

Sustainable Development Utilizing Local Agricultural Resources: A Network Analysis of Interorganizational Collaborations in Tsuruoka, Noto, and Aso in Japan

Sotaro Inoue^{1*}, Noriko Ito¹, Yuta Uchiyama² and Ryo Kohsaka²

Employing social network analysis, this study quantitatively compares interorganizational collaboration networks in Tsuruoka, Noto, and Aso in Japan. These networks apply innovative strategies and techniques to the use of local agricultural resources. The major findings of this study are the following: (1) Tsuruoka's and Noto's networks are characterized by relatively centralized structures. (2) Aso's network is characterized by a relatively decentralized structure. (3) Organizations that coordinate the various sectors and regions have played an important role in maintaining decentralized networks. Through comparison of the networks, we supply objective information useful for formulating structural change strategies induce sustainable development in Japan.

Key words: sustainable development, local agricultural resources, social network analysis

1. Introduction

The utilization of local agricultural resources, including traditional gastronomic cultures and agricultural systems, and the creation of new value through interorganizational collaborations (rural innovation) are important for sustainable rural development. The Japanese government has been promoting rural diversification, increase in employment, and the development of regional communities through such policies as the Food Industry Cluster Project (2005); the Support Project for the Collaboration among Agriculture, Commerce, and Industry (the *noshoko-renkei* project) (2008); and the 6th Industrialization Policy (2010) (Inoue *et al.*, 2014).

Tsuruoka in Yamagata prefecture, Noto in Ishikawa prefecture, and Aso in Kumamoto prefecture are leading agricultural regions in Japan (Table 1). These regions' unique gastronomic cultures and traditional agricultural systems have been valued by two international registration systems: UNESCO Creative Cities Networks (UCCN) and the Globally Important Agricultural Heritage Systems (GIAHS). Following the consolidation in 2005, Tsuruoka city is now the largest in Northeastern Japan, and its unique gastronomic culture has become a principal driver of further development of food-related industries since its UCCN designation in 2014. The Noto region was awarded GIAHS

Table 1. Summary of survey areas and the numbers of surveyed organizations

| | Tsuruoka | | Noto | | Aso | |
|---|----------------------|----|-----------------------|----|----------------------|----|
| Population (2019) | 124,554 | | 184,232 | | 60,607 | |
| Size (km ²) | 1,312 | | 1,978 | | 1,079 | |
| Production of agriculture & livestock (million yen, 2017) | 31,280 | | 23,660 | | 33,200 | |
| Sectors | Government | 7 | Government | 10 | Government | 17 |
| | Agriculture | 6 | Agriculture | 13 | Agriculture | 44 |
| | Tourism | 23 | Tourism | 6 | Tourism | 21 |
| | Research & Education | 3 | Research & Education | 3 | Research & Education | 20 |
| | Tradition | 7 | Environment | 7 | Environment | 30 |
| | - | - | - | - | Green tourism | 13 |
| | - | - | - | - | Special interest | 22 |
| Regions | Wide area | 14 | Wide area | 8 | Aso-city | 64 |
| | Former Tsuruoka | 12 | Nanao-city | 5 | Minamioguni-town | 7 |
| | Asahi | 3 | Wajima-city | 4 | Oguni-town | 9 |
| | Atsumi | 7 | Suzu-city | 3 | Ubuyama-village | 4 |
| | Kushibiki | 3 | Hakui-city | 5 | Takamori-town | 12 |
| | Haguro | 4 | Shika-town | 2 | Minamiaso-village | 11 |
| | Fujishima | 3 | Houdatsushi-mizu-town | 2 | Nishihara-village | 3 |
| | - | - | Nakanoto-town | 2 | Yamato-town | 3 |
| | - | - | Anamizu-town | 3 | Outside Aso | 44 |
| | - | - | Noto-town | 5 | Outside Kumamoto | 10 |
| Total | 46 | | 39 | | 167 | |

Source: Government statistics and authors' survey.

