Sixth Annual IIASA-DPRI Forum
Integrated Disaster Risk Management
Risk and Challenges for Business and Industry

Developing evaluation indicator for disaster shelter planning from the viewpoint of local people

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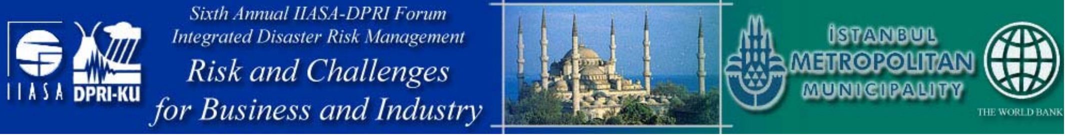
August, 12-17, 2006



Outline

- Background
- Evaluation indicator (performance criteria) for disaster shelter planning

  -- Case study in Nagata Ward by using questionnaire survey
- Conclusion and discussion

Background

- Lots of countries have started to set up disaster shelters, however performance criteria of shelter planning are different

Criteria of disaster shelter planning in some countries

Contents	Tokyo Pref., **Japan** Ordinance of Earthquake Disaster Countermeasure of Tokyo Metropolitan	Aichi Pref., **Japan** Shelter management manual of Aichi Prefecture, Japan	FEMA 361, **USA** Design and construction guidance for community shelters (FEMA 320)	Beijing, **China** Beijing Regional Criteria: <Earthquake emergency shelter criteria>	**Nagata Ward**, Kobe City, Hyogo Prefecture, Japan
Purpose	Protect people from earthquake and earthquake triggered fire disaster	Protect people from disaster, and as a basis of local people to start their new life	Protect people from tornado and hurricane (lasts no more than 36 hours)	Protect people from disaster (especially earthquake, flood, fire and explosion)	Protect people from disaster (especially earthquake and fire)
Principle	1. To be located in safety area and with safe evacuation routes 2.To be managed by community people	1. Location safety and will be closed after restoration 2.offer lifeline support 3.To be rebuilt, designed and organized, managed and operated by community people	1. occupant safety 2. design space limitations 3. shelter benefit and cost	1. To be located in safety area 2. To be consistent with urban planning and operable 3. To be used as other facilities during normal period 4.shortest evacuation distance	1. local area criteria 2. elementary school campus 3. shortest evacuation distance
Types	Temporary Accommodation	Temporary; Accommodation	Temporary	Emergency	Temporary Accommodation

Continued

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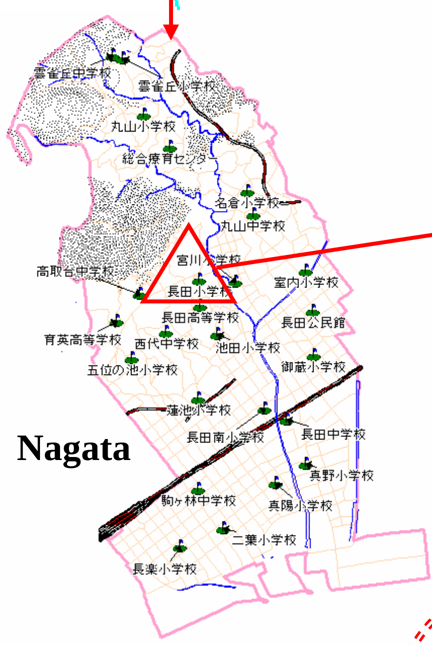
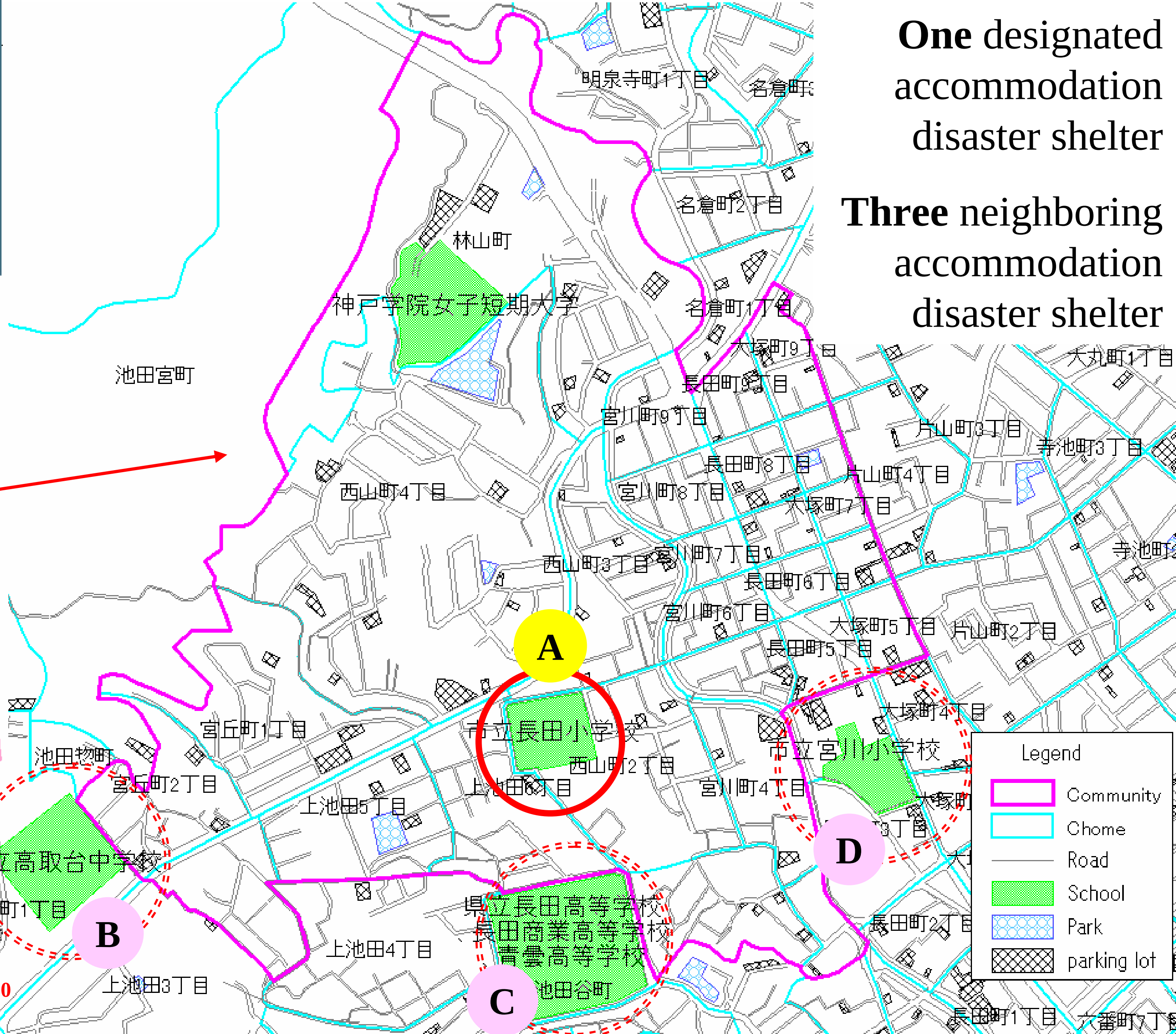
Criteria	Location	Outside hazard prone area	Outside hazard prone area	Outside hazard prone area, away from large objects & multi-story buildings, near public facilities	Outside hazard prone area	--
	Structure	Aseismatic and fireproof	Aseismatic and fireproof	Aseismatic and fireproof	Temporary tents	--
	Facilities	Public or private facilities such as park, school,	Public or private facilities such as park, school,	Single-use and multi-use Stand-alone and internal shelter	Park, public green land, plaza, playground, or gym	Elementary school, park, play ground
	Scale & Capacity	At least 600sq.m 1sq.m /person (temp) 1.5sq.m /person (accomm.)	Accept more than 50 persons 2 sq. m /person	6sq.ft/person for tornado, 20sq.ft/person for hurricane	More than 10 000sq. m 1.5-2sq.m/person	More than 10ha, 1 sq. m /person (temp. shelter)
	Evacuation routes	Wider than 12m	Wider than 12m	--	At least 2 evacuation routes	--
	Evacuation tool, time or distance	Car is forbidden Service radius 500-700m	Service radius 500-700m	Within 5mins to reach shelters and within 10mins to secure shelter doors	Within 5-10mins (walking) Service radius 500m	Service radius 2km
	Signage	National standard signal	National standard signal	Yes	Multi-language, clear and understandable	--
	Parking	no	no	yes	no	no
	Pets	no	no	yes	no	no
	Others	local people's familiarity management manual	local people's familiarity	Ventilation, lighting, emergency provision, emergency power	Emergency command center, power, toilet and helicopter are offered	Managed by local people

