

Agropolitan Development in East Tomohon, North Sulawesi Indonesia

Altje. E. Poli^{1,2}, Mohammad Bisri³, Surjono⁴, Edy Lengkong⁵

¹ Environmental Science and Technology Graduate Program, University of Brawijaya, Indonesia;

² Department of Electrical Engineering, Faculty of Industrial Technology, Minaesa Institute of Technology,
Tomohon North Sulawesi, Indonesia;

³ Department of Water Engineering, Faculty of Engineering, University of Brawijaya, Indonesia;

⁴ Department of Regional Planning and Development, Faculty of Engineering, University of Brawijaya,
Indonesia;

⁵ Department of Soil Sciences, Faculty of Agriculture, University of Sam Ratulangi, Indonesia

Abstract : Agropolitan is one of the rural development strategies whose area brings all components of the agricultural industrial aspect into an integrative agricultural area. The aim of the research was to determine the spatial structure of agropolitan development in Tomohon (North Sulawesi, Indonesia) and identify the crucial component for agropolitan development. The result of the study confirms that the potential agropolitan area of East Tomohon consists of settlement, forest, plantation, orchards and paddy field. The agropolitan area of East Tomohon consists largely of plantation area. Shrub areas were dominant and it becomes the opportunities to convert such barren land into productive lands (i.e. agroforestry). The abundance resources of agropolitan area in Tomohon opens opportunities for the area to maximize the agricultural product based on agroforestry systems. Every component has its special characteristics and roles that should be linked in order to build an integrated agropolitan area. In such a case, network is important.

Keywords: agriculture conservation, sustainable agriculture, agropolitan, landscape management

I. INTRODUCTION

Concern of rural development in developing countries often emphasizes the development of agropolitan as a key of development. The agropolitan has been considered an important strategy for rural poverty reduction through the acceleration of rural economic growth based on the agricultural industry [1]. Rural areas in developing countries are often closely related to the problems of agricultural production, employment, human resources and technology. These aspects have been identified in contributing to the weakness of rural agricultural product in national and global market competition. The principal aim of agropolitan is promoting agricultural and rural development in order to enhance peasant prosperity. Through the agropolitan development, it is projected that rural employment problems will be overcome [2].

Agropolitan is a system which consists of some principal components. The interaction between such components are complex [3]. Land management is a vital factor in agropolitan planning and development. The agropolitan area needs sufficient land area which is able to support agricultural activities. In such a case, spatial planning provides the solution to problems at the beginning of the development process. In agropolitan area development, spatial planning is dealing with the future of area sustainability to produce the agricultural product. It particularly becomes the basic requirement to meet sustainable development agendas. Spatial planning and management has reportedly been able to draw the land allocation for the development scenario and therefore able to minimize conflict significantly [4] [5].

With the recent growth of the sustainable development issue, the conservation of natural resources to support an agropolitan area has become crucial. This means agropolitan development should be able to accommodate economic, social and environmental aspect into planning. The major constraint to agropolitan development is the misconception and assumption that maximal economic earning from agricultural produce is related to the intensity of management agricultural lands. Consequently, in many agropolitan areas, land and water heavily degraded due to intense of chemical material usage. Agropolitan development often involves massive land use changes and chemical fertilizer in order to improve the agricultural product [6].

Tomohon is one of the fastest growing city in North Sulawesi. In this area, agricultural sectors have become the main economy power in Tomohon. Agropolitan has been viewed as an opportunity to enhance the agricultural sector in order to improve the local economic status. The aim of the research is to identify the suitability of an area for sustainable agropolitan development.

