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# Water Demand Estimation Until 2045 in the New Capital City of Indonesia", Kutai Kartanegara Regency

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**ABSTRACT**

The National Capital (IKN) in East Kalimantan is a planned governmental center to achieve the "Golden Indonesia" vision by 2045. Kutai Kartanegara Regency serves as a partner to IKN, with parts of its territory designated as IKN development areas, including the sub-districts of Loa Janan, Loa Kulu, Sanga Sanga, Muara Jawa, West Samboja, and Samboja. This partnership impacts various needs in the area, including the demand for clean water. This study aims to estimate the clean water demand in these six sub-districts up to 2045. The analysis of clean water needs was conducted based on population projections using arithmetic, geometric, and least square methods. Water demand calculations were performed for average daily flow (Qrh), maximum daily flow (Qhm), and peak hourly flow (Qjp), with Qjp serving as the reference for meeting clean water needs. The findings indicate that water demand increases in line with population projections and is influenced by territorial changes and the area's development as part of IKN. In Loa Janan, Loa Kulu, and Sanga Sanga, where parts of the territory will become part of IKN, the water demand managed by the Kutai Kartanegara Regency Government is projected to decrease by 2045, from 400.7 L/s, 330.6 L/s, and 98.9 L/s to 106 L/s, 288.4 L/s, and 98.5 L/s, respectively. In contrast, the 2045 water demand for Muara Jawa, West Samboja, and Samboja is projected at 266.2 L/s, 175 L/s, and 222.9 L/s, respectively. The water demand in these three sub-districts must be met by the IKN authority as their entire areas fall within the IKN development region. A comprehensive analysis of water resources and the development of water supply infrastructure is needed to support clean water demands in the study area.

**Keywords:** Estimation, Water demand, IKN partner areas, Population projection

## INTRODUCTION

The National Capital is a planned area designated as the center of government (Mazda, 2022). The relocation of the National Capital (IKN) Nusantara to East Kalimantan is one of the government's strategies to achieve Indonesia's primary economic goals. By 2045, this initiative is expected to foster more inclusive and equitable economic growth through accelerated development in eastern Indonesia. The IKN area spans two regencies: Penajam Paser Utara Regency and Kutai Kartanegara Regency. The development of IKN is projected to impact East Kalimantan Province, not only within the IKN area itself but also in surrounding regions, referred to as buffer or partner areas of IKN. Various sectors, such as education, industry, tourism, and services, are expected to develop as part of this initiative (Sumendar & Yasin, 2023). Based on Law No. 3 of 2022 on the National Capital and Presidential Decree No. 63 of 2022 on the Master Plan Details for the National Capital, Kutai Kartanegara Regency has been designated as one of the supporting or partner regions for IKN (Anonymous, 2022).

The IKN area directly borders several sub-districts within Kutai Kartanegara Regency. To the north and west lies Loa Kulu Sub-District, while the northern boundary also includes Loa Janan and Sanga-Sanga Sub-Districts (Anonymous, 2022). The development of IKN and its partner areas will result in changes to various needs, including the demand for clean water. These changes are a consequence of population growth and the emergence of new economic activities. The area's development, the improvement of the community's socio-economic conditions, the enhancement of living standards, and population growth are all factors contributing to the increased demand for clean water (Hajia et al., 2015; Simatupang & Harahap, 2022).

Clean water is defined as water that meets the quality standards required for daily needs (Afriyanda et al., 2019). The demand for clean water refers to the estimated quantity of water used to meet daily living requirements as well as supplementary needs, such as industrial and public facilities. Water demand depends on population size and activity levels. As the population and activity within an area grow, so does the demand for water. Water needs can be categorized into domestic and non-domestic demands. Domestic water demand includes household needs such as drinking, cooking, sanitation, religious activities, and watering plants (Noperissa & Waspodo, 2018).

