(Main Section: Ecological Planning)

Spatial Cognition of Residents towards the Conservation Area of Upo Wetland

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Abstract: Wetlands are being negatively affected by various human activities such as reclamation, construction of levees, and conventional agricultural activities. Upo Wetland is the largest inland wetland in the Republic of Korea (hereinafter Korea). It has not only been designated as a wetland protection area by the Wetland Conservation Act of Korea but also registered as a Ramsar Site in 1998. In this study, cognitive mapping of the Upo Wetland and surrounding areas was applied to identify sensitive and vulnerable areas that should be carefully managed. The results of the cognitive mapping were compared with existing land-use zones of the wetland conservation area. Furthermore, this paper discusses the advantages of resident participation in cognitive mapping over conventional social and environmental analysis for landscape planning on other conservation areas.

1.   INTRODUCTION

Nowadays, the ecological and cultural values of wetlands are highly valued as interests and awareness on biodiversity increase. Wetlands provide diverse habitats and food for different organisms by cycling nutrients, improving soil quality, controlling microclimate, and regulating natural hazards and pollution with their unique hydrological, biochemical characteristics (Maltby & Barker, 2009). A strong relationship has existed between humans and wetlands for 2000 years in China and European countries (An et al., 2007; Davidson et al., 1991) and 300 years in North America (Dahl, 1990). Overall, the world has lost 64–71% of its wetlands since 1700 AD as a result of various human activities and development (Davidson, 2014). Due to these circumstances the convention on wetlands (Ramsar Convention) was established in 1971 to cope with the decreasing trend of global wetland areas. Today, the Ramsar Convention has 169 Contracting Party countries with over 2,200 Ramsar sites around the world designated to take initiatives to conserve their significant value and contribution to humanity.

Upo Wetland was designated as a Ramsar site in 1998. It is the largest freshwater wetland in Korea. From the 1930s to early 1990s, Upo Wetland was disturbed by the construction of levees as a flood protection measure

and by reclamation for agricultural land. The development resulted in a loss of 1/3 of the original wetland surface area. The Ministry of Environment, Korea designated Upo Wetland as a 'Wetland Protection Area' (hereinafter WPA) in 1999. Since then, development and other human activities have been restricted. This strict approach segregated the local community from the wetland, as local residents were no longer allowed to enter the WPA. Consequently, local residents had to find ways to make a living along the boundary of the WPA. They started to cultivate garlic and onion around the WPA to support their livelihood. Human activities are restricted within the WPA, but no specific management strategy has been applied to the wetland environment outside the WPA boundary.

Despite the conservation-oriented governance, negative effects of mass production through agriculture on wetland quality have been observed, particularly non-point and point source pollution around the wetland through four main streams (Ministry of Environment, 2002; Nakdong River Basin Environmental Office, 2011). On the other hand, a wide range of community activities have been limited by policies and management focused on conservation, which has resulted in complaints from residents (Gyeongsangnamdo Development Institute (GDI), 2007).

Generally, spatial planning and management are established through understanding the status of related communities and their natural environment within a targeted site. Environmental data related to that status are collected through regional scale analyses and text based surveys and by performing statistical analyses. Local community participation has been recognized as one of the keys to successful spatial planning and management for both environment and humanity (World Commission on Environment and Development (WCED), 1987; Calheiros, Seidl, & Ferreira, 2000; Hyett, Kenny, & Dickson-Swift, 2017; Lee, J.-h. & Son, 2017; Ramsar Convention Bureau, 2000). However, promoting community participation has been challenging due to a lack of communication with stakeholders of different backgrounds.

1.1   OBJECTIVES

This study attempts to build an ethical and spatial connection between the wetland and local residents for deriving practical management strategies that achieve the conservation of the wetland and sustainable livelihood simultaneously. Focusing on the application of cognitive mapping with residents of areas with high natural and social values as participants, the objectives of this study are twofold: the first objective is to delineate vulnerable areas requiring enhanced conservation and utilization based on resident perspectives; the second objective is to define pros and cons of cognitive mapping when applied to rural communities within an ecologically sensitive environment as an alternative communication tool.

2.   LITERATURE REVIEW

2.1   Environmental Status of Upo Wetland

Upo Wetland is the largest freshwater wetland in the Korean peninsula with a total surface area of 2.31 km² (Kim, J. W. et al., 2011). The wetland is

a part of the Topyeung stream watershed that is connected to Nakdong River. It consists of four sub-wetlands 'Upo', 'Mokpo', 'Sajipo', and Jjokjibeol, sustained by multiple streams (Kim, J. W. et al., 2011). Sub-wetlands exist in the form of either large oxbow lakes, marshes (Ramsar Convention Bureau, 1998) or freshwater wetlands and back marshes (Ministry of Environment, 2010), all of which are most likely to be influenced by surrounding surface water bodies or streams (Kim, J. W. et al., 2011; Koo, 2009). Because the elevation of Upo Wetland is at least 5 m lower than the surrounding topography, areas around it have a strong hydrological connectivity (Koo, 2009), which remains persistent even during the dry season. Topyeung stream is the main stream having a major effect on the wetland environment because of its size and hydrological characteristics. The stream flows from Mt. Yulwang (662.5 m) and merges with tributaries from Mt. Wangryung (252.6 m) and Mt. Guryong (207.6 m) through Upo Wetland. It enters Nakdong River but during the rainy season, overflooding of Nakdong River causes counterflow, which results in dynamic changes of the landscape (Kim, J. W. et al., 2011). Such dynamic changes provide diverse habitats, which significantly affect biodiversity (Ahn, 2010; Kim, T. G., Lee, & Oh, 2007; Oh et al., 2004; Federal Interagency Stream Restoration Working Group (FISRWG), 1998).

