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THE DEVELOPMENT OF A HAZARD MAP FOR DISASTER PREVENTION USING AUGMENTED REALITY

ABSTRACT

This study, based on the identified shortcomings of previous hazard maps, proposes a new map whose effectiveness is demonstrated through practical experiments. One aim in particular is to provide clear visual information that residents can grasp; that information is visualized using a technical method called "augmented reality" (AR). AR is a form of virtual reality. After AR technology was used to improve certain aspects of the map, an original technique that integrated real scenery with an imagined disaster was proposed. Exposing residents to images of damage and disaster is appropriate, and indeed essential, as it makes it possible for them to realistically imagine what damage and disaster could potentially look like. Furthermore, overlaying damaged scenery onto familiar scenery creates a greater sense of reality for the residents.

KEYWORDS: HAZARD MAP, DISASTER PREVENTION, AUGMENTED REALITY, FLOOD DAMAGE, EVACUATION

1. INTRODUCCION

Being ready for an emergency can make a significance difference on the outcome of a crisis. Since flood damage occurs almost every year in Japan, residents need to prepare by acquiring accurate knowledge and developing an interest in disaster prevention. To this end, a flood hazard map has been developed and is currently used in daily life. The flood hazard map is an informational tool that every local government creates and then distributes to residents by law. The map has two functions: to provide residents with accurate knowledge about disaster prevention, and to inform them about how to properly evacuate. In other words, local governments produce flood hazard maps in order to reduce the human damage caused by disasters. However, the general feeling is that the existing hazard maps are too specialized and complicated though they are technically accurate. As a result, the knowledge they present is not effectively communicated to the residents, as they cannot understand the information contained in the maps. In other words, previous hazard maps have not achieved their objective of protecting residents during disasters and preparing them for evacuation.

One solution for this problem is to provide disaster prevention education to have residents understand hazard maps including technical terms and specialized signs.

In general, though, it is difficult to expect the majority of residents have sufficient knowledge.

In this work, we take an alternative approach to provide a visualization tools for helping people easily and effectively grasp disaster information.

In this study, we first carried out questionary survey in order to extract problems. Then, we propose to add augmented reality functions. Finaly, questionary survey to investigate effects of hazard map using Interactive technology and AR were carried out.

This study does not presuppose any specific regions but, as a concrete example, we chose Soja-city, where our university locates. Soja-city is about 200km west of Osaka and belongs to Okayama prefecture. It has 67,000 residents. There is the first-grade river called the Takahashi River in the western part of the town, and the mean quantity of water is 63.93 m3/s. This river may overflow under the influence of a heavy rain.

2. EVALUATIONS OF THE EXISTING HAZARD MAP

Figure 1 shows the existing harzard map of Soja-city. This hazard map contains too many kinds of information. For example, it includes five levels of “predicted inundation areas”, five kinds of “predicted landslide and sediment disaster areas”, and three kinds of “shelter facilities”. In addition, many hospitals, police stations and fire stations are indicated. Although this hazard map has

