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Research Article

Assessment of biodiversity risks in urban agriculture: Case of Jakarta, Indonesia

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ABSTRACT

Urban agriculture is a permanent and dynamic part of urban socio-economic and ecological systems. It uses typical urban resources, competes with other urban functions for land and water, is influenced by urban policies and plans, and contributes to urban social and economic development. To assess agricultural sustainability and predict future food security, it is essential to understand the relationship between farming systems and biodiversity. The research aimed to assess biodiversity risk in urban agriculture. This research employed a mixed-methods approach, combining quantitative and qualitative methods, and incorporated a field survey that involved collecting data from research and literature reviews. The field survey involved collecting data from research questionnaires distributed to respondents to determine their perceptions of biodiversity risks to flora and fauna resulting from urban agricultural activities. The results of the study showed that the p-value was greater than the alpha level (α = 0.05), indicating that urban agriculture in East Jakarta does not significantly affect biodiversity risks of flora and fauna.

Keywords: agripolitan; city greenery; conservation; East Jakarta; food security

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INTRODUCTION

According to the UNEP (2021), by 2050, 70% of the world's population is expected to live in urban areas, and 80% of global food consumption is anticipated to occur in cities. The challenges posed by the demand for reliable food will be influenced by various factors, including climate change, water scarcity, and limited land due to increasing urbanization (Siregar et al., 2022; Ye et al., 2025).

In recent years, urban agriculture has emerged as a potential solution for achieving various sustainability goals, including city greenery, ensuring food security, and providing other ecosystem services (Santosa et al., 2021; Herianti et al., 2022; Ruwaida et al., 2022a; Saputro et al., 2022). Urban agriculture plays a crucial role in urban sustainability (Santosa et al., 2021). It is a permanent and dynamic part of urban socio-economic and ecological systems that uses typical urban resources. Urban agriculture competes with other urban functions for land and water, is influenced by urban policies and plans, and contributes to urban social and economic development (Dona et al., 2021). To assess agricultural sustainability and predict future food security, it is essential to understand the relationship between agricultural systems and biodiversity (Cock et al., 2012).

Landscape urbanization causes the fragmentation of the natural environment by altering ecological processes to accommodate urban areas. Urbanization occurs at a scale and speed that ecosystems and biodiversity cannot withstand. This makes it difficult for them to be resilient and resistant. Although it is generally assumed that cities and biodiversity are incompatible, many cities boast a rich diversity of species (Smith et al., 2018).

Jakarta is one city currently participating in urban agriculture. According to ICLEI (2021), urban agriculture is a priority sector for Jakarta's low-emission development and sustainable city initiatives. Despite operating in limited space and amid high urbanization pressures, agriculture in Jakarta still plays a crucial role in maintaining food security and supporting the urban environment (BPS, 2024). In this regard, risk assessment on urban agriculture in relation to biodiversity is important.

This is a case study of urban agriculture research in East Jakarta, which involves 10 sub-districts. Three urban agriculture sampling locations were established in public spaces, namely *Ruang Publik Terpadu Ramah Anak* (RPTRA- Child-Friendly Integrated Public Space). The focus research was at RPTRA Duren Sawit, Ciracas Prima, and Condet Balekambang. Little research has been conducted in Jakarta on the impact of urban agriculture on biodiversity sustainability (Santosa et al., 2021). Therefore, this study aims to explore the impact of urban agriculture on the sustainability of biodiversity in open spaces, considering the ongoing risks to biodiversity in urban areas, such as the case of East Jakarta. The positive impact of open spaces on ecosystem services, both direct and indirect, is not well understood. According to the research of Semeraro et al. (2021), the main benefits of urban open spaces are producing small-scale fruits, evacuating air pollutants such as CO_2, NO_2, CO, and SO_2 particles, absorbing carbon, reducing carbon footprints, mitigating heat flow in the city, preventing floods and storing water, providing habitats for insects, soil fauna, and wildlife, and providing places for plant growth and development, as well as relaxation and recreation for the community. The research aimed to assess biodiversity risk in urban agriculture.

MATERIALS AND METHODS

This study took samples case study from ten subdistricts of East Jakarta Regency, i.e., (1) Cipayung, (2) Cakung, (3) Kramat Jati, (4) Ciracas, (5) Makasar, (6) Matraman, (7) Duren Sawit, (8) Pulo Gadung, (9) Pasar Rebo, and (10) Jatinegara. The samples were collected from January to April 2024.