Background

- Work systematically conducted with indicator system of shelter planning is few
  - Design criteria of community shelters for extreme wind events—building structure (William, et al, 2002)
  - Hurricane shelter location selection—hazard info. & building structure (John, et al, 2003)
  - Shelter location selection—household, food, accommodation capacity (Tomohiro, et al, 2004)
  - Evaluation index for evacuation planning (Akiyoshi, et al, 2006)
- Most existing shelter plans are done by governments, need local people participatory

Nagata Element School Community





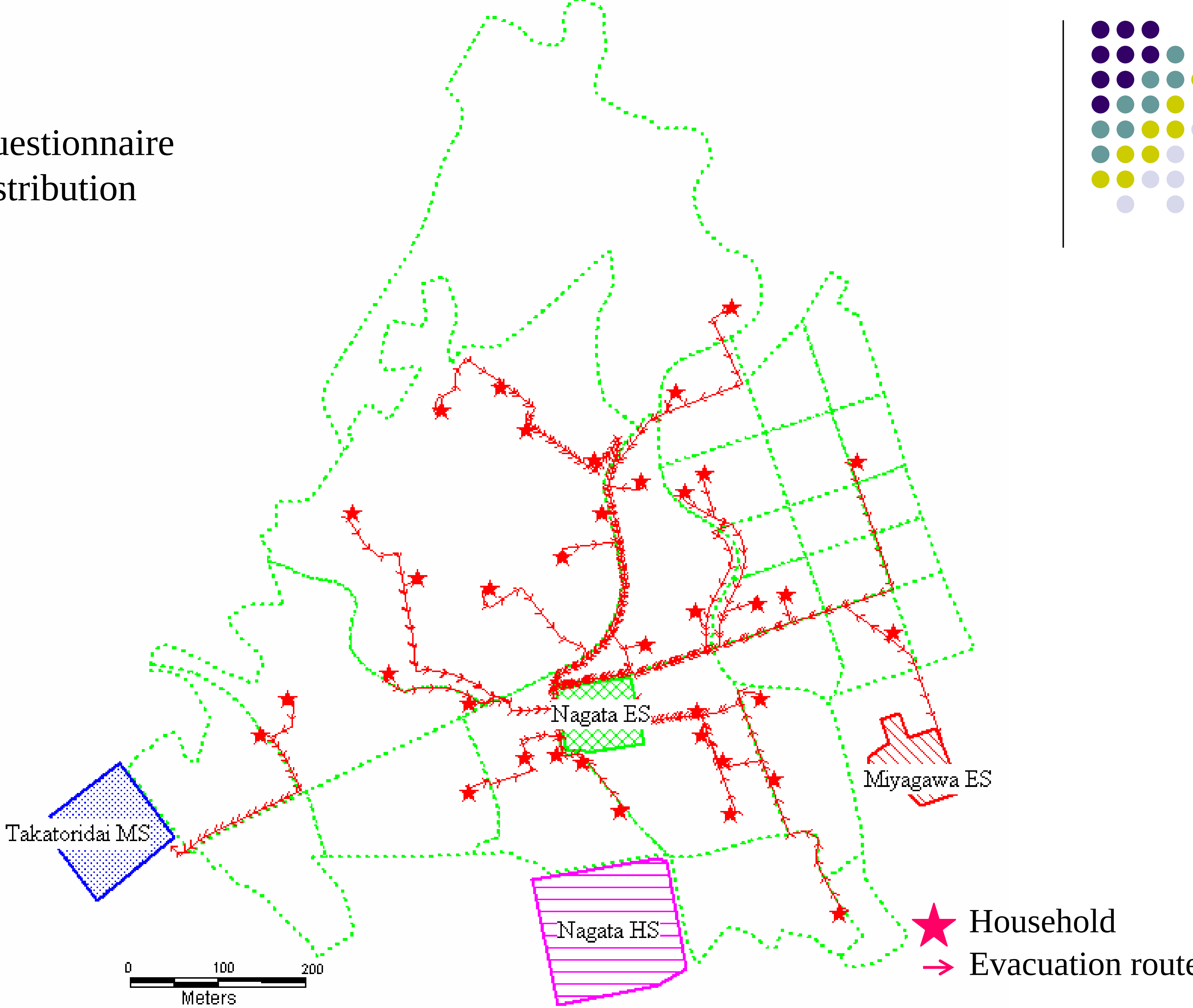
One designated accommodation disaster shelter