Despite its great landscape characteristics, a reclamation measure was taken from the 1930s to 1970s to create agricultural land for securing food. In the 1930s, a large portion of the wetland was converted into agricultural land through the construction of Daedae levee. In the 1970s, the Korean Agricultural and Rural Infrastructure Corporation developed 32 ha of the wetland into paddy fields followed by continuous construction of levees, including the Sajipo levee in 1976, and Mokpo and Jjokjibeul levees in 1982, all of which resulted in a loss of 1/3 of the original wetland surface area (Ministry of Environment, 2002).

Numerous studies insist that Upo Wetland is exposed to disturbances caused by various human activities, such as construction of levees, roads, and conventional agricultural activities (Ahn, 2010; Jun, 2017; Kim, T. G., Lee, & Oh, 2007; Ministry of Environment, 2002; Nakdong River Basin Environmental Office, 2011; Oh et al., 2004; Seo, 2006; Gyeongsangnamdo Development Institute (GDI), 2007).

2.2   Cognitive Mapping

There are numerous mapping tools to engage a great number of participants such as Public Participatory GIS (PPGIS), Participatory 3-D modelling (P3DM), Multimedia mapping, GPS mapping, Ground mapping Transect mapping, and Scale mapping, which are proven to be effective information communication tools (Corbett, 2009). Internet or GPS based tools such as PPGIS and GPS mapping are useful for collecting large quantities of accurate data, but they require a steep learning curve and high cost, which are critical limitations for engaging local residents. When considering cost, efficiency and ease of mapping approaches, such as Transect mapping, Ground mapping and P3DM are options, but they are also labor-intensive and less accurate, which undermines their credibility with government officials during decision making processes (Brown & Kyttä, 2014).

Cognitive mapping is defined as a method to either conceptually or geographically delineate contents cognized by people (Kim, Y. H., 2011). Cognition is defined as a means of gaining knowledge or awareness by

connecting present or past environmental conditions to personal behaviour in the future or past (Im, 1988). Appleyard (1970) analyzed over 200 maps of one typical city and classified cognitive maps into sequential maps and spatial maps. Sequential maps are generated on the basis of continuous experience gained along a line or path, whereas spatial maps are generated on the basis of importance or significance of a point or polygon. (Downs & Stea, 1974) insisted that human instinct is more likely to transfigure reality, human behavior, and expectations to mediate and control environmental impacts, resulting in incomplete, distorted or exaggerated or schematized forms of cognitive maps. Therefore, more samples of cognitive maps are preferable for identifying specific characteristics of an area with high precision.

In the past, cognitive maps have mostly been used for urban areas. Lynch (1960) analyzed how a first-time visitor cognized Boston, Jersey City, and Los Angeles through sketch mapping and clarified the urban scape based on five components of paths, edges, district, nodes, and landmarks. Yi (2008) analyzed symbolic images of Cheongju-si city with college students as participants. Lee, S. J. (2002) used cognitive maps to analyze differences between environmental images of recreation space cognized by visitors and managers in a traditional Korean village. In this study, cognitive mapping is employed to identify areas that could contribute to sustainable management of rural communities in Korea.

3.   METHODOLOGY

3.1   Research Site and Scope

[Gyeongsangbuk-do, South Korea] [Changnyeung County]

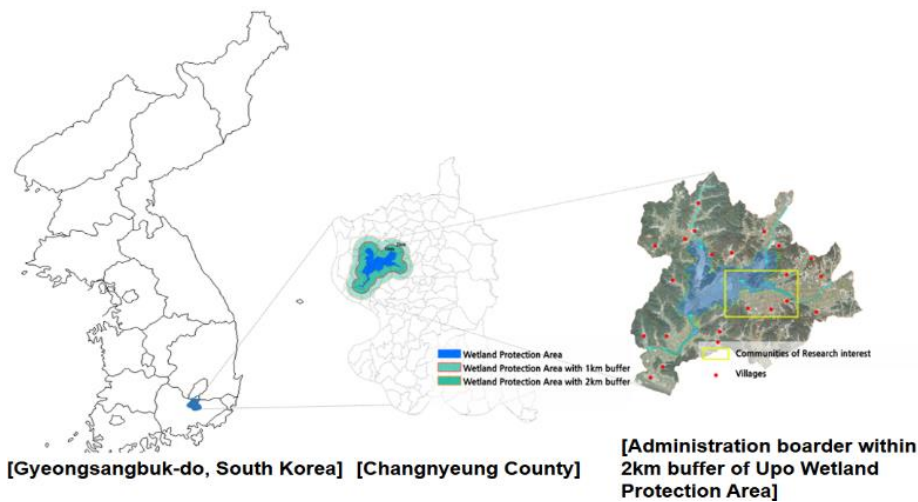[Administration boarder within 2km buffer of Upo Wetland Protection Area]

Figure 1. Research site

The research site includes the upper Topyeung stream and the surrounding communities within a 2 km² buffer of the current WPA. As the site includes the boundary of the WPA, unilateral conservation measures are employed on one side and human activities take place on the other side. Therefore, the research site represents an area of great ecological value with exposure to non-point and point sources of pollution from various human

activities. The site encompasses four villages, which are 'Daedae Village,' Kwandong Village', 'Soya Village' and 'Hyojung Village'.