Note: In Tsuruoka and Noto, "Wide area" organizations mainly operate throughout Tsuruoka city and Noto area, and most of them are located in Former Tsuruoka and Nanao-city, respectively. In Aso, organizations classified as "Outside Aso" mainly operate outside Aso area inside Kumamoto prefecture, and those classified as "Outside Kumamoto" operate outside Kumamoto prefecture.

¹Policy Research Institute, MAFF

²Nagoya University

Corresponding author*: sotaro_inoue470@maff.go.jp

status in 2011 in recognition of its unique socio-ecological landscape of “*Satoyama-satoumi*.” The Aso region is famous for its unique landscape of caldera covered by grassland, which has traditionally been maintained through burning and which received GIAHS status in 2013.

It is assumed that a diverse set of stakeholders have worked toward the sustainable and innovative utilization of their unique local resources in these areas. However, the collaborations between the different sectoral and regional organizations have not yet been fully explored quantitatively. This study employs social network analysis (SNA), which is a quantitative analytical method used to explain network structures. The method estimates “network indices” for comparison of the network features. This comparison may shed light on some essential differences between the network structures that can induce rural innovation and those that cannot. By supplying above mentioned objective information on model cases of interorganizational collaborations, this study draws implications for structural change toward sustainable rural development in Japan.

2. Methodology

1) Social network analysis

The aim of SNA is to detect and interpret a pattern of social relationships among actors, which is represented as a graph (a set of nodes and ties) (Figure 1). In this study, organizations such as local governments and tourist associations are represented as “nodes” or “actors.”

SNAs on organizational networks have examined how network structures are related to firms’ economic performance and communities’ resource management as follows. Sakata *et al.* (2007) emphasized the importance of the development of close linkages among the core enterprises. Structural adjustment of enterprises’ trade networks corresponds to policy changes improved the economic performance of firms in industrial clusters (Morishima 2016). In a case of rural community in the Netherlands, diversity of stakeholders involved in river

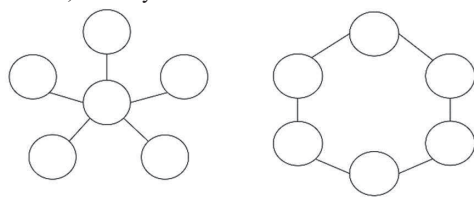


Figure 1. Hypothetical social network patterns of organizations
Note: The left graph illustrates a star-like network structure in which one actor has more ties than the others do, whereas the right graph illustrates an equal network in which all actors have the same number of ties.

management was important, while governments did not have enough information, power, or finance. Essential for sustainable resource management was that top-down governance structures became collaborations between stakeholders that extends beyond the sectors (Fliervoet *et al.* 2016). The existing SNAs focus on elucidating the firms’ trade networks in a specific industry-related cluster or stakeholders’ networks involved in the natural resource management in certain small areas. The uniqueness of this study is comprehensive coverage of the related sectors and regions. We hope to gain a better grasp of overall project structures including public and private organizations spreading across a wide area.

2) Data collection

A total of 46, 39, and 167 organizations in Tsuruoka, Noto, and Aso, respectively, are identified as important actors for undertaking various projects and initiatives to foster and utilize regional resources in accordance with UCCN or GIAHS (Table 1). These organizations are grouped into several sectors and regions. For example, the “Government” sector includes city, town, and village offices. A questionnaire survey on “collaborations with other organizations,” including information exchange, attendance at the same meetings, and e-mail and phone contacts involved in activities related to UCCN or GIAHS, was conducted from 2016 to 2018. In Tsuruoka and Noto, all the organizations were listed, and each respondent was asked whether his/her organization collaborated with each other’s organization. In Aso, respondents were asked the same question, in addition, they could provide the names of up to five organizations in each sector. Although we did not send the questionnaire to Aso’s government offices, the connections between government and non-government organizations were identified from the survey responses of non-government organizations.¹⁾ The networks were then

1) This different method of data collection do not necessarily influence the network indices directly. For instance, if the Aso’s surveyed organizations identified overlapping collaborative partners, the network density would not be lower than that of the others. In addition, we devised the following steps to mitigate the different methods’ effects. First, if organizations in Tsuruoka and Noto collaborated with others not included on the list, they added up to five organizations freely. Second, as Aso’s organizations rarely specified their collaborative partners each other, the dual-directional ties in Tsuruoka and Noto were replaced by the undirected ties. This means that for a given pair of actors, if at least one of the actors indicated the other, we regarded these two actors as connected by an edge, which resulted in a decreasing average degree and density of Tsuruoka’s and Noto’s networks.

