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Stunting Allevation in Kalibaru Subdistrict, North Jakarta trough the Implementation of Integrated Urban Farming and Rainwater Harvesting System

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Abstract: Stunting remains a serious public health problem in urban areas. A contributing factor to the high prevalence of stunting in the region is the limited availability of clean water and nutrient-rich foods. In addition, this sub-district is at risk of experiencing a clean water crisis in the future. This study aims to analyze the effectiveness of the integration of rainwater harvesting (RWH) and urban farming to overcome stunting, access to clean water, and food supply in Kalibaru District, North Jakarta. The method used is a social experiment through three processes: community education, RWH installation, and urban agricultural system development. For each process, data collection was carried out through field observations and surveys of 39 respondents. Community knowledge was measured before and after the process through questionnaires, and the results of the integration of RWH and urban farming systems were described. The results showed an increase in public knowledge about the benefits of RWH integration and urban farming. RWH has helped alleviate the problem of clean water availability effectively and economically. Meanwhile, urban agriculture has given communities better access to nutrient-rich foods, which in turn can help reduce the problem of stunting.

Keywords: Rainwater harvesting; Stunting; Urban farming

Introduction

Indonesia is ranked fifth in the world with the highest death rate due to consumption of unsafe water (CUMINGS, 1962) and based on the World Resources Institute report, 2015, Indonesia has a high risk (40-80%) of experiencing a clean water crisis in 2040. In inclusive development and implementation of sustainable development goals, the results highlight that social goals related to water access require more attention, especially to the household economy for the sustainability of water services (Kayaga et al., 2018). Economic conditions, especially coastal households, are limited due to limited livelihoods, as a result of low financial capital, low education, and limited skills (Baum et al., 2016). Evaluations of household water supply services in developing countries should take into account the volume each household needs, water quality, accessibility such as distance and time and constraints, and the cost of water services (Markantonis et al., 2018).

This research focuses on the contribution to Sustainable Development Goal (SDG) 6 on "clean water and sanitation for all" in the Kalibaru Subdistrict, North Jakarta. Current rise in population will cause the need for clean water to increase. Furthermore, the escalating number of human activities will also give rise to the potential for water pollution. The clean water crisis occurs in part due to limited water sources. North Jakarta, in particular, is experiencing sea water intrusion and uneven coverage of municipal piped water services. At the Kampung Nelayan (Fishermen's Kampung) of Kalibaru Subdistrict, the water sources available to the

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community include groundwater, municipal piped water, and rainwater (Huwaina et al., 2022).

Limited land is available in Kalibaru Subdistrict due to the dense residential areas. The application of urban farming has considerable benefits in improving access to vegetables, fruits, and protein-rich foods. Other benefits include creating businesses (Aubry et al., 2012; Indraprahasta & Agustina, 2012), encouraging healthy lifestyles (Mourão et al., 2019), increasing social cohesion (Chan et al., 2015; Dimitri et al., 2016; Säumel et al., 2019; Sletto et al., 2019), creating positive urban ecosystems (Post, 2018), and reducing the negative impact of ecological footprints from the food marketing and distribution chain (Helwig et al., 2011; Specht et al., 2014). However, the application of urban farming in Kalibaru Subdistrict must be supported by alternative methods to obtain clean water. Difficulties in accessing clean water remain in the coastal areas of North Jakarta due to the problem of sea water intrusion and the high price of municipal piped water when compared to the population's monthly income (Hargianintya et al., 2020). Current alternative water sources used by residents to meet their daily water needs still do not meet standards for smelling and tasting due to high levels of salinity (Asseggaf et al., 2017; Hargianintya et al., 2020).