The volume of domestic water demand is determined by population size and per capita water consumption. The per capita water consumption rate varies based on the classification of the area (Brahmanja et al., 2013). Kutai Kartanegara Regency has a total population of 738,189 (Central Statistics Agency, 2023), categorizing it as a large city with a clean water demand rate of 170 L/person/day (Masduqi & Assomadi, 2019). As a support area for IKN, Kutai Kartanegara Regency needs to conduct studies to estimate clean water demand, as its fulfillment plays a strategic role in supporting life and facilitating development (Afriyanda et al., 2019). This study aims to determine the projected clean water demand up to 2045 in the partner areas of IKN located within Kutai Kartanegara Regency, specifically in the sub-districts of Loa Janan, Loa Kulu, Sanga-Sanga, Muara Jawa, West Samboja, and Samboja.

## RESEARCH METHODS

This study utilizes secondary data on population figures from the past ten years (2013–2022) in the IKN partner areas, which include the sub-districts of Loa Janan, Loa Kulu, Sanga-Sanga, Muara Jawa, West Samboja, and Samboja. The data were obtained from the Central Statistics Agency (BPS) in each sub-district.

### Population Projection Method

The analysis of water demand begins with population projections, as the population size is directly proportional to water demand in the study area. Population projections were conducted up to the year 2045 using population data from the last ten years (2013–2022). Three projection methods were utilized: arithmetic, geometric, and least square methods. The most suitable method for each sub-district was determined based on an analysis of correlation values and standard deviation for each method. The method yielding a correlation value closest to 1 or the smallest standard deviation was selected for projecting the population up to 2045 (Siswanto et al., 2022; Suhendra, 2023).

### Arithmetic Method

The arithmetic method assumes a constant population increase over time. This method is suitable for regions with relatively low and stable population growth rates. The projection calculations for this method are based on Equation:

$$P_n = P_O + (r \ x \ n) \quad (1)$$

$P_n$ =Projected population in the target year (persons)
$P_o$ =Initial population (persons)
r =Increase in population (persons)
n =Projection period (years)

### Geometric Method

The geometric method assumes that population growth in a region follows a geometric pattern and does not account for any decline in population growth rate. This method is suitable for regions with high population growth rates that align with a geometric function. The projection calculations are based on Equation 2:

$$P_n = P_O \ x \ (1 + r)^n \quad (2)$$

$P_n$ =Projected population in the target year (persons)
$P_o$ =Initial population (persons)
r =Population growth rate (decimal form)
n =Projection period (years)

### Least Square Method

The least square method is a regression technique used to establish the relationship between population size (YYY) and time or year (XXX). The projection calculation uses Equation 3, where the coefficients aaa and bbb can be determined using Equations 4 and 5 or derived from the linear equation that connects the variables XXX and YYY.

$$y = ax + b \quad (3)$$

$$a = \frac{(\sum Y . \sum X^2) - (\sum X . \sum XY)}{n \sum X^2 - (\sum X)^2} \quad (4)$$

$$b = \frac{n . \sum XY - (\sum X . \sum Y)}{n \sum X^2 - (\sum X)^2} \quad (5)$$

$X$ = Year
$Y$ = Population size (persons)
n = Number of data points

(Chandra Astiti, 2023; Hartati et al., 2016; Siswanto et al., 2022; Suhendra, 2023; Suheri et al., 2019; Yanti & Dewanti, 2022)

### Clean Water Demand Calculation

The population projection results are utilized to analyze water demand, which is categorized into domestic and non-domestic needs. Domestic water demand encompasses household needs such as drinking, cooking, washing, and sanitation. It is calculated based on the population size using Equation 6 (Joshua et al., 2023). The per capita domestic water demand ranges between 100–190 L/person/day, depending on the classification of the study area (Masduqi & Assomadi, 2019).

$$Q_{domestic}(L/day) = population \ x \ water \ demand \ (L/person.day) \quad (6)$$

Non-domestic water demand refers to water used for facilities such as educational institutions, commercial areas, markets, parks, and others. This demand depends on the number of such facilities in the study area. Alternatively, it can be estimated as 15–30% of the total domestic water demand within the study area (Masduqi & Assomadi, 2019).