Table 2. Network characteristics

| | Tsuruoka | Noto | Aso |
|--|----------|--------|--------|
| Density | 0.3208 | 0.3617 | 0.0382 |
| Degree centralization | 0.6792 | 0.6383 | 0.1486 |
| Cross-boundary exchange (sectoral boundary) | 64% | 71% | 74% |
| Cross-boundary exchange (regional boundary) | 71% | 88% | 51% |

Source: Authors' calculation.

analyzed using Pajek software.

Because of the difficulty of collecting data regarding on social networks at different times, SNA approach may have certain limitations. Our survey had to be interrupted by the large earthquake in Aso in 2016 and we needed to only focus on the network structure before the earthquake.

3. Structural Features of Collaboration Networks in Tsuruoka, Noto, and Aso

1) Properties of the whole network

Table 2 describes the indices of whole network properties. "Density" is the number of actual ties in a network divided by the maximum number of possible ties, which represents the cohesiveness of the network. "Degree centralization" is the ratio of the actual variance of degree scores to the maximum possible variance. "Cross-boundary exchange" is the number of ties connecting actors in different groups divided by the total number of ties in the network. Cross-boundary exchange represents the proportion of collaborative ties between groups, which is a measure of network heterogeneity (Fliervoet *et al.*, 2016).

Tsuruoka's network is characterized by the highest degree centralization (0.6792) and the lowest cross-sectoral boundary exchange (64%). Its higher degree centralization reflects its tighter structure organized around its most central point, or how "star-like" the network structure is (the left graph in Figure 1), compared with other two networks. Noto's network has the highest density (0.3617) and cross-regional boundary exchange (88%). Although a higher density implies more potential for collective action, it is said that a very high network density may decrease the effectiveness of collective action because synchronized behavior among actors and the homogenization of knowledge are encouraged (Bodin and Norberg, 2005). The results suggest that Tsuruoka's and Noto's organizations tend to have more ties inside sectors and sometimes across regional categories. For example, while the head office of

the city and its branches (town and village offices) are well connected beyond the regional boundary, they have fewer ties with other sectors' organizations inside each region. This situation can be referred to as "sectionalism," which may cause potential problems when implementing balanced and sustainable development policy, as we explain later.

On the contrary, Aso's network has the lowest density (0.0382) and degree centralization (0.1486), which indicates that the difference in status among actors is relatively small (see the right graph in Figure 1). Furthermore, its lowest cross-regional boundary exchange (51%) and highest cross-sectoral boundary exchange (74%) indicate that actors within each region have historically cooperated with other sectors for the purpose of maintaining local ecosystems.

2) Properties of groups

We compare the network indices of sectors in each network to specify the sectors (or combinations of two sectors) with strong and weak connectivity within (or between) them. Table 3 presents the densities within sectors and between pairs of sectors. In Tsuruoka, the within-sector densities of Research & Education (0.6667) and Government (0.5714) are higher than those of other sectors. Thus, the research & education and government sectors have more potential for collective action inside the groups. On the contrary, the within-sector density of Tradition (0.1429) and the between-sector density of Agriculture and Research & Education (0.1667) are lower. Among the non-government sectors, the density between Tourism and Research & Education (0.2899) is the highest, followed by those between Tourism and Agriculture (0.2464) and between Tourism and Tradition (0.2422). In Noto, the within-sector densities of Research & Education (1.0000) and Government (0.8667) are higher. However, the between-sector densities of Agriculture and Environment (0.0989) and Agriculture and Tourism (0.1410) are lower. Among combinations of non-government sectors, the between-sector density of Research & Education and Environment (0.5238) is the highest, followed by those of Research & Education and Tourism (0.3889) and Research & Education and Agriculture (0.2821). In Aso, the within-sector densities of Tourism (0.1286) is the highest, whereas the between-sector density of Research & Education and Special interest (0.0023) is the lowest. In addition, the between-sector densities of Green tourism and other sectors [such as Tourism (0.0549), Environment (0.0487), and Research & Education (0.0423)] are relatively