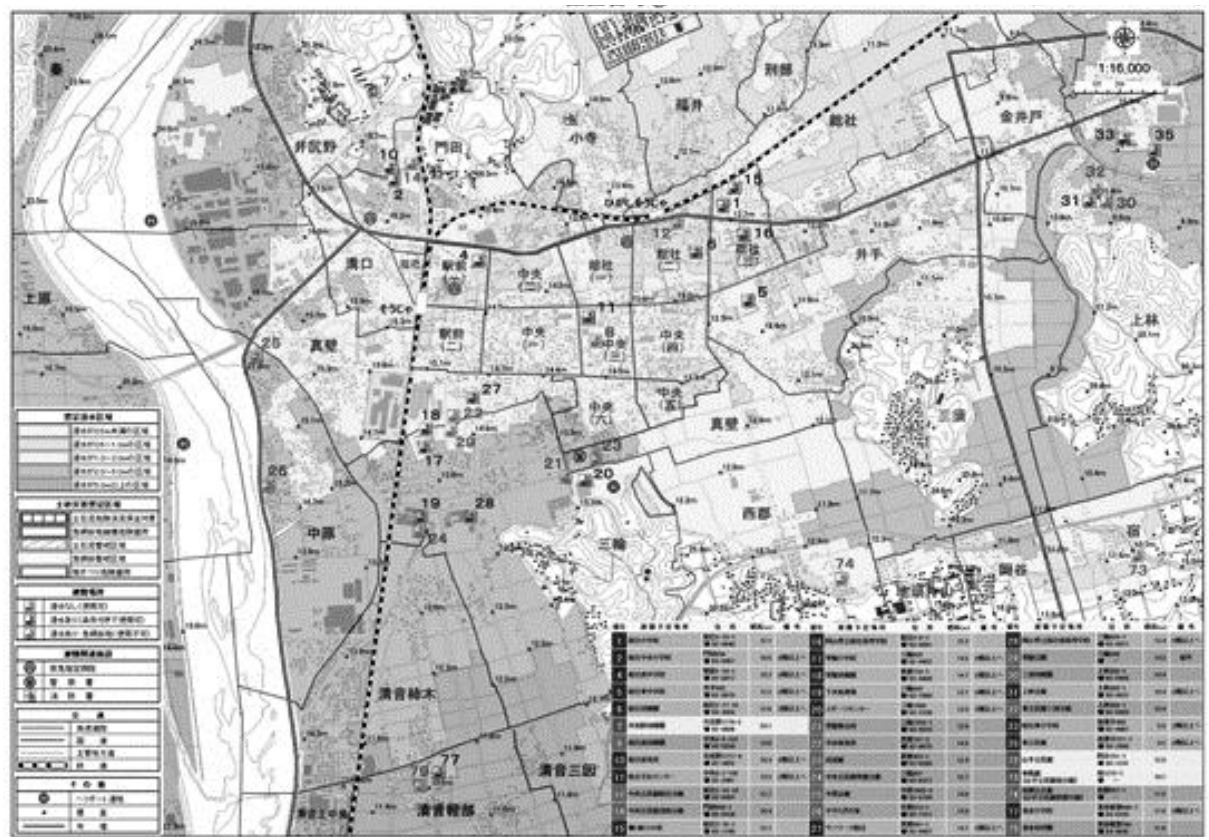

Figura 1 - The existing hazard map **Fuente:** Soja-city, Okayama, 2012.

many colors for residents to understand easier, we cannot expect residents to grasp important information.
In order to extract ptoblems with the existing hazard map, we conducted a questionary survey. 240 men and women (18 - 42 years old) residents in Soja-city participated in the survey The participants were shown an existing hazard map and a questionary sheet. The questionary consists of the following 5 questions:

Q1. Can you understand information intuitively?
Q2. Do you want to understand information in detail?
Q3. Do you think about your action when you suffer?
Q4. Do you prepare for a disaster in daily life?
Q5. Can you imagine the suffering situation?

The first 3questions (i.e., Q1, Q2 and Q3) ask how well participants "understand" hazard information. The remaining two questions ask how much they realize the serious.

For each question, participants were requested to select one item from the following five options.
• No, I can/do not at all.
• No, I can/do not so very much.
• Not either.
• Yes, I can/do a little.
• Yes, I can/do so much.

Results are shown in Figure 2
The result of the survey is summarized as follows:.
a) The residents cannot understand the hazard information that there is too much. Naturally they do not have further interest. (Q1,Q2,Q3)
b) The residents cannot imagine a disaster. Therefore they do not feel the sense of impending crisis for the disaster. (Q4, Q5)
These are two major problems in existing hazard map. Considering the above results were obtained from young and middle-aged residents, we can expect more problem for elderly residents and children.