The total water demand in a region is the sum of domestic and non-domestic water demands, accounting for water losses. Water loss refers to the discrepancy between processed water flow, distributed water flow, and measured customer flow. This can result from factors such as maintenance of processing units, measurement inaccuracies, leaks in the distribution system, water theft, and usage for firefighting (M & Mariappan V.E, 2011). Water losses are estimated at 20–30% of the total domestic and non-domestic water demand (Masduqi & Assomadi, 2019). The total water demand is calculated using Equation 7 (Tambalean et al., 2018):

$$Total\ Water\ Demand = (Q_{domestic} + Q_{non\ domestic}) + [(\%\ Water\ Loss) x\ (Q_{domestic} + Q_{non\ domestic})] \quad \text{.............(7)}$$

Water demand or flow (Q) fluctuates (Hasbiah & Kurniasih, 2019) and can be expressed as:

a. The average daily flow rate (Qrh) represents the average volume of water demand per day over the course of one year (M & Mariappan V.E, 2011). Qrh is equivalent to the total water demand, which is calculated using Equation 7. This value serves as a baseline for estimating water requirements across various periods and scenarios.
b. The maximum daily flow rate (Qhm) refers to the highest volume of water demand recorded within a single day, expressed in liters per day (L/day). This parameter is critical for ensuring that water supply systems, treatment facilities, and transmission infrastructure can handle peak daily demands (M & Mariappan V.E, 2011). Qhm is calculated using Equation 8 (Tambalean et al., 2018), where the maximum daily factor (fhm) typically ranges between 1.15 and 1.2 (Masduqi & Assomadi, 2019).

$$Q_{hm} = f_{hm} x\ Q_{rh} \quad \text{.......(8)}$$

c. The peak hourly flow rate (Qjp) represents the largest volume of water demand required within a single hour. This parameter is essential to ensure that the water distribution system can adequately meet sudden surges in water demand (M & Mariappan V.E, 2011). Qjp is calculated using Equation 9 (Tambalean et al., 2018), where the peak hour factor (fjp) typically falls within the range of 1.65 to 2.0 (Masduqi & Assomadi, 2019).

$$Q_{jp} = f_{jp} x\ Q_{rh} \quad \text{.......(9)}$$

In this study, $Q_{rh}$, $Q_{hm}$, dan $Q_{jp}$ are calculated, with $Q_{jp}$ serving as the reference for fulfilling water demand in each sub-district of the study area. The clean water demand for sub-districts that will become part of the IKN development area is calculated under two conditions: with and without IKN development.

## RESULTS AND DISCUSSION

The analysis involves calculating population projections, which serve as the basis for estimating clean water demand up to 2045 in six sub-districts of the study area: Loa Janan, Loa Kulu, Sangasanga, Samboja, Samboja Barat, and Muara Jawa.

### Population Projections

The population is a critical variable in determining clean water demand. An increase in population corresponds to a higher water demand in a region. Population growth rates align with trends in increased water requirements (Afrianto, 2015). Population projections can be calculated using arithmetic, geometric, and least square methods (Dairi, 2018; Suheri et al., 2019). These projections estimate future population sizes based on trends from previous years and are influenced by factors such as births, deaths, and migration (Mantra, 2000). The choice of projection method depends on the demographic characteristics of the study area, with a minimum of five years of time-series data required (Afriyanda et al., 2019). The selected projection method is determined through correlation analysis, where a correlation coefficient closer to 1 indicates the preferred method (Rohmaningsih et al., 2017; Suheri et al., 2019; Susilah, 2013). Another analysis involves calculating the standard deviation for each method, with the method yielding the smallest standard deviation being selected (Afriyanda et al., 2019; Sukmara et al., 2020).The results of correlation and standard deviation analyses for each method in the sub-districts of the study area are presented in Table 1.

