Social Network Analysis of Aquaculture Projects on Provisioning Services Enhancement of Peatland Forest Ecosystem in Central Kalimantan, Indonesia

Francisca Mutwa Kilonzi1*, Takahiro Ota1, Kazuhiro Moji2 and Aswin Usup3

1School of Fisheries and Environmental Sciences, Nagasaki University, Nagasaki, Japan
2School of Tropical Medicine and Global Health, Nagasaki University, Nagasaki, Japan
3F2KLH-LPPM, University of Palangkaraya, Central Kalimantan, Indonesia

Abstract
Improper implementation of peatland forest activities has altered the forest ecosystem resulting to near extinct or degradation of the peatland forest and its biodiversity. This research focuses on stakeholder attribute analysis for successful management of the aquaculture projects to ensure enhancement of provisioning services (fish) in the streams, ponds and rivers in the peat forest by providing an alternative source of fish to the community in a case study of Hampangen village, central Kalimantan in Indonesia. The exclusive features in our analysis shows that the income of the stakeholders or their educational level do not necessarily influence their roles and position in the leadership network nor determine the ES usage from the forest. This research challenges the mainstream understanding on stakeholders’ selection based on educational background or income levels. From our study, we propose stakeholder selection based on social network attributes for a successful group or communal project management.

Keywords: Aquaculture; Ecosystem services; Indonesia; Social network analysis

Introduction
Ecosystem services are benefits obtained from the ecosystem provided to the humans through the transformation of resources (or environmental assets, including land, water, vegetation and atmosphere) into a flow of essential goods and services e.g., clean air, water, and food [1]. According to the Millennium Ecosystem Assessment [2], ecosystem services can be categorised as regulating, cultural or provisioning services.

In this paper, we focus on the provisioning services which are purely the products obtained from the ecosystem such as food. According to Kilonzi et al. [3], fish obtained from the natural ponds and river streams in the tropical peatland forest in central Kalimantan recorded the highest obtained provisioning services in the recent years. This is mainly because of the rewetting of the tropical peat swamp in central Kalimantan, a recovery measure to reduce carbon emissions from the forest fires experienced in the region [4].

We base our research on Social Network Analysis (SNA) concept whereby we focus on the social capital of the stakeholders and analyse their potential in the management of the aquaculture projects as well as the overall characteristics of the network. Social capital is defined by the Organization for Economic Co-operation and Development (OECD), as “networks together with shared norms, values and understandings that facilitate co-operation within or among groups”. It is the quality of relationship among and between people that promotes strong and resilient network of individuals [5].

Social network analysis therefore offers tools that enhance understanding of power structure within a community by identifying the links between social capital and management of the natural resources [6]. It shows the existing subgroups in a network structure and enhances the understanding of the specializations around livelihood activities [7]. The two key elements of social network that we focus on are the stakeholders of the aquaculture projects known as nodes and their relations known as social ties. The “nodes” of a network are the people and the “links” are the relationships between people [8].

In the SNA concept, diverse actors in the social network contribute to the shaping of the society on how to use and access the natural resources such as forest and water systems whereby various interactions among the community influence how people approach and, govern the natural resources [9,10].

For instance, governance through intra-community relationships includes activities such as local participations in the increase in wildfire risk prevention actions [11], and forest management information flow through various groups such as women and youth groups. On the other hand, inter – community relationships play the bridging role in social capital [12]. Their weak ties increase adaptability, social and ecological resilience [13], in the forest management. A good example of bridging role was in Sweden in a model forest establishment [14].

Researchers have pointed out the role of Social network in the management of forests by creating social norms. Brooks [15] proposed a model depicting the role of social networks in a community in the endogenous creation of informal rules. He explains that after a community becomes aware of the existing forest problems surrounding them, people start implementing good practices which eventually become formalized.

*Corresponding author: Francisca Mutwa Kilonzi, Ph.D, School of Fisheries and Environmental Sciences, Nagasaki University, Nagasaki, Japan, Tel: +810891080729; E-mail: franciscakarem@gmail.com

Received July 19, 2017; Accepted July 29, 2017; Published August 05, 2017

Citation: Kilonzi FM, Ota T, Moji K, Usup A (2017) Social Network Analysis of Aquaculture Projects on Provisioning Services Enhancement of Peatland Forest Ecosystem in Central Kalimantan, Indonesia. J Ecosyst Ecography 7: 238. doi:10.4172/2157-7625.1000238

Copyright: © 2017 Kilonzi FM, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.
Ros-Tonen et al. [16] affirmed that social capital facilitates changes in the institutions for the management of forests in Ghana. Relationship between local institutions and social capital through the provisioning of anchoring role has been proved in a case study of villages in Paraguay [17]. Kim et al. [18] focused on the role of local institutions in the implementation of the Reducing Emissions from Deforestation and Forest Degradation and the Conservation and Enhancement of Forest Carbon Stocks (REDD+) in a case study of one of the Indonesian Forest Management units.

