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EVALUATION OF DIALOGUE PROCESS FOR SUBLATION (AUFHEBEN) USING SWARM PLANNING FOR RECONSTRUCTION AFTER 2011 JAPAN EARTHQUAKE AND TSUNAMI

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ABSTRACT: Flexible planning and consensus building are important issues in tackling climate change and natural disasters. However, verification of successful discussion and planning processes are limited. This study verifies the effectiveness of the Swarm Planning's Centre for Development of Creative Thinking (COCD) tool, a creative planning process. We organized workshops with eight student groups to plan house relocation and seawall reconstruction in the 2011 Tohuku Disaster area. We allocated students who had pros and cons on housing-relocation and seawall reconstruction. For comparison, four Conventional planning Groups (CG) used the two-dimensional box sheet, while the four Swarming planning Groups (SG) used the COCD box tool. It was difficult to overcome the conventional planning, as all CG plans rebuilt the seawall. On the contrary, all SG plans didn't include seawall. Half of SG groups also proposed land-use beyond the minimum agenda (housing relocation and new seawall). Notably, the SG1's housing relocation site was located within the highest area flooded by the 2011 tsunami; they explained this plan can minimize both land-purchasing costs and tsunami risks, while victims can still live nearby the sea. After the workshop, every group presented their proposal, and the audience evaluated each proposal including their own using the Semantic Differential Method. As a result, statistically, the majority of the students evaluated the SG's land-use proposals with higher scores than the CG's proposals. Thus, the Swarm Planning process seemed to have provoked discussions of new possibilities (sublation) by putting together conflicting opinions, expanding the possibility for more flexible alternatives.

Keywords: Participatory planning, Post-disaster, Design Charrette, Future Design, Tsunami Disaster

1. INTRODUCTION

After the 2011 Japan Earthquake Tsunami disaster, many Tohoku cities which had been built through legally appropriate processes were damaged: 18,430 people were dead or missing, 404,890 buildings were destroyed (Fig.1). After the disaster, despite strong opposition by the residents and ecologists which were less than a half of the population, a huge seawall was reconstructed, and relocation of houses on the hill was developed in the disaster area. This decision was a reflection of the majority of people's judgment, when many people hated nature (namely the ocean that caused the tsunami) because they lost their families, houses, jobs, and everything. As a result, these developments consumed 4 billion yen (around 37 million USD). However, about 100,000 survivors did not return to the new town because old residents who did not have car feel the inconvenient town center and sea was accessible from higher ground new town or a huge new seawall hid beautiful views of the coastline. (Fig.2). Why is it that the town that the disaster victims wanted to live in immediately after the earthquake was built has shrunk in population? Perhaps this was because the victims' hatred and anger toward the ocean was alleviated after a while. An alternative planning process is required, rather than the past conventional planning process for adaptation to climate change and recovery from natural disasters. This is our research question. Previous studies reported that digital technologies (GIS, 3D-mapping) in workshops can help to

Fig.1 2011 Japan Earthquake tsunami Disaster area 561Km^2.The Taro district where there was a large X-shaped seawall with a total length of 2.4 km and a sea-level height of 10 m. The seawall collapsed in an instant in a range of about 500 meters, killing nearly 200 people at 2011 Tsunami.