The climate conditions of North Jakarta, which has fairly high rainfall levels of 200 mm/month for 8 months/year, support the application of RWH installations as an economical and sustainable alternative to source clean water. Application of urban farming that is integrated with RWH installations can be used to sustainably produce healthy food. The implementation may also be supported by educational activities on health and nutrition. Based on sociocultural mapping done by Habib et al. (2023), there are active community organizations present in Kalibaru Subdistrict that carry out activities such as mutual cooperation to care for and manage the surrounding public spaces. The presence of such communities can encourage and sustain the implementation of RWH and urban farming practices to benefit local residents. This research aims to analyse the effectivity in integrating rainwater harvesting (RWH) and urban farming to alleviate problems of stunting, access to clean water, and provision of nutrient-rich food in Kalibaru Subdistrict, North Jakarta.

Method

This research was carried out within a residential area around the Nur Arrahman Mosque at RW (Rukun Warga, a national categorization for hamlets) 13, Kalibaru Subdistrict, North Jakarta.

Figure 1. Map of research site

The research was preceded by identifying problems based on real conditions around the research location through surveys and direct observation. Problem analysis is then directed to design actions in the form of specifications, researcher involvement, and success indicators. A Focus Group Discussion (FGD) activity is then conducted for residents of RW 13, Kalibaru subdistrict, as part of the implementation of the educational session on RWH and urban farming carried out on 8 and 10 October 2023.

Table 1. Table of FGD Attendance

Position	Number of People
Representative of the mayor of North Jakarta	1
Department of Hygiene and Environment, DKI Jakarta Province	1
DKI Jakarta environmental department	1
Sub-district head of Cilincing	1
Headman of Kalibaru	1
Chairman of RW 13	1
Representative of the Head of RT 3	2
Head of KOCAK (Komunitas Cerdaskan Anak)	1
Community representatives	2

The population in this study involves 7000 residents living in RW 13 of Kalibaru subdistrict, North Jakarta. The research sample was 39 respondents engaged using the accidental sampling technique. The data collected is primary data and a questionnaire was used as the research instrument. The questionnaire was distributed to determine the level of community knowledge regarding the benefits of RWH and urban farming to reduce stunting in the area. During the educational session, participants were divided into two small groups to take part in workshops and education based on their interests. Participants were given questionnaires, namely a pre-test and post-test, to measure their understanding before and after the session.

Table 2. Table of Pre-Test and Post-Test Questionnaire

Questionnaire
Name
Age
Recent education
Work
Average earnings
Status of Residence
Number of Occupants of the house
Clean water sources used daily
Range to be paid to meet water needs
Understanding rainwater harvesting
Understanding the benefits of rainwater harvesting
How rainwater harvesting is applied
Fulfillment of balanced nutrition for daily intake
Understanding stunting
Understanding of edible garden with hydroponics

22 respondents completed the pre-test, and 32 respondents completed the post-test. Out of the total, 14 respondents completed both tests.

Result and Discussion

General Profile of Respondents

Based on the questionnaire data, the various types of work held by respondents include traders, laborers, teachers, pre-school teachers, housewives, entrepreneurs, and metal scavengers. The majority of respondents were housewives (61%), while the least common type of work is metal scavenger (2%). Details of the respondent's types of work can be seen in Figure 2. The majority of respondents have an income in the range of Rp. 500,000 – Rp. 1,000,000 (41%) per month and the least number of respondents have an income of < Rp. 500,000 (28%). Details of the percentage of respondents' income can be seen in Figure 3.