II. METHODS

Study site

A field survey was conducted at East Tomohon sub-district, North Sulawesi, Indonesia. Geographically, it is located at 1°11' - 1° 12' latitude and 124° 54' - 124° 74' longitude. The area is located at a high mountain at 757 – 806 asl. The climate of East Tomohon is greatly influenced by the existence of two mountains with its tropical rain forest, namely Mt. Mahawu and Mt. Masarang (560 m). The natural forests are, in general, primer and secondary type forest. Little is known related to the forest species diversity, but it was predicted that Mt. Mahawu and Mt. Masarang is a habitat for numerous plant and animal species. Relative humidity ranges from 87 to 93 % while the daily temperature was about 19.9 – 23.7 °C. Soil was considered fertile. The East Tohomon is a small rural area and approximately 2.5 km from Tomohon City. According to Tomohon City Development Planning Policy, East Tohomon is projected as an agropolitan city due to its agricultural industry potential. The growth of the agricultural market has stimulated the development of Tomohon as an agropolitan area. The study was conducted at three villages, namely Rurukan, Rurukan Satu and Kumelembuai.

Methods

Prior to the agropolitan mapping area analysis, a preliminary study was conducted in order to collect basic data and information about agricultural industry in the study area. Secondary data was collected from a local agricultural office and National Statistics office in Tomohon City. Documents related to local development policy were collected from Tomohon City Hall office. Data was collected systematically and relevant information was documented for further analysis.

The agropolitan area mapping was done following four steps: data acquisition, pre-processing, analysis and map-product generation. Prior to the agropolitan area mapping, a researcher identify the boundary of the agropolitan study area. In this study, a physical and administrative boundary was used to define the agropolitan area of study. In such a case, a topographic map of Minahasa District was used. The topographic map of the study area target was scanned and the digital file was stored in the computer system.

In the field, geographical coordinates of the agropolitan area attributes were recorded using GPS. In the survey, the bio-physical characteristics of subject were observed systematically. All of the geographical data was imported and stored in the computer systems basic data for further analysis. The agropolitan area was digitally created using ArcView software.

III. RESULT AND DISCUSSION

The Agropolitan Area

Physically, East Tomohon has some basic environmental characteristics which provide significant advantages for agricultural development. The area receive rainy season for a significant period of time. The highest rain occurs in November (245 mm) while the lowest in August (98 mm). Based on the Oldeman climates classification, the climate of Tomohon is categorized into D1. According to official data, it is reported that the hydrological aspect is sufficient to support agropolitan development. Mean monthly temperatures range from 22.02 to 22.8°C. Impact of ash volcanous provides a positive impact to land fertility. These climates and physical factors are one of the most important determinants for agropolitan area development.

The potential agropolitan area occupies an area about 6438.2 m². The area consists of some basic elements, namely a settlement, forest, plantation, orchards, shrub area and paddy field. Land use characteristics of a particular area are critical in area development, especially agropolitan development. The existence of such elements indicates the traditional rural landscapes which are often dominated by a large percentage of agricultural and forested area. The agropolitan area ultimately depends on the functions of each element inside the referred area. Details of the study area are given in Table 1.

Table 1. Land uses of the study area

No	Description	Areas (m2)	% of total area	Notes
1	Settlement	270.58	4.20	Traditional Minahasanese settlement, permanent and semi permanent house
2	Protected forest	1144.9	17.78	Tropical rain forest, protected by governmental law; forest is part of the Mt. Masarang and Mt. Mahawu ecosystem with huge biodiversity content
3	Plantation	2,623.22	40.74	The management practices of the traditional plantation system followed the agroforestry system.
4	Paddy field	128.6	0.01	Wet land area with intensive agricultural practices. Traditional practices in land management was practiced (called <i>Mapalus</i>)

				but agricultural intensification was the common phenomena
5	Orchards	918.2	2.03	Agricultural lands for planting numerous vegetables with high economic value
6	Shrubs area	1,352.729	21.01	Barren land, dominated by Imperata grass, ferns and others shrubs species
	Total	6438.2		

Settlement and community

The settlement was dominated by peasant houses. In the observed area, it can be said that the basic infrastructure was available, including rural roads. Most of the community members in the area are workers in the agricultural field. The local community was bound into a traditional relationship called *Mapalus*, a practices of working together among community members. Small and medium enterprises in agricultural product processing were absent. Fresh vegetables and fruit were directly sold to a nearby market in Tomohon. The traditional market could be reached within 1 km, or ten minutes from the modeled area. Transportation network, a fundamental aspect in an agropolitan area, was available. In the modeled area, however, the numbers of good roads were limited. The rural road has a higher frequency of uses. It is seems that the facility never planned for agropolitan development.