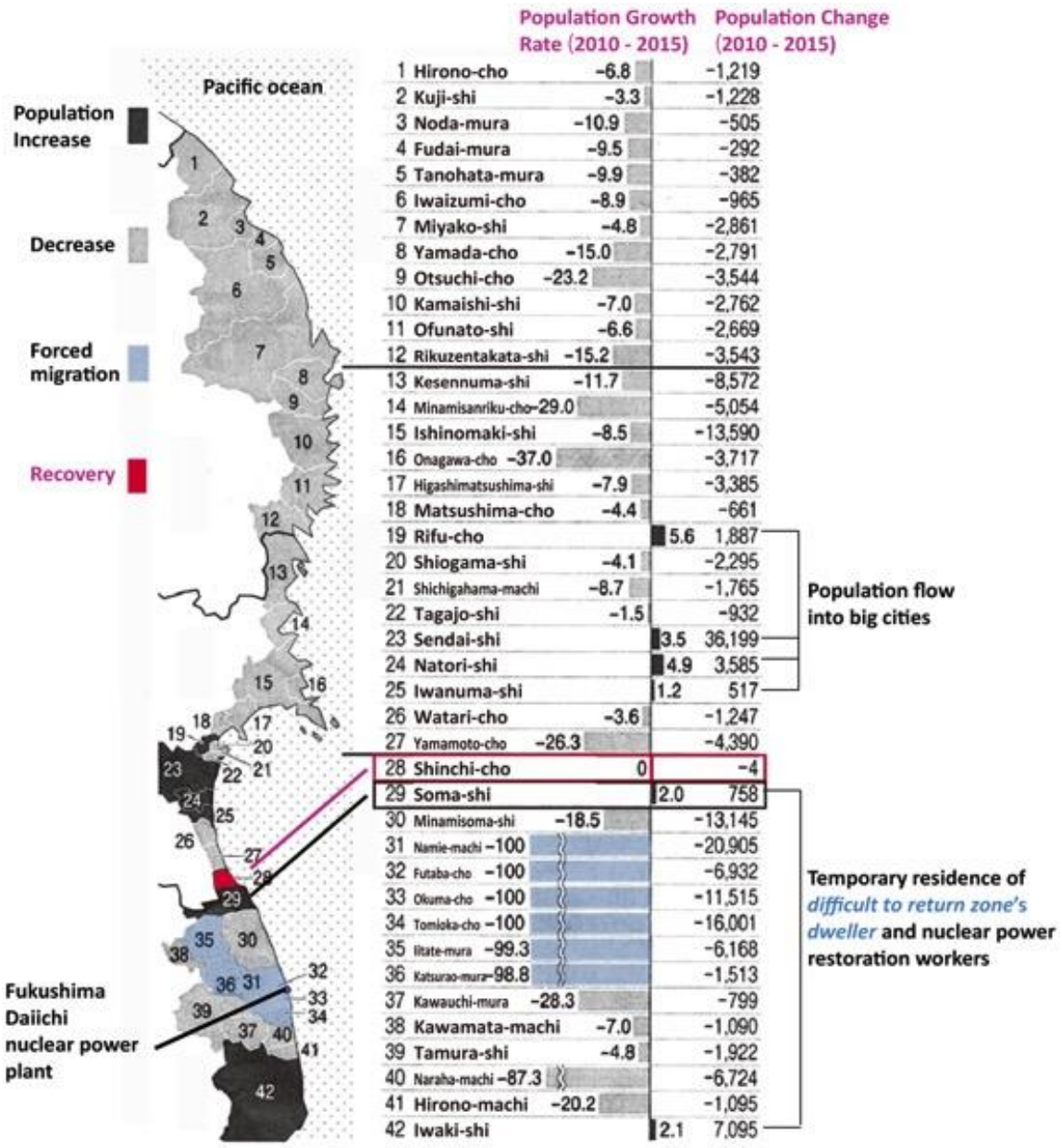

Fig.2 Population transition of 2010 to 2015 in 2011 disaster area. Although, 40 trillion yen of reconstruction expenses were used, 100 thousand victims moved to other big cities from restoring home-towns.

stimulate understanding and discussion of issues by the interview survey and participatory observations [1-7]. On the other hand, Warden and Woodcock [8] indicated the demerits of using digital tools. Zhang et al. [9,10] showed the importance of a simple discussion tool in disaster areas and rural areas where digital data resources are not available. Höppner et al. [11-13] verified the merits of the whole workshop program. Thus, there are very few quantitative empirical studies on the effects of workshops with citizen's participation. Therefore, the purpose of this paper is to compare the final qualities of the reconstruction plans of two different workshop discussion processes for the 2011 Tsunami disaster by quantitative analysis.

2. STUDY MATERIALS AND METHODS

This article focuses on the process of a comparative design, which makes it possible to identify the potential benefits of Swarm Planning (Roggema, 2012)[14] over Conventional planning . Conventional planning process and design aim to provide limited solutions relatively straight forward, 'tame' problems [15], while climate adaptation is seen as a 'wicked' problem [16]. In Conventional planning processes, the main stakeholders are 'consulted', which means they are approached with some design proposals which have been already well thought through and proven. The role left for the stakeholders

who participated in the workshop is, in general, to accept or reject such proposals. Real influence or a contribution in the form of suggestions are often neither possible, nor welcomed. In addition, although different opinions are introduced, it is likely that the final decision reflects the majority's opinions, while the minority's opinions tend to be ignored.
On the other hand, in a Swarm Planning process the key factor is how to deal with complex issues: it is the most important advantage of working in design charrettes; the method that is possible to make complex issues, such as climate adaptation which is concrete and conceivable [17]. Roggema developed a workshop process integrating the COCD-box methodology [18].

In our article, the benefits of the Swarm Planning's COCD-box thinking process are investigated. We set up workshop themes for eight student groups to plan house relocation sites and sea wall reconstruction in the tsunami-damaged Tohuku Disaster area. For comparative analysis, Conventional planning four groups used with two-dimensional box sheet, while the other Swarm Planning four groups used the COCD box tool. After each group discussion and the workshop for house relocation and seawall reconstruction planning, every group presented their design proposal, and the audience, as an individual, scored each proposal and their own group's proposal. To evaluate each proposal, a Semantic Differential Method questionnaire was used.