**Table 1**

Results of Correlation and Standard Deviation Calculations for Population Projection Methods

| No | Sub-District | Correlation | | | Standard Deviation | | |
|---|---|---|---|---|---|---|---|
| | | Arithmetic | Geometric | Least Square | Arithmetic | Geometric | Least Square |
| 1 | Loa Janan | 0,74 | 0,89 | 0,90 | 510,58 | 484,16 | 320,26 |
| 2 | Loa Kulu | 0,82 | 0,89 | 0,91 | 878,91 | 805,35 | 394,56 |
| 3 | Sanga-Sanga | -0,16 | 0,89 | 0,89 | 1227,94 | 1097,97 | 620,29 |
| 4 | Muara Jawa | 0,004 | 0,89 | 0,91 | 2264,32 | 2078 | 1158,54 |
| 5 | Samboja | 0,28 | 0,89 | 0,91 | 1640,57 | 1633,5 | 823,79 |

The correlation and standard deviation analyses in Table 1 are based on ten years of population data for each method. The correlation and standard deviation calculations for Samboja Barat and Samboja are conducted using overall data from Samboja, as the ten-year time series data available has not yet been administratively separated. Across all sub-districts in the study area, the correlation analysis shows that the least square method has the value closest to 1.

In Sanga-Sanga, the correlation value for the arithmetic method is negative due to a population decline between 2020 and 2021, and the geometric method's correlation is equal to that of the least square method. The standard deviation analysis also supports the least square method, as it consistently has the smallest values compared to the arithmetic and geometric methods in all sub-districts. Based on the correlation and standard deviation analyses, the least square method is chosen as the projection method because it has a value closest to 1 and/or the lowest standard deviation.

The least square method is applied across all areas of the study as the population projection method. The population estimates for the six sub-districts in the study area—Loa Janan, Loa Kulu, Sanga-Sanga, Muara Jawa, Samboja Barat, and Samboja—using the least square method up to the year 2045 are presented in Table 2.

**Table 2**
Projected Population for the Years 2023-2045 in the Study Area

| Year | Population (people) | | | | | |
|---|---|---|---|---|---|---|
| | Loa Janan | Loa Kulu | Sanga-sanga | Muara Jawa | Samboja Barat | Samboja |
| 2023 | 69.301 | 52.263 | 21.601 | 45.937 | 31.617 | 39.270 |
| 2024 | 70.138 | 53.277 | 21.764 | 46.661 | 32.117 | 39.891 |
| 2025 | 70.974 | 54.291 | 21.927 | 47.385 | 32.617 | 40.512 |
| 2026 | 71.811 | 55.305 | 22.090 | 48.109 | 33.117 | 41.133 |
| 2027 | 72.648 | 56.319 | 22.253 | 48.833 | 33.617 | 41.754 |
| 2028 | 73.485 | 57.333 | 22.416 | 49.557 | 34.117 | 42.375 |
| 2029 | 74.322 | 58.347 | 22.578 | 50.281 | 34.617 | 42.996 |
| 2030 | 75.158 | 59.361 | 22.741 | 51.005 | 35.117 | 43.617 |
| 2031 | 75.995 | 60.375 | 22.904 | 51.729 | 35.617 | 44.238 |
| 2032 | 76.832 | 61.389 | 23.067 | 52.453 | 36.117 | 44.859 |
| 2033 | 77.669 | 62.403 | 23.230 | 53.177 | 36.617 | 45.480 |
| 2034 | 78.506 | 63.417 | 23.393 | 53.901 | 37.117 | 46.101 |
| 2035 | 79.342 | 64.431 | 23.556 | 54.625 | 37.617 | 46.722 |
| 2036 | 80.179 | 65.445 | 23.718 | 55.349 | 38.117 | 47.343 |
| 2037 | 81.016 | 66.459 | 23.881 | 56.074 | 38.617 | 47.964 |
| 2038 | 81.853 | 67.473 | 24.044 | 56.798 | 39.117 | 48.585 |
| 2039 | 82.690 | 68.487 | 24.207 | 57.522 | 39.617 | 49.206 |
| 2040 | 83.526 | 69.501 | 24.370 | 58.246 | 40.117 | 49.827 |
| 2041 | 84.363 | 70.515 | 24.533 | 58.970 | 40.617 | 50.448 |
| 2042 | 85.200 | 71.529 | 24.696 | 59.694 | 41.117 | 51.069 |
| 2043 | 86.037 | 72.543 | 24.858 | 60.418 | 41.617 | 51.690 |
| 2044 | 86.874 | 73.557 | 25.021 | 61.142 | 42.117 | 52.311 |
| 2045 | 87.710 | 74.571 | 25.184 | 61.866 | 42.617 | 52.932 |

