Complexity and Metamorphosis Patterns of Common Areas in Coastal Fishing Regions
Based on Environmental Recognition

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Abstract
In this study, according to the relationship between the extent of the commonness of recognition by local inhabitants and the physical environment, as ascertained from a questionnaire survey of local inhabitants, we will analyze the commonality based on the environmental recognition of inhabitants in their regional space, and determine the patterns of changes from an area which is settled by two or more to an area complex as a whole. Then, by analyzing the relationships of legibility and ambiguity in the elements and spatial structures constituting the regional space, we will examine the complexity and metamorphosis patterns of common areas in coastal fishing regions.

Keywords: environmental recognition; cognitive area; common area; coastal fishing regions; local inhabitants

1. Introduction
In recent years, there has been growing demand for planning techniques based on symbiosis with the environment, and this has become an important issue for cooperative international efforts in today’s society. Japan’s coastal fishing villages amalgamate the environments of the sea, town (human communities), and mountain (hills). They have self-sustaining systems that encompass natural ecology as well as a cultural and social environment, and there is recognition of the environment as people conduct the activities of their daily lives. Environmental recognition is the process of awareness by inhabitants in their regional environment. The sharing of that process is a system for empathetic recognition by the inhabitants themselves to the effect that the environment around them is a common asset of the region. Incorporation of this system as a planning technique can be a tool for urban and regional planning based on practical and effective symbiosis with the environment.

In this study, rather than considering the formation of villages in coastal fishing regions as independent units, we will consider multifaceted, composite commons based on analysis of environmental recognition in the aggregate, considering them to be the nodes of interrelationships among surrounding villages in the surrounding region. Specifically, according to the relationship between the extent of the commonness of recognition by local inhabitants and the physical environment, as ascertained from a questionnaire survey of local inhabitants, we will analyze the commonality based on the environmental recognition of inhabitants in their regional space, and determine the patterns of changes from an area which is settled by two or more to an area complex as a whole. Then, by analyzing the relationships of legibility and ambiguity in the elements and spatial structures constituting the regional space, we will examine the complexity and metamorphosis patterns of common areas in coastal fishing regions.

Fig.1. Japan’s Coastal Fishing Regions (Tago Village)
(Photo: Fishing Port Maintenance Room, Department of Agriculture, Forestry and Fisheries, Shizuoka Prefecture, 1998)
Fig. 2. Investigated Regions

2. Methods
2.1 Regions and Periods of Investigation

The investigated regions are located along the coastlines of the Boso Peninsula (29 villages) and Izu Peninsula (30 villages). The investigated regions are shown in Fig. 2.

The periods of investigation for the Boso Peninsula were July - August and October 1988, July 1991, and October 1995. For the Izu Peninsula, the periods of investigation were June and August - September 1988, July 1992, and September 1995.

2.2 Method of Investigation

In order that the subjects of the investigation target might clarify the environmental recognition of the general public, questionnaire were given to local inhabitants who were older than a third-year junior high school student. An investigator prepared the questionnaire and the 1/5000 blank map, and filled in the questionnaire with the responses of the subject. I basically asked the subject to fill in the blank map. In this way, we obtained 651 samples from the Boso Peninsula (29 villages), and 710 samples from the Izu Peninsula (30 villages).

2.3 Items of Investigation

1) Attributes: Age, sex, occupation, years of residents, and location of dwelling.

2) Cognitive areas of Town, Sea, and Mountain: Subjects were asked to circle areas on a map that corresponded to their images of Town, Sea, and Mountain. This method is effective when focused on a subject who has adequate recognition of the area. It is suitable for studying relatively limited spaces in small areas, such as an area surrounding a personal dwelling. The purpose of this method is to indirectly determine the structure of a space imagined by the subjects, by investigating not only quantitative factors (such as recognition of existence of objects and spaciousness) but also spatial discontinuities imagined by them.

3) Cognitive Area Composition Element: For each of the above three areas, the subjects were asked about the image in their mind when they circled the area on the map. Based on their answers, the elements that composed each cognitive area were investigated.

4) Landmarks: The subjects were asked to draw on a map as many details or impressive things as they could remember about Town. Objects other than buildings were also acceptable (places, events, trees, signboards, etc.).

5) Districts: Subjects were asked to enclose on a map any areas they associated with prosperity.

6) Use of space in daily activities: Investigation of places where a fundamental life activity (9 daily life activities and 4 sporting activities) takes place.