2.1 Defining the Design Teams

This study investigated the effects of two different discussion and planning processes on the quality of proposals on the reconstruction of the 2011 Tohoku earthquake and tsunami disaster. In order to make each group include students who had different opinions equally, we asked the 41 university students about their opinions and interests in the 2011 Tohoku disaster area.

The score of answers to this questionnaire showed the difference of their premise knowledge and opinions about the 2011 disaster area. The members of the eight design groups were arranged by the score of answers (Table 1). Additionally, informing the group members, we also considered gender balance. We allocated each eight groups with approximately five students through the above process. As a result of this adjustment, each group had the same allocation of people who had pros and cons for housing-relocation to the high land and sea wall reconstruction (Table 1). In order to discover the usability of swarming planning statistically, the four Swarm Planning groups used the COCD-box sheet, while the other four Conventional planning groups did not. This design set made it possible to compare the qualities of the proposals by two different thinking and planning processes.

2.2 Planning Theme and Target Issue

All eight groups were required to plan a new sea wall development and relocation housing site planning for the residents affected by the tsunami disaster. In the actual disaster area, 40 trillion yen of reconstruction budget was used, and the sea wall and the new town were rebuilt [19]. However, the planned population has not recovered, and many of these new-residential sites and rebuilt apartments' rooms are left empty. Thus, this is a very important issue.

Each workshop group had a diversity of opinions about the disaster area's situation. They also spent the same working time (one and a half hours), had the same design task, and the same proposal materials, such as plasticine (colored clay) for the seawall plan (yellow clay), new housing site plan (red clay) and another land-use plan (green clay), according to design charrettes settings [17]. All groups were given the advance same information; disaster areas' general pros and cons opinions for relocating houses to higher land and reconstructing seawalls.

The four groups of Swarm Planning used the COCD-box sheet, which was developed by COCD (Centre for development of Creative Thinking) (Fig. 3,5). The COCD-box has 2 axes: 1. Difficulty or ease of implementation, and 2. Agree or oppose to existing proposals, (Generality or uniqueness of planning idea). Therefore, compared to the conventional two-dimensional box sheet, even if the discussion is used with the same positive and negative opinions, new discussion direction with the conflict of two opinions was assumed to be stimulated. Swarm Planning process groups (SG1-4) discussed the matter with the COCD box to focus on the new direction (red column of Fig.3,5); the ease of implementation of the normal idea and the creative idea which is not (yet) feasible.

The Conventional planning groups used a simple two-dimensional box sheet (Fig.4,6). Every group consisted of students with approximately the same percentages of pros and cons of the development plan (house relocation and seawall reconstruction). Conventional planning process groups (CG1-4) had a discussion which is based on the original ideas. This is the ease of implementation and creative idea which is not (yet) feasible in parallel (Fig.4,6). The majority's opinions were mostly reflected on the decisions, while the minority's options be ignored was assumed.

2.3 Evaluation of Two Different Planning's Outcomes Using A Semantic Differential Method

Table 1 Eight groups' member composition, based on the responses of the questionnaire survey