According to Michele Barnes-Maute et al. [19], there's a strong relationship between social network and ecosystem services in that strong social network enhance ecosystem services flow by enhancing collective action plan that leads to sustainable natural resource governance. Therefore, it is important to consider the quality of relationship among people working together to understand the common set expectations, the shared values and the trust amongst the individuals. This is mainly because for instance, weak social capital can result to conflicting values and lack of trust and strong social capital can lead to harmonious coexistence [20].

Social capital can be used to determine the stakeholders who emerge as influential in a natural resource management institution thereby empowering or disempowering the stakeholders [19]. Christina Prell et al. [21] and, Grimble and Wellard [22] pointed out that many initiatives and projects more so the conservation projects have often failed because little or no attention is paid to the stakeholders their interests and attributes, due to this, a lot of focus has now been given to the stakeholder analysis in natural resources management projects.

SNA measures have been suggested as important for the adaptive management of natural resources and for the ability of communities or groups to engage in a collective action for a successful project. Focus has been put on the bridging social capital which is the within group interaction and not the interaction between groups known as bridging social capital [23]. Thus, in our study, we address social networks as real observable phenomena that can be measured using quantitative techniques [24] and analysed using social network analysis [25,26].

We focus on stakeholder identification and attribute analysis of two major aquaculture projects in central Kalimantan. We attempt to find out the position of the stakeholders in the network, their attributes and the role that they play or ought to play to ensure the success of the aquaculture projects they help to manage in order to enhance fish quantity in the natural peatlands by offering alternative source of production from the aquaculture.

We emphasize on power and influence [27,28], since social networks are important in studying different kinds of influence phenomena. There is a well-established study on how social network influences behaviour among people to adopt new practices that affect their lives [29-31]. This influence has resulted to positive impacts in the social network such as behaviour change, social network change, improve organizational efficiency, enhance social change, bringing of new ideas and innovations in the network among others [13,29], [31-34].

Materials and Methods

Scope of the study

This research was based in central Kalimantan, in Indonesia, in Hampangen village which borders Hampangen peatland forest, an important source of livelihood to the surrounding communities. In the recent past, central Kalimantan has been experiencing forest fires caused by anthropogenic activities which have resulted to high carbon emissions. To salvage the situation, the government set strict rules on use of the peatland forest which resulted to permanent closure of timber related industries rendering the people jobless. To protect the peatland forest ecosystem and its services and offer income to the communities, the government initiated alternative livelihood projects such as aquaculture projects.

We focused on the SNA of Hampangen Indah Fish Group (HIFG) keeping catfish (ilele) and Maneser Panatau Fish Group (MPFG) that keeps irrigation shark (patin) fish species, to examine their potential to ensure alternative source of fish to the community to avoid over utilization of the fish from the HEF. The fish species kept are highly adaptable to the local conditions and can live in waters with low levels of dissolved oxygen and low pH levels such as peatland [35]. The interviews and questionnaires were administered to the 11 members of each group.

We first sought out the formation criteria of the groups. Each group is composed of ten members whose income should not be more than 6 USD per day; they should come from the same village and commit to tropical peatland conservation. After the members meet the required conditions, they form a group and come up with a constitution which is handed to the government with the help of an influential member of the group or from the village.

The government goes through the constitution if accepted; the group is given financial support to start the project in form of fishing materials and fingerlings all worth 2000 USD. Three officials in each group are also given free training on how to manage fish farm that then comes to teach the other members. These ponds are built on the natural peatlands and generally depend on rainwater.

Methods

The SNA data were collected through interviews and name generator questionnaires to the members of each of the two aquaculture groups. We used recall method (respondents to generate a list of his/ her relations) to get relational data since this kind of data is frequent in interaction, intense and recent hence possible to identity the most influential stakeholders [24].