7) Daily Movements: Subjects were asked to draw a map of their daily movements, including routes they regularly use and routes they occasionally used.

8) Institution and Distribution: An investigation of the distribution of goods in daily life and the institutions of production in the region.

9) Modes of Transportation: An investigation of the modes of transportation usually used by the subject.
10) Reference Investigation

As an example of the investigation results, Fig.3 shows Ajiro’s cognitive area. Table 1 lists explanatory notes. In this study, the cognitive area composition elements (items obtained from investigation 3) were first classified into three categories: point, line, and field element. Recently, however, consideration of events (such as festivals and fireworks) and factors that change over time (such as the smell of seawater and sound of waves) is increasingly important. With this background in mind, the authors introduced these composition elements, that cannot be explained solely by the above three categories, into the study as well.

3. Complex Areas in Coastal Fishing Regions

The questionnaire was given to the entire village in order to obtain an overall view of the local inhabitants’ environmental recognition. Consequently, two tendencies were seen regarding complex areas. The two concepts are defined as follows.

1) **Areas with regional integrity are complex areas**: a cognitive area is linked when two or more individual areas (village units) share an element. This forms a single spatial settlement area with regional integrity and is considered a complex area.

2) **Area that are considered to be already complex**: in the past, the basic village consisted of fisherman’s houses and was characterized by people coming together and sharing. Any area in which the cognitive area is united and forms a single area (the village unit) is considered to be a complex area.

Table 2 shows an analysis of 12 examples (19 areas) of complex areas as seen from the inside of all 59 villages. In this study, ‘Common area’ as the mode where the inhabitants in the coastal fishing villages share the daily life (cognitive) area, and the requirements for the ‘Complex area’ is described.

Examples of areas with regional integrity that are considered to be complex include Onjyuku + Iwawada, and Emi + Tayuzaki + Amatsura + Hamanabuto. Tago and Tomisaki are also examples of complex areas. All of these examples are described below.

4. Areas with Regional Integrity are Complex Areas

4.1 Area Formation in Onjyuku + Iwawada

Fig. 4 shows the formation of a cognitive area over an extensive part of this region and the overlapping of the cognitive areas in Onjyuku and Iwawada. A table summarizes the element (indicating 20% or more...
percentage of cognition) that constitutes the cognitive area.

A settlement that is mutual between villages in an extensive region shows the cognitive area held in common by Town and Sea, and the cognitive area of Mountain is divided.

The factor that is in common with cognition of Sea and has a high percentage of cognition is the sand beach. It defines the range of the Sea area from Market to Wharf, which is the landmark of a partner village. Moreover, since the display of fireworks (13.0%) is mentioned as one factor in defining the range of the Sea area, a time-change element, such as an event, is considered to be a related element of the common cognitive area.

Although in Iwawada the cognitive area of Mountain is large, since the railway in Onjyuku divides Town and Mountain, the cognitive areas are not easily connected. The prosperity of Town is defined as a place that attracts stores, which is a landmark of both villages. Since the cognitive area of Town has spread to include this prosperity, the daily life space is held in common.

These villages become the element by which the sand beach and the prosperous store group connect an area, and they are considered to have the directivity that changes to one area.

4.2 Area Formation in Hamanabuto + Amatsura + Tayuzaki + Emi

The formation of a cognitive area in an extensive region is shown in Fig. 5.

Although the cognitive areas of Hamanabuto and Amatsura are separate, the cognitive areas of Amatsura, Tayuzaki, and Emi meet, and they have common perceptions of environmental recognition. From this, the settlements in the extensive region of this area are said to be unified.

The relationship between Amatsura and Tayuzaki is defined by the bridge, which in turn defines the range of the area of Town and Landmark, and the two villages hold common perceptions of environmental recognition. Similarly, the relationship between Tayuzaki and Emi is defined by the river, and the two villages hold common perceptions of environmental recognition. Moreover, by holding in common their shrines and temples, which are landmarks in each village, these areas tend to become

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**Fig. 5. Formation of A Cognitive Area in An Extensive Region: Emi+Tayuzaki+Amatsura+Hamanabuto**
unified. The railway has many tunnels and beautiful vistas of flowers and the sea, which the inhabitants can fully enjoy.

In these villages, the elements of bridge, river, shrine/temple, railway, and tunnel connect two villages, forming one area, and it has directivity, which changes to complexity.