Table 3. Density within a sector and between two sectors

| | | Government | Agriculture | Tourism | Research & Education | Tradition | - | - |
|----------|----------------------|------------|-------------|---------|----------------------|-------------|---------------|------------------|
| Tsuruoka | Government | 0.5714 | 0.4524 | 0.3975 | 0.3333 | 0.2653 | - | - |
| | Agriculture | | 0.4000 | 0.2464 | 0.1667 | 0.1905 | - | - |
| | Tourism | | | 0.3794 | 0.2899 | 0.2422 | - | - |
| | Research & Education | | | | 0.6667 | 0.1905 | - | - |
| | Tradition | | | | | 0.1429 | - | - |
| | | Government | Agriculture | Tourism | Research & Education | Environment | - | - |
| Noto | Government | 0.8667 | 0.4077 | 0.6167 | 0.7333 | 0.2571 | - | - |
| | Agriculture | | 0.3333 | 0.1410 | 0.2821 | 0.0989 | - | - |
| | Tourism | | | 0.4667 | 0.3889 | 0.2619 | - | - |
| | Research & Education | | | | 1.0000 | 0.5238 | - | - |
| | Environment | | | | | 0.1429 | - | - |
| | | Government | Agriculture | Tourism | Research & Education | Environment | Green tourism | Special interest |
| Aso | Government | - | 0.0762 | 0.1232 | 0.0265 | 0.0765 | 0.0860 | 0.0401 |
| | Agriculture | | 0.0465 | 0.0206 | 0.0068 | 0.0258 | 0.0402 | 0.0155 |
| | Tourism | | | 0.1286 | 0.0071 | 0.0111 | 0.0549 | 0.0065 |
| | Research & Education | | | | 0.0263 | 0.0383 | 0.0423 | 0.0023 |
| | Environment | | | | | 0.1034 | 0.0487 | 0.0318 |
| | Green tourism | | | | | | 0.1282 | 0.0350 |
| | Special interest | | | | | | | 0.0216 |

Source: Authors' calculation.

Note: The density of Government in Aso cannot be calculated owing to the survey method.

Table 4. Degree and betweenness centrality (average by groups)