Sex	Visit to the disaster area	Childhood environment	Desire to live in the future	Donations to the disaster areas	Plans for volunteer or donations	Experience of volunteering	Assessment of the current reconstruction	Pros and cons of the seawall reconstruction	Pros and cons of housing relocation to higher ground	Total point	Group division
F	-1	1	0.5	1	-1	1	1	0	0	2.5	
M	1	-0.5	-0.5	1	-1	-1	1	1	0	1	
F	-1	-0.5	0	1	-1	-1	1	0	0	-1.5	CG4
M	-1	-0.5	0.5	1	1	-1	-1	-1	0	-2	
M	-1	1	-0.5	-1	-1	1	-1	0	-1	-3.5	
M	-1	1	0.5	-1	1	1	1	-1	1	2.5	
M	-1	0	0.5	1	-1	1	1	0	-1	0.5	
F	-1	-0.5	-0.5	-1	1	-1	1	0	0	-2	CG3
M	-1	-0.5	-0.5	-1	-1	1	1	-1	0	-3	
F	-1	0.5	0.5	-1	-1	1	-1	-1	-1	-4	
M	1	-0.5	1	1	-1	1	1	1	-1	3.5	
F	-1	-0.5	0.5	1	-1	1	1	0	1	2	
F	-1	1	1	1	-1	1	1	-1	0	2	CG2
M	-1	-0.5	-0.5	-1	-1	-1	1	0	0	-4	
M	-1	-1	1	-1	-1	1	-1	0	-1	-4	
F	-1	1	0.5	1	1	1	-1	0	1	3.5	
M	-1	-0.5	0.5	1	-1	1	-1	0	1	0	
F	-1	-0.5	0.5	-1	0	1	1	-1	0	-1	CG1
M	-1	-0.5	-0.5	-1	-1	1	1	-1	-1	-4	
M	-1	0.5	-0.5	-1	-1	-1	1	-1	0	-4	
M	-1	-0.5	1	1	-1	1	-1	1	1	1.5	
F	-1	1	1	-1	-1	1	1	0	0	1	
M	-1	-0.5	1	-1	1	1	1	1	-1	1.5	SG4
F	-1	0.5	0.5	1	-1	1	-1	0	0	0	
M	-1	-0.5	-0.5	-1	-1	1	-1	0	0	-4	
M	-1	1	-0.5	1	-1	-1	-1	-1	0	-3.5	
F	-1	0.5	0.5	-1	-1	1	1	1	1	2	
M	1	-0.5	-0.5	1	-1	1	1	-1	-1	0	
F	-1	-1	0.5	1	-1	1	1	-1	0	-0.5	SG3
M	-1	-0.5	-0.5	0	-1	1	-1	0	-1	-4	
M	-1	0.5	-0.5	-1	-1	1	-1	-1	-1	-5	
M	1	1	1	1	-1	1	1	-1	-1	3	
M	-1	-0.5	-0.5	1	1	1	1	0	-1	1	
F	-1	-0.5	0.5	-1	-1	1	1	0	1	0	SG2
F	-1	-0.5	-0.5	-1	-1	1	-1	-1	1	-4	
M	-1	-0.5	-0.5	-1	-1	1	-1	0	-1	-5	
M	-1	-0.5	0.5	1	1	1	1	0	0	3	
F	-1	0.5	0	1	-1	1	1	0	-1	0.5	
M	-1	0.5	1	-1	-1	-1	1	0	0	-1.5	SG1
F	-1	-0.5	-0.5	-1	-1	1	1	0	-1	-3	
M	-1	-0.5	-0.5	-1	-1	-1	1	-1	0	-5	

Sex :female=f, male=m, Visit to the disaster area : Yes=1, No=-1, Childhood environment : Countryside=1, Suburbs=0.5, Urban Suburbs=-0.5,Urban=-1, Desire to live in the future : Countryside=1, Suburbs=0.5, Urban Suburbs=-0.5,Urban=-1, Donations to the disaster areas : Yes=1, No=-1, Plans for volunteer or donations : Yes=1, No=-1, Experience of volunteering : Yes=1, No=-1, Assessment of the current reconstruction : Advanced=1, Late=1, Pros and cons of the seawall reconstruction : Should continue = -1, Difficult to judge=0, Should be stopped=1, Pros and cons of housing relocation to higher ground : Should continue = -1, Difficult to judge=0, Should be stopped=1, Group division : CG = Conventional planning method, SG= Swarming planning method

After the workshop, all students scored each proposal employing Semantic Differential Method including their own teams plan, over the course of about 90 minutes. In order to abandon potential biases, the SG's groups and CG's groups presented their proposals alternately. The respondents evaluated using Semantic Differential Method scale; a point value is assigned for each of the spaces form －2 to 2 so that a set of five scales (－2,－1, 0 ＋1, ＋2) and a continuous line between the opposing adjectives could be constructed. The positive adjective is on the right side, assign the values －2 to ＋2 from left to right; for example, －2 = uninhabitable, 0 = no opinion, ＋2 = habitable. After evaluation, the authors analyzed the evaluation score's differences between the four proposals by Swarm Planning and the four proposals by the Conventional planning . This analysis used Welch's t-test. This showed the relationship between two types of the planning process (Swarm Planning and Conventional planning) and these evaluation scores' average difference.

	Disagree with seawall reconstruction (Difficult to implement:Challenges)
	・Industry declines by seawall construction (fisheries industry and tourism industry). ・Many people died because they believe the seawall was safe. ・If tsunami damaged housing moved to upland, seawall is unnecessary.
Agree with seawall reconstruction (Easy to implement: Done before)	**Innovative ideas (Feasible solution:Breakthrough)**
・To defend person's life (Seawall should be big as much as possible) ・The revival budget can be used only now. ・There are residents who can sell tsunami disaster land for the seawall construction.	

Fig.3 The COCD-box sheet with pros and cons of reconstructing seawalls

Disagree with seawall reconstruction (Difficult to implement :Challenges)	Agree with seawall reconstruction (Easy to implement : Done before)
・Industry declines by seawall construction (fisheries industry and tourism industry).	・To defend person's life (Seawall should be big as much as possible)
・Many people died because they believe the seawall was safe.	・The revival budget can be used only now.
・If tsunami damaged housing moved to upland, seawall is unnecessary.	・There are residents who can sell tsunami disaster land for the seawall construction.