5. Areas that are Considered to be Already Complex

5.1 Area Formation in Tago

Itago, which faces the Tago Fishing Port, and Otago, which faces the Otago beach are complex and they form a single cognitive area. The cognitive area of Tago is shown in Fig. 6.

The cognitive area of Town has spread toward Otago with a focus on Tago Fishing Port. The spread of the cognitive area has been influenced by the elementary school and junior high school, which are landmarks. Fudomyoo, the tunnel located between the two villages, is considered to be the element that connects their cognitive areas.

The cognitive areas of Sea spread from Tago Fishing Port and the Otago seashore toward Sonnno Island and encompass the entire bay. Events, such as the display of fireworks, connect the two cognitive areas.

The villages’ cognitive areas of Mountain, which separates the two villages, are unified by the Nanzan Woods, which are located on the mountain. Moreover, it turns out that certain landmarks, such as the community center, sluice gate, town hall, and post office, are held in common.

Therefore, by holding in common certain elements, such as the schools, shrines and temples, tunnel, fishing port, sand beach, islands, display of fireworks, woods, community center, sluice gate, town hall, and post office, Itago village and Otago village are complex and form one village.

Tomiura and Uchiura is a similar example of an area that is considered to be an already complex area.

5.2 Area Formation in Tomisaki

In the Tomisaki area, the Mera Fisherman’s Cooperative and the Aihama Fisherman’s Cooperative have joint use of the Tomisaki Fishing Port. The cognitive area of Tomizaki is shown in Fig. 7.

Perception of prosperity in Mera village include the Shopping Street and Aihama Village, and the cognitive areas of the towns spread and are unified. The elementary schools, which are landmarks, are located in the centers of the two villages.

The cognitive areas of the sea spread from Mera Fishing Port and Aihama Fishing Port and are unified. The breakwater that protects the fishing ports as well as time change elements such as fishing boats, scent of tide, and birds are the composing elements.

The cognitive area of the mountain is held in common with the cognitive area of the woods. Moreover, the road to neighboring Daijingu Village divides the cognitive areas, and inhabitant’s cognitive areas are not unified.

Therefore, the villages of Mera and Aihama form one area with the complex village by holding in common...
Katase is a similar example of an area considered to be already complex.

6. Complexity Pattern of a Village

As mentioned above, an analysis of areas with regional integrity that are considered to be complex, and areas considered to be already complex, shows that their patterns of complexity can be arranged as follows. Fig. 8 shows the metamorphosis model in coastal fishing regions based on environmental recognition.

Pattern A has the features seen in the examples of Onjyuku + Iwawada, Kamogawa, Katsuyama, and Ajiro. These areas have train stations, and when large-scale and small-scale villages become complex, the cognitive area of the town grows larger.

Pattern B has the features seen in the examples of Hamanabuto + Amatsura + Tayuzaki + Emi. These are small-scale villages, and the area between the villages cannot easily grow. It is influenced by complexity between villages in the forms of maintenance of the roads, railways, bridges and tunnels that connect the villages, etc. An example of this pattern was not seen in areas considered to be already complex.

Pattern C has the features seen in the examples of Mera + Nishikoura, Tomiura, Tago, and Uchiura. The pattern is defined by a bay enclosed by mountains, two or more villages facing the bay, and a small-scale village complicated by a trunk road, etc. The area is one into which the Town spreads.

Pattern D has the features seen in the examples of Kumomi + Ishibu + Iwachi, Tomisaki, and Katase. These areas, including a small-scale village complicated into which the Town can spreads.

7. Cognitive Area Composition Elements of Complexity Patterns

Each item that defined the cognitive areas of Town, Mountain, or Sea, as well as each landmark, was classified as a point element, line element, field element, or time-change element. Table 3 and Fig. 9 shows the cognitive area composition elements (omitting percentage of cognition of 10% or less) and the composition element rate as classified by the pattern attributes described in the preceding section.