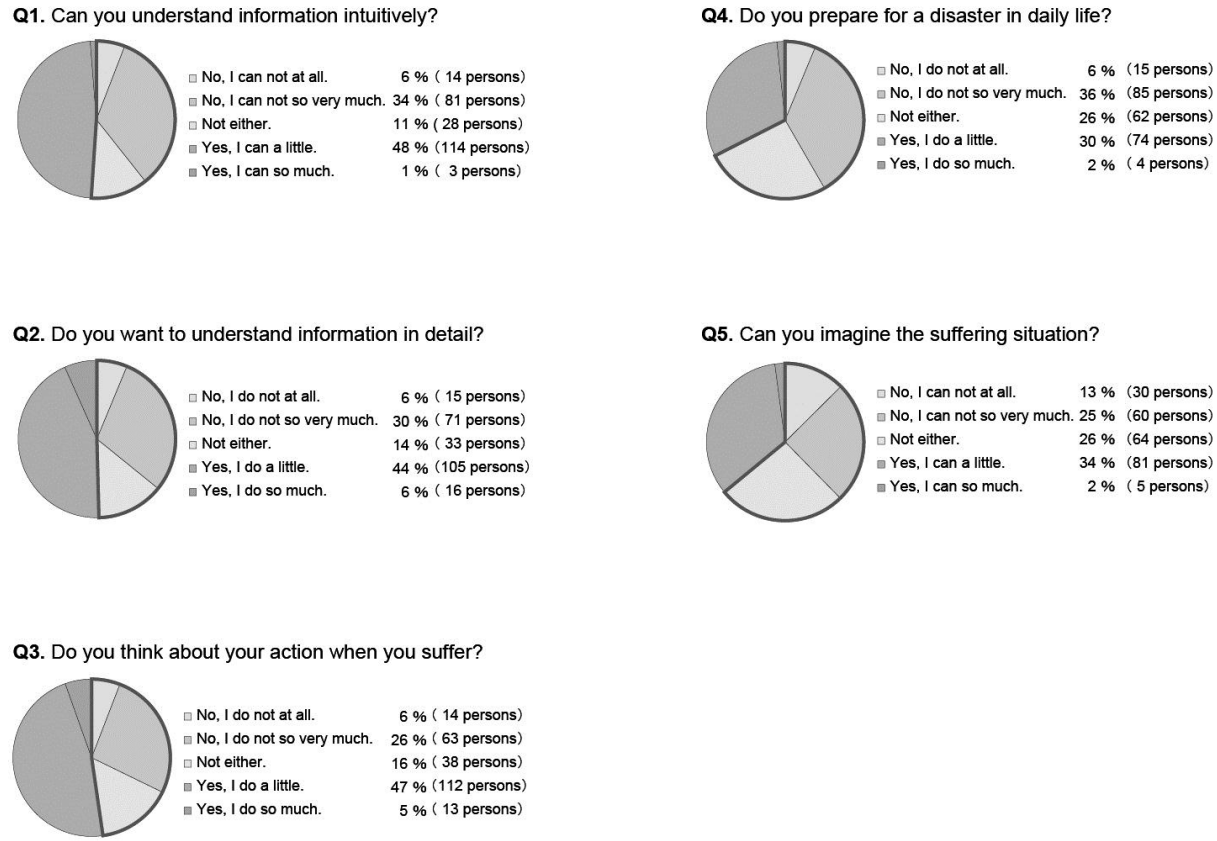

Figure 2 - Survey results of the existing hazard map **Fuente:** Elaboración propia

3. AUGUMENTED REALITY FOR HAZARD MAP

The two problems, descrived in the previous section, can be partly solved by providing clear visual infomation, not with specialized signs and words that residents can easily and intuitively grasp. The visual information should, preferably, be 'personalized', in order for each residents can realice (and "feel") hazardious situations. A technical method called auguented reality (AR) is promissing to present visual information.
Our AR system for hazard map have two functions: 1) visualization of predicted hazardious situation,

in our case, inundation, and 2) visualization of emergency equipments placed in parks, public buildings, etc.

Figure 3 shows our AR visualization of predicted inundation situation. Water image is overlayed on the actual scenary.

Exposing residents to images of damage and disaster is appropriate, and indeed essential, as it makes it possible for them to realistically imagine what damage and disaster could potentially look like. Furthermore, overlaying damaged scenery onto familiar scenery creates a greater sense of reality for the residents.

Figure 4 shows sample visualizations of emergency equipments in a park.

The place where the emergency toilet is placed in the figure (a) is usually a grass field. Users can see an image of toilet imposed upon actual image of the park. (b) and (c) show kitchen ranges transformed from benches (in the park). These visualizations helps residents to grasp how to behave in emergency situation.

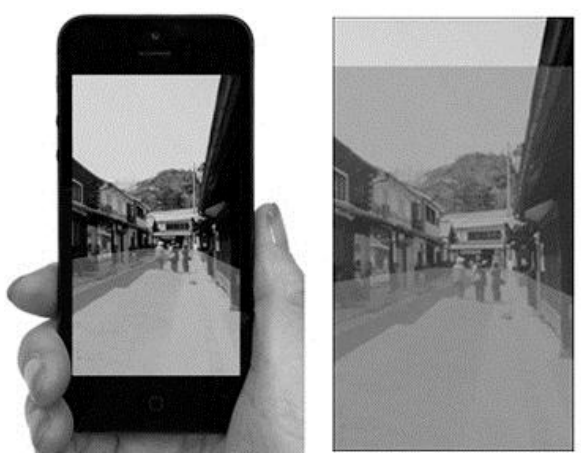

Figure 4: An Image for inundation assumption areas with some variations by using AR.