The greatest people density per Km² and the lowest peasant percentage was found in Rurukan Satu and indicates that the area was more urbanized that Rurukan and Kemelembuai. The basic and important infrastructure was found in Rurukan Satu and such an amenity becomes the significant rural capital for agricultural development. Rurukan Satu seems to have the potential to be developed as a centre of agribusiness in an agropolitan system in east Tomohon. In this village, nearly a half of the community relies on agricultural activity for jobs.

Table 2. Peasant and community status in the study area

Villages	% to East Tohomon area	People density (per Km ²)	Peasant percentage to total community
Rurukan	29	325	22.32
Rurukan Satu	10	1005	21.73
Kemelembuai	28	352	37.38

Protected Forest

The protected forest was part of the protected system of Mt. Mahawu and Mt. Masarang. Ecologically, this forest area is a habitat for numerous plants and animal species. This forest was managed under the Forestry Office of Tomohon city. Ecologically, the relative undisturbed forest plays an important role in the hydrological process to enhance water availability of agricultural systems. The forest also is the home of pollinators, which provide benefits to plant pollination in order to produce numerous fruits. Humans have influenced the forest ecosystem.

The forest is often ignored in agropolitan area design. A forest provides environmental services which are important to enhance agropololitan area productivity. The forest plays an important role in the water cycle in agropolitan areas. The opportunity for a sustainable agropolitan area, therefore, is how to maintain forest quality and integration into agropolitan area planning. There is now great interest in the possible integration of forest conservation and agriculture sustainability [7].

Plantation

Some areas with the driest environments were used to plant clove and coconut. Plantation area is the dominant component the agropolitan area land uses system in East Tomohon. Plantation is particularly found in the Rurukan and Kumelembuai. In the past, clove was the favorite agricultural product. Coconut is among the most important palm trees species in the plantation system. Coconut was cultivated for its numerous functions, ranging from cultural to economical. In some areas, a large coconut area was found to produce copra. Stands of coconut are range from a few hectares to tens hectares. Arenga palms grow patchy like wild palm trees species inside a plantation. The flower of an Arenga palm was tapped and the collected liquid was processed as traditional beer and sugar. Plantation expansion is likely limited. The opportunity for enhancing the plantation system into agropolitan system is related to the introduction of agroforestry systems. Inside agroforestry, numerous fruits can be cultivated together with coconut, Arenga, and clove. Agroforestry is one of the significant strategies to improve economic earning of peasants in developing countries [8], and it has the opportunity to integrate with agropolitan development.

Orchards

Areas with little water resources were managed as orchards. In East Tomohon, orchard areas were considered important economically. Many crops were cultivated in orchard areas, ranging from fruit to vegetables. Corn, onion, carrots, chili, tomatoes, and cabbage were the major agricultural products in Rurukan, Rurukan Satu and Kemelembuai. There were also mustard, eggplant, spinach, and cucumber that were cultivated as minor agriculture products. Other crops which were cultivated in the orchard areas were maize, cassava and ipomoea. Unfortunately, the vegetable production was not sustainable. That is indicated by intensive use of chemical pesticides and fertilizer. Moreover, many areas for vegetable cultivation were located at slope areas with a land slope of > 8% to > 40%. Vegetable cultivation in a highland is one of the activities which contributes to land degradation. Landslides and erosion have been widely reported in highland areas with intensive agriculture area [9] [10]. The sustainable agriculture practices in orchard areas were considered crucial. It is particularly important due to the fact that orchard areas are dominant in agropolitan area.