Table 3. Cognitive Area Composition Elements of Complexity Patterns

<table>
<thead>
<tr>
<th>Pattern</th>
<th>My Town</th>
<th>Mountain</th>
<th>Sea</th>
<th>Landmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Attribute/Frequency</td>
<td>Degree of cognition</td>
<td>Item</td>
<td>Attribute/Frequency</td>
</tr>
<tr>
<td>Road</td>
<td>Line 20</td>
<td>21.7%</td>
<td>Road</td>
<td>Line 39</td>
</tr>
<tr>
<td>River</td>
<td>Line 25</td>
<td>21.2%</td>
<td>Woods</td>
<td>Field 29</td>
</tr>
<tr>
<td>Railway</td>
<td>Line 15</td>
<td>15.6%</td>
<td>Park</td>
<td>Field 26</td>
</tr>
<tr>
<td>Pattern A</td>
<td>Market 14</td>
<td>11.9%</td>
<td>Shrine / Temple</td>
<td>Point 17</td>
</tr>
<tr>
<td>Shopping street 12</td>
<td>10.2%</td>
<td>12.7%</td>
<td>12.7%</td>
<td>12.7%</td>
</tr>
<tr>
<td>(22 Items of others) 82</td>
<td>66.4%</td>
<td>(13 Items of others) 23</td>
<td>20.9%</td>
<td>(17 Items of others) 61</td>
</tr>
<tr>
<td>Pattern B</td>
<td>Bridge 26</td>
<td>26.6%</td>
<td>Road</td>
<td>Line 28</td>
</tr>
<tr>
<td>Railway</td>
<td>Line 15</td>
<td>21.7%</td>
<td>Bridge</td>
<td>Point 15</td>
</tr>
<tr>
<td>Shopping street 12</td>
<td>16.0%</td>
<td>16.0%</td>
<td>16.0%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Pattern C</td>
<td>Amusement facilities 9</td>
<td>12.7%</td>
<td>12.7%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Shopping street 12</td>
<td>15.3%</td>
<td>15.3%</td>
<td>15.3%</td>
<td>15.3%</td>
</tr>
<tr>
<td>Pattern D</td>
<td>(10 Items of others) 21</td>
<td>43.7%</td>
<td>(6 Items of others) 9</td>
<td>12.7%</td>
</tr>
<tr>
<td>(10 Items of others) 190</td>
<td>200.0%</td>
<td>Subtotal</td>
<td>11.0%</td>
<td>11.0%</td>
</tr>
<tr>
<td>Pattern A</td>
<td>Mountain 38</td>
<td>48.3%</td>
<td>Road</td>
<td>Line 64</td>
</tr>
<tr>
<td>River</td>
<td>Line 25</td>
<td>25.8%</td>
<td>Woods</td>
<td>Field 45</td>
</tr>
<tr>
<td>Railway</td>
<td>Line 23</td>
<td>19.2%</td>
<td>Park</td>
<td>Field 19</td>
</tr>
<tr>
<td>Shopping center 18</td>
<td>19.2%</td>
<td>19.2%</td>
<td>19.2%</td>
<td>19.2%</td>
</tr>
<tr>
<td>Shrine / Temple 18</td>
<td>15.0%</td>
<td>15.0%</td>
<td>15.0%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Store 16</td>
<td>13.3%</td>
<td>13.3%</td>
<td>13.3%</td>
<td>13.3%</td>
</tr>
<tr>
<td>(24 Items of others) 259</td>
<td>36.4%</td>
<td>(13 Items of others) 47</td>
<td>29.2%</td>
<td>(24 Items of others) 42</td>
</tr>
<tr>
<td>(24 Items of others) 102</td>
<td>200.0%</td>
<td>Subtotal</td>
<td>11.0%</td>
<td>11.0%</td>
</tr>
<tr>
<td>Pattern B</td>
<td>Mountain 23</td>
<td>29.0%</td>
<td>Road</td>
<td>Line 30</td>
</tr>
<tr>
<td>River 26</td>
<td>29.7%</td>
<td>Woods</td>
<td>Field 35</td>
<td>29.2%</td>
</tr>
<tr>
<td>Railway 15</td>
<td>15.4%</td>
<td>Park</td>
<td>Field 17</td>
<td>15.4%</td>
</tr>
<tr>
<td>Shrine / Temple 13</td>
<td>11.1%</td>
<td>11.1%</td>
<td>11.1%</td>
<td>11.1%</td>
</tr>
<tr>
<td>(17 Items of others) 56</td>
<td>56.4%</td>
<td>(13 Items of others) 30</td>
<td>23.2%</td>
<td>(17 Items of others) 34</td>
</tr>
<tr>
<td>Subtotal 233</td>
<td>207.0%</td>
<td>Subtotal 233</td>
<td>207.0%</td>
<td>Subtotal 234</td>
</tr>
</tbody>
</table>

Fig. 8. Metamorphosis Model
As an overall tendency, there is a high percentage of recognition of 'Town and Mountain' being Road, of 'Sea' being Sandy Beach/Craggy Place, and of 'Landmark' being Shrine/Temple. These elements are important items that constitute a cognitive area and their common nature and positioning between the villages affect the complexity of a cognitive area.