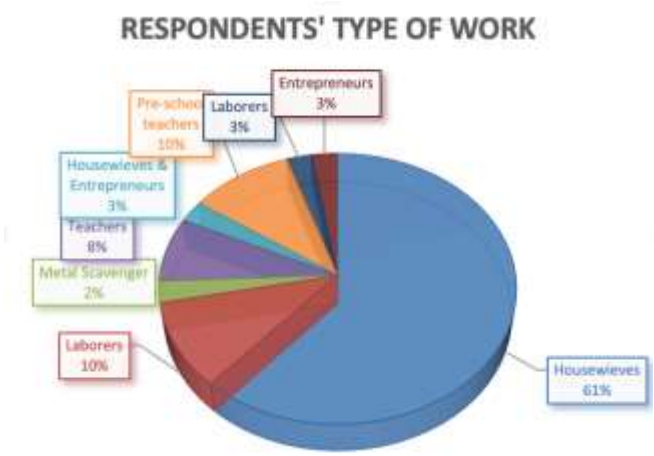

Figure 2. Percentage of Respondents' Type of Work

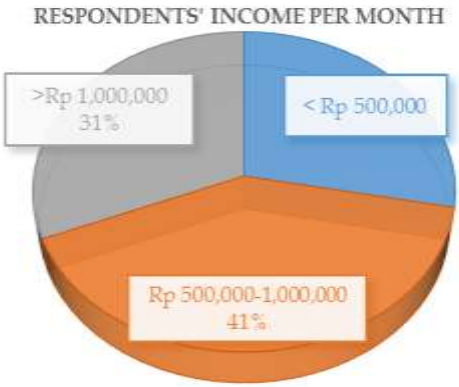

Figure 3. Percentage of respondents' income per month

Public Clean Water Source

The water sources used by the community consist of well water and water supplied by the municipal Drinking Water Company (Perusahaan Air Minum, PAM). Surveys and observations carried out show that 72% of residents generally use clean water sourced from PAM, which is purchased at the available water kiosks. Apart from that, the community also uses clean water sources from wells/groundwater (28%) (Figure 4).

The use of water sourced from PAM is done by purchase from a water kiosk every day and then using it for household purposes. The water kiosk at the research location is filled every day by PAM twice a day (Figure 5). The majority of the costs spent by respondents per month for clean water are between Rp. 100,000 – Rp. 300,000 (50% of respondents) and the least respondents spend more than Rp. 1,000,000 and between Rp. 300,000 – Rp. 500,000 (3.1% each). Details of respondents' expenditure for purchasing clean water from water kiosks can be seen in Figure 6.

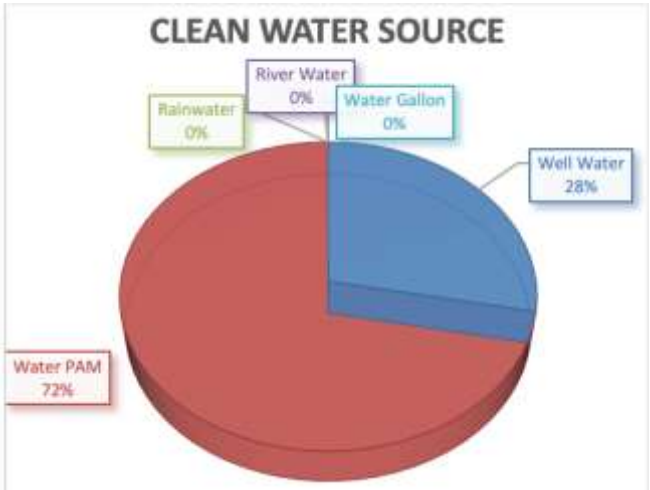

Figure 4. Percentage of Clean Water Source

Figure 5. Community water kiosks as a water source provided by the municipal water company

Figure 6. Respondent's cost of purchasing clean water per month

The community uses PAM water to meet their daily needs; Research by Huwaina et al. (2022) states that the types of activities for using clean water in Kalibaru Subdistrict include bathing and toileting, drinking and cooking, washing clothes, cleaning the house, cleaning of tools and materials such as fishing equipment, ablution, washing vehicles, and watering plants. The high use of PAM water in the research area is due to the high pressure on groundwater conditions which makes it difficult to use groundwater. This pressure is caused by the high use of land for residential and industrial purposes, as well as the threat of sea water intrusion. This water scarcity is the main driving factor for the importance of implementing RWH installation at the research location.

Stunting Within the Community

The problem of stunting is still prevalent and experienced by children in the research area. Based on the questionnaire results, the number of respondents who have children with stunting is 19%, which can be seen in Figure 7.