Three neighboring accommodation disaster shelter

Questionnaire survey

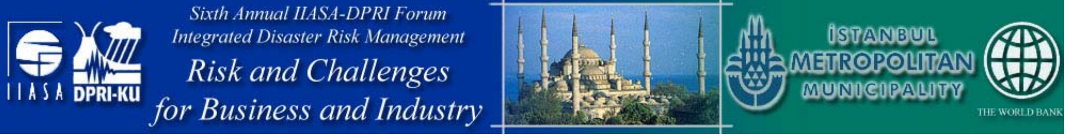
- Area: Nagata Elementary School Community of Nagata Ward, Kobe City, Hyogo Pref. Japan (heavily affected during the Hanshin-Awaji Earthquake in 1995)
- Object: households (responders are owners)
- Sample: N=50 (researcher ←→ local leader ←→ local people)
- Date: 21/07/2006-04/08/2006
- Response rate: 100%
- Contents: disaster shelter planning, evacuation route, hazard map, and personal information

Questionnaire distribution

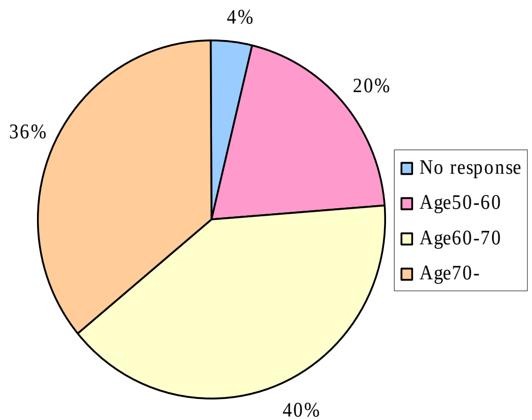


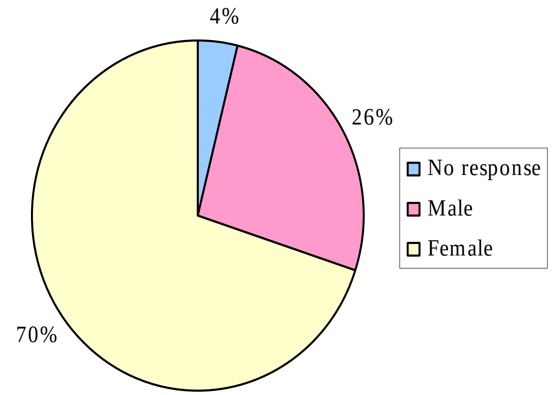
Earthquake: temporary & accommodation

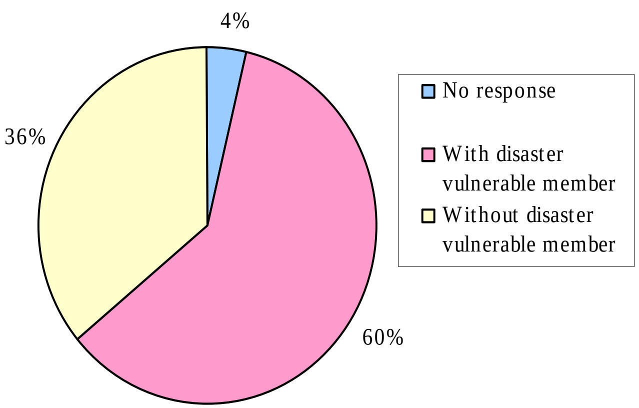
category	Performance criteria	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	
Security	1. There is no danger in the shelter	1	2	3	4	5	Survivability
	2. There is safe road available to evacuate	1	2	3	4	5	
Sustainability of lifeline service	3. Equipment, such as toilet is satisfactory	1	2	3	4	5	
	4. Drinking water and food are enough	1	2	3	4	5	
	5. Rain, wind, cold and hot are kept off	1	2	3	4	5	
	6. Injury and illness can be cured	1	2	3	4	5	
Accommodation capacity	7. Area per capita in the shelter is big enough	1	2	3	4	5	Vitality
Comfortability	8. Private space is available	1	2	3	4	5	
	9. There is no noise	1	2	3	4	5	
Accessibility to shelter	10. It is possible to evacuate in a short time	1	2	3	4	5	Communication
	11. Wide road without slope & step is available to evacuate	1	2	3	4	5	
	12. Other people's help is offered when evacuating	1	2	3	4	5	
	13. Understandable guide is offered when evacuating	1	2	3	4	5	
Connectivity to external resources and information	14. Sufficient information is offered	1	2	3	4	5	
	15. Safety confirmation can be done	1	2	3	4	5	
	16. It is easy to go to hospital and other facilities	1	2	3	4	5	
	17. Social support such as consultant is received	1	2	3	4	5	