Questions and Interviews required each member to nominate the most influential members up to 5 and indicate the frequency of communication. Least communication got a score of 1; most communication score of 5. This was to get the relations among actors, their position in the network and how relations are structured into overall network pattern.

Results and Discussions

We examined the SNA measures in each group to determine the role of SNA in ES enhancement by examining the characteristics of each group and its members. Tables 1 and 2 show the calculated degree centrality for both indegree and outdegree, While Figures 1 and 2 show the visually directed ties for indegree and outdegree in the MPFG and HIFG networks, respectively. Figures 3 and 4 illustrate the tie strength, for MPFG and HIFG respectively by showing the connection lines and their thickness levels.

The thicker the lines of connection between stakeholders, the more the frequency of communication. The core stakeholders are located at the centre of the network while the periphery members are at the far edges of the network. Each group consists of 11 stakeholders, leaders being chairperson, secretary, treasurer and the organizing secretary.
Stakeholders; leader 1, leader 2, leader 3, leader 4, member 6, member 4 and leader 3 have the same degree centrality of 8 and 5, respectively, which means that their influence level in the project is similar and thus they can competently play each other's role in the case of replacement or substitution. Member 3 and leader 1, leader 2, member 4 and member 3, while weakest ties are between member 2 and member 4, and between member 2 and member 3. Generally, the network has very strong ties as depicted in Figure 2 above, hence very strong social bond and high levels of influence among the stakeholders.

Maneser Panatau fish group

Degree centrality (indegree and outdegree): Indegree and outdegree of each actor was examined by counting the number of stakeholders who communicate to each actor as shown in Figure 1. For indegree we counted the incoming ties indicated by the arrows representing the number of stakeholders who communicate to the actor. For outdegree we counted the outgoing ties for the stakeholder whom we referred to as leader 1, leader 2, leader 3, leader 4 and the other stakeholders without any leading role were referred to as member 1, member 2, etc. Dina's social is a stakeholder representing the government with no leadership role, in MPFG but in HIFG, we referred to him basically as leader 1 because he plays a leadership role.

Core and peripheral stakeholders MPFG: Leader 1, leader 2, Dina's social, and member 6 are the most central actors (located at the centre of the network) while leader 4, leader 3, member 2, member 4 and member 5 are at the periphery (located at the edges) of the network of MPFG as shown in Figure 1. The most central members tend to have the most responsibilities in a network organization; this is well proved in Figure 2 by the thickness of the communication lines. While the most peripheral members tend to be less active in the network as shown by thin communication lines in Figure 2.

Tie strength of the stakeholders for MPFG: In MPFG the network size (nodes) is 11 with a total number of 55 ties. The highest tie score is 5 and lowest tie score is 2. The thickness of lines indicates the strength of ties as shown in Figure 2. Thicker lines represent most frequency of communication between stakeholders that is a score of 5 which denotes strong ties while thin lines indicate few frequency of communication or a low tie score which means weak ties.

The strongest ties are manifested among stakeholders namely; Dina’s social, leader 2, leader 1, leader 4, member 6, member 4 and member 3, and between member 2 and member 4. Generally, the network has very strong ties as depicted in Figure 2 above, hence very strong social bond and high levels of influence among the stakeholders.

Hampang indah fish group

Degree centrality (indegree and outdegree): Looking at Table 2, leader 3 has the highest indegree of 9, this means 9 stakeholders communicate to him in regard to the fish project, he is therefore the most popular stakeholder in the network, however, he is not influential with an out degree of 1 means that he only communicates to one stakeholder. Leader 1 is also popular with an indegree of 7, but least influential with an outdegree of 1. Member 7 is the least popular stakeholder in the network, no stakeholder communicates to him while he communicates with only two stakeholders in the group. This means that his absence in the network has no significant impact in the management of the aquaculture project.

Stakeholders; leader 1, leader 4, member 5, and leader 4, member 2, member 6 have the same degree centrality of 6 and 5, respectively, this means that their influence level in the project is similar and thus they can competently play each other’s role in the case of replacement or substitution. Member 5 comes has an indegree of 4 and an outdegree of 4 meaning that the rate of his influence and popularity is same in the group.