| Tsuruoka | | | | Noto | | | Aso | | | | |
|---|----------------------|-------|--------|---|------------------------|--------|----------------------|---|-------------------|------------------------|--------|
| | | | | Degree centrality | Betweenness centrality | | | | Degree centrality | Betweenness centrality | |
| Sectors | Government | 18.71 | 0.0282 | Government | 20.80 | 0.0418 | Government | 10.76 | 0.0202 | | |
| | Agriculture | 12.67 | 0.0054 | Agriculture | 10.46 | 0.0068 | Agriculture | 5.50 | 0.0085 | | |
| | Tourism | 15.17 | 0.0194 | Tourism | 13.33 | 0.0106 | Tourism | 6.90 | 0.0111 | | |
| | Research & Education | 12.67 | 0.0051 | Research & Education | 19.00 | 0.0227 | Research & Education | 3.15 | 0.0033 | | |
| | Tradition | 10.00 | 0.0028 | Environment | 7.86 | 0.0050 | Environment | 7.77 | 0.0220 | | |
| | - | - | - | - | - | - | Green tourism | 9.00 | 0.0166 | | |
| | - | - | - | - | - | - | Special interest | 3.41 | 0.0041 | | |
| Differences between gov. & non-gov. | | 5.05 | 0.0150 | Differences between gov. & non-gov. | | 9.49 | 0.0300 | Differences between gov. & non-gov. | | 4.93 | 0.0093 |
| Regions | Wide area | 17.50 | 0.0295 | Wide area | 16.50 | 0.0418 | Aso-city | 8.39 | 0.0153 | | |
| | Former Tsuruoka | 14.50 | 0.0178 | Nanao-city | 16.80 | 0.0244 | Minamioguni-town | 5.00 | 0.0068 | | |
| | Asahi | 16.00 | 0.0069 | Wajima-city | 12.75 | 0.0080 | Oguni-town | 5.56 | 0.0092 | | |
| | Atsumi | 11.00 | 0.0038 | Suzu-city | 14.00 | 0.0090 | Ubuyama-village | 4.50 | 0.0042 | | |
| | Kushibiki | 12.00 | 0.0025 | Hakui-city | 9.80 | 0.0046 | Takamori-town | 5.92 | 0.0096 | | |
| | Haguro | 12.00 | 0.0032 | Shika-town | 9.00 | 0.0013 | Minamiaso-village | 7.00 | 0.0165 | | |
| | Fujishima | 12.00 | 0.0055 | Houdatsushimizu-town | 13.00 | 0.0136 | Nishihara-village | 2.67 | 0.0003 | | |
| | - | - | - | Nakanoto-town | 13.00 | 0.0063 | Yamato-town | 4.67 | 0.0051 | | |
| | - | - | - | Anamizu-town | 15.00 | 0.0151 | Outside Aso | 5.09 | 0.0115 | | |
| | - | - | - | Noto-town | 12.60 | 0.0093 | Outside Kumamoto | 2.40 | 0.0037 | | |
| Differences between central areas & other areas | | 3.87 | 0.0198 | Differences between central areas & other areas | | 4.31 | 0.0268 | Differences between central areas & other areas | | 3.33 | 0.0056 |
| Total | | 14.43 | 0.0154 | Total | | 13.74 | 0.0173 | Total | | 6.34 | 0.0119 |

Source: Authors' calculation.

Note: "Central areas" includes "Wide area" and "Former Tsuruoka" in Tsuruoka, "Wide area" and "Nanao-city" in Noto, and "Aso-city" in Aso.

high. In Tsuruoka and Noto, the higher positions of the government and research & education sectors and relatively isolated position of agriculture have been clarified. However, such distinct differences are not clear in Aso's network. In addition to the government, other sectors such as tourism in Tsuruoka, research & education in Noto, and green tourism in Aso are well connected with other non-government sectors directly and serve as hubs of cross-sectoral collaboration in each network.

3) Properties of actors

Table 4 shows the averages of individual actors' degree and betweenness centralities by group (sectors and regions). "Degree" ("degree centrality") is an actor's number of ties. "Betweenness centrality" is the probability that an actor is on the shortest path between any two actors in a network. These concepts can be used to express the power of an actor. Groups with high average centralities are regarded as having more influential power than other groups have.

The average degree centrality is the highest for Government organizations in Tsuruoka (18.71), Noto (20.80), and Aso (10.76). In Tsuruoka and Noto, the average betweenness centrality of Government organizations is also the highest (0.0282 and 0.0418, respectively). In Aso, however, the average betweenness centrality of Environmental organizations (0.0220) is the highest, which indicates that environmental organizations could play a more important role than the government in bridging organizations. In addition, degree centrality of Environment (7.77), degree centrality and betweenness centrality of Green tourism organizations (9.00 and 0.0166, respectively) are not so much lower than those of the Government sector (10.76 and 0.0202, respectively). The differences between the average centralities (degree and betweenness centralities) of Government and those of non-government organizations are the lowest in Aso (4.93 and 0.0093, respectively), followed by those in Tsuruoka (5.05 and 0.0150) and Noto (9.49 and 0.0300).

Turning to regions, we find that the average degree and betweenness centralities of the Wide areas in Tsuruoka (17.50 and 0.0295) and Noto (16.50 and 0.0418) are the highest in each network. In Tsuruoka, the average degree and betweenness centralities of areas that were added to the present Tsuruoka city after the consolidation in 2005 (Asahi and so on) are generally lower than those of the central areas, which include Wide area and Former Tsuruoka. Such the organizations are considered at relatively isolated and