## Water Demand Estimation

The projected population serves as the basis for estimating total water demand, including both domestic and non-domestic needs. From the population projection results in Table 2, it is evident that the population size for the years 2023–2045 across all sub-districts in the study area falls within the small city category. Consequently, the water demand projections are calculated by multiplying the projected population by the per capita water consumption for a small city, set at 130 L/person/day for domestic needs. Non-domestic water demand is assumed to range between 15–30% of domestic water demand. The criteria used for calculating clean water demand are presented in Table 3. Based on the projected population and selected calculation criteria, the results for the estimated water demand projections for each sub-district are provided in Tables 4–9.

**Table 3**
Criteria for Calculating Water Demand Projections

| Criteria | Criteria Used |
|---|---|
| Category of city | Small city, 20.000 - 100.000 residents |
| Percentage of service | 100% |
| Residents per SR | 5 |
| Domestic water demand | 130 L/person.day |
| Non-domestic water demand | 20% of domestic water demand |
| Water leak | 30% of total water demand |
| Fhm | 1,15-1,2; selected based on population |
| Fjp | 1,65-2; selected based on population |

**Table 4**
Water Demand Estimation for Loa Janan Sub-District

| Criteria (unit) | 2023 | 2025 | 2026 | 2026 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|
| Population (people) | 69301 | 70974 | 71811 | 75158 | 79342 | 83526 | 87710 |
| Domestic water demand | | | | | | | |
| a. Number of SR (unit) | 13861 | 14195 | 14363 | 15032 | 15869 | 16706 | 17543 |
| b. Domestic water demand (L/s) | 104.3 | 106.8 | 108.0 | 113.1 | 119.4 | 125.7 | 132.0 |
| Non-domestic water demand (L/s) | 20.9 | 21.4 | 21.6 | 22.6 | 23.9 | 25.1 | 26.4 |
| Total water demand (L/s) | 125.1 | 128.1 | 129.7 | 135.7 | 143.3 | 150.8 | 158.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Water leak (L/s) | 37.5 | 38.4 | 38.9 | 40.7 | 43.0 | 45.2 | 47.5 |
| Qrh (L/s) | 162.7 | 166.6 | 168.6 | 176.4 | 186.2 | 196.1 | 205.9 |
| Qhm (L/s) | 192.1 | 196.9 | 199.3 | 209.0 | 221.1 | 233.2 | 245.5 |
| Qjp (L/s) | 303.5 | 312.0 | 316.3 | 333.7 | 355.6 | 378.0 | 400.7 |