This research employed a mixed-methods approach, combining qualitative and quantitative methods through a field survey and a literature study. The field survey involved collecting data from a questionnaire distributed to urban agricultural stakeholders in East Jakarta to determine their perceptions. The questionnaire contained questions about the ecological functions necessary to identify potential biodiversity risks due to urban agricultural activities, which are currently causing a decrease in urban biodiversity (Table 1). These questions were designed to determine the presence of various fauna, such as bees, other insects, termites, ants, caterpillars, and birds, as well as the presence of beehives. Although plant biodiversity was observed, the study did not include sampling or measurement of plant species, as the primary focus was on stakeholders' perceptions of biodiversity risks associated with urban agriculture. This is because the research is limited to determining the extent to which urban agriculture has impacted the sustainability of biodiversity, based on the perspective of respondents who are urban agriculture actors. The research does not focus on flora and fauna samples, so measurements are not taken on the types of flora and fauna active in urban agriculture.

Respondents in this study used purposive sampling. This sampling was based on the age criteria of urban agriculture actors and their experience. The criteria for respondents involved in this study were urban agricultural actors in East Jakarta who were over 19 years old and had over two years of experience in urban agricultural activities. Five respondents were selected from each sub-district.

Three of the ten subdistrict locations chosen as sampling locations were in public spaces: Duren Sawit subdistrict (RPTRA Duren Sawit, latitude 6.235298, longitude 106.917363), Ciracas subdistrict (RPTRA Ciracas Prima, latitude 6.323899, longitude 106.875799), and Kramat Jati subdistrict (Condet Balekambang, latitude -6.3085, longitude 106.8652).

Table 1. The identification of risks to biodiversity resulting from urban agricultural activities.

No	Identification	Yes (√)	No (√)
1	Bee	√	
2	Other insect	√	
3	Termite	√	
4	Ant	√	
5	Catterpilar	√	
6	Bird	√	
7	Pollen trap		√

Furthermore, the data collected from the respondent questionnaire was subjected to chi-square analysis using data from the Guttman scale. Then, data processing continued using SPSS 17 software. In this study, a score of 1 was assigned to respondents who answered "no," and a score of 2 was assigned to those who answered "yes." For the study, respondents' ages were categorized as <35 years or >35 years. Respondents aged <35 years received a score of 1, while respondents aged >35 years received a score of 2. The Guttman scale is not a numerical scale, but rather a dichotomous scale that uses the responses “yes” or “no”. In this study, converting the responses to numbers is only for the purpose of processing the research results.

A difference is considered significant if the chi-square value is equal to or greater than the value corresponding to a given level of significance in the chi-square table. According to Negara and Prabowo(2018), the testing criteria in Chi-square analysis:

If $\boldsymbol{x^2}$ count ≤ $\boldsymbol{x^2}$ table, so H_o : accepted
If $\boldsymbol{x^2}$ count > $\boldsymbol{x^2}$ table, so H_o : rejected
If sig. α (0.05) so H_o : accepted
If sig. α (0.05) so H_o : rejected

RESULTS AND DISCUSSION

The results of the study on respondents' perceptions of potential biodiversity risks from urban agricultural activities are shown in Table 2. The results indicate that there was no significant difference between urban agriculture and biodiversity risks. This is evident from the Chi-square analysis, which shows that the p-value is greater than the alpha level (α) of 0.05. This suggests that urban agriculture does not solely influence biodiversity risks.

Table 2. Chi-square analysis result.

Factor	Σn	Chi-square analyze		Information
		P-value	α (0.05)	
Respondent’s age*bee	50	0.258	0.05	Not significant
Respondent’s age*insect	50	0.718	0.05	Not significant
Respondent’s age*termite	50	1	0.05	Not significant
Respondent’s age*ant	50	1	0.05	Not significant
Respondent’s age*caterpillar	50	0.131	0.05	Not significant
Respondent’s age*bird	50	0.690	0.05	Not significant
Respondent’s age*pollen	50	0.355	0.05	Not significant

The most concerning biodiversity risks in urban areas are the loss of local species due to climate change, pollution, and human hunting. Other factors influencing biodiversity measurements in this study include quantitative measurements of specific species matching the research locus, not just qualitative assessments from respondents. Additionally, the sampling time can influence the results if it is done quantitatively; this relates to fauna activities that differ in time. Morning active fauna (such as ants, birds, butterflies, grasshoppers, chickens, and cats) will differ from night-active fauna (nocturnal) such as bats, owls, frogs, and civets. According to Giglio et al. (2023), many factors influence biodiversity risks in urban areas. The three highest influencing factors in the city are the energy, utilities, and real estate sectors. Cities provide opportunities for new approaches to supporting biodiversity that would not otherwise be feasible in rural areas (Kowarik et al., 2020).