Stunting may be caused by multiple factors, one of which is the dietary habits and availability of clean water. Dietary habits that may affect stunting include the nutritious food consumed by pregnant women and toddlers to meet balanced nutritional needs (Rosha et al., 2020; Ruswati et al., 2021). In addition, stunting has an impact on children's cognitive, motor, and verbal development to be not optimal. In the future, stunted children have a higher risk of obesity and other diseases. In addition, children's learning capacity and performance as well as productivity and work capacity are also not optimal. The adverse effects of stunting also affect reproductive health (Pitoyo et al., 2022). They begin their lives under disadvantaged conditions, such as facing learning difficulties in school, earning low as adults, and facing barriers to participation in society (United Nations-World Health Organization, 2019). The adverse effects of stunting can last a lifetime, even affecting the next generation. Hence, the problem of stunting in the research location may be partly caused by the limited access to healthy food, especially vegetables, due to limited land in a densely populated location and the scarcity of clean water. Based on the results of the questionnaire, there are still residents who only sometimes and even rarely (28% respectively) have balanced nutrition in their everyday diet. The percentage can be seen in Figure 8. This is supported by the fact that there are still many respondents who rarely consume vegetables every day (41%) which can be seen in Figure 9.

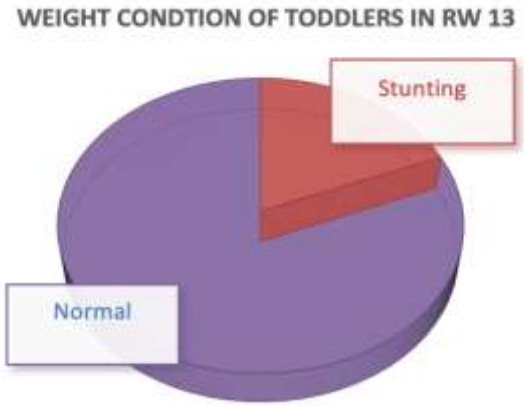

Figure 7. Weight condition of toddlers in RW 13

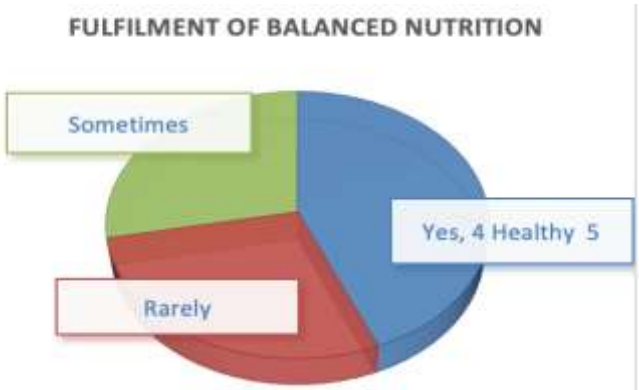

Figure 8. Percentage of fulfilment of balanced nutrition

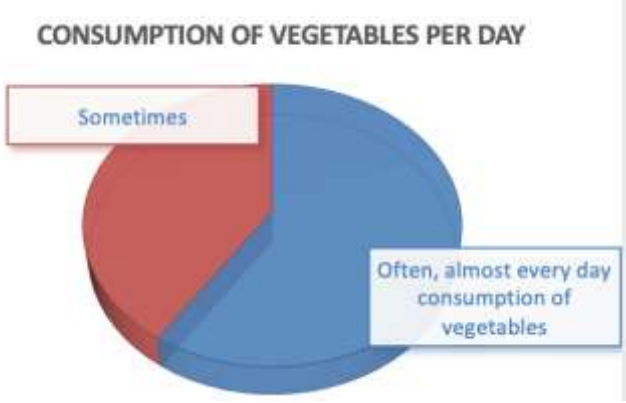

Figure 9. Percentage of consumption of vegetables per day

Integration of RWH Installation and Urban Farming

Rainwater harvesting is an alternative to meet the need for clean water in coastal settlements at the research location. The RWH installation is designed to capture rainwater on a surface and channel it to then be stored and used for various purposes. RWH can be used to save groundwater and as an alternative domestic water source (Susilo & Prayogo, 2019). There are two main types in rainwater harvesting systems: total flow systems and diverter systems. Total flow system or first filter system, which is rainwater harvesting that captures roof runoff and directly stores it in a holding tank. Water is filtered to remove particles before being put into the tank and excess water will flow into the drainage system if there is excess water. This system is effective in storing and storing large amounts of water. Rainwater harvesting with a diverter system takes place by separating part of the runoff water from the roof into the drainage system and the other part into the tank. This system is effective to apply to locations that experience frequent heavy rainfall (Sardjito et al., 2018).