**Table 5**
Water Demand Estimation for Loa Kulu Sub-District

| No. | Criteria (unit) | 2023 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|---|
| 1 | Population (people) | 52263 | 54291 | 55305 | 59361 | 64431 | 69501 | 74571 |
| 2 | Domestic water demand | | | | | | | |
| | a. Number of SR (unit) | 10453 | 10859 | 11061 | 11873 | 12887 | 13901 | 14915 |
| | b. Domestic water demand (L/s) | 78.6 | 81.7 | 83.2 | 89.3 | 96.9 | 104.6 | 112.2 |
| 3 | Non-domestic water demand (L/s) | 15.7 | 16.3 | 16.6 | 17.9 | 19.4 | 20.9 | 22.4 |
| 4 | Total water demand (L/s) | 94.4 | 98.0 | 99.9 | 107.2 | 116.3 | 125.5 | 134.6 |
| 5 | Water leak (L/s) | 28.3 | 29.4 | 30.0 | 32.2 | 34.9 | 37.6 | 40.4 |
| 6 | Qrh (L/s) | 122.7 | 127.4 | 129.8 | 139.3 | 151.2 | 163.1 | 175.0 |
| 7 | Qhm (L/s) | 143.5 | 149.3 | 152.1 | 163.7 | 178.1 | 192.7 | 207.3 |
| 8 | Qjp (L/s) | 219.7 | 229.4 | 234.2 | 253.9 | 278.9 | 304.5 | 330.6 |

**Table 6**
Water Demand Estimation for Sanga Sanga Sub-District

| No. | Criteria (unit) | 2023 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|---|
| 1 | Population (people) | 21601 | 21927 | 22090 | 22741 | 23556 | 24370 | 25184 |
| 2 | Domestic water demand | | | | | | | |
| | a. Number of SR (unit) | 4321 | 4386 | 4419 | 4549 | 4712 | 4874 | 5037 |
| | b. Domestic water demand (L/s) | 32.5 | 33.0 | 33.2 | 34.2 | 35.4 | 36.7 | 37.9 |
| 3 | Non-domestic water demand (L/s) | 6.5 | 6.6 | 6.6 | 6.8 | 7.1 | 7.3 | 7.6 |
| 4 | Total water demand (L/s) | 39.0 | 39.6 | 39.9 | 41.1 | 42.5 | 44.0 | 45.5 |
| 5 | Water leak (L/s) | 11.7 | 11.9 | 12.0 | 12.3 | 12.8 | 13.2 | 13.6 |
| 6 | Qrh (L/s) | 50.7 | 51.5 | 51.8 | 53.4 | 55.3 | 57.2 | 59.1 |
| 7 | Qhm (L/s) | 58.4 | 59.2 | 59.7 | 61.5 | 63.7 | 65.9 | 68.2 |
| 8 | Qjp (L/s) | 84.0 | 85.4 | 86.0 | 88.7 | 92.1 | 95.5 | 98.9 |

**Table 7**
Water Demand Estimation for Muara Jawa Sub-District

| No. | Criteria (unit) | 2023 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|---|
| 1 | Population (people) | 45937 | 47385 | 48109 | 51005 | 54625 | 58246 | 61866 |
| 2 | Domestic water demand | | | | | | | |
| | a. Number of SR (unit) | 9188 | 9478 | 9622 | 10202 | 10926 | 11649 | 12373 |
| | b. Domestic water demand (L/s) | 69.1 | 71.3 | 72.4 | 76.7 | 82.2 | 87.6 | 93.1 |
| 3 | Non-domestic water demand (L/s) | 13.8 | 14.3 | 14.5 | 15.3 | 16.4 | 17.5 | 18.6 |
| 4 | Total water demand (L/s) | 82.9 | 85.6 | 86.9 | 92.1 | 98.6 | 105.2 | 111.7 |
| 5 | Water leak (L/s) | 24.9 | 25.7 | 26.1 | 27.6 | 29.6 | 31.5 | 33.5 |
| 6 | Qrh (L/s) | 107.8 | 111.2 | 112.9 | 119.7 | 128.2 | 136.7 | 145.2 |
| 7 | Qhm (L/s) | 125.7 | 129.8 | 132.1 | 140.0 | 150.2 | 160.5 | 170.8 |
| 8 | Qjp (L/s) | 190.1 | 196.8 | 199.9 | 213.8 | 231.0 | 248.5 | 266.2 |