Fig.4 The simple two-dimensional box sheet with pros and cons of reconstructing seawalls

	Disagree with relocating houses to higher land :Challenges)
	・It will make it difficult for elderly people and children who do not own cars. ・Historically, the high land's new town after the tsunami was back to a convenient lowland area. ・Fishermen are far from work.
Agree with relocating houses to higher land (Easy to implement : Done before)	**Innovative ideas (Feasible solution:Breakthrough)**
・Government subsidies are available for collective relocation. ・Land prices have plummeted in the area flooded by the tsunami. ・It is more efficient to develop all the affected communities on higher ground.	

Fig.5 The COCD-box sheet with pros and cons of relocating houses to higher land

Disagree with relocating houses to higher land :Challenges)	Agree with relocating houses to higher land (Easy to implement : Done before)
・It will make it difficult for elderly people and children who do not own cars.	・Government subsidies are available for collective relocation.
・Historically, the high land's new town after the tsunami was back to a convenient lowland area.	・Land prices have plummeted in the area flooded by the tsunami.
・ Fishermen are far from work.	・It is more efficient to develop all the affected communities on higher ground.

Fig.6 The simple two-dimensional box sheet with pros and cons of relocating houses to higher land

3. RESULTS

In this paper, we compared the quality of the proposals prepared by two different discussions and planning processes, and we evaluated the validity of the use of the Swarm Planning approach. First, we compared the design proposals' quality by the two different processes. Next, we compared the evaluation scores by each students statistically.

3.1 Differences of Design Proposals

The Conventional planning process group's (CG) discussion was not active. Some of CG groups finished their discussions and submitted their proposals early, leaving plenty of extra time unused. Figure 7 shows the results of the proposals by the Conventional planning process. As a whole, all CG groups made proposals to rebuild the sea wall for tsunami breakwaters (yellow clay) (Fig.7). This decision appeared to be the same as the actual disaster area. The CG3 group also proposed to rebuild the residential area in tsunami flooded area again, and CG1 and CG2 proposed high land relocation. The remaining CG4 group could not propose relocation sites until the workshop's time limit. Especially CG3's plan seems to lack consideration the cost aspect: the seawall doubled its height compared to before (10 m), in addition, they proposed a new 100 m tower. The reason for the relocation housing site also did seem to be logical (Fig.7).

Although many seawalls could not save the coastal residents at the 2011 disaster, from the CG's discussions and proposals, we can see that it is difficult to break through from the conventional and general decision, even the post-disaster reconstruction planning. Furthermore, using the CG discussion process, there were some cases when the proposal became childish, and cases when answers to the requested task could not be made (Fig.7,CG4). These CG's outcomes included few green clay suggestions (such as tide protection forest), which proposed land-use other than seawalls (yellow) and relocation housing (red) (Fig.7). CG groups' many land-use plans are very similar to those actually implemented in many affected areas.

On the other hand, the Swarm Planning process group's (SG) discussion seemed to be very lively. Fig.8 shows the results of the proposals by the Swarm Planning process. All groups also proposed