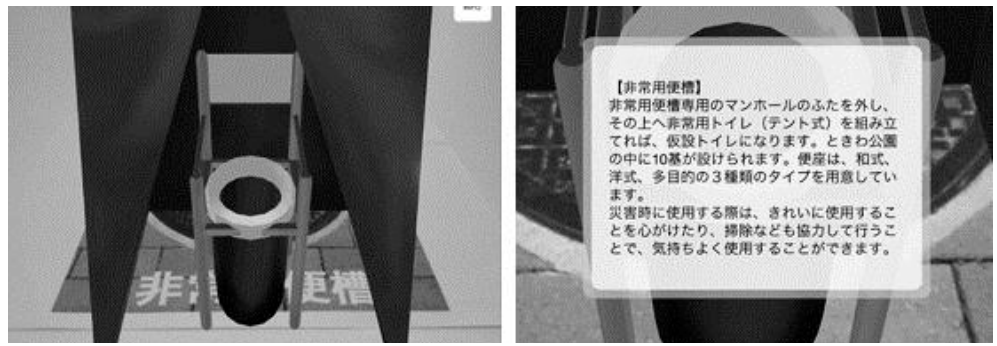

Figure 4a: A image for the emergency toilet by using AR. The residents can urgently watch facilities by a smartphone and a tablet PC

Figure 4b: A image for kitchen ranges transformed from benches (in the park) by using AR .The residents can urgently watch facilities by a smartphone and a tablet PC

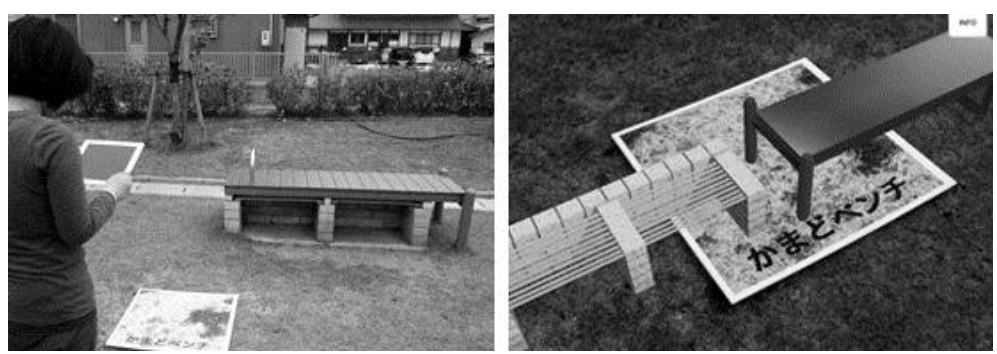

Figure 4c: An image for kitchen ranges transformed from benches (in the park) by using AR. The residents can urgently watch facilities by a smartphone and a tablet PC

4. PRELIMINARY EVALUATION

A practical experiment was conducted using 28 participants to demonstrate this original AR application. After practicing using this AR application, participants were asked whether they wanted to receive visual information through this application.

Figure 5, shows results based on questionary survey for Hazard map using by AR. 90% of the participants were eager to understand this information. Then, participants were asked whether the use of the application changed their perceptions of the reality of a disaster. Results showed that 70% of the participants felt a sense of reality concerning disaster. Many participants voiced the opinion that the different viewpoints of the application caused them to change their own ideas about disasters. The results of the experiment revealed that the flood hazard map incorporating the AR application had an effect on residents' interest in and eagerness to understand disaster prevention.

Since this AR application is useful in promoting residents' consciousness and their understanding of evacuation, it should be implemented as a tool that can help protect and save their lives.

5. SUMMARY AND FUTURE DIRECTION

Interactive technology and AR is a form of virtual reality. After AR technology was used to improve certain aspects of the map, an original technique that integrated real scenery with an imagined disaster and emergency equipments was proposed. Exposing residents to, and indeed essential, as it makes it possible for them to realistically imagine what damage and disaster could potentially look like. Furthermore, overlaying damaged scenery onto familiar scenery creates a greater sense of reality for the residents.

In this paper, we revealed through the questionary survey that the existing hazard map has two problems: difficult to understand and hard to realize the disaster situations. Then we proposed two AR functions: showing overlaying damaged scenery onto familiar scenery and showing emergency equipments in use. These functions helped residents easily and effectively grasp and caused them change their own ideas about disasters. The results of the experiment revealed that the hazard map incorporating AR application had an effect residents' interest in and eagerness to understand disaster prevention.