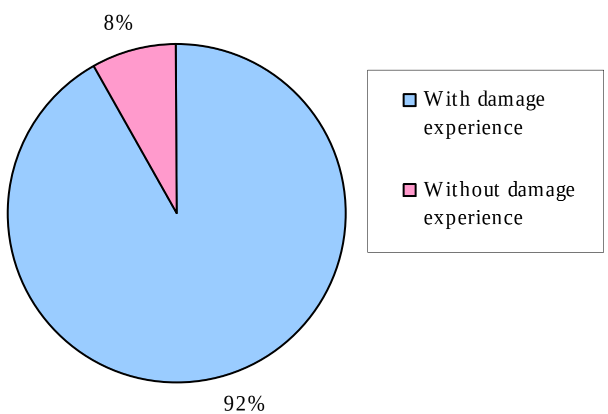


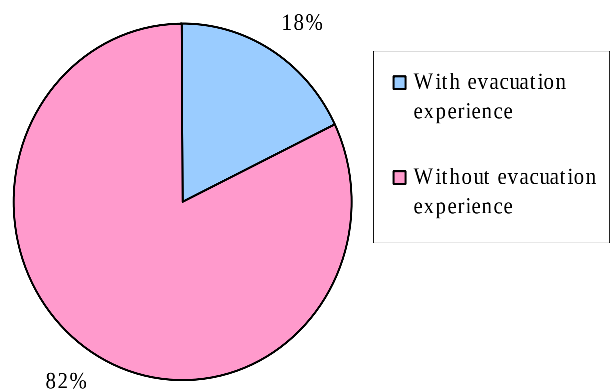
Population characteristics of responders & their relation with disaster impact







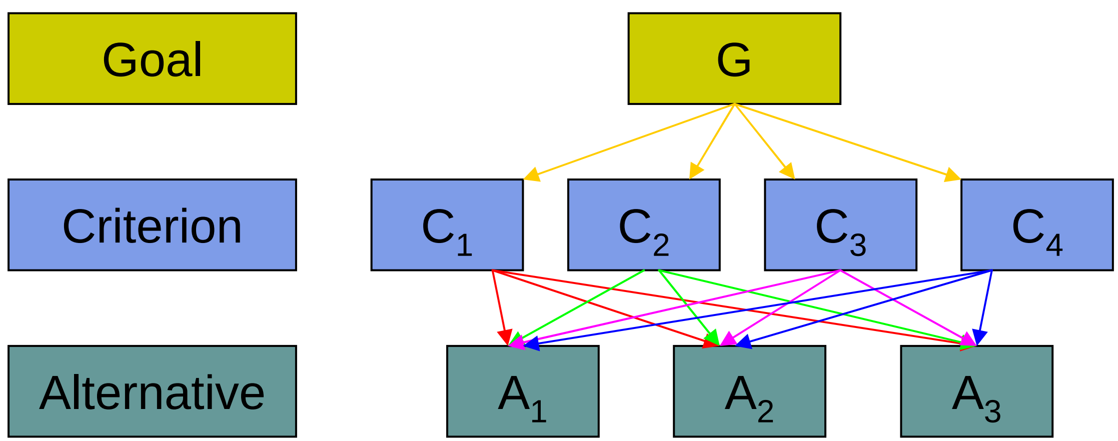




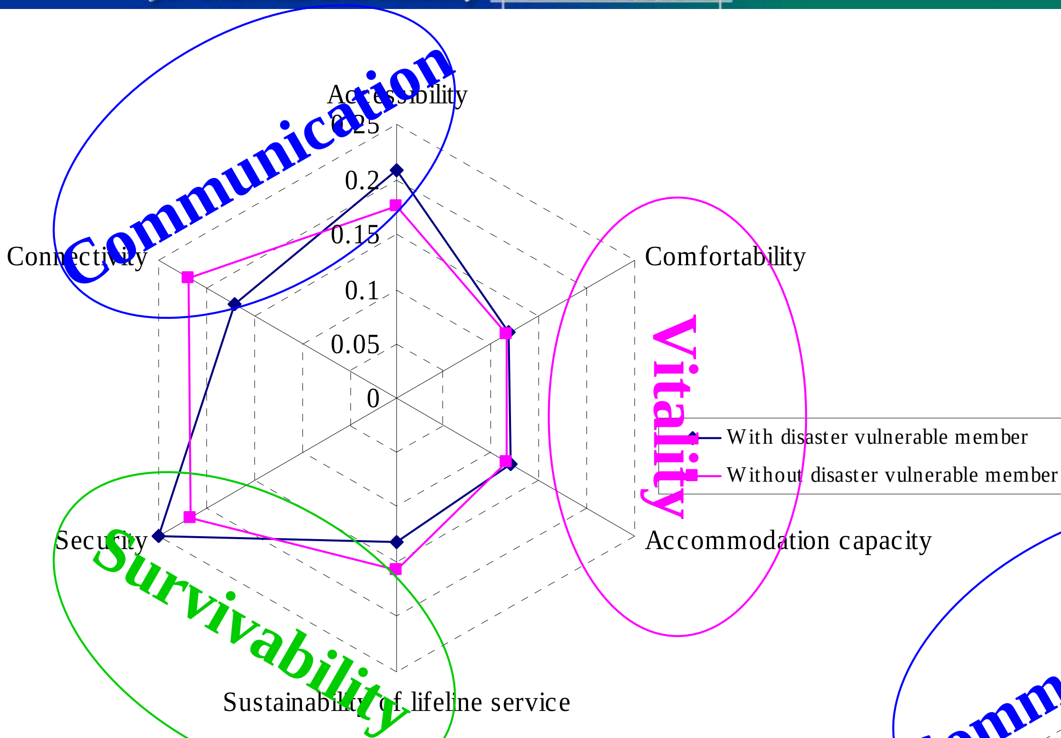
AHP (Analytical Hierarchy Process)

a mathematical technique for multi criteria decision making (Saaty, 1980)