Generally, the degree centrality of the group is high, and strong

| Actor/node | Indegree/popularity | Outdegree/influence | Degree centrality |
|------------|---------------------|---------------------|------------------|
| Leader 1   | 7                   | 1                   | 8                |
| Leader 2   | 5                   | 4                   | 9                |
| Leader 3   | 9                   | 1                   | 10               |
| Leader 4   | 4                   | 4                   | 8                |
| Member 1   | 5                   | 2                   | 7                |
| Member 2   | 3                   | 3                   | 5                |
| Member 3   | 4                   | 0                   | 4                |
| Member 4   | 5                   | 1                   | 6                |
| Member 5   | 4                   | 4                   | 8                |
| Member 6   | 2                   | 3                   | 5                |
| Member 7   | 0                   | 2                   | 2                |

Table 1: Measures of degree centrality; indegree and outdegree for MPFG.

Network centralization of 9.93%

| Actor/node     | Indegree/popularity | Outdegree/influence | Degree centrality |
|----------------|---------------------|---------------------|------------------|
| Dina's social  | 9                   | 1                   | 10               |
| Leader 1       | 7                   | 1                   | 8                |
| Leader 2       | 5                   | 4                   | 9                |
| Leader 3       | 9                   | 1                   | 10               |
| Leader 4       | 4                   | 4                   | 8                |
| Member 1       | 5                   | 2                   | 7                |
| Member 2       | 3                   | 3                   | 5                |
| Member 3       | 4                   | 0                   | 4                |
| Member 4       | 5                   | 1                   | 6                |
| Member 5       | 4                   | 4                   | 8                |
| Member 6       | 2                   | 3                   | 5                |
| Member 7       | 0                   | 2                   | 2                |

Group centralization network- 31.93%

Table 2: Measures of degree centrality; indegree and outdegree for HIFG.
Figure 1: Directed communication lines for indegree and outdegree for MPFG network.

Figure 2: Various line thickness indicating stakeholders tie strength for MPFG.
ties among the central members meaning there's are close knit social bond amongst the members. This is very important in social network for communal or group responsibility, hence, high success rates for the group.

**Core and peripheral stakeholders HIFG:** The core or most central stakeholders are; leader 1, leader 2, leader 3 and leader 4 normally located at the centre of the network. The peripheral stakeholders are member 1, member 2, member 3, member 4, member 5, member 6 and member 7 located at the edges of the network as shown in Figure 3. Member 3 and member 7 are the most peripheral stakeholders in HIFG. The peripheral stakeholders hold minor responsibilities in the network.

Figure 3: Directed communication lines for indegree and outdegree for HIFG Network.

Figure 4: Various lines thickness indicating stakeholders tie strength for HIFG.
In terms of economic income and employment, only three out of the 21 out of 22 interviewed stakeholders of the two groups, 10 members obtain fish from the HEF, and nine of them are casual workers in the village earning less than 300 USD in a month (Table 3). This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement. This can be interpreted that, the success of these fish projects, shall lead to decline in frequency and amount of fish catch from the natural river streams and ponds in HEF, resulting to fish ES enhancement.
home consumption was identified as the most consumed ecosystem service. Therefore, we carried out the social network analysis of the aquaculture projects in Hampangen village as an alternative potential source of fish to the community.

The stakeholder attribute analysis of the two groups reveals good leadership skills and harmonious coexistence amongst the project members from the tie strength and the frequency of communication. This eventually shall lead to high success of the projects resulting to more fish production hence alternative source of fish to the people. Having an alternative source of fish implies reduction in fish catch from the natural pond hence enhancement of fish in the natural ponds in the forest.

The exclusive features in our analysis from the stakeholder attributes indicate that income or educational levels do not influence the roles and position of stakeholders in the leadership network nor do they determine the ES usage from the forest. High income stakeholders as well as low income stakeholders were found to obtain various provisioning services from the forest. Again, both high and low education level members were found to occupy leadership positions in the project and portrayed good management skills.

Acknowledgment

We acknowledge the financial support offered by Environmental Research and Technology Development Fund (4-1506) of the Ministry of the Environment, Japan during the field exercises.

