The Role of Agrotourism in Environmental Sustainability  
(Case Study: Batu City, East Java)

Fardiah Qonita Ummi Naila\* & Djoko Santoso Abi Suroso

School of Architecture, Planning, and Policy Development, Institut Teknologi Bandung

\*Email: Fardiahqonita123@gmail.com

**Abstract.** The change in tourism trends during the Covid-19 pandemic to rural tourism is the basis for considering the role of agro-tourism as a rural tourism option. Previous research has shown an increase in demand for the tourism market has a correlation with increased consumption of clean water, giving rise to issues of justice for access to rural air. Therefore, this study seeks to be able to give consideration to environmental potential in agro-tourism activities with the case study of Batu City. In this study, a comparative study was used in three different villages in Batu City with vegetation characteristics as an agro-tourism attraction offered by the Temperature Vegetation Dryness Index (TVDI) methodology. The results showed that there was a relationship between the area of ​​the vegetation index as shown by the Normalized Difference Vegetation Index (NDVI) approach in each village and the degree of drought shown in the results of the Temperature Vegetation Dryness Index (TVDI). The results of the study show that agro-tourism plays a big role in maintaining air availability as indicated by the minimum level of drought in areas with high vegetation.

**Keywords:** Agrotourism; Environmental Sustainability; Drought Level.

# Introduction

We have now entered the city century and the term urbanization will become a perspective that is more widely used in viewing social, economic and environmental characteristics in the future [1]. Scientists agree, we are currently living in a new urban era which is termed as 'Asticcene' which refers to the meaning of humans changing environmental functions globally [2]. The context of urbanization can also be brought into the context of tourism, where currently urban tourism tends to increase rapidly compared to other forms of tourism [3].

Besides being an important destination, cities have a significant role in the tourism as a whole system, by being a gateway for international and domestic tourists as well as being a node in the transportation system [4]. Furthermore, regarding the role of the city as a multifunctional entity and an attraction for tourists to be able to visit, it has the opportunity to shape the relationship between urbanity and various tourism activities. This is because there is an intersection between the needs of residents and tourists so that cities face different demands in the provision of services and facilities. The tourist burden in a city can have an impact on reducing the quality of urban life.

The rapid development of the tourism industry is a real threat to the issue of climate change [5]. This is evidenced by data regarding a number of countries that are vulnerable to climate change which are both domestic and international tourist destinations [4], this condition will also cause drastic changes in the decline in tourist visits including in coastal, mountainous and polar regions. due to drought, heat waves and hurricanes. The amount of dependence on other sectors causes the tourism industry to be the first to receive the impact of a disaster. On the other hand, the tourism sector is one of the factors that perpetuate global warming and natural disasters. The tourism sector is a contributor of 8% of greenhouse gas (GHG) emissions as a result of aviation (40%), transportation (30%), and consumption of goods and services (30%) including accommodation needs [6]. This causes the tourism sector to be a bigger pollutant sector than the construction sector.

In the context of Southeast Asia, many countries make the tourism sector a driving force for the economy. According to data from Southeast Asia: Travel and Tourism GDP Contribution, 2021 the tourism sector in Southeast Asia as a whole made the highest contribution in 2019, namely 393.12 billion dollars, then in experienced a significant decrease to 180.21 billion dollars in 2020 and amounted to 143.25 billion dollars in 2020. 2021 due to the covid-19 pandemic.

Limited access to foreign tourists is the main factor in the decline in the contribution of the economic sector to GDP. Therefore, many countries in Southeast Asia have developed a strategy for recovering the tourism sector by promoting domestic tourism by implementing policies [7], [8]:

1. Identify new niches in the domestic tourism market
2. Re-orientation of tourism services
3. Support SMEs and startups
4. Develop tourism in rural areas

The demand for rural tourism increased during the covid-19 pandemic due to the need for psychological and physical recovery during the face of the covid-19 pandemic [9], [10]. This shift in tourism preferences is also supported by the need to implement health protocols. Rural tourism is defined as tourism that showcases artistic, cultural and heritage life in rural areas [11]. Rural tourism, specifically, is also defined as agro-tourism where tourism activities are integrated with agricultural activities of local communities [12].

