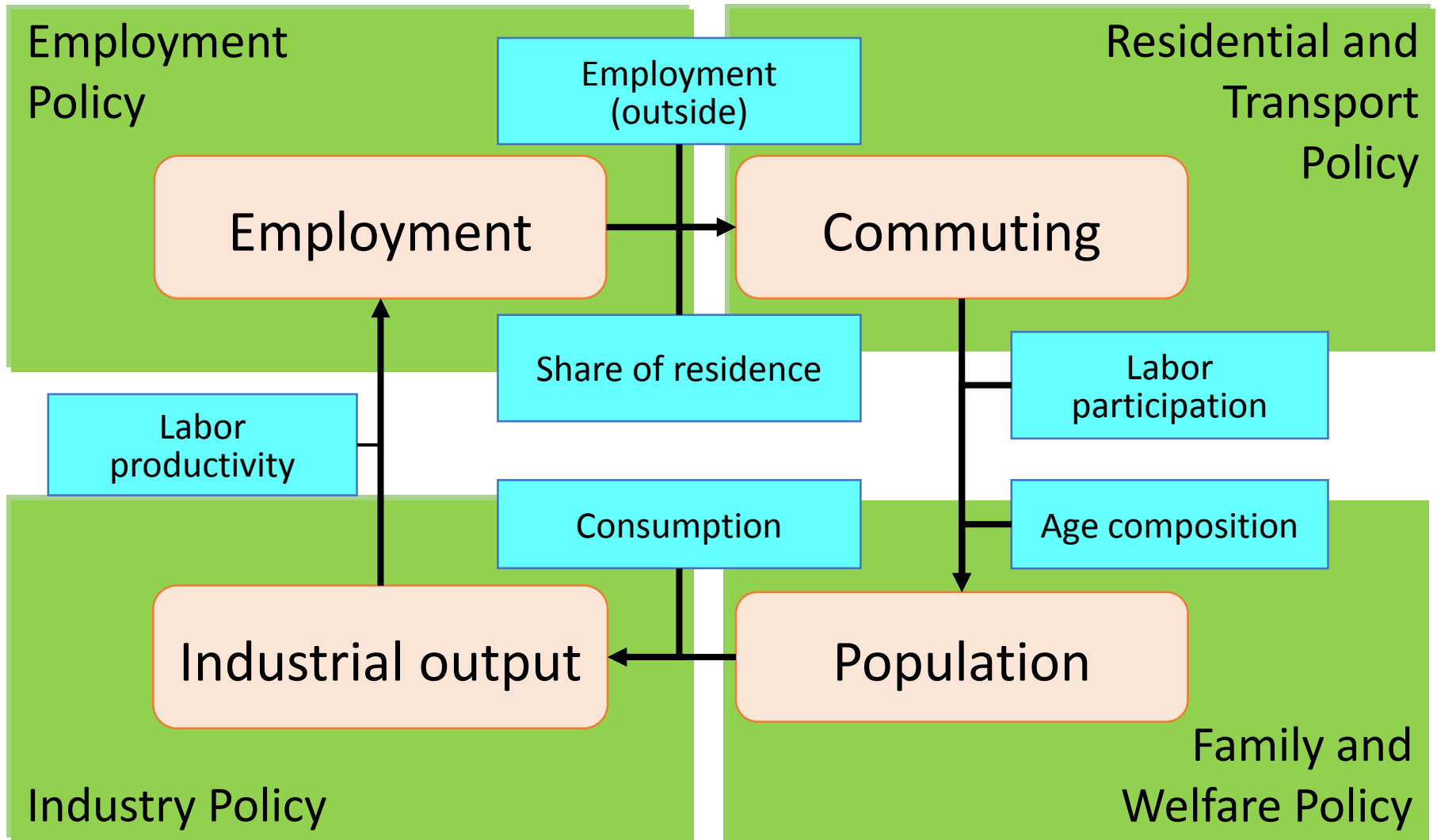
Share of returned population against registered number of citizens