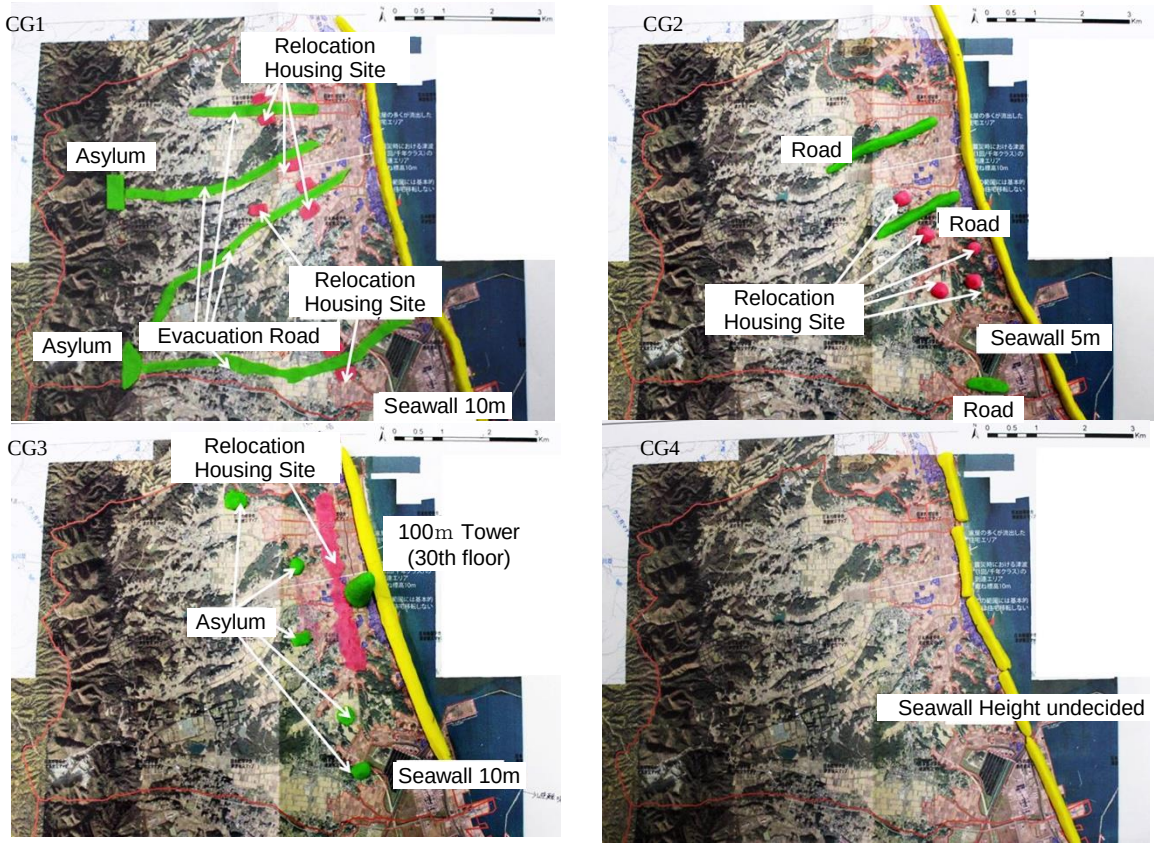

Fig. 7 Results of land use planning by Conventional planning process group's (CG)

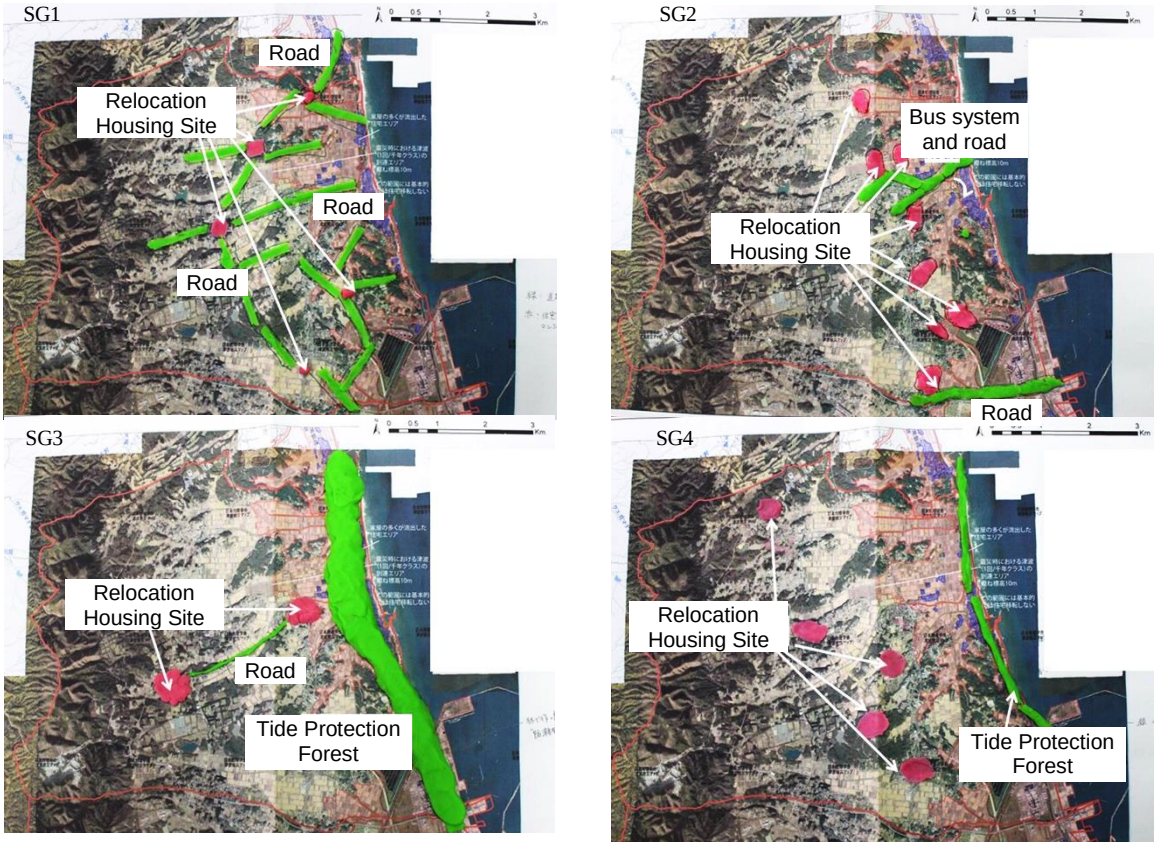

Fig. 8 Results of land use planning by the Swarm Planning process group's (SG)