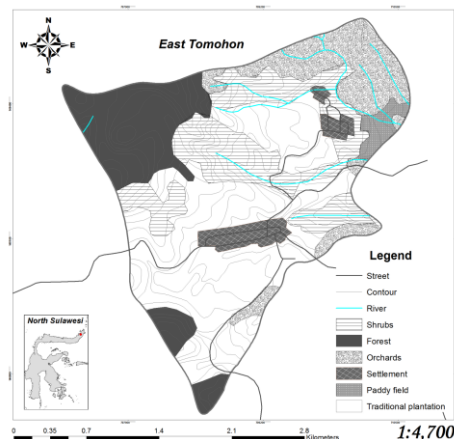


Fig.1. Agropolitan area of East Tomohon

The Agropolitan Element Network

The objective of agropolitan area is to increase agricultural value in order to meet community welfare in rural areas [11] [12]. Since villages have numerous elements and many of them have their own characteristics, defining and characterizing an element's value is important. The agropolitan element should be in network [13]. This means that each component of the agropolitan system should be linked to each other and the build relationship should allow each component to exchange products. In fact, there is little thought of the network of the rural elements for an argropolitan system. They should be coordinated at both the local and regional levels.

There are two aspects of the network that should be highlighted. First, it is related to the spatial network, and second, it is related to the functional networks. Both aspects of the network are principally close each other (Fig.2). Spatially, the agropolitan area is possible only if the area has sufficient road infrastructure to link each part of the agricultural industrial component. In east Tomohon, rural road corridors consist of several categories, such as asphalt road, gravel and stone roads. Rural roads are intensively used to pick-up agricultural products and transport them to the local markets. Consideration, however, must be given to the frequency and weight capacity of the transport vehicles that use the rural roads. Rural road quality decline is often caused by high frequency and vehicles that have a heavy weight. In East Tomohon, the supporting infrastructures such as transportation, communication facility and energy support were sufficient to support agropolitan development.

Functionally, each part is the crucial to the whole agropolitan system. Critics of agropolitan development often focus on the lack of integration of the functional components. This lack of integration can decrease the function and objectives of agropolitan development, especially its economic aspect. The economic activity of the agropolitan component (i.e. orchards, plantation, paddy field and settlement-community) should be interlinked, and the forest should be conserved properly. The economic issues in rural development are crucial, and therefore should be considered as one of the aspects of rural development. The principles of economic development, however, should be put on the sustainable spirit of rural production. In other words, economy, ecology and social in agropolitan development should be in balance [14].

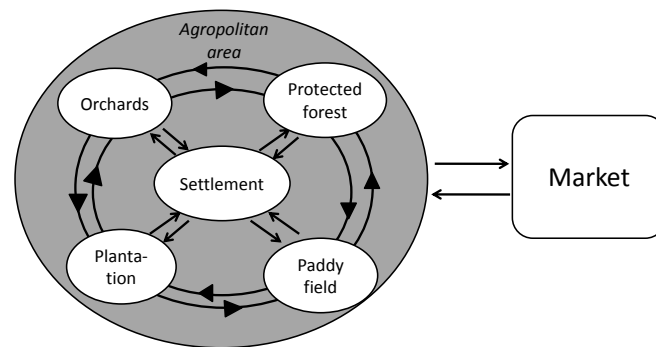


Fig. 2. Framework for an agropolitan area's component integration

Sustainable landscape, including agropolitan area, nowadays becomes the crucial agenda [15]. Agropolitan development may clash with environmental conservation needs. The massive and intensification of land during the agropolitan development process may diminish future soil productivity. Agropolitan development often employs hazardous chemical material which reduces biodiversity. Agropolitan areas require the best quality of environmental aspects. Significant action should be taken against intensive chemical fertilizer uses. Sustainable agricultural practices should be promoted. The sustainable agriculture practices can yield considerable agricultural products [16] [17].