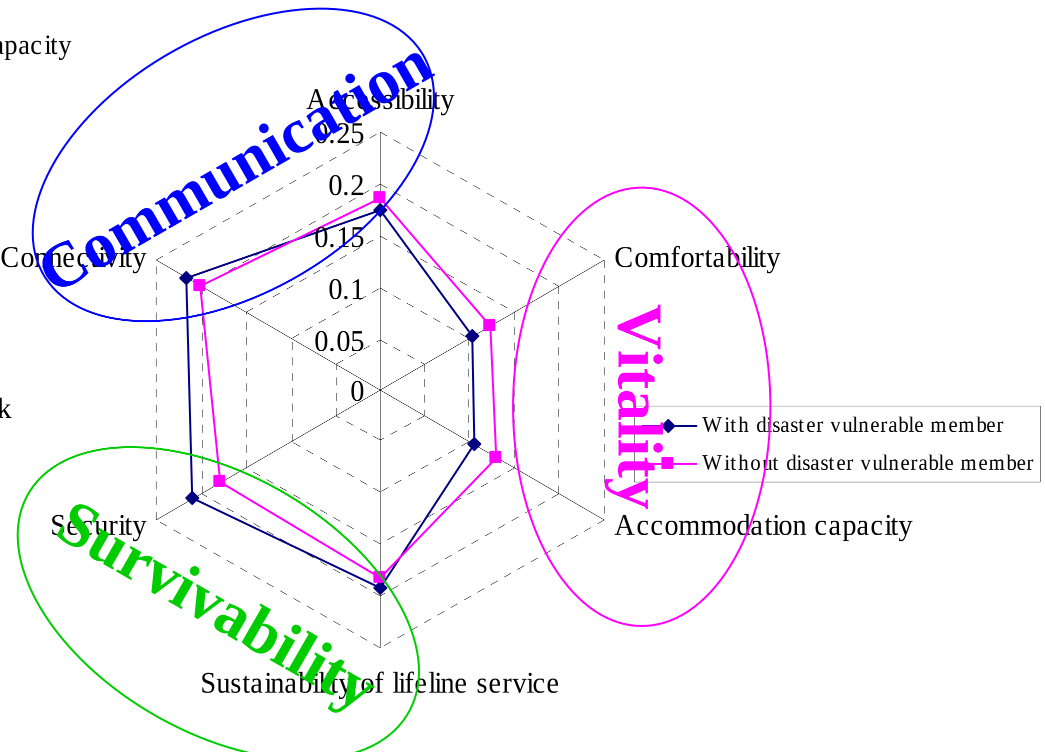
- **Determine the priorities or weights of the criteria in achieving the goal;**
- **Determine the weights of the alternatives for each criterion; and**
- **Determine the overall weight of each alternative in achieving the goal.**