In the context of tourism, as a specific activity for rural areas, concentrated in rural areas as a destination, offering functional accommodation structures and other special services. Rural tourism has been recognized as:

* An alternative to the declining agricultural sector, which is unable to sustain the subsistence needs of the rural population;
* As a possibility to stimulate entrepreneurial opportunities for rural farmers, ensuring stability through the new jobs created

Among the forms of rural tourism, agro-tourism is one of the potential areas of concern because it demands the maintenance of the original characteristics of rural areas under current development demands.

The same phenomenon also occurs in the study location, Batu City, East Java. The designation of Batu City as a National Tourism Destination (DPN) with a type of natural tourist attraction in the 2010-2025 National Tourism Development Master Plan as stipulated in the Government Regulation of the Republic of Indonesia Number 50 of 2011 has a direct impact on the development of infrastructure, infrastructure and public facilities, increasing empowerment community and investment development. Supporting this, the construction of a number of supporting infrastructure for the tourism sector in Batu City will encourage the growth and development rate of the city marked by an increase in population, increased economic and social interaction between interconnected areas that lead to spatial and a-spatial transformation in the Batu City area. In the transformation of the spatial aspect, it can be seen that Batu City has experienced an increase in residential land cover reaching 33% in the period 2013 – 2022. Meanwhile, in the a-spatial aspect, Batu City continues to experience urban growth and development, especially in the trade, agriculture, construction and accommodation provision sectors. in terms of GRDP data according to constant prices in 2013-2019 and population growth. GRDP as a measure of economic growth in Batu City has increased, but on the other hand, the development of tourism in Batu City continues to have an impact on the sustainability of agro-tourism activities in Batu City.

Meanwhile, the intent and purpose of this research is to see the role of agro-tourism in environmental sustainability. To be able to analyze the relationship between agro-tourism and environmental sustainability, it was carried out by comparing the environmental performance of agro-tourism in three different villages in Batu City with different vegetation characteristics, namely Sidomulyo Village with flower vegetation types, Sumbergondo Village with fruit (apple) plant vegetation types, and Tulungrejo Village with types of vegetable vegetation.

# Methods

The research was conducted and placed in a rural area of Batu City, a region with high potential for agro-tourism which can offer a wide variety of agricultural-based tourism products including vegetables, flowers and fruit. Where these three agricultural products depend on meeting water needs, therefore, three areas are selected which are developed from a vegetation point of view as agro-tourism attractions selected, and compared using the Temperature Vegetation Dryness Index (TVDI) approach.

TVDI is a drought index based on the sensitivity spectrum of visible and near infrared light on vegetation behavior and vegetation stress conditions associated with water shortages. In general, NDVI, the Normalized Vegetation Index will increase along with a decrease in surface temperature (LST). This is related to the ability of vegetation to regulate temperature through latent heat transfer, namely heat transfer through evapotranspiration. Radiation absorbed and the amount of water available at the soil surface are the two main elements that regulate surface temperature. When the availability of water becomes minimal whether the land is vegetated or not, the surface temperature will increase. The consideration for using the TVDI approach in this study is because TVDI shows better linearity in vegetation density under existing conditions [13]. Following are the details of the equations used in the study:

**NDVI =, (1)**

**LST = (2)**

**TVDI= , (3)**

**Keterangan:**

NDVI : Normalized Difference Vegetation Index

LSTmin : Minimum Surface Temperature

LSTmax : Maximum Surface Temperature

LST : The observed surface temperature at a Pixels

TVDI : Temperature Vegetation Dryness Index

**Table 1** Dryness Index According to TVDI:

| **Dryness Index** | **TVID** |
| --- | --- |
| Very Wet | 0 < TVDI≤ 0.2 |
| Wet | 0.2 < TVDI≤ 0.4 |
| Normal | 0.4< TVDI≤ 0.6 |
| Dry | 0.6 < TVDI≤ 0.8 |
| Very Dry | 0.8 < TVDI≤ 1.0 |

Source: [14]

# Results

## Representation of Agrotourism Areas in Sidomulyo Village, Batu City

Sidomulyo Village is one of the agro-tourism destinations in Bumiaji District, Batu City with superior ornamental plant products. According to the vegetation analysis, using the NDVI method it is known that Sidomulyo Village has the following plantation area:

**Table 2** Normalized Difference Vegetation Index (NDVI) in Sidomulyo Village, Bumiaji, Batu City

| Vegetation Index | Coverage (Ha) | Percentage |
| --- | --- | --- |
| High Vegetation | 1.74 | 0.17% |
| Medium Vegetation | 758.88 | 74.28% |
| Very Low Vegetation | 142.08 | 13.91% |
| Low Vegetation | 102.38 | 10.02% |
| Non Vegetation | 16.56 | 1.62% |

Source: Analytical Resource, 2022

TVDI as an indicator used to measure the level of drought in one study area, in the context of the research The Role of Agro-tourism in Environmental Sustainability is used as a basis for measuring the role of tourist attraction in Sidomulyo Village on the basis of superior ornamental plant products seen from the level of drought

**Table 3** Temperature Vegetation Dryness Index (TVDI) in Sidomulyo Village, Bumiaji, Batu City

| **Class** | **Dryness Index** | **TDVI** | **Coverage (Ha)** | **Pecentage** |
| --- | --- | --- | --- | --- |
| Class 1 | Very Wet | 0 - 0.2 | 100.43 | 41.40% |
| Class 2 | Wet | 0.2 - 0.4 | 108.16 | 44.60% |
| Class 3 | Normal | 0.4 - 0.6 | 33.03 | 13.60% |
| Class 4 | Dry | 0.6 - 0.8 | 0.68 | 0.30% |
| Class 5 | Very Dry | 0.8 - 1.0 | 0.00 | - |
| **Total** | | | 242.31 | 100% |

Sumber: Analytical Result, 2022

## Agrotourism Area Representation in Sumbergondo Village, Batu City

Sumbergondo Village is one of the agro-tourism destinations in Bumiaji District, Batu City with superior apple products. According to the vegetation analysis, using the NDVI method, it is known that Sumbergondo Village has the following plantation areas:

**Table 4** Normalized Difference Vegetation Index (NDVI) di Desa Sumbergondo, Bumiaji, Kota Batu

|  |  |  |
| --- | --- | --- |
| **Vegetation Index** | **Coverage (Ha)** | **Percentage** |
| High Vegetation | 115.27 | 2.18% |
| Medium Vegetation | 3972.54 | 74.98% |
| Very Low Vegetation | 450.93 | 8.51% |
| Low Vegetation | 748.27 | 14.12% |
| Non Vegetasi | 10.95 | 0.21% |

Source: Analytical Result, 2022

TVDI as an indicator of drought level measurement in a certain study area, in the context of The Role of Agrotourism on Environment Sustainibility study, it function as a fundamental on measuring the Tourism Attraction in Sumbergondo Village with apple product as its superior based product reviewed from the drought level.

**Table 5** Temperature Vegetation Dryness Index (TVDI) in Sumbergondo Village, Bumiaji, Kota Batu

| **Class** | **Dryness Indeks** | **TDVI** | **Coverage (Ha)** | **Percentage** |
| --- | --- | --- | --- | --- |
| Class 1 | Very Wet | 0 - 0.2 | 519.88 | 28% |
| Class 2 | Wet | 0.2 - 0.4 | 663.73 | 36% |
| Class 3 | Normal | 0.4 - 0.6 | 489.80 | 27% |
| Class 4 | Dry | 0.6 - 0.8 | 156.02 | 8% |
| Class 5 | Very Dry | 0.8 - 1.0 | 10.67 | 1% |
| **Total** | | | 1840.10 | 100% |

Source: Analytical Result, 2022

## Agrotourism Area Representation in Tulungrejo Village, Batu City

Tulungrejo Village is one of several agrotourism destination on Bumiaji District, Batu City with apple as its superior product. Based on a vegatation analysis, using NDVI method, it is known that Tulungrejo Village has total land coverage as presented in the following table :

**Table 6** Normalized Difference Vegetation Index (NDVI) di Desa Tulungrejo, Bumiaji, Kota Batu

|  |  |  |
| --- | --- | --- |
| **Vegetation Index** | **Coverage (Ha)** | **Percentage** |
| High Vegetation | 672.55 | 10% |
| Medium Vegetation | 5289.11 | 77% |
| Very Low Vegetation | 364.37 | 5% |
| Low Vegetation | 541.82 | 8% |
| Non Vegetation | 42.15 | 1% |

Source: Analytical Result, 2022

TVDI as an indicator of drought level measurement in a certain study area, in the context of The Role of Agrotourism on Environment Sustainibility study, it function as a fundamental on measuring the Tourism Attraction in Tulungrejo Village with apple product as its superior based product reviewed from the drought level.