peripheral position in the network. Alike in Tsuruoka, the average degree and betweenness centralities of most areas except Nanao-city (Wajima-city and so on) are so much lower than those of Wide area (most of them are located in Nanao-city) and Nanao-city. Thus, there are regional differences in the level of commitment to UCCN activities in Tsuruoka and GIAHS activities in Noto. In Aso, although the degree and betweenness centralities of Aso city (8.39 and 0.0153) are the highest, those of Outside Aso (5.09 and 0.0115) and some other areas, such as Minamiaso-village (7.00 and 0.0165) are also relatively high. In particular, the centralities of outside Aso organizations in Kumamoto city are high. Information and knowledge can be shared not only within Aso but also outside it. In fact, the differences between the average centralities (degree and betweenness centralities) of the central areas and those of other areas in Aso (3.33 and 0.0056) are smaller than those of Tsuruoka (3.87 and 0.0198) and Noto (4.31 and 0.0268). In Aso, an environmental non-profit organization serves as a model of "integrating organization" in the region, coordinating different sectoral and regional actors (Ohe, 2014). The organization has not only worked on environmental issues related to grassland preservation and management but has also promoted green tourism and the branding and marketing of local native beef in the grassland through collaborations with actors in the tourism and agriculture spaces inside and outside Aso.

4) Policy implication from the results

Although the different survey methods among the three areas should be taken into consideration, the characteristics of networks are clarified as follows. Tsuruoka's and Noto's networks, which have higher densities and degree centralizations and lower cross-sectoral boundary exchanges, are considered to have relatively centralized structures. The position of main entities of the projects, or the government and central areas' organizations is largely above those of others. Such the structure may induce a so-called sectionalism dividing the networks vertically and decrease the participation awareness among relatively peripheral organizations. In contrast, Aso's network has a lower density, a lower degree centralization, and a higher cross-sectoral boundary exchange. Coordinated mainly by green tourism and environmental organizations, information can be shared beyond fields. Thus, Aso's network is considered to have a relatively decentralized structure compared with the structures of Tsuruoka and Noto.

The cross-linkage among the different sectors and remote areas is said to stimulate the actor's creativity and induce innovation in the network through the change of the information transmission path from that among the similar and neighborhood actors (Nishiguchi, 2007). The peripheral organizations in Tsuruoka's and Noto's networks having less cross-linkage with other fields may be prevented from their stimulating of creativity for innovation. Therefore, the transition from the current centralized network structures to a more decentralized one is desirable to implement balanced and sustainable development projects. For example, providing more opportunities of cross-linkage to relatively peripheral organizations (such as Tradition in Tsuruoka and Environment in Noto, Table 4) can be suggested as inclusive strategies. The structural change can be expressed as the increase of the average centralities of relatively peripheral organizations, which is followed by the decrease of the degree centralization and the increase of the cross-sectoral exchange of the whole networks (Table 2). Supports for cross-sectoral hubs (Tourism in Tsuruoka and Research & Education in Noto, Table 3) could increase densities among sectors, fostering "integrating organizations" in the regions. The scrutinization of the network structures reveals the desirable interventions for structural change.

4. Conclusion

This study compared the interorganizational collaboration networks of the three areas and supplied objective information useful for formulating development strategies. The major findings of the study are the following.

1) Tsuruoka's and Noto's networks are characterized by their relatively centralized structures, in which social relations are concentrated in the government sector and central areas. This situation may limit the opportunities of most non-government sectors and organizations in peripheral areas to access useful information and may lead to the homogenization of knowledge, which may make it difficult to induce innovation. 2) Aso's network is characterized by its relatively decentralized structure, as the differences in the positions of sectors and regions are relatively small. This situation may lead to spillovers of knowledge and innovation through cross-boundary collaborations. 3) Organizations that coordinate the various sectors and regions such as green tourism and environmental organizations in Aso are considered to play important roles in maintaining decentralized networks.

To realize the transition from a centralized structure to a more decentralized one and induce innovation, the inclusion of relatively peripheral organizations and the support to cross-sectoral collaboration hubs are recommended. Because we focused on an organizational network analysis, the roles of personal networks and the activities of stand-alone organizations are not involved in this study. The influence of these elements on the utilization of regional resources remains a subject for further qualitative research.

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