The features found in every pattern are described below.

**Pattern A** has a high number of point elements for Town and Landmark as compared with other patterns, as well as major institutions that relate to life such as stores, markets, stations, shopping streets, and agricultural/fisherman’s cooperatives. The range of action in the area is considered to be complex.

**Pattern B** has a relatively high number of line elements for Town and Mountain, and it is thought that the circulation base that connects to Life becomes the factor that complicates an area through the maintenance of railways, roads, bridges, etc.

**Pattern C** has a relatively high number of field elements for Sea. Areas of production, such as a fishing port, are a factor. This pattern is considered complex.

**Pattern D** has a relatively high number of time-change elements for Town, Mountain, and Sea. Since the percentage of cognition of individual time-change elements is low (10% or less), it is difficult to include it in Table 3. However, birds (7.7%), the scent of the tide (5.1%), the sound of waves (4.3%), etc., are recognized as cognitive area composition elements for Sea. Moreover, the number of field elements for Town and Landmark is comparatively high. Scenes of nature can be used as an indicative factor, and the Mountain and Sand Beach/Rocks, etc., make the area complex.

8. Spatial Structures of Complex Patterns

In this chapter, to examine the spatial structures of each complex pattern, we will analyze the legibility (LE) and ambiguity (AM) of these characteristics of each village, which are the sea, town, mountain, and landmarks. The value of a-d shown in Fig.10 is data used when following LE and AM are obtained (ex. Ajiro’s landmark).

Legibility is a value which describes the observable clarity of the spatial structures of a village (Kevin Lynch, 1960). It is obtained by the following formula. \[ LE = \frac{\text{Overall recognition rate} \times \text{Highest number of recognized items}}{\text{Total number of recognized items}} \times 100 \]. When there is a small number of recognized items in the area, the value of LE becomes high, as it does when the items have a high recognition rate. In other words, it shows the degree of concentration by which the inhabitants recognize a small number of items.

Ambiguity is a value which describes the uncertainty or vagueness of the spatial structures of a village (Rapoport & E.Kantor, 1968). It is obtained by the following formula. \[ AM = \frac{\text{Overall recognition rate} \times \text{Total number of items}}{\text{Total number of recognized items}} \]. When there are a large number of items in the area, the AM value becomes high, as it
This LE and AM value is used as a relative index between areas, and it is not an absolute index. The AM value does not necessarily have a meaning opposite to the LE value.

Fig. 11 shows the deviation value in the case that the average of 19 settlements with regard to the average LE and AM values for each pattern is taken as the standard deviation (50).

The following is a summary of the characteristics of the spatial structures in each complex pattern. With Pattern A, there is a high level of landmark ambiguity and sea legibility. With Pattern B, there is a high level of town and mountain legibility. With Pattern C, there is a high level of sea, town, and mountain ambiguity. And with Pattern D, sea, town and landmark legibility and mountain ambiguity are high.

9. Conclusions

The following are our findings obtained through analyses conducted in this study.

Regions belonging to Pattern A have a large number of recognized items with regard to landmarks with a high overall rate of recognition. There are many elements functioning as landmarks in the town, and the sharing of daily life activities are common and combined among villages.

Regions belonging to Pattern B have a small number of recognized items with regard to town and mountain with a high rate of recognition. The town and mountain have a distribution infrastructure which links the villages, and this is shared and combined.

Regions belonging to Pattern C have a large number of recognized items with regard to sea, town, and mountain with a high overall rate of recognition. The sharing of the sea (or bay) which is used in common for productive activities is shared and combined.

Regions belonging to Pattern D have a small number of recognized items with regard to sea and town with a high rate of recognition, but a large number of recognized items with regard to mountain with a high overall rate of recognition. The natural landscape is shared and combined among the villages, including the element of changes over time.

As we have seen, several units spaces (area) were determined, and four patterns, which share the unit spaces and form larger spaces, were created depending on the type of the recognition of the environmental. Further, the spatial structure of each pattern was determined. As these findings suggest, the commonality of a regional space can provide an indicator for systems of combination toward the attainment of symbiosis and empathy in awareness; and it is concluded that the use of such indicators as basic data for future urban and regional planning based on symbiosis with the environment can provide an effective methodology.

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