Weight of each category



Temporary disaster shelter

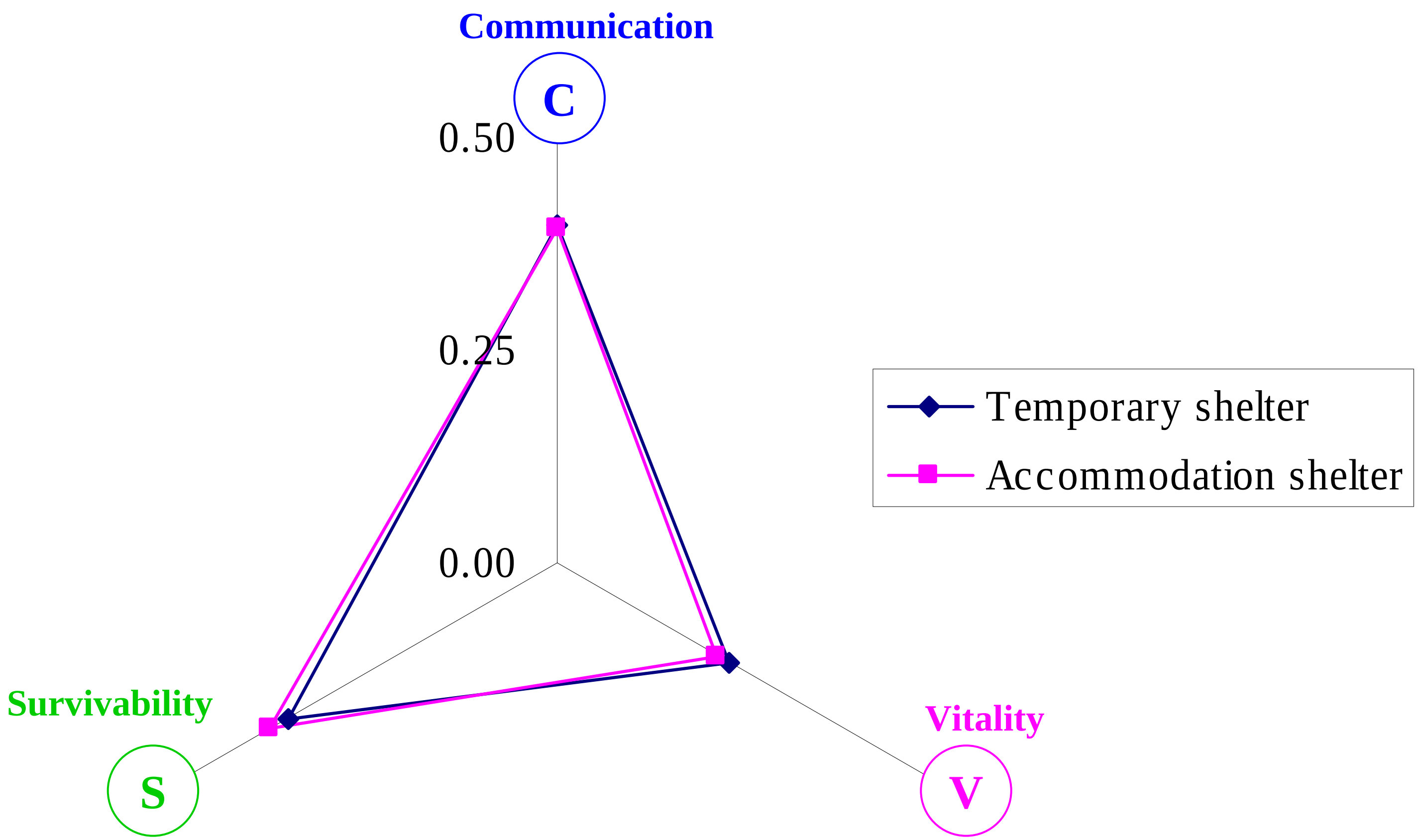


Accommodation disaster shelter

Category	Temporary	Rank	Accommodation	Rank
Security	0.235	1	0.199	2
Sustainability	0.139	4	0.189	3
Capacity	0.124	5	0.113	5
Comfortability	0.119	6	0.109	6
Accessibility	0.201	2	0.180	4
Connectivity	0.182	3	0.211	1

communication

Weight of each basic and critical function (the Vitae System)



	Temporary shelter	Accommodation shelter
Survivability	0.37	0.39
Vitality	0.24	0.22
Communication	0.39	0.39

Shelter planning from the viewpoint of local people

$$\underset{j}{Max}\, U_{ij} = u(S_{ij}, D_{ij}, C_{ij}, V_{ij}, A_{ij}, E_{ij})$$

i: household

j: shelter

A simple function of U_{ij} (taking the example of accommodation shelter)

$$\underset{j}{Max}\, U_{ij} = 0.2S_{ij} + 0.19D_{ij} + 0.11C_{ij} + 0.11V_{ij} + 0.18A_{ij} + 0.21E_{ij} + \delta$$

constant

Symbol	criterion	weight	Nagata Elementary School	Nagata High School	Miyagawa Elementary School	Takatoridai Elementary School
S_{ij}	Security	0.20	0.25	0.25	0.25	0.25
D_{ij}	Sustainability	0.19	0.25	0.25	0.25	0.25
C_{ij}	Capacity	0.11	0.25	0.25	0.25	0.25
V_{ij}	Comfortability	0.11	0.25	0.25	0.25	0.25
A_{ij}	Accessibility	0.18	A_{i1}	A_{i2}	A_{i3}	A_{i4}
E_{ij}	Connectivity	0.21	0.25	0.25	0.25	0.25
Utility			$0.205+0.18A_{i1}$	$0.205+0.18A_{i2}$	$0.205+0.18A_{i3}$	$0.205+0.18A_{i4}$

Assumption: S_{ij}, D_{ij}, C_{ij}, V_{ij} & E_{ij} are same

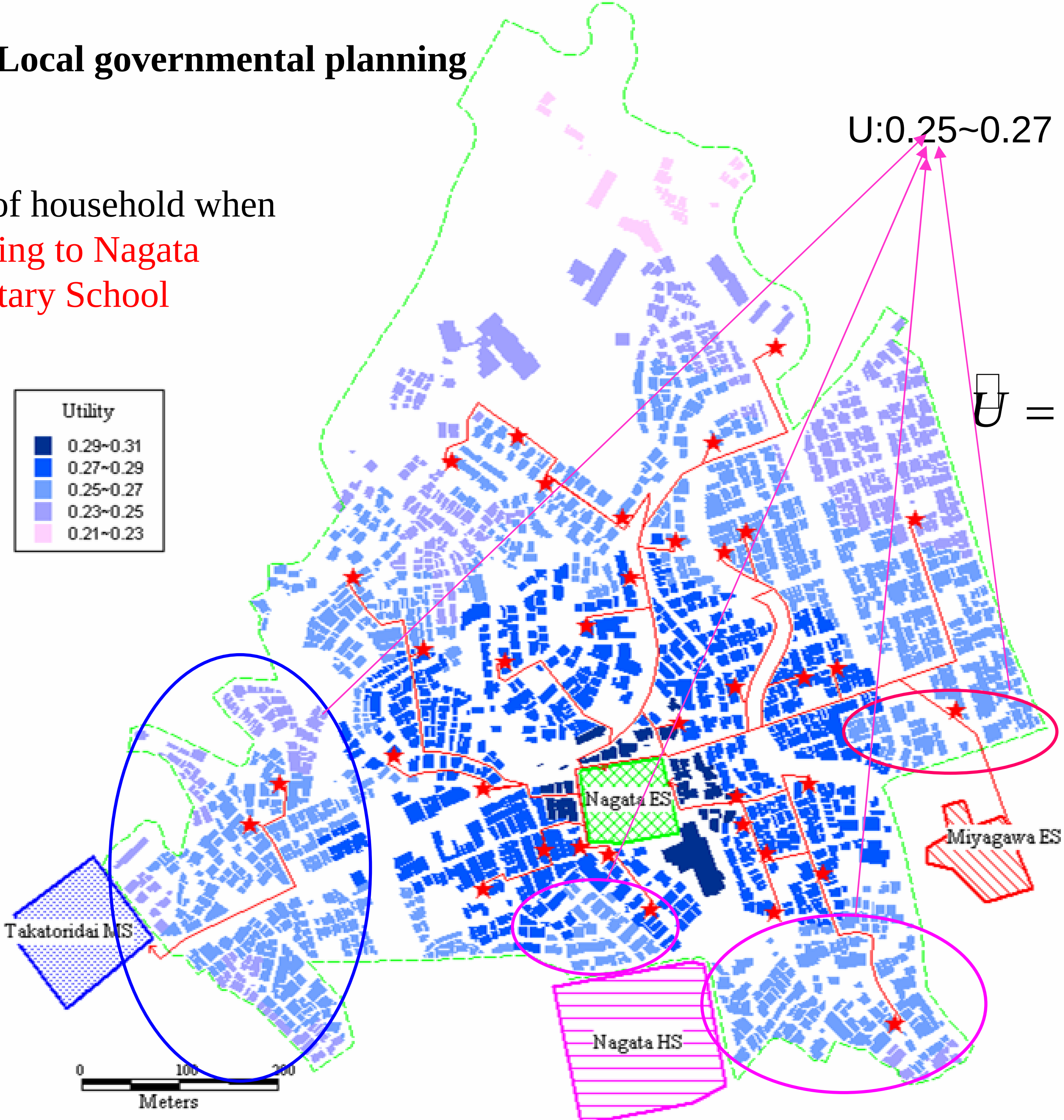
A_{ij} is related with evacuation distance & evacuation route