Biotic and abiotic factors cause the environmental risks of urban agriculture in East Jakarta. Therefore, the urban ecosystem can be analyzed by examining its components as ecological factors. This approach is based on the concept of urban ecology as a means of understanding physical spaces and urban functional cycles. In other words, it involves evaluating both the abiotic (biotope) and biotic (biocenosis) elements, while considering the integration of urban abiotic elements into life processes for biodiversity conservation (Tarsitano et al., 2021). To assess the sustainability of agricultural systems and predict future food security, it is necessary to understand how these systems function and the intricate relationships between aboveground and belowground biodiversity (Rahmayanti et al., 2025). Nevertheless, urban agriculture is necessary to maintain urban biodiversity and species sustainability. Plants in urban environments provide habitats for urban species and support the formation of natural food chains, which help maintain the balance of the ecosystem. To achieve environmental carrying capacity, which is the environment's ability to support human life and other living things in balance, all ecosystems must be maintained. When carrying capacity is met, environmental capacity is also achieved because the environment can absorb substances, energy, and/or other components introduced into it (Hardati, 2015). The environmental benefits of urban agriculture include increased biodiversity, mitigation of the urban heat island effect, and reduced flooding risk (McEldowney, 2017). According to Royer et al. (2023), urban agriculture plays a crucial role in both food production and ecological aspects, particularly air and water quality and biodiversity.

RPTRA Duren sawit

RPTRA (Child-Friendly Integrated Public Space) Duren Sawit practiced urban agriculture by using the land to grow medicinal plants, vegetables, ornamental plants, fruit trees, and catfish with pond cultivation techniques. The RPTRA also used hydroponic techniques with polybags and pots, as well as direct ground planting. RPTRA Duren Sawit intentionally planted flora as an effort to reforest and preserve various species. More than 100 fruit trees had been planted here as part of the *Pundi Amal Peduli Kasih Foundation* (YPP)'s Eco Green program. These trees include mango (*Mangifera indica*), rambutan (*Nephelium lappaceum*), starfruit (*Averrhoa carambola*), longan (*Dimocarpus longan*), and water apple (*Syzygium aqueum*). RPTRA Duren Sawit was also one of the areas fostered by the East Jakarta City Agriculture Sub-department (Sudin KPKP) for preserving biological resources, therefore various horticultural were maintained, including catfish pond (aquaculture). In addition to the fruit trees, RPTRA Duren Sawit had multiple ornamental plants, including leafy and flowering plants.

RPTRA in Jakarta is an open space designed as a public facility that includes an artificial ecosystem (DLH, 2019). The RPTRA functions as a safe and friendly recreational space for children, as well as a green open space (RTH) that is necessary for preserving and greening the urban environment, and for enhancing urban aesthetics. According to Widyarini and Heddy (2018), aesthetics can be described as beauty that provides a harmonious relationship among all elements or components, which humans perceive as a result of the harmony among elements, whether they be elements in objects, spaces, or activities. One of the goals of urban agricultural spaces, such as RPTRA, is the implementation of urban agriculture. This goal is included in the RPJMD (Regional Medium-Term Development Plan) for 2022-2027. According to the DGSPE (2018), there were 292 RPTRA in Jakarta, and some of the land was used for urban agriculture.

These results demonstrate that the RPTRA Duren Sawit is a public space intentionally designed to conserve biological resources through the presence of diverse species, thereby preserving species and genetic diversity. The presence of these species and genetic resources is expected to open the ecological food chain and create a microclimate around the RPTRA. This microclimate will positively impact carbon absorption and cooling, increasing the RPTRA ecosystem's potential to adapt to and withstand environmental changes. According to Gunawan and Permana (2018), flowers provide nectar as food for certain birds, while shrubs and shade plants serve as hiding places, food reserves, shade, and nesting and sites for specific species.

RPTRA Ciracas prima

RPTRA Ciracas Prima had the ecological potential to function as a green, open space that supports local biodiversity. Its main potential included the following: (1) providing a habitat for urban flora and fauna such as birds, insects, shrubs, and other plants; (2) functioning as a provider of ecosystem services such as rainwater absorption, regulating the microclimate temperature, and filtering air pollution; (3) preserving local species; and (4) providing environmental education. However, there were risks that needed to be anticipated, such as habitat fragmentation due to development activities, pollution, waste, and the presence of invasive species. The maintenance of vegetation and facilities is also important because it impacts the sustainability of the species.

Like the Duren Sawit RPTRA, the Ciracas Prima RPTRA offered a multi-functional open space. The Ciracas Prima RPTRA practiced urban farming, cultivating plants using various techniques. Hydroponics was used for vegetables, which were planted using PVC pipes as containers. The main crops were bok choy and Chinese cabbage. In addition to hydroponics, conventional cultivation techniques were used, such as direct planting in soil and in pots or polybags.