**Table 7** Temperature Vegetation Dryness Index (TVDI) di Desa Tulungrejo, Bumiaji, Kota Batu

| **Class** | **Dryness Index** | **TDVI** | **Coverage (Ha)** | **Percentage** |
| --- | --- | --- | --- | --- |
| Class 1 | Very Wet | 0 - 0.2 | 1333.49 | 48% |
| Class 2 | Wet | 0.2 - 0.4 | 924.75 | 33% |
| Class 3 | Normal | 0.4 - 0.6 | 447.06 | 16% |
| Class 4 | Dry | 0.6 - 0.8 | 88.80 | 3% |
| Class 5 | Very Dry | 0.8 - 1.0 | 0.00 | - |
| **Total** | | | 2794.10 | 100% |

Source: Analytical Result, 2022

# Discussion

The result of the study shows that most of the research related with agrotourism in the last few years indicating a shift in consumer preference from conventional tourism to agrotourism. Besides, earlier study about agrotourism development are focused on qualitative method, resulting in the shortcoming of this paper on methodology contribution.

The result of the analysis in Batu City shows that agrotourism could be promoted as one of the alternative on environment sustainability. In this research 3 (three) village with agrotourism potential are chosen as a subject of case study in order to be given a rating towards agrotourism’s role on environment sustainability. In general, environment continuity on the potential tourism site could be measured through dryness index which has an impact on water crisis for the locals where drought as a normal climate feature and recurring phenomena has a consequence towards the decreasing of rainfall or temperature in a long period of time. On many cases, an escalation of drought phenomena are positively corelated on vegetation in most of the region [15], [16]. This study adds an understanding about vegetation ability on withhold drought and from this research findings give an evidence to support the response towards drought threat as a result of the increasing activity of tourism.

In this research, vegetation index are divided into 5 (Five) category, which is High Vegetation, Medium Vegetation, Very Low Vegetation, Low Vegetation, and Non Vegetation. The higher the vegetation indeks has a positive correlation towards the ability to minimize drought risks.

Diagram

Description automatically generatedMap

Description automatically generated **(a) (b)**

Map

Description automatically generated **Figure 1** Map Analysis Temperature Vegetation Dryness Index   
Batu City, East Java  
Source: Analytical Result, 2022

NDVI and TVDI application on this research, shows that there is an evidence on correlated response between vegetation and drought that affected by an increasing tourism activity resulting in drought potential escalation which endanger a regional system ecology.

Picture 1 Map Analysis Temperature Vegetation Dryness Index shows a significant difference on drought level in each study location. Tulungrejo Village with the highest vegetation index compared to Sumbergondo Village and Sidomulyo Village with Vegetation Index of 10%, has a land coverage percentage with the lowest drought level on level 1 and 2. Meanwhile, in Sumebergondo Village with coverage percentation accumulation with *very low*, *low*, and *non-vegetation* Vegetation Indeks higher than the two other village on 22.84% has a relation towards drought response that shown by TVDI index normal classification (Level 3) with 27% percentage, dry (Level 4) with 8% percentage, and very dry (Level 5) with 1% percentage.

# Conclusion

Analytical result on the 3 (three) village which is Sidomulyo Village, Sumbergondo Village, and Tulungrejo Village shows a correlation between coverage index that shown with *Normalized Difference Vegetation Index* (NDVI) approach on each village on drought level that are shown by *Temperature Vegetation Dryness Index*.

The changes in tourism tren are expected to increase the role of agrotourism in increasing environment sustainibility in emphasizing agricultural plantation as a tourism charm by taking care of water availibility that are shown by the low drought level on an area with high vegetation in Batu City.

Nevertheless, this study has some limitations that must be resolved in future research. First, how can agro-tourism be questioned more through ecosystem services. Second, how is the ecological risk assessment model of agro-tourism development. Third, a comparison of approaches in determining the results of an ecological risk assessment of the development of agro-tourism.