Local governmental planning

Utility of household when evacuating to Nagata Elementary School

U:0.25~0.27

$$\bar{U} = \sum_{i} U_{i\,j(i)} = 650$$



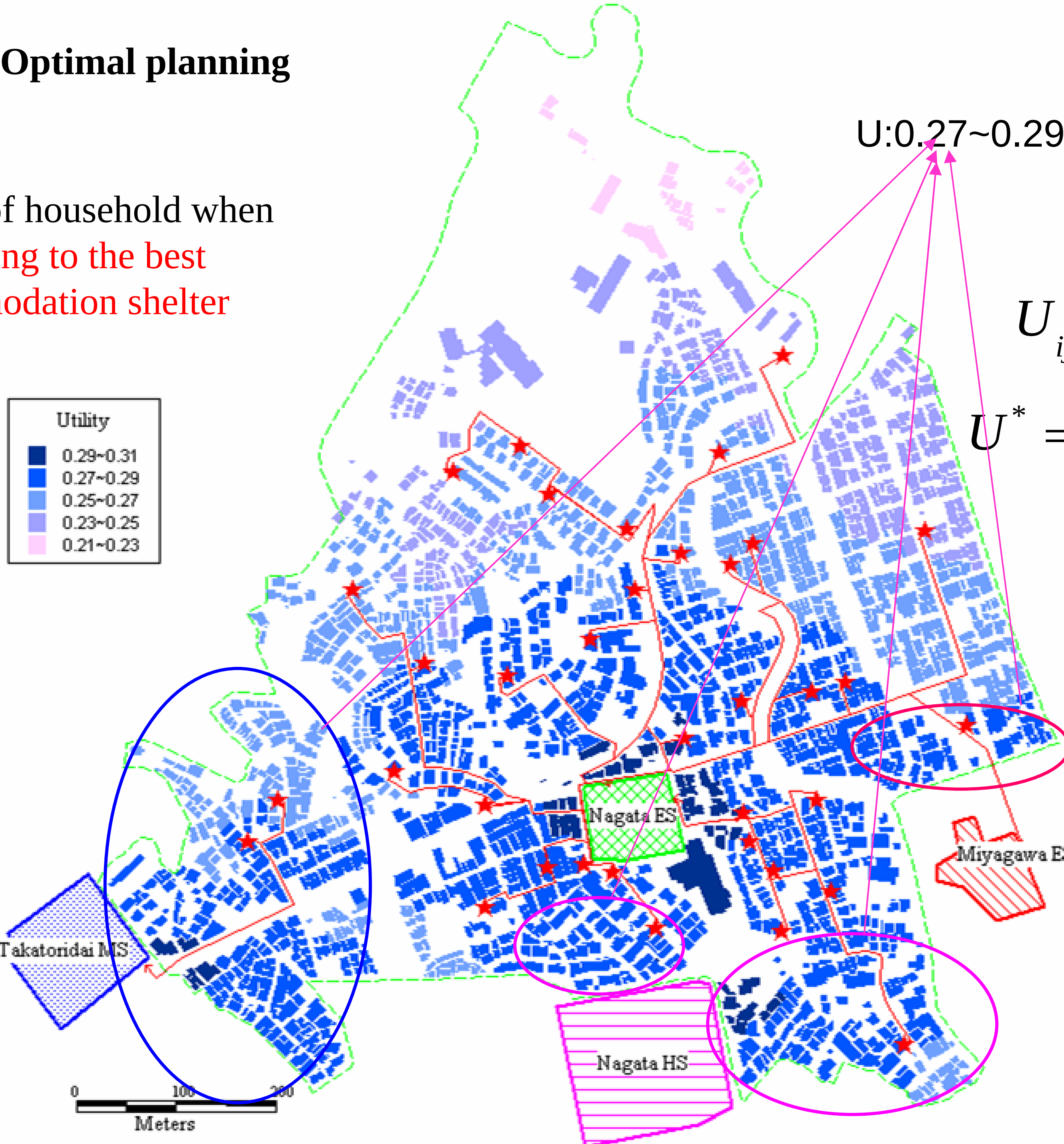
Optimal planning

Utility of household when evacuating to the best accommodation shelter

U:0.27~0.29

$$U_{ij^*_{(i)}} = \underset{j}{Max}\, U_{ij}$$

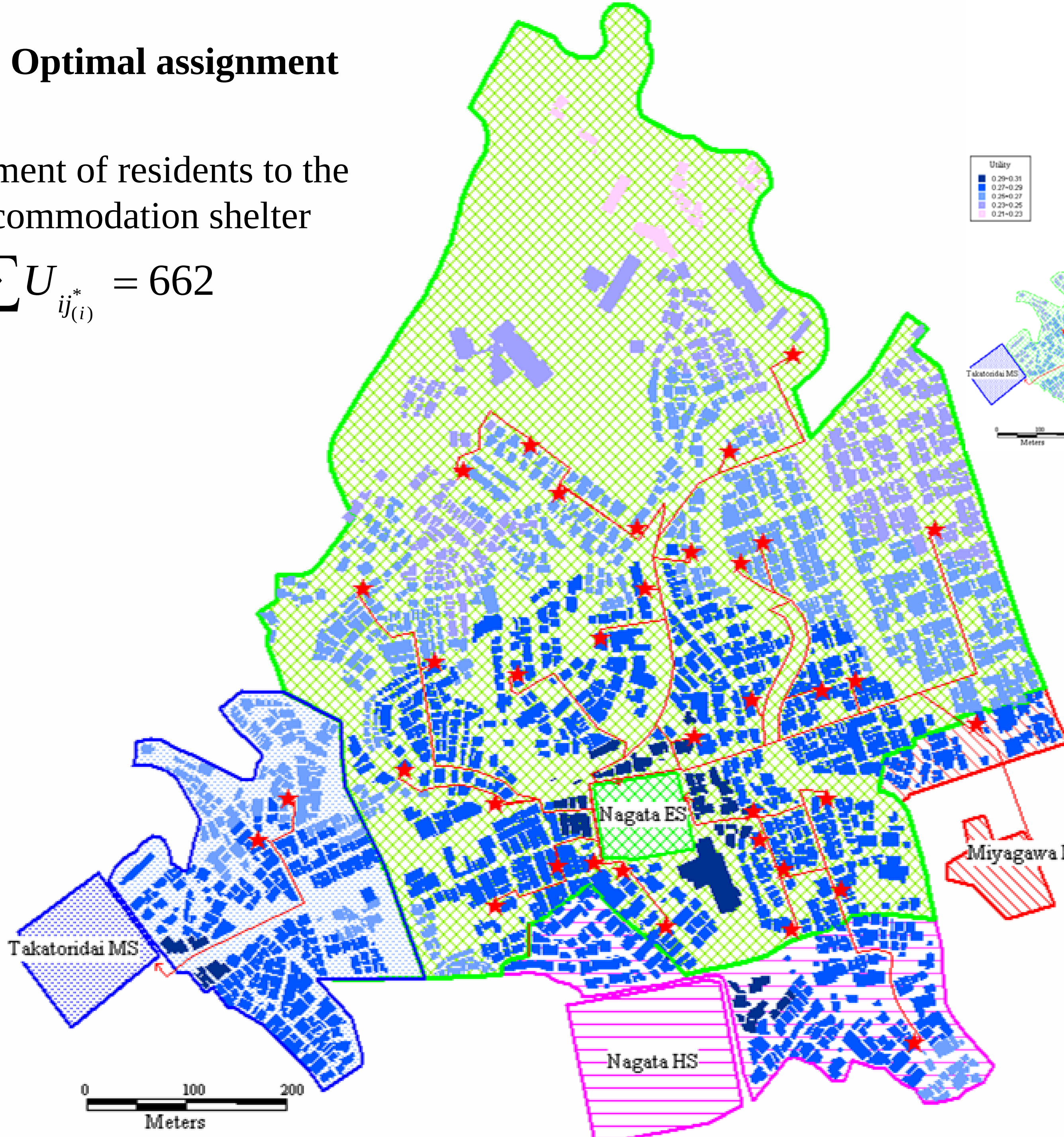
$$U^* = \sum_i U_{ij^*_{(i)}} = 662$$

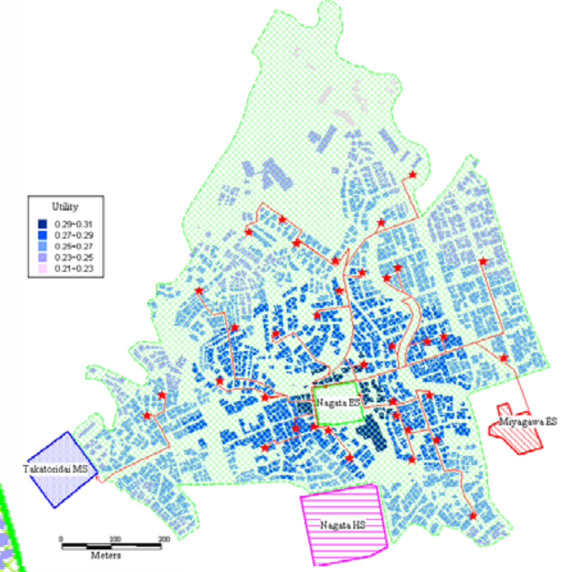


Optimal assignment

Assignment of residents to the best accommodation shelter

$$U^* = \sum_i U_{ij^*_{(i)}} = 662$$





Local governmental Assignment

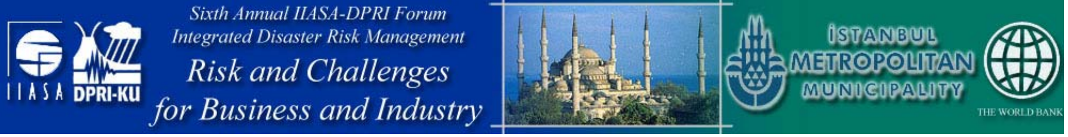
$$\tilde{U} = \sum_i U_{i\tilde{j}_{(i)}} = 650$$

Conclusion & Discussion

- An example of developing evaluation indicator for disaster shelter planning (old, with disaster experience & high rate of disaster vulnerable member)

Future work

- To check the survey result with local community and get feedback (Communicative survey)
- To develop integrated evaluation indicator system
- To diagnose the existing disaster shelter planning



Thank you very much!