land use beyond the minimum agenda (housing relocation site and new seawall). As a whole, all the groups' plans did not proposed seawall re-construction; they reached a consensus not to construct seawalls after a series of discussions. Because they decided the new housing sites were developed on high lands, tsunami disaster risks appeared to be smaller than before.

They allocated the budget for road networking construction instead of seawall construction. The SG1,2,3 plans seem to be a consideration on both coastal site and hill site with road networking. Especially, we were interested in the SG1's housing relocation site which was located within the highest area which was flooded by 2011 tsunami; they explained that this land selection can minimize both costs for land purchase and disaster risk from tsunami, while they can still stay nearby the sea.

Unlike the CG process group, half of the groups had additional proposals of seaside tide forest and network roads using green clay (Fig.8).

3.2 Evaluation Scores and Its Comparison

In order to conduct a Semantic Differential Method test, a total of eight design proposals were introduced with a brief presentation. The students evaluated each proposal using the method of semantic differential scale. The proposed plans in each of the methods of CG and SG had alternating announcements, to reduce the impact of the order on evaluation; it is to avoid the possibility that the first half of the proposals are excessively evaluated than the second half of the proposals.

In this test, preferences on the plans were scored along a five-scale. A score of ＋2 points means that the plan has a strong positive impression of the sample, while a score of －2 point denotes a strong negative impression: Each land use plan's appropriateness, habitability, and originality. This result of the analysis shows the effects of Swarm Planning, as interpreted through the Welch's t-test (Fig.9,10,11). Overall, the evaluated scores were significantly higher in Swarm Planning groups plans than Conventional planning group' ones, based on a statistical analysis. In other words, statistically the majority of the 41 students evaluated the Swarm Planning groups land use plans with higher scores than the Conventional planning's plans (Fig. 9,10,11).

The evaluation scores of suitable (＋2) to non-suitable (－2) was significantly higher in Swarm Groups (mean 0.65) than Conventional Groups (mean 0.35), with t=4.00 p<0.001 (two-tailed), df=489.2 (Fig.9). The evaluation scores of habitable (＋2) to non-habitable (－2) was significantly higher in Swarm Groups (mean 0.34) than Conventional Groups (mean -0.04), with t=4.59, p<0.001 (two-tailed), df=489.4(Fig.10). Similarly, the evaluation

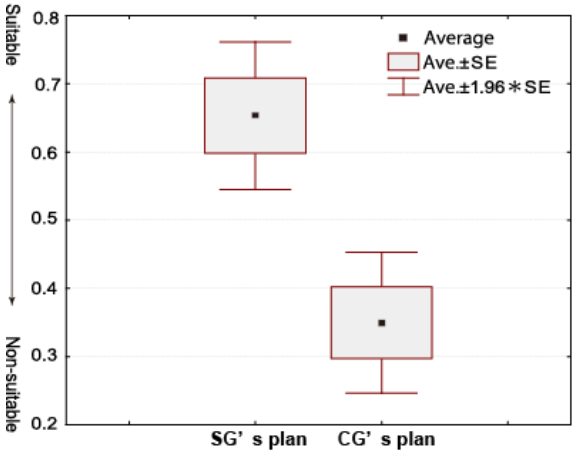

Fig.9 Box plot of evaluation on the plans' suitability (Conventional planning groups (CG) and Swarm planning groups(SG))

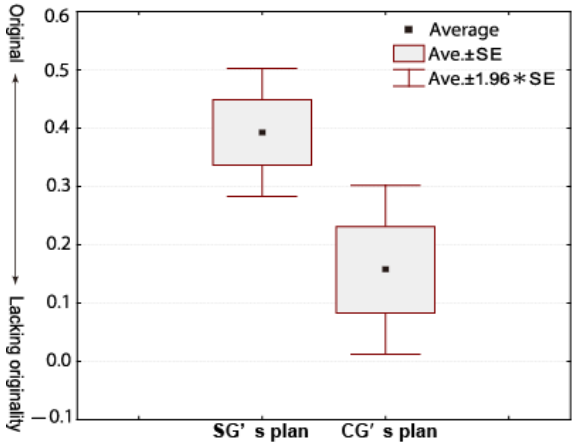

Fig.10 Box plot of evaluation on the plans' habitability (Conventional planning groups (CG) and Swarm planning groups(SG)