This study analyzed the perceptions of residents of the four villages toward their surrounding environment, including farmlands, streams, levees, forests, and residential areas to delineate practical and reliable methods for enhanced resident-oriented management. In order to communicate and interpret the opinions of local residents living in areas with complex issues, a stepwise approach was conducted from an in-depth interview to cognitive mapping followed by overlapping analysis as shown in *Figure 2*.
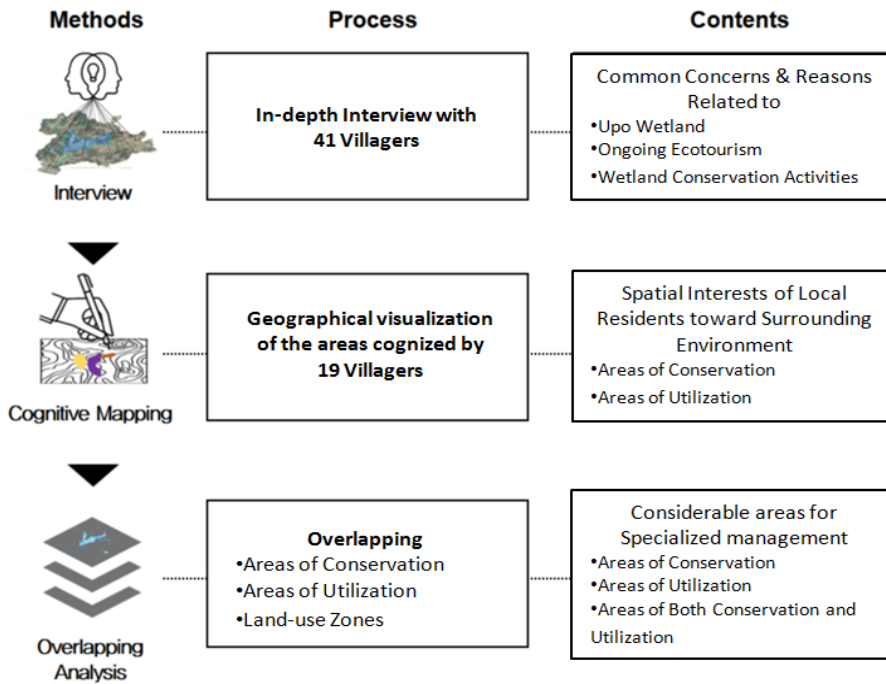

Figure 2. Research flow

3.2   Process of Cognitive Mapping and Overlapping Analysis

The interviews with local residents of Upo Wetland provided information on the common spatial interests of the community for preparing cognitive mapping items. The interviews covered three topics: the 'Ecotourism industry', 'Changes in Upo wetland over time', and 'Conservation activities'.

After preparing mapping items, cognitive mapping with residents including community leaders within the research site was implemented. Participants were assisted by the researchers to help them understand geographic features of the base map and encourage them to freely draw their ranges of spatial cognition regarding mapping items. Then, geographically visualized areas were collected and digitized over the base map.

After the digitization of the hand drawings, each layer of polygons was categorized into two groups. The first group comprised mapping items indicating areas requiring enhanced management for 'Conservation' (hereinafter EMC), which includes mapping items indicating tendencies of 'vulnerable' and 'ecological' areas. The second group comprises mapping

items indicating areas requiring enhanced management for 'Utilization' (hereinafter EMU), which includes mapping items indicating tendencies of 'agricultural usage' and 'service provisioning' areas.

Once mapping items are grouped, polygons belonging to same group are overlapped using the tool 'Count overlapping area' of Arc GIS 10.2 to verify areas with different levels of tendencies of 'Conservation' and 'Utilization'. After verifying two different groups of areas, each group is overlapped with current land-use zonings for analyzing differences between current land-use zones and the spatial cognition of local residents.

4.   RESULTS

4.1   Delineating Areas with Tendencies of Utilization and Conservation

4.1.1   Cognitive Mapping Items

To select practical mapping items regarding the ongoing issues of Upo Wetland, 38 local residents from 22 villages located within two kilometers outside of the 'WPA' were interviewed as shown in *Figure 3*.
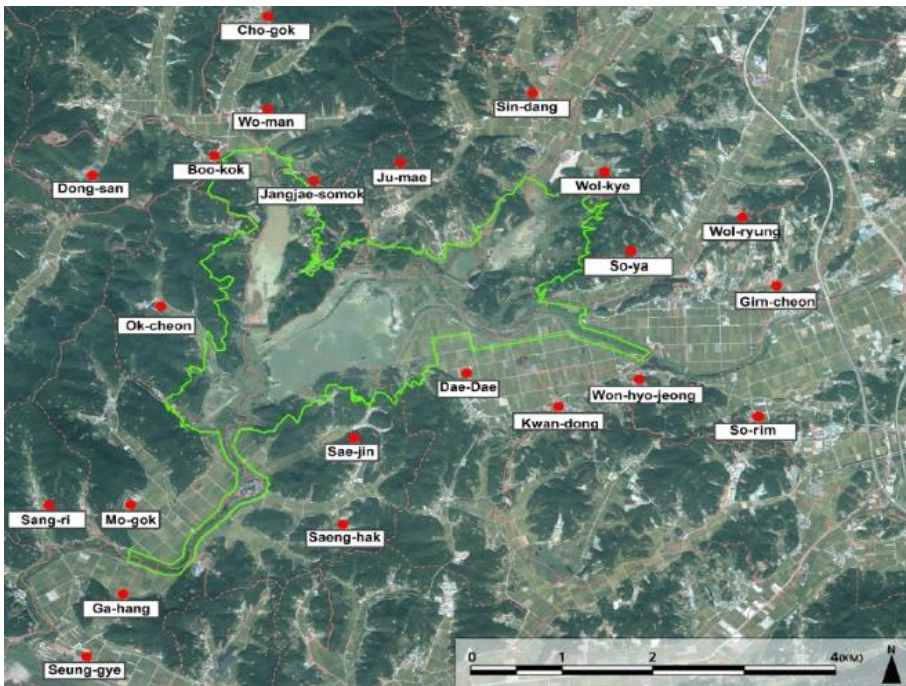