**Table 8**
Water Demand Estimation for Samboja Barat Sub-District

| No. | Criteria (unit) | 2023 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|---|
| 1 | Population (people) | 31617 | 32617 | 33117 | 35117 | 37617 | 40117 | 42617 |
| 2 | Domestic water demand | | | | | | | |
| | a. Number of SR (unit) | 6324 | 6524 | 6623 | 7024 | 7524 | 8023 | 8523 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | b. Domestic water demand (L/s) | 47.6 | 49.1 | 49.8 | 52.8 | 56.6 | 60.4 | 64.1 |
| 3 | Non-domestic water demand (L/s) | 9.5 | 9.8 | 10.0 | 10.6 | 11.3 | 12.1 | 12.8 |
| 4 | Total water demand (L/s) | 57.1 | 58.9 | 59.8 | 63.4 | 67.9 | 72.4 | 76.9 |
| 5 | Water leak (L/s) | 17.1 | 17.7 | 17.9 | 19.0 | 20.4 | 21.7 | 23.1 |
| 6 | Qrh (L/s) | 74.2 | 76.6 | 77.7 | 82.4 | 88.3 | 94.2 | 100.0 |
| 7 | Qhm (L/s) | 85.9 | 88.6 | 90.2 | 95.6 | 102.5 | 109.5 | 117.1 |
| 8 | Qjp (L/s) | 126.2 | 130.5 | 132.9 | 141.5 | 152.5 | 163.7 | 175.0 |

**Table 9**
Water Demand Estimation for Samboja Sub-District

| No. | Criteria (unit) | 2023 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
|---|---|---|---|---|---|---|---|---|
| 1 | Population (people) | 39270 | 40512 | 41133 | 43617 | 46722 | 49827 | 52932 |
| 2 | Domestic water demand | | | | | | | |
| | a. Number of SR (unit) | 7855 | 8103 | 8227 | 8724 | 9345 | 9965 | 10586 |
| | b. Domestic water demand (L/s) | 59.1 | 61.0 | 61.9 | 65.6 | 70.3 | 75.0 | 79.6 |
| 3 | Non-domestic water demand (L/s) | 11.8 | 12.2 | 12.4 | 13.1 | 14.1 | 15.0 | 15.9 |
| 4 | Total water demand (L/s) | 70.9 | 73.1 | 74.3 | 78.8 | 84.4 | 90.0 | 95.6 |
| 5 | Water leak (L/s) | 21.3 | 21.9 | 22.3 | 23.6 | 25.3 | 27.0 | 28.7 |
| 6 | Qrh (L/s) | 92.2 | 95.1 | 96.5 | 102.4 | 109.7 | 117.0 | 124.2 |
| 7 | Qhm (L/s) | 107.1 | 110.6 | 112.0 | 119.2 | 127.9 | 136.7 | 145.4 |
| 8 | Qjp (L/s) | 159.9 | 165.4 | 168.0 | 179.5 | 193.8 | 208.2 | 222.9 |

The calculations for the clean water demand in the study area show a direct correlation with the increasing population (Figure 4). As the population grows, so does the demand for water in the region. This confirms that population size is a critical factor influencing water needs in a given area (Simatupang & Harahap, 2022). The highest water demand is observed in **Loa Janan Sub-District**, as it has the largest population compared to other sub-districts.