Basically, PAH is the activity of collecting rainwater and storing it in reservoirs with the aim of utilizing the water for various purposes, such as maintaining groundwater preservation (infiltration wells) and as an alternative source of clean water (water reservoirs) (Susilo, 2018). Domestic RWH refers to rainwater used for domestic purposes, watering gardens, and small-scale farming in each of the 43 households. RWH is used to collect and store rainwater from rooftops during rains and is stored for use as a substitute for tap water for non-potable or potable applications. Rainwater harvesting can be an alternative applied in cities to deal with expensive water and energy supply problems. RWH practices are able to increase the efficiency of annual water saving. Research conducted in various cities in Brazil shows that the potential efficiency of PAH's annual water savings has increased from 12% to 79%. In Jordan, RWH can save about 14.5 million m3 of water per year for households and in China, water savings from PAH use show efficiencies of 2% to 20% in arid regions (Meshram et al., 2021).

The installation of RWH at the research location is integrated with urban farming to address food limitations to fulfil balanced nutrition. Determining the location for the RWH and urban farming is carried out based on considerations such as sufficient land area for the installation, an area that can be used as a water catchment, and the location functioning as a public space for optimal use, ease of maintenance, and monitoring by the community residents (Huwaina et al., 2022). Habib et al. (2023) elaborated the central role of community organizations in Kalibaru Subdistrict, such as the Karang Taruna youth and PKK women's organization in collaboration with the Subdistrict Office, to foster the community wellbeing and mediate support from external entities (private foundations, CSR, political parties, educational institutions) to tackle economic, social, and environmental problems in the area.

Study by Habib et al. (2023) on cultural spaces in Kalibaru Subdistrict has also accounted for a number of mosques and prayer rooms that function as core cultural spaces for various social and religious activities including public educational lectures and mutual cooperation to clean and care for public premises. In particular, the Nur Arrahman Mosque at RW 13 has such an active and longstanding organization headed by its local leaders. The location for the RWH installation and urban farming was decided at RW 13, precisely in the courtyard of the Nur Arrahman Mosque, so that it can be utilized optimally by the community. The rainwater storage capacity is 650 l consisting of 3 tanks in a parallel system. The urban farming installation consists of two self-watering hydroponic units. The installations at the research location can be seen in Figure 10.

Figure 10. Integration of RWH and urban farming

The implementation of RWH and urban farming at the research location includes an educational session (Figure 11), practical workshop (Figure 12), and Focus Group Discussion (FGD) with stakeholders (Figure 13) on RWH as an alternative clean water source and urban farming to supplement the food supply for overcoming the problem of stunting. The activities were carried out to also increase public acceptance of the built

installations in the research area. Target participants include community members around the installation location, local government, and pre-school teachers. The number of participants who attended ranged from 30 – 40 participants for each activity.

Figure 11. Educational session on clean water and fulfilment of balanced nutrition

Figure 12. Implementation of RWH and urban farming workshops

Figure 13. Implementation of the focus group discussion (FGD)

Assessment of community acceptance and perception was carried out through administering the pre-test and post-test questionnaires, before and after the educational session and workshops. Based on the results of the questionnaire, there has been an increase in public knowledge regarding rainwater as an alternative clean water source and urban farming (Figure 14 and Figure 15).