The cultivated commodities included biopharmaceutical plants such as white turmeric and red ginger; fruit plants such as Jamaican guava, papaya, and banana; vegetable plants such as water spinach, basil, eggplant, okra, luffa, and bitter melon; and ornamental plants such as sunflowers, roses, and pothos. Since 2023, RPTRA Ciracas Prima has offered an educational program for children called "Learning to Plant," held every Sunday. The program's objectives were: (1) developing children's sensory abilities, (2) encouraging children to eat vegetables, (3) fostering responsibility and patience, (4) expanding knowledge, and (5) teaching children the importance of environmental protection.

Condet Balekambang Urban Agriculture

The research was conducted through sampling in the Condet Balekambang area, around the Condet Fruit Reserve Garden (see Figure 1). The respondents were native Betawi residents of Condet, some of whom were currently members of the Condet Balekambang Forest Farmer Group (KTH-Kawasan terbuka hijau). The Condet Balekambang KTH had been conducting agricultural activities involving various types of plants, including fruit, annual, and ornamental. According to BPS (2022), activities in the forestry sub-sector include forestry plant commodities, breeding, wild plant and animal breeding, forest product collection, and hunting. The Condet area was managed under the Kramat Jati subdistrict. Condet had a trademark for its local commodities, such as *duku* Condet (*Lansium domesticum var* Condet) and *salak* Condet (*Salacca edulis cainato var* Condet).

Following the Regulation of the Governor of the Province of Jakarta No.144 (DKI Jakarta Government, 2018) concerning the management of native plants typical of Jakarta, the Jakarta Agricultural Technology Assessment Center (BPTP), in collaboration with the

Jakarta Province Food Security, Maritime Affairs, and Agriculture Agency (DKPKP), has registered local plant varieties typical of Jakarta at the Ministry of Agriculture's Center for Plant Variety Protection and Agricultural Licensing (Bardono, 2018). This registration is a form of protection for local plant genetic resources (SDG). This registration provides legal protection for these biological resources, ensuring their preservation. Condet duku (*Lansium domesticum var* Condet) and Condet snake fruit (*Salacca edulis cainato var* Condet) are local commodities from Jakarta. Furthermore, genetic resource management activities continued in 2020 with the release of Condet duku (*Lansium domesticum var* Condet) for field planting (BPTP, 2020). Genetic resources are essential for increasing food security; therefore, efforts are needed to preserve and maintain this valuable genetic diversity through *ex situ* conservation (seed storage, gene bank storage, botanical gardens, in vitro conservation, DNA storage, and pollen storage) and *in situ* conservation (genetic management on agricultural land, genetic reserves, biodiversity centers, and national parks). The main factors influencing changes in genetic diversity are mutation, selection, genetic drift, and gene flow (Salgotra & Chauhan, 2023). In urban agriculture, the change could be affected by government policy, economic, risk, and public preference (Santosa et al., 2021; Ruwaida et al., 2022a; Ruwaida et al., 2022b).

In addition, the Condet Balekambang area currently cultivated variety of plants to preserve local species, including melinjo (*Gnetum gnemon*), pucung (*Sterculia foetida*), menteng (*Baccuria rasemosa*), gandaria (*Buoea marcophila*), agam (*Ficus septica*), waru (*Hibiscus tiliaceus*), namnam (*Cynometro cauliflora*), water apple (*Syzygium aqueum*), guava (*Psidium guajava var Wijaya Merah*), durian (*Durio zibethinus var Cipaku*), cempedak (*Artocarpus integer*), and rambutan (*Nephellium lappacium*). The Condet fruit reserve's natural state is one of its ecological values that should be maintained. Various types of plants are cultivated based on conservation principles, and great care is taken due to their rarity. This ensures that their original state is highly protected from changes in human behavior (Azriati & Devi, 2018).

Figure 1. The Condet Fruit Reserve, which is located in the Balekambang area of the Kramat Jati district (left), and variety of Condet snake fruit collection (right).

Table 3 describes the conditions and necessary conservation efforts of the three sampling locations in public spaces: RPTRA Duren Sawit in Duren Sawit District, RPTRA Ciracas Prima in Ciracas District, and Condet Balekambang in Kramat Jati District. Plant diversity could significantly enhance cultural services in urban areas. Plants are a key element of rain gardens; however, in selecting suitable plants for urban agriculture, many aspects are considered, including gender preference (Ruwaida et al., 2022b). Plants benefit from the water cycle through transpiration as well as the long-term maintenance of suitable soil structures that increase water infiltration. Plants also remove nitrogen and phosphorus, as well as partially non-biodegradable pollutants such as heavy metals, from stormwater runoff and can contribute to climate change mitigation (Dorr et al., 2021). Thanks to their ornamental features, the plants also enhance the aesthetic value of the landscape (Francini et al., 2022). The other benefits for the economy include local job creation and generating more revenue from the sale of agricultural products (Santosa et al., 2021; Sharma et al., 2023).