**References**

1. K. C. Seto, R. Sánchez-Rodríguez, and M. Fragkias, “The New Geography of Contemporary Urbanization and the Environment,” *http://dx.doi.org/10.1146/annurev-environ-100809-125336*, vol. 35, pp. 167–194, Oct. 2010, doi: 10.1146/ANNUREV-ENVIRON-100809-125336.
2. “What does astycene mean - Definition of astycene - Word finder.” https://findwords.info/term/astycene (accessed Sep. 14, 2022).
3. C. Aall and K. Koens, “The discourse on sustainable urban tourism: The need for discussing more than overtourism,” *Sustain.*, vol. 11, no. 15, pp. 1–12, 2019, doi: 10.3390/su11154228.
4. D. Edwards, T. Griffin, and B. Hayllar, “Urban Tourism Research. Developing an Agenda,” *Ann. Tour. Res.*, vol. 35, no. 4, pp. 1032–1052, 2008, doi: 10.1016/j.annals.2008.09.002.
5. “The Link Between Tourism and Climate Change — Sea Going Green,” Mar. 03, 2020. https://www.seagoinggreen.org/blog/the-link-between-tourism-and-climate-change (accessed Sep. 14, 2022).
6. M. Lenzen, Y. Y. Sun, F. Faturay, Y. P. Ting, A. Geschke, and A. Malik, “The carbon footprint of global tourism,” *Nat. Clim. Chang. 2018 86*, vol. 8, no. 6, pp. 522–528, May 2018, doi: 10.1038/s41558-018-0141-x.
7. M. Goretti *et al.*, *Tourism in the Post-Pandemic World*, no. 21. 2021.
8. Asian Development Bank, “Domestic Tourism in Southeast Asia: Opportunities and Pathways - Matthias Helble and Jaeyeon Choe | Asian Development Bank.” https://www.adb.org/news/op-ed/domestic-tourism-southeast-asia-opportunities-and-pathways-matthias-helble-and-jaeyeon (accessed Oct. 22, 2022).
9. F. Nearchou and E. Douglas, “Traumatic Distress of COVID-19 and Depression in the General Population: Exploring the Role of Resilience, Anxiety, and Hope,” *Int. J. Environ. Res. Public Health*, vol. 18, no. 16, Aug. 2021, doi: 10.3390/IJERPH18168485.
10. S. Zach, J. Fernandez-Rio, A. Zeev, M. Ophir, and S. Eilat-Adar, “Correction to: Physical activity, resilience, emotions, moods, and weight control, during the COVID-19 global crisis,” *Isr. J. Health Policy Res.*, vol. 10, no. 1, p. 55, Dec. 2021, doi: 10.1186/S13584-021-00489-3.
11. “UNWTO Recommendations on Tourism and Rural Development – A Guide to Making Tourism an Effective Tool for Rural Development,” *UNWTO Recomm. Tour. Rural Dev. – A Guid. to Mak. Tour. an Eff. Tool Rural Dev.*, Sep. 2020, doi: 10.18111/9789284422173.
12. S. Rauniyar, M. K. Awasthi, S. Kapoor, and A. K. Mishra, “Agritourism: structured literature review and bibliometric analysis,” *Tour. Recreat. Res.*, vol. 46, no. 1, pp. 52–70, 2021, doi: 10.1080/02508281.2020.1753913.
13. A. Bannari, H. Asalhi, and P. M. Teillet, “Transformed difference vegetation index (TDVI) for vegetation cover mapping,” *Int. Geosci. Remote Sens. Symp.*, vol. 5, no. March, pp. 3053–3055, 2002, doi: 10.1109/igarss.2002.1026867.
14. I. Sandholt, K. Rasmussen, and J. Andersen, “A simple interpretation of the surface temperature/vegetation index space for assessment of surface moisture status,” *Remote Sens. Environ.*, vol. 79, no. 2–3, pp. 213–224, Feb. 2002, doi: 10.1016/S0034-4257(01)00274-7.
15. Z. Gao, W. Gao, and N. Bin Chang, “Integrating temperature vegetation dryness index (TVDI) and regional water stress index (RWSI) for drought assessment with the aid of LANDSAT TM/ETM+ images,” *Int. J. Appl. Earth Obs. Geoinf.*, vol. 13, no. 3, pp. 495–503, Jun. 2011, doi: 10.1016/J.JAG.2010.10.005.
16. X. Shi, F. Chen, H. Ding, M. Shi, and Y. Li, “Assessing Vegetation Ecosystem Resistance to Drought in the Middle Reaches of the Yellow River Basin, China,” *Int. J. Environ. Res. Public Health*, vol. 19, no. 7, Apr. 2022, doi: 10.3390/IJERPH19074180.