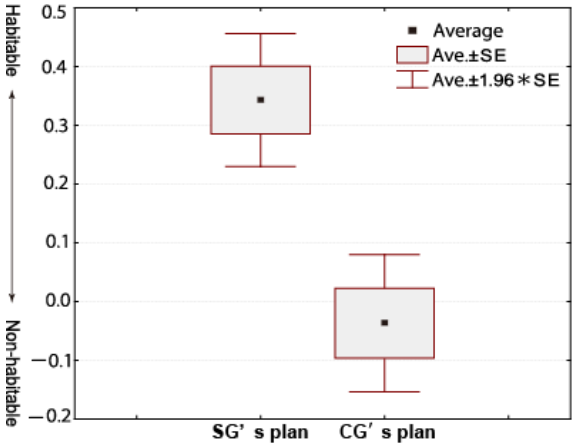

Fig.11 Box plot of evaluation on the plans' originality (Conventional planning groups (CG) and Swarm planning groups(SG))

scores of Originality (＋2) to lacking-originality (－2) was significantly higher in Swarm Groups (mean 0.39) than Conventional Groups (mean 0.16), with t=2.56, p=0.011(two-tailed), df=454.1 (Fig.11).

The results suggest that the Swarm Planning process using the COCD-box sheet will lead to more favorable outcomes of planning than the Conventional planning process with two-dimensional box sheet. This analysis revealed the relationship between the two different planning processed and the their quality of proposals in terms of landscape planning creative thinking. Thus, we could verified the effectiveness of the Swarm Planning approach based on both qualitative and quantitative analysis.

4. CONCLUSION

This paper highlights the effects of consensus-building process differences in spatial planning through empirical, quantitative analysis of two different discussion processes. First, we compared the design proposals' quality by planning process types. Second, we also compared each plan's evaluation scores by planning process type statistically. Empirical verification of successful and creative discussion and planning processes is limited because experimental verification of the effect of such planning theory and communication is extremely difficult. Although there are based on qualitative interviews, Cheng et al. [2] point out the importance of using a matrix for thinking and forcing new ideas with different options. Kamijo et al. [20] also revealed that when members of an imaginary future generation (Free mind set from current ties) are present during negotiations, groups tend to select more sustainable options. The results of this study indicates the possibility such as creative design process by quantitative evidence.

In this article, we accomplished to analyze the suitability/usability of the Swarm Planning approach with COCD- box tool. In addition, this study revealed that the creativity of the proposal by the Swarm Planning process was clearly higher than the Conventional Planning process. All groups had the same disagreement because we assigned members with diverse opinions in each group. Despite the above design settings, through a process of investigating the relationship between the discussion and planning process types (Swarm or Conventional) and the realized qualities in the field, it can be concluded that the Swarm Planning approach performs better than Conventional Planning approaches.

Each group also included students who opposed the standard relocation housing and sea wall development idea of the 2011 disaster areas. After that, the same study time and the same materials for suggestions were provided. Thus, although the group conditions and design work tasks were unified, the proposal contents by two different processes appeared to be distinctly different. Also, in the individual evaluation of 41 students for the proposal, the proposals with COCD-box were statistically evaluated higher than the proposals made through the conventional method of planning. This result appears to be one piece of evidence that overcomes the fundamental challenges of spatial planning caused by conventional discussion processes; when conflicting opinions are expressed, the discussions tend to be inactive, resulting in only reflecting one-sided opinion supported by the majority. On the other hand, Swarm Planning process seemed to have provoked discussions of new possibilities (dialectic proposal) through putting together conflicting opinions.

In fact, despite strong opposition by a few people, a huge seawall was constructed, and the relocation houses on the hill were developed in the affected areas. As a result, the seawall construction and the relocation of houses were completed at a cost of 4 billion yen, but about 100,000 victims did not come back to the reconstructed town. This fact indicates an inconsistency in the conventional planning process outcomes and victims' demands. The victims' desires have changed as time went by. The newly built town where people couldn't even view the ocean because of the huge seawall did not become the place they wanted to live. In that context, we suggest a flexible planning process using Swarming Planning and COCD-Box. The Swarm Planning approach is recommended in a wide variety of contexts, including the planning process before and/or after a climate disaster event, where severe conflicts may exist.

This study implies the possibility that even negative arguments or minor opinions can contribute to creating positive outcomes, by putting together both pros and cons, providing an opportunity for a sublation by the discussion-based decision-making process. In these cases, the design with Swarm planning approach could help to expand the possibility of imagining more flexible alternatives beyond the 'wicked' problems of conventional planning processes.

5. ACKNOWLEDGMENTS

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