Figure 14. Pre-test and post-test percentage of community knowledge regarding RWH

Figure 15. Pre-test and post-test percentage of community knowledge regarding urban farming

Discussion

Compared with similar research conducted in the nearby region of North Jakarta, this research differs in the type of work of its direct beneficiaries. In the research of (Hargianintya, 2019; Huwaina et al., 2022) the majority of beneficiaries from the RWH installation are fishermen. As such, there will be differences in the amount of water needed and consumption habits regarding clean water. The greatest need for clean water in this study is for household needs. Even though the amount of clean water required is smaller when compared to previous research, alternative sourcing of clean water such as from rainwater is still needed as there is no access municipal piped water at the research location.

The installation location in this research is a public facility, namely a mosque, which still uses groundwater as a water source for the ablution activities. The condition of the water that the authors observed directly was its color and taste. The groundwater is brownish in color and salty to taste, as the location of the mosque is very close to the sea. There is a limited quantity of municipal water that local residents can use every day through water kiosks that are filled by water trucks. With all these limitations, clean water still remain as a main daily need for residents and can indirectly reduce the prevalence of stunting through the habit of washing hands (Kwami et al., 2019).

The choice of urban farming method using a hydroponic system was due to the hot environmental conditions and limited land. The choice of water source as irrigation for this system needs to be considered, as using saline groundwater will affect the fresh weight of

food crops (Subadi & Buchori, 2013). As such, the water source for the hydroponic irrigation is taken from the RWH installation that is also integrated with the hydroponic system itself. The types of food plants that were choose are plants with a short growing season, such as mustard greens, bok choy, and lettuce. The crops planted are not diverse because low food diversity is not significantly related to stunting (Gassara et al., 2023).

Community acceptance of the RWH installation and urban farming is very good, seen from the enthusiasm of the community when the educational session and practical workshop were carried out. Placing the installation in a mosque was deliberate to avoid private ownership of the installation and increase the function of the place of worship as a cultural space in RW 13, which had already exhibited strong community cohesion (Habib et al., 2023). The management of urban farming is carried out by community representatives who are also administrators of the Nur Arrahman Mosque. As such, the distribution of urban farming harvests may be prioritized for families in need, especially to families at risk of stunting.

Conclusion

The research identified a critical problem faced by the residents in Kalibaru Subdistrict, North Jakarta, specifically stunting as a serious problem that can affect children's growth and development. The problem of stunting is closely related to the availability of clean water and access to nutrient-rich food. Through the integration of rainwater harvesting installation and urban farming, the research proposed a solution to alleviate the problem of stunting at the research location. The implementation of RWH will be able to provide an economical and sustainable source of clean water, reduce pressure on groundwater usage, and provide better access to clean water for the community. Urban farming will encourage local potential for increased access to nutritious and healthy food. The research results show an increase in local community and residents' knowledge regarding RWH and urban farming after going through a series of educational sessions, practical workshops, and a focus group discussion. This is a positive step towards better utilization of RWH and urban farming systems. However, this research recognizes that challenges exist and further improvements are needed to implement the systems more broadly and effectively. Cooperation between government, community organizations, and local residents is needed to ensure the sustainability of this project and maximize its benefits. The conclusion of this research is that the integration of RWH and urban farming has great potential in overcoming the stunting problem in Kalibaru Subdistrict, North Jakarta. Continued efforts and support from various parties are needed to make this solution a success and have a positive impact on the welfare of the people in the area.

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Author Contributions

Conceptualization, Hayati Sari; methodology, Risma Anisa; software, Analissa Huwaina; validation, Ahyahudin Sodri and Sri Setiawati; formal analysis, investigation, data curation; Nur Khafifah and Annisa Fitri; data curation, Nur Khafifah; writing—original draft preparation, Annisa Fitri; writing—review and editing, Hayati Sari, Ahyahudin Sodri and Sri Setiawati; visualization, Muhammad Hasnan.; supervision, Hayati Sari, Ahyahudin Sodri and Sri Setiawati; project administration, Analissa Huwaina and Risma Anisa.

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Conflicts of Interest

The authors declare no potential conflicts of interest.(Mulyani & Idawati, 2007)

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