Figure 3. Interview points

Out of the total 38 interviewees, 28.9% were females and 71.1% were males with an average age of 64 years. Interviewees expressed a diverse range of concerns regarding 'Upo Wetland over time', the 'Ecotourism industry', and 'Wetland conservation activities'. Regarding the topic 'Upo Wetland over time', the major concerns were degradation of water quality, and isolation of communities and the wetland due to six spatially relatable reasons. As for the topic 'Ecotourism industry', five concerns were drawn, including 'Having no tourist attraction', 'Not having enough workforce', 'Having no strategies nor support to start ecotourism', 'Visitors threatening

the livelihood of the residents', and 'Lack of community participation', due to nine spatially relatable reasons. As for the topic 'Wetland Conservation Activities', concerns of 'Releasement of Japanese Crested Ibis', 'Prohibition on entering wetland', 'Preservation of water surface level', 'Unmanaged government owned land' and 'Prohibition of hunting wild animals' were verified due to six spatially relatable reasons.

In total, 20 spatially relatable reasons were collected. However, the reasons varied with complicated perceptions of different individuals since conservation activities and agricultural activities are simultaneously being practiced. Therefore, the reasons were regrouped as whether it was focused on 'Wetland environment' or 'Economic and Cultural activities'.

As mapping items were prepared in order to delineate areas for enhanced conservation and utilization management of two different groups, reasons were categorized and rephrased against specific tendencies indicating 'Conservation' and 'Utilization'. As for mapping items indicating 'Conservation', reasons regarding 'Wetland environment' were rephrased based on the area representing 'vulnerability' and 'ecological value'. For mapping items indicating 'Utilization', reasons regarding 'Economic and cultural values' were rephrased based on the area representing 'Production', 'Service', and 'Opportunity' as shown in *Table 1*.

Table 1. List of mapping items derived from the interview

Mapping Item	Management					Tendency
	EMC (Wetland Env.)		EMU (Economic & Cultural Value)			
	Vulnerability	Ecological value	Production	Service	Opportunity	
1. Ancient paths, daily walking trail				√	√	Utilization
2. Evidence of interesting or native plants and animal	√	√		√		Conservation
3. Great memories/ viewpoint		√		√	√	Utilization
4. Existence of edible plants			√	√	√	Utilization
5. Appearance of water fluctuation		√		√	√	Utilization
6. Approachable stream	√		√	√	√	Utilization
8. Destructed /disturbed roads	√					Conservation
9. Source of unpleasant odour	√					Conservation
10. Dysfunctional stream flow	√					Conservation
11. Contaminated by fishermen and villagers	√					Conservation
12. Appearance of degraded wetland or stream	√					Conservation
14. Stacked manure	√					Conservation
16. Farmland with low yield due to poor infiltration					√	Utilization
17. Farmland with excessive herbicide or pesticides	√		√		√	Utilization
18. Left fallowed field					√	Utilization
19. Cultivation of crops other than garlic and onion			√		√	Utilization
21. Drainage (without wastewater treatment)	√					Conservation

4.1.2 Areas Requiring Enhanced Conservation and Utilization

From each of the four villages, four to five residents, including community leaders, participated in the cognitive mapping as presented in *Figure 4*.

Figure 4. Location of cognitive mapping participants

Regarding the age of the participants, 42% were in their 50s, 26% in their 60s, 21% in their 80s, and 11% in their 70s. Regarding their occupations, 74% were involved in agriculture only, 16% in both livestock farming and agriculture, and 10% had no occupation. Regarding their origin, 69% were born within Upo Wetland and 31% moved to Upo wetland at least 20 years ago.
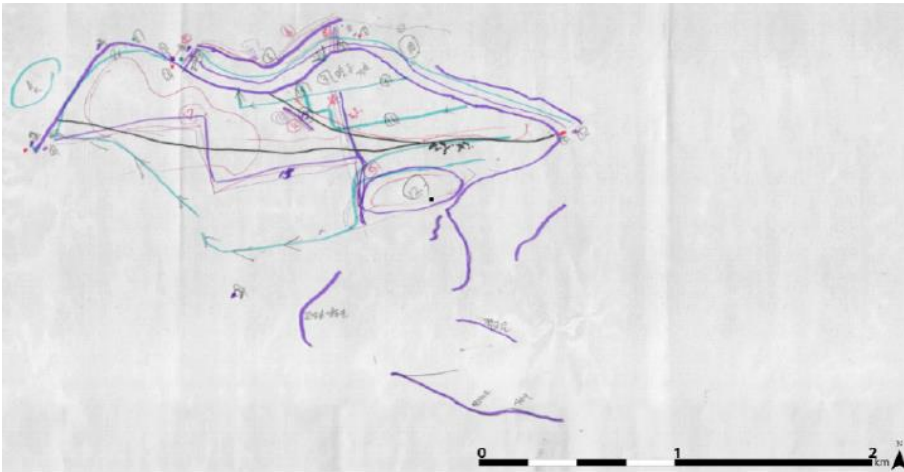

Figure 5. Preliminary form of cognitive map (hand drawing)

The cognitive mapping was conducted on different days and the process took 40 to 80 minutes per participant depending on the capability of each participant to understand the base-map. Prior to the mapping, the purpose of the research was explained to the participants. After the explanation, the participants were given the prepared materials and requested to draw either lines or polygons regarding each mapping item. While going through the mapping items, the participants were given the option to skip items. Out of 19 participants, 10 participated individually, three conducted cognitive mapping in a group, and three groups of two participants conducted

cognitive mapping together. However, without the help of researchers, most of the participants had difficulties geographically indicating the specific area of their interest during the cognitive mapping. Therefore, cognitive mapping was implemented one participant at a time. *Figure 5* shows a preliminary map drawn by a participant.