IV. Conclusion

Agropolitan development must be viewed as one integrative system with a continuous interaction between rural component, namely settlement, forest and agricultural lands area. The agropolitan area in East Tomohon can be enhanced by the proper management of the agropolitan's space and its components. The agropolitan area of East Tomohon consists largely of plantation area. This conditions opens opportunities for the Tomohon agropolitan area to maximize the agricultural product based on agroforestry systems. Shrub areas were dominant and it becomes the opportunities to convert such barren land into productive lands. Forest areas should be managed in order to enhance water resource quality in order to support the agropolitan area. Agropolitan development must be viewed as one of the systems with a continuous interaction between the agropolitan's component. Sustainable agropolitan is functions of integrated elements in integrative networks. The interrelationship among elements has an important implication for sustainable agropolitan development.

Acknowledgements

Many thanks to the people in Rurukan, Rurukan Satu, Kemelembuai and staff of Tomohon City Office for supporting our research. We want to thank Directorate General of Higher Education Republic of Indonesia for scholarship support.

REFERENCES

- [1] M. Douglass, Agropolitan Development: An Alternative for Regional Development in Asia, *Himalayan Review*, 13, 1981, 37-71.
- [2] J. Friedmann, Political and technical moments in development: agropolitan development revisited, *Environment and Planning D: Society and Space* 3(2), 1985, 155 – 167.
- [3] A. Buang, A. Habibah, J. Hamzah and Y.S. Ratnawati, The Agropolitan Way of Re-Empowering the Rural Poor. *World Appl. Sci. J*, 13, 2011, 1-6.
- [4] S.M. Swinton, F. Lupi, G.P. Robertson and S.K Hamilton, Ecosystem services and agriculture: cultivating agricultural ecosystems for diverse benefits. *Ecological economics*, 64(2), 2007, 245-252.
- [5] B. Egoh, B. Reyers, M. Rouget, D.M. Richardson, D.C. Le Maitre and van A.S. Jaarsveld., Mapping ecosystem services for planning and management. *Agriculture, Ecosystems & Environment*, 127(1), 2008, 135-140.
- [6] D. Tilman, K.G. Cassman, P.A. Matson, R. Naylor and S Polasky, Agricultural sustainability and intensive production practices, *Nature*, 418(6898), 2002, 671-677.
- [7] S. Jose, Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforestry Systems*, 76(1), 2009, 1-10.
- [8] J. Arnold and M.R. Pérez, Can non-timber forest products match tropical forest conservation and development objectives?. *Ecological economics*, 39(3), 2001, 437-447.
- [9] J. A. Foley, R. DeFries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, J.K. Helkowski, T. Holloway, E.A. Howard, C.J. Kucharik, C. Monfreda, J.A. Patz, I.C. Prentice, N. Ramankutty and P.K. Snyder, Global consequences of land use. *Science*, 309(5734), 2005, 570-574.
- [10] L. Hakim, Cultural Landscapes of the Tengger Highland, East Java. In: S.-K. Hong, et al. (eds.) *Landscape Ecology in Asian Cultures*. Ecological Research Monographs, Part I, pp: 69-82, Springer Verlag, Tokyo, 2011.
- [11] D. Gollin, S. Parente and R. Rogerson, The role of agriculture in development. *The American Economic Review*, 92(2), 2002, 160-164.
- [12] I. Scoones, Livelihoods perspectives and rural development. *The Journal of Peasant Studies*, 36(1), 2009, 171-196.

- [13] J. Murdoch, Networks—a new paradigm of rural development?. *Journal of rural studies*, 16(4), 2000, 407-419.
- [14] S. Wiggins and S Proctor, How special are rural areas? The economic implications of location for rural development. *Development policy review*, 19(4), 2001, 427-436.
- [15] M. Antrop, Sustainable landscapes: contradiction, fiction or utopia?. *Landscape and urban planning*, 75(3), 2006, 187-197.
- [16] E. Lichtfouse, M. Navarrete, P. Debaeke, V. Souchère, C. Alberola and J. Ménassieu, Agronomy for sustainable agriculture: a review. In *Sustainable Agriculture* (pp. 1-7). Springer Netherlands, 2009.
- [17] P.R. Hobbs, K. Sayre and R. Gupta, The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1491), 2008, 543-555.