References

1. Costanza R, d’Arge R, De Groot R, Farber S, Grasso M, et al. (1997) The value of the world’s ecosystem services and natural capital. Nature 387: 253-260.
2. Ecosystems and human well-being (2005) Millennium Ecosystem Assessment.
3. Kilonzi F, Moji TO, Usup A (2016) Societal role in cultivating and enhancing peatland ecosystem services: a case study of Hampangen forest in central Kalimantan, Indonesia. Journal of Agriculture and Environmental Sciences 5: 8-14.
4. Hirose K, Osaki M, Takeda T, Kashimura O, Ohki T, et al. (2016) Contribution of hyperspectral applications to tropical peatland ecosystem monitoring. In: Tropical Peatland Ecosystems, pp: 421-431.
5. Lockwood A (1996) Community collaboration and social capital: an interview with Gary G. Wehagle. Lead. Towards Sch 2: 19-25.
6. Rico Garcia-Amado L, Ruiz Perez M, Iniesta-Arandia I, Dahringer G, Reyes F, et al. (2012) Building ties: social capital network analysis of a forest community in a biosphere reserve in Chiapas, Mexico. Ecology and Society 17.
7. Girvan M, Newman ME (2002) Community structure in social and biological networks. Proceedings of the National Academy of Sciences 99: 7821-7826.
8. Hoppe B, Reinert C (2010) Social network analysis and the evaluation of leadership networks. The Leadership Quarterly 21: 600-619.
9. Bodin Ö, Crona BI (2009) The role of social networks in natural resource governance: What relational patterns make a difference? Global Environmental Change 19: 366-374.
10. Göröz-Mifsud E, Secco L, Pisani E (2016) Exploring the interlinkages between governance and social capital: A dynamic model for forestry. Forest Policy and Economics 65: 25-36.
11. Bihari M, Ryan R (2012) Influence of social capital on community preparedness for wildfires. Landscape and Urban Planning 106: 253-261.
12. Granovetter MS (1973) The strength of weak ties. American Journal of Sociology 78:1360-1380.
13. Wasserman S, Faust K (1994) Social network analysis: Methods and applications. Cambridge University Press.
14. Keskitalo EC, Vulturius G, Scholten P (2014) Adaptation to climate change in the insurance sector: examples from the UK, Germany and the Netherlands. Natural Hazards 71: 315-334.
15. Brooks N (2010) Human responses to climatically-driven landscape change and resource scarcity: learning from the past and planning for the future. In: Landscapes and Societies, pp: 43-66. Springer, Netherlands.
16. Ros-Tonen MA, Derkyi M, Insaidoo TF (2014) From co-management to landscape governance: Whither Ghana’s modified taungya system? Forests 5: 2996-3021.
17. Szulecka J, Pretzsch J, Seccob L (2014) Paradigms in tropical forest plantations: a critical reflection on historical shifts in plantation approaches. International Forestry Review 16: 128-143.
18. Kim YS, Bae JS, Fisher LA, Latfah S, Affii M, et al (2016) Indonesia’s forest management units: effective intermediaries in REDD+ implementation? Forest Policy and Economics 62: 69-77.
19. Barnes-Mauhle M, Gray SA, Aria S, Lyham J, Leung P (2015) What determines social capital in a social-ecological system? Insights from a network perspective. Environmental Management 55: 392-410.
20. Burt RS (2009) Structural holes: The social structure of competition. Harvard University Press.
21. Prell C, Hubacek K, Reed M (2009) Stakeholder analysis and social network analysis in natural resource management. Society and Natural Resources 22: 501-518.
22. Grimble R, Wellard K (1997) Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities. Agricultural Systems 55: 173-93.
23. Woolcock M (2001) The place of social capital in understanding social and economic outcomes. Canadian Journal of Policy Research 2: 11-17.
24. Marsden PV (1990) Network data and measurement. Annual Review of Sociology 16: 435-463.
25. Degeneve A, Forse M (1999) Introducing social networks. Sage.
26. Scott MS (2002) Problem-oriented policing: Reflections on the first 20 years. Washington, DC: US Department of Justice, Office of community oriented policing services.
27. Mitchell RK, Agile BR, Wood DJ (1997) Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. Academy of Management Review 22: 853-886.
28. Frooman J (1999) Stakeholder influence strategies. Academy of Management Review 24: 191-205.
29. Newman M, Barabasi AL, Watts DJ (2011) The structure and dynamics of networks. Princeton University Press.
30. Monge PR, Contractor NS (2003) Theories of communication networks. Oxford University Press, USA.
31. Valente TW (2012) Network interventions. Science 337: 49-53.
32. Robins GL, Pattison PE, Woolcock M (2005) Social networks and small worlds. American Journal of Sociology 110: 894-936.
33. Merton RK (1957) Social theory and social structure, Rev.
34. Merton RK (1951) Social theory and social structure: Toward the Codification of Theory and Research.

35. The State of World Fisheries and Aquaculture Opportunities and challenges (2014) Food and Agriculture Organization (FAO).