A2 size tracing papers with drawings of local residents were scanned with a rolling scanner then the images were digitized and processed into polygons. After digitization, all the layers of polygons were grouped into 'Conservation' and 'Utilization'. All the polygons of the two groups were imported into Arc GIS 10.2 to delineate areas with different levels of concentration of overlapping polygons.
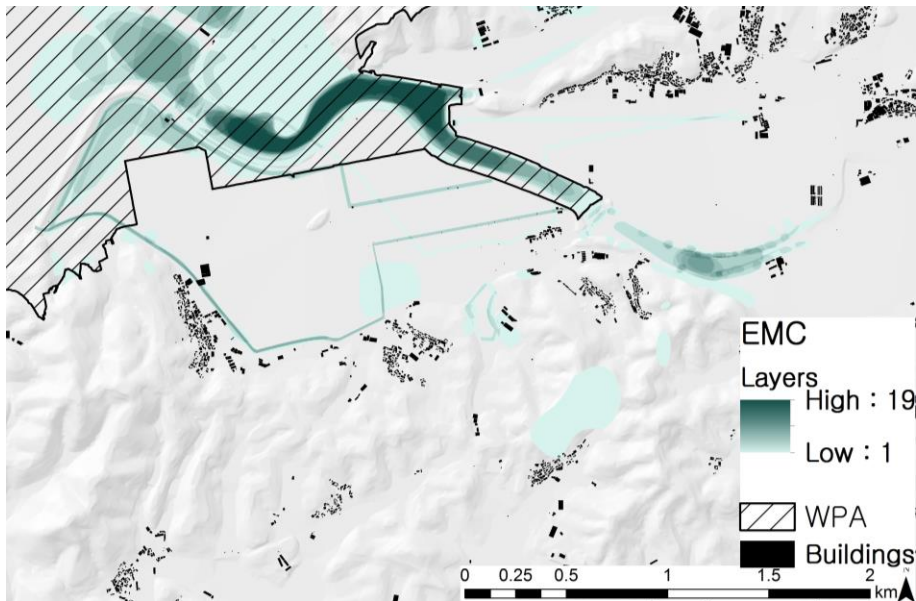

Figure 6. Cognitive map showing areas in need of enhanced conservation management

Figure 6 Shows areas requiring enhanced conservation management cognized by local residents. Levels of concentration of overlapping polygons ranged from 1 to 19. High levels of overlapping polygons were generally located over water surface, wetlands, and partially agricultural land. Areas with the highest levels of overlapping polygons could be delineated along Topyeung stream, which indicated significant interest from the community. The related mappings are 'Dysfunctional stream flow', 'Contaminated by Fishermen and villagers', 'Source of unpleasant odour', and 'Appearance of degraded wetland or stream'. As for the surface area of Upo Wetland, the mapping item, 'Evidence of interesting or native plants and animals' was most concentrated. As for agricultural areas, residents appeared to be highly interested in the mapping item 'Source of unpleasant odour' and 'Drainage without wastewater treatment'.

Figure 7 shows areas requiring EMU cognized by local residents. Levels of concentration of overlapping polygons ranged from 1 to 11. High levels of overlapping polygons appeared over agricultural land, forest areas behind the villages, and partially over Topyeung stream and Daedae levee. Delineated areas were more likely dispersed compared to the 'Conservation' map, which could be possibly due to the different levels of knowledge of participants as the areas are closely related to the livelihood of the residents. Agricultural land appeared to be of the most significant interest to the community with combinations of mapping items, 'Farmland with low yield

due to poor infiltration', 'Farmland with excessive herbicide or pesticides', 'Left fallowed field', and 'Cultivation of crops other than garlic and onions'. Forest areas behind villages also appeared to be of interest to the community with combinations of mapping items, 'Great memories/view point' and 'existence of edible wild plants'. The community was also interested in Topyeung stream and Daedae levee with combinations of mapping items, 'Great memories/view point', 'Existence of edible plants', 'Appearance of water fluctuation', and 'Approachable stream'.
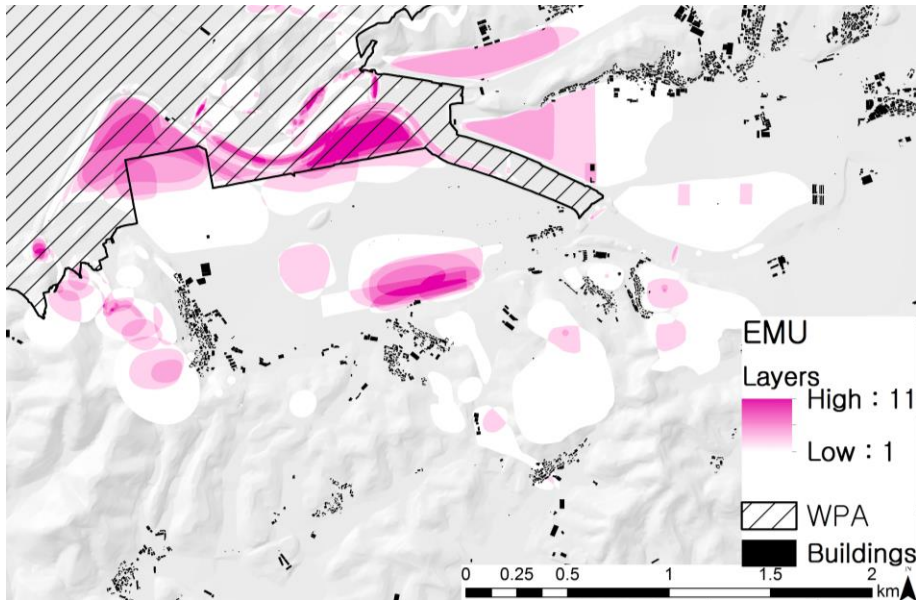