A remaining problem is to link the disaster simulation tool using the AR technology to the hazard map. We want to develop the tool which can use sight information to feel reporting and the actual feeling with the map transversely in the future.

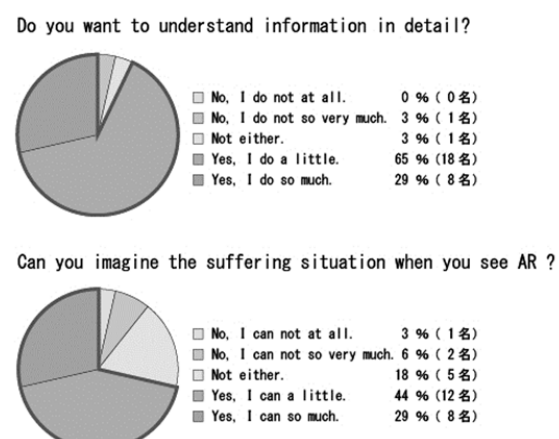

Figure 5 Results based on questionary survey for Hazard map using by AR

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> **EJE 2**
> *THEME 2*
> *EIXO 2*

FORMA Y ESTRUCTURA URBANA, ORGANIZACIÓN DEL TERRITORIO, ORIENTACIÓN DEL CRECIMIENTO

Las cambiantes morfologías y estructuras territoriales que se entrelazan o se superponen en nuestras ciudades son la expresión espacial y ambiental de tendencias y procesos de crecimiento contradictorios que son impulsados por distintos actores sociales. Las relaciones entre ellos - armónicas o conflictivas - van dando al espacio urbano sus formas y sus conexiones, van imprimiendo sus discontinuidades y fragmentaciones, van señalizando y significando los lugares del encuentro o del conflicto social, del aislamiento o de la secesión voluntaria o forzada. A través de procesos y modalidades de ocupación y apropiación y resignificación social de los territorios urbanos, muchos movimientos sociales vienen levantando desde largo tiempo atrás otras demandas que no son cabalmente registradas en las agendas públicas ni atendidas por las políticas estatales ni por los mercados formales. Estas contradicciones irresueltas sugieren la conveniencia de analizar (y planificar y regular) las implicancias ambientales y políticas de la forma, la estructura y la conectividad urbana, así como los de sus fronteras y de las modalidades de su expansión territorial.

> EJE 2

> THEME 2

> EIXO 2

URBAN FORM AND STRUCTURE: ORGANIZING TERRITORIES, GUIDING GROWTH PATTERNS

The changing territorial morphologies and structures that intertwine or overlap in our cities are the spatial and environmental expressions of contradictory growth trends and processes that are driven by different social actors. Relations among them - whether conflictive or harmonic - shape and connect the urban space, imprint their discontinuities and fragmentations, mark and confer meaning to the places of social encounter or conflict and may lead to isolation or (voluntary or forced) secessions. By means of turbulent processes and modes of occupation, appropriation and signification of urban territories, many social movements' demands are not satisfactorily addressed in the public agenda or met by State policies or formal markets. These unsolved contradictions suggest the convenience to analyse (to plan, to regulate) the environmental and political implications of urban form, structure and connectivity patterns, as well as those of the modes of territorial expansion and the definition of (new) urban borders.

FORMA E ESTRUTURA URBANA, ORGANIZAÇÃO DO TERRITÓRIO, ORIENTAÇÃO DO CRESCIMENTO

As variadas morfologias e estruturas territoriais que se entrelaçam ou se sobrepõem em nossas cidades são a expressão espacial e ambiental de tendências e processos de crescimento contraditórios que são promovidos pelos distintos atores sociais. As relações entre eles - harmônicas ou conflituosas - vão dando ao espaço urbano suas formas e suas conexões, imprimindo suas descontinuidades e fragmentações, mostrando e dando significado aos pontos de encontro ou de conflito social, de isolamento ou de desagregação voluntaria ou forçada. Através dos processos e modalidades de ocupação, apropriação e ressignificação social dos territórios urbanos, muitos movimentos sociais vêm presentando desde muito tempo outras demandas que não são devidamente registradas nas agendas públicas nem atendidas pelas políticas estatais ou pelos mercados formais. Essas contradições não resolvidas sugerem a conveniência de analisar (e planejar e regular) as implicâncias ambientais e políticas na forma, estrutura e conectividade urbana, assim como nas suas fronteiras e nas modalidades da sua expansão territorial