Table 3. Efforts to improve the condition and preservation of the Duren Sawit RPTRA, Ciracas Prima RPTRA, and Condet Balekambang.

Types of flora/fauna	Benefits	Threats	Conservation efforts
• Starfruit (*Averrhoa carambola*) • Water apple (*Syzygium aqueum*) • Longan (*Dimocarpus longan*) • Mango (*Mangifera indica*) • Rambutan (*Nephelium lappaceum*) • White turmeric (*Curcuma zedoaria*) • Red ginger (*Zingiber officinale var. rubrum*) • Jamaican guava (*Syzygium malaccense*) • Papaya (*Carica papaya*) • Banana (*Musa* spp.) • Water spinach (*Ipomoea aquatica*) • Basil (*Ocimum basilicum* var. *sanctum*) • Eggplant (*Solanum melongena*) • Okra (*Abelmoschus esculentus*) • Chayote (*Luffa acutangular*) • Bitter Gourd (*Momordica charantia*) • Sunflower (*Helianthus annuus*) • Roses (*Rosa* spp.) • Ivory betel (*Epipremnum aureum*) • Melinjo (*Gnetum gnemon*) • Pucung tree (*Pangium edule*) • Menteng tree (*Baccaria racemosa*) • Gandaria (*Buoea marcophila*) • Agam tree (*Ficus religiosa*) • Hibiscus tree (*Hibiscus tiliaceus*) • Namnam tree (*Cynometro cauliflora*) • Water guava (*Syzygium aqueum*) • Guava (*Psidium guajava*) • Durian (*Durio zibhentinus*) • Cempedak (*Artocarpus integer*) • Rambutan (*Nephellium lappacium*) • Jackfruit (*Artocarpus heterophyllus*) • Ornamental plant	• Produces fruit and plant (Sereenonchai et al., 2022) • Attracts pollinating insects • Rich in antioxidants • Source of vitamins • Habitat for soil microbes • Balances the microclimate and macroclimate (Jayaraman et al., 2021; Grigorieva et al., 2023) • Absorption and reserves of water (Jayaraman et al., 2021) • Urban gardening initiatives could be used to bring health and sustainability goals for cities into practice (healthy soils support healthy crop growth, consuming these crops contributes to citizens' healthy lifestyles) (Schram-Bijkerk et al., 2018; Barbillon et al., 2023) • Stress reduction • Social cohesion and physical activity (Kim & Sim, 2023) • Ornamental plants can be used to recover degraded areas and remove heavy metals (Francini et al., 2022) • Economic advantage (Sharma et al., 2023)	• Loss of species • Pests and plant diseases • Climate (climate change, temperature, and dry seasons) • Pollution (air, water, soil) • Disturbance by humans/ wild animals	• Governance regulating for protecting fauna/flora (Gavrilas et al., 2025) • Urban planning regulations for protected flora and fauna are important (Jap et al., 2021; Steenkamp et al., 2021) • Regular watering, fertilizing, weeding, and pruning • Use organic fertilizers and pesticides according to the recommended dosage • Establishment of conservation zones in RPTRAs and play areas • Use of small fences • Installation of information boards and prohibition signs • Propagating species through research • Regular monitoring by botanists and other experts • Transformative action, such as agrobiodiversity reintroduction by definition, innovation, practice, collective mobilization, and commitment for system change (Rossi, 2020)

Types of flora/fauna	Benefits	Threats	Conservation efforts
Catfish (*Clarias gariepinus*)	• Source of animal protein • Pond wastewater provides nutrients for plants • Economic advantage (Sharma et al., 2023)	• Low water quality • Waste • Predators	• Create water filtration systems • Building safety fences and cover nets • Regular fish releases • Regular monitoring by fisheries experts and veterinarians

CONCLUSIONS

This study identified the role of urban agriculture in mitigating biodiversity risks. However, urban agriculture was not the sole cause of these risks, nor is it the sole solution. Nevertheless, urban agriculture provided a diverse range of flora and fauna that maintain the city's ecological function. Conservation efforts are necessary to maintain the sustainability of Jakarta's remaining local biological resources. Therefore, optimal care is needed to ensure their sustainability within their natural habitats.

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