*Figure 7. Cognitive map showing a*reas requiring enhanced utilization management

4.2 Overlapping Analysis of Current Land-use Zones

4.2.1 Simplification of Current Land-use Zones

To analyze differences between the spatial cognitions of the local residents toward their environment and current land use zones, three different types of cognitive maps were compared with simplified land-use zones. The research site has seven land use zones designated by the Ministry of Environment and Ministry of Land, Infrastructure and Transportation. Within the site, each zone has its own purpose, allowance, and restrictions. However, there are various overlapping zones resulting in dispersion of management.

Each layer of the seven zones, the WPA, Rural Settlement Zone (RSZ), Planned Management Zone (PLMZ), Conservation Management Zone (CMZ), Production Management Zone (PMZ), Agriculture Promoted Zone (APZ), and Agricultural Activity Zone (AAZ), were overlapped using Arc GIS 10.2 to verify existing combinations of different zones. In total, 31 different combinations of zonings could be derived. The total area of the research site is estimated to be 14.9 km² and areas less than 5 m² were excluded from the analysis since such size would not have a significant impact and there could be subtle differences in geographic coordination.
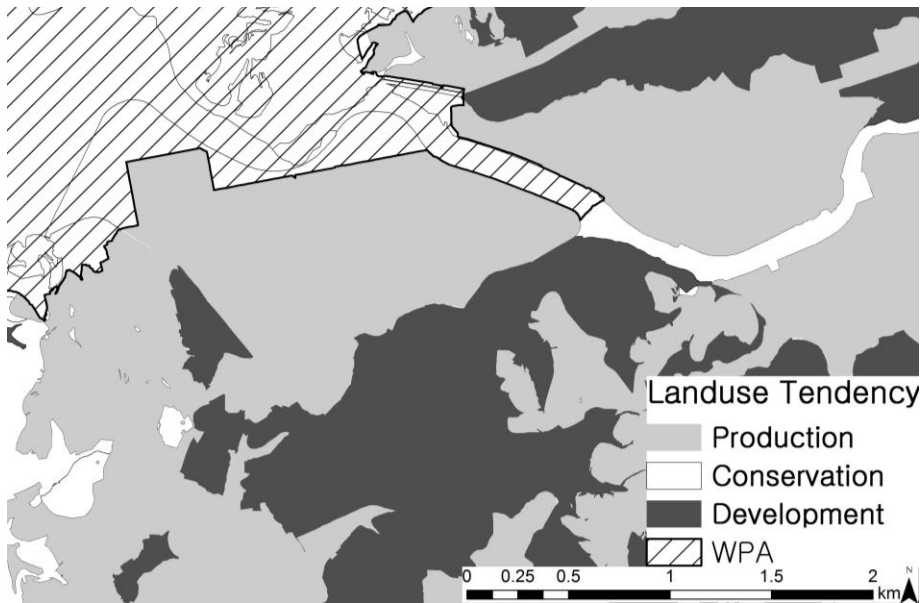
Figure 8. Simplified land-use zones with tendencies of 'Conservation', 'Production', 'Development'

The 31 combinations of zones were simplified into 'Conservation', 'Production', and 'Development' based on their purpose, allowance and restrictions regarding the 'National Land Planning and Utilization Act' and 'Wetland Conservation Act'. The simplification of zones allowed overlapping the analysis with the results of cognitive mapping as shown in *Figure 8* above.

4.2.2   Spatial Cognitions of Local Residents towards the Environment Compared with Current Land-use Planning
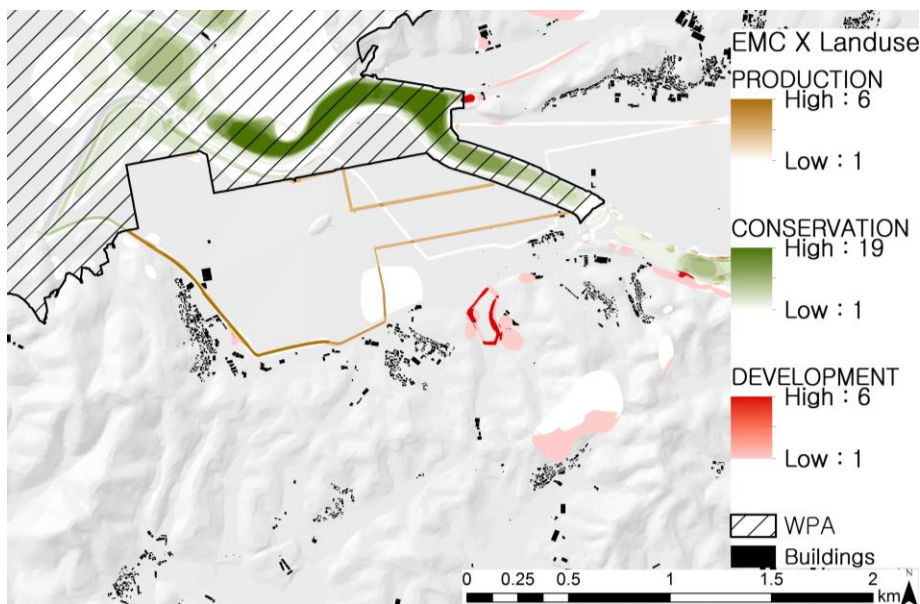