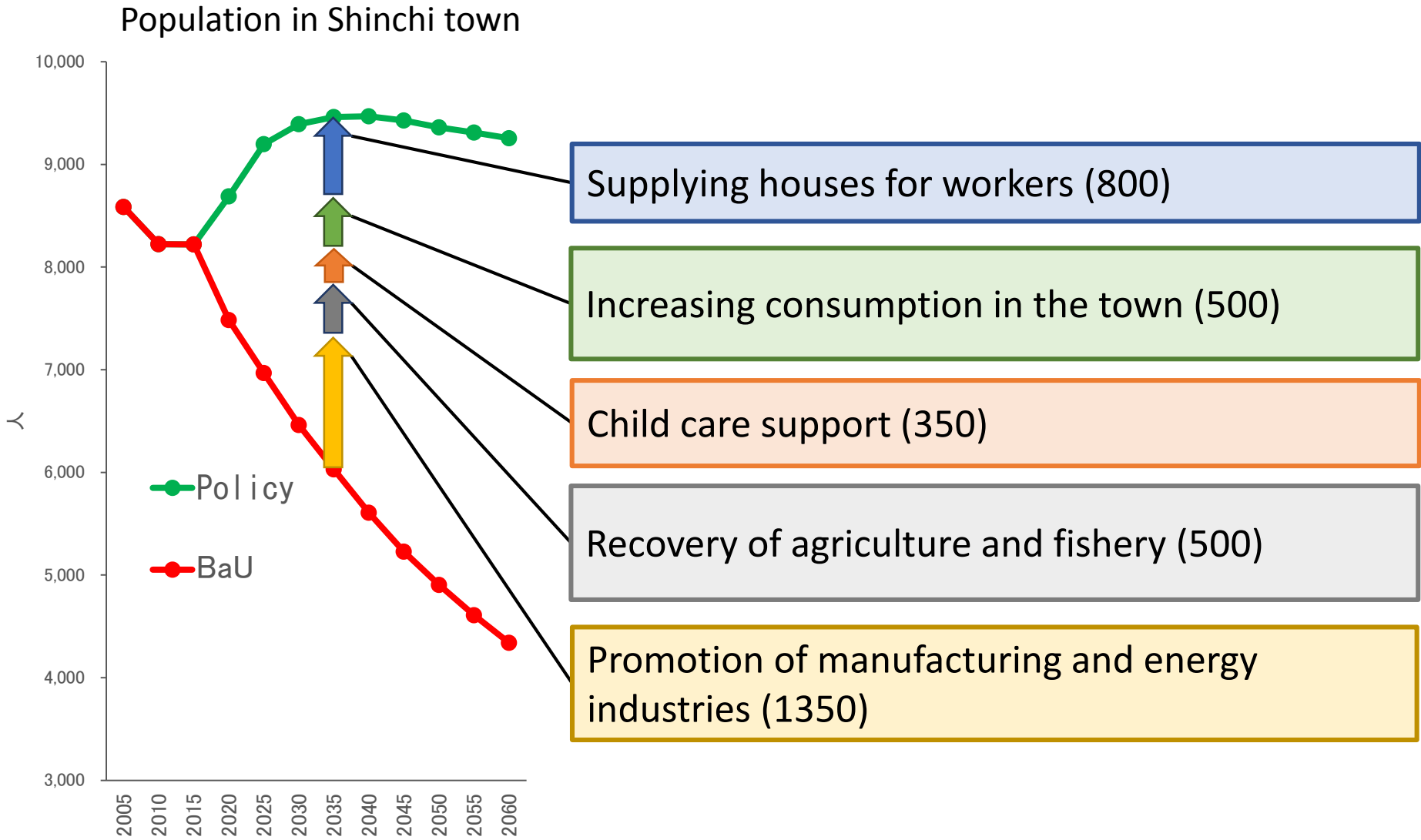
Retuning behavior and willingness



Local Snapshot model:
Integrated model of population and local economy



How can population be maintained?



Issues to be considered

- Physical development
 - “Specific reconstruction and recovery base” in the heavily polluted area
 - Infrastructure construction
 - Facility re-open
- Economic reconstruction project (METI)
 - “Fukushima Innovation Coast” projects
 - Robotics, Medical, High-tech agriculture, Smart energy
- Environmental recovery project (MOE)
 - Fukushima future-oriented projects
 - Low-carbon project: H2, Biomass, local transport, etc.

Preliminary experimental simulation

- Simulate long-term population dynamics in the area using standard cohort-type model
- Develop alternative scenarios based on willingness to return

Summary

- Recovery, reconstruction and return of evacuees are still underway in Fukushima
- Monthly population data shows different progress of return in different municipalities
- Preliminary population simulation projected a highly aged, smaller-than-ever society
- Economic and environmental reconstruction and recovery projects should be considered