Figure 9. Areas in need of EMC within three different Land-use zones

An overlapping analysis of simplified land-use zones over three different cognitive maps derived from the spatial cognition of the residents towards

their environment was performed to investigate differences between the cognition of local residents towards the environment and land-use zones planned by the government. For areas requiring EMC, a total area of 1.62 km² was cognized by the local residents as shown in *Figure 9*. Land-use zones with a tendency of 'Conservation' (hereinafter LUTC) matched 75% (1.62 km²) of the areas cognized by local residents for enhanced management of 'Conservation'. Land-use zones with a tendency of 'Production' (hereinafter LUTP) matched 17% (0.36 km²) of the cognized area and that of 'Development' matched 8% (0.18 km²) of the cognized area. Overlapping polygons were found to be significantly concentrated along Topyeung stream, the water channel for agricultural purpose within Daedae community, and the forest behind Hyojung village.

For areas requiring EMU, a total area of 3.18 km² was cognized by the local residents as shown in *Figure 10*. When overlapping simplified land-use zones over the cognitive maps, LUTP matched 65% (2.08 km²) of the areas cognized by local residents for EMU. LUTC matched 24% (0.76 km²) of the cognized area and that of 'Development' matched 11% (0.34 km²) of the cognized area. Overlapping polygons were significantly concentrated mostly over fallowed agricultural land, forests behind multiple villages, and a portion of Topyeung stream where it enters the wetland.
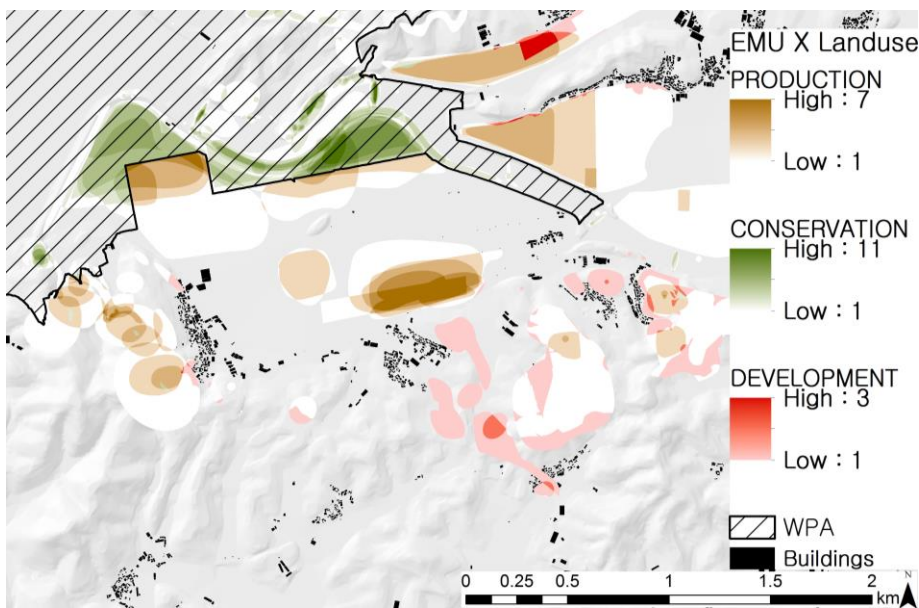

Figure 10. Areas requiring EMU within three different land-use zones

5.   DISCUSSION

5.1   Specificity of Cognitive Mapping

Despite the conservation and sustainability approach, challenges of balancing the quality of livelihoods and environment remain a problem, especially among areas that are recognized for their high ecological value. The cognitive mapping approach in this study has numerous limitations regarding the quality and quantity of the data and time efficiency. Today, internet based participatory mapping tools such as PPGIS are widely

recognized for their time efficiency, accuracy and sample size (Brown, 2012). Due to the fact that residents in the research site were not familiar with information technology, cognitive mapping was applied to provide evidence for the fact that constructing mapping items and drawing cognitive maps increased the environmental awareness of participants as they started to share their thoughts for a better environment and made them feel connected to the wetland.

5.2   The Different Thoughts on the Environment

Since agricultural lands around the Upo wetland are designated land use zones with tendencies of 'Production', they remain a great source of community income. Therefore, intensified agricultural practices, such as the application of heavy loads of herbicide and fertilizers have been legally applied to the fields seasonally. On the other hand, throughout the interview conducted in the beginning of the study, many interviewees were aware of the contamination of the wetland and pointed out the numerous reasons responsible for wetland degradation. Although almost every interviewee had different perceptions toward the environmental problems, some interviewees were more concerned for the environment because of the potential impacts, including stronger regulation on agricultural practices and declining land values. Some considered the wetland as their heritage and were upset by its degradation under government management. With such different perceptions, novel but effective ways of integrating the voices of local residents had to be applied, with cognitive mapping being one of the options.

5.3   Interpretation of the Cognitive Map

Cognitive mapping was effective for diagnosing an environment by integrating and geographically visualizing specific issues cognized by participants. Specific areas verified for EMC and EMU could be useful in the decision-making process since different combinations of mapping items related to the area allowed decision makers to come up with varieties of management and planning strategies for areas with specific phenomena. Such management and planning strategies based on mapping items could potentially solve problems or increase the efficiency of current land-use zones by engaging local communities, as a majority of the participants cognize the needs of specific areas. Those specific areas can be classified into six land types.

Land type 1 is the area in need of EMC within LUTC as shown in *Figure 9*. This land type indicates that complementary conservation strategies are needed to cope with specific phenomena within LUTC. Such phenomena are indicated by combinations of mapping items such as 'Source of unpleasant odour', 'Dysfunctional Stream flow', 'contaminated by fishermen and villagers', 'Appearance of degraded wetland or stream', 'Evidence of interesting or native plants and animals' and lastly 'Great memories / view point'. The most representative area of land type 1 is an inlet of Topyeung stream. The related mapping items show potential for opportunities for participation of the local community in monitoring, guarding, cleaning, and guiding the area. Furthermore, by offering incentives for local participants to freely enter the conservation area like in the past, the connection between the wetland and the community may return.

Land type 2 is the area in need of EMC within LUTP as shown in *Figure 9*. This land type indicates that production activities within LUTP have been threatening the environment. Such phenomena are indicated by combinations of mapping items such as 'Source of unpleasant odour' and 'Drainage (without wastewater treatment)'. The most representative area of land type 2 within the site is a few lines of drainage channel that deliver wastewater originating from the farmland and housing into the wetland directly across the WPA. Considering the mapping items above, implementation of conservation measures such as the provision of education or support funds for raising environmental awareness among landowners and farmers near water channels can be developed.

Land type 3 is the area in need of EMC within LUTD as shown in *Figure 9*. This land type indicates that the area is possibly exposed to more threatening activities compared to land type 1 and 2 since LUTD is less regulated. Such phenomena are indicated by combinations of mapping items like 'Source of unpleasant odour', 'Contaminated by fisherman and villagers', 'Stacked manure'. The most representative area of land type 3 within the site is the pond located between the Kwandong and Hyojung villages. Most participants have indicated that this area is a dumping ground. However, there were numerous farmers who have been highly dependent on pond water as a source of irrigation for farming. Considering the mapping items above, implementation of conservation measures such as enhancement of regulation on activities threatening the water quality and installation of CCTVs could improve the current status of the area.

Land type 4 is the area in need of EMU within LUTC as shown in *Figure 10*. This land type indicates that even though the area is in LUTC, it has a great potential for wise use of natural resources for production, ecotourism, education, and many more. Such potential is indicated by combinations of mapping items like 'Ancient paths, daily walking trail', 'Great memories/view point', 'Existence of edible plants', 'Appearance of Water fluctuation' and 'Approachable stream'. The most representative area of land type 4 within the site is the farmland by the levees along the inlet of Topyeung Stream within the WPA. Due to unilateral conservation measures, the farmlands under conservation are left alone, allowing invasive plants to disperse seeds around active farmlands, causing the residents to complain. Considering the mapping items above, beneficial activities such as agro-ecotourism, birding, or construction of wetlands for waste water treatment could be implemented.

Land type 5 is the area in need of EMU within LUTP as shown in *Figure 10*. This land type indicates that there are opportunities for wise use of the specific areas within LUTP other than production. Such potential is indicated by combinations of mapping items like 'Farmland with low yield due to poor infiltration', 'Farmland with excessive herbicide or pesticides', 'Left fallowed field' and 'Cultivation of crops other than garlic and onion'. The most representative area of land type 5 within the site is the plot of farmland located in front of the Kwandong Village, which has not been used due to poor infiltration. This particular plot of farmland could be transformed into a constructed wetland for growing native plants to contribute to the biodiversity of the Upo wetland.

Land type 6 is the area in need of EMU within LUTD as shown in *Figure 10*. This land type indicates that there are opportunities for wise use of the specific areas within LUDP other than for development. However, there were no significant signs of Land type 6 within the research site since the highest number of overlapping layers is found to be only three.

6. CONCLUSION

This research paper shows how groups of local residents of the Upo Ramsar Wetland community in Korea cognize their surrounding environment. Cognitive mapping was performed, focusing on delineating areas that require EMC and EMU to cope with wetland degradation and segregation of the community from the wetland. Mapping items were constructed on the basis of aggregated reasons for the concerns of 38 local residents toward ongoing challenges.

The proportions, locations, and current status of significant areas in need of EMC and EMU within different land-use zones with tendencies of 'Conservation', 'Production' and 'Development' were geographically visualized. The cognitive mapping, with residents as participants, revealed large differences between the viewpoints of residents and conventional environmental and social analyses implemented by the government prior to planning. The first difference was that each area delineated by the cognitive mapping featured definite and diverse reasons that could improve the practicality of the management, whereas conventional analyses only focus on the conceptual approach. The second difference is that in the process of cognitive mapping, the participants voluntarily searched for resources and solutions to solve the problem, whereas only community leaders and decision makers participate in workshops and meetings in general. The third difference is that cognitive mapping assisted local residents in sharing their opinions by providing mapping items reflecting common interests of local residents and drawing tools for map marking, whereas conventional social surveys are conducted through verbal communication or questionnaires that limit the expression of one's thought.

This research fully depended on the cognition of residents to delineate socially and ecologically vulnerable areas involving the WPA without any ecological analysis and monitoring. Therefore, the areas delineated as showing potential versus vulnerability in this study may not fully reflect the actual status of the area. However, as there are more overlapping polygons, delineated areas could be made more precise. This indicates that by involving more participants and scientifically selecting mapping items along with ecological data, cognitive mapping will contribute to diverse spatial planning and management for promoting sustainable livelihood and ecological conservation.

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