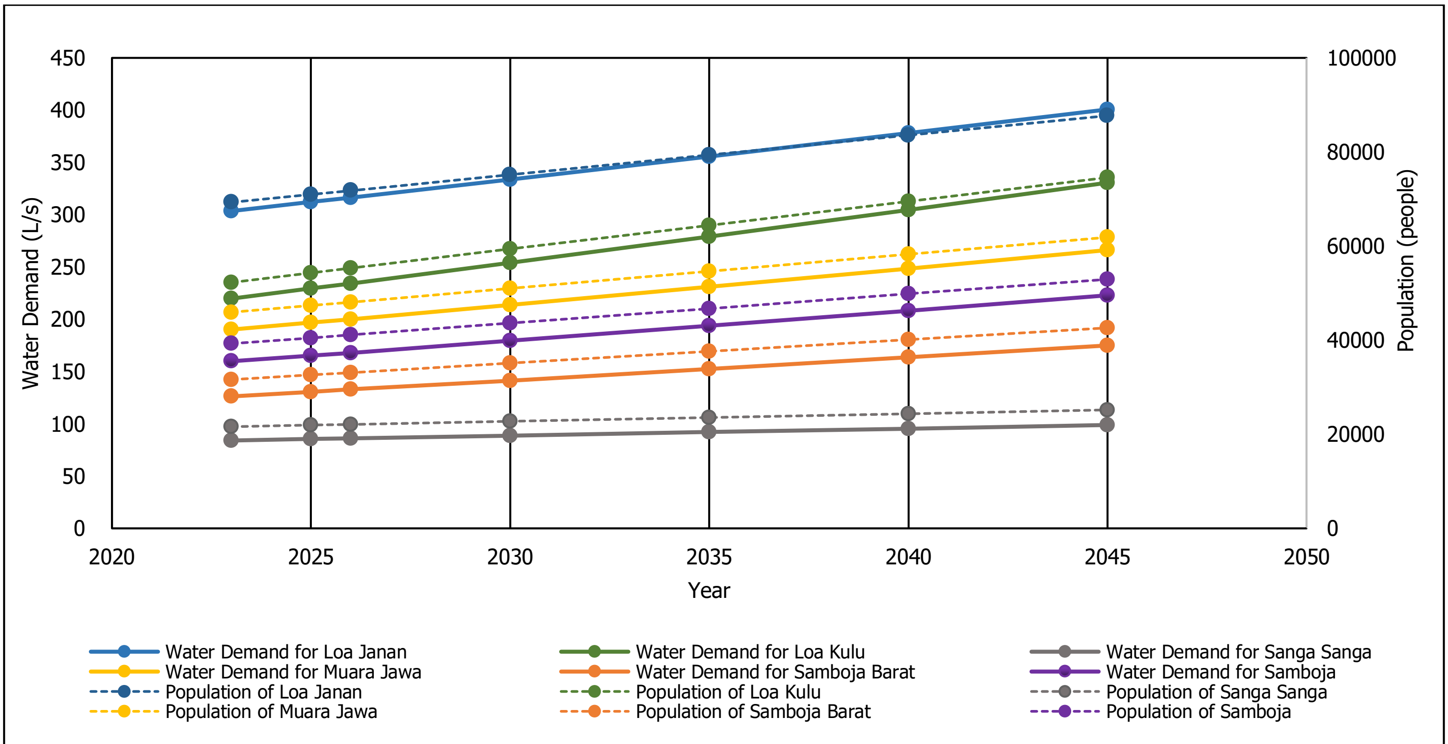

**Figure 4.** Water Demand Estimation and its Relation to Population Projection in the Study Area

Meicahayanti, I., Nurdiana, J., Rahayu, D. E., & Rahmawati, A. (2025). Water Demand Estimation Until 2045 in the New Capital City of Indonesia", Kutai Kartanegara Regency. *Gema Lingkungan Kesehatan*, *23*(1), 111–120. https://doi.org/10.36568/gelinkes.v23i1.156

**Comparison of Water Demand Estimates in Relation to Kutai Kartanegara's Transition to the National Capital Region**

The study area, comprising six sub-districts in Kutai Kartanegara Regency (Kukar)—Loa Janan, Loa Kulu, Sanga-Sanga, Muara Jawa, Samboja Barat, and Samboja—is designated as a development zone for the National Capital Region (IKN). The development of this region is scheduled to take place in 2026. The transition of Kutai Kartanegara into IKN will significantly affect the clean water demand estimates until 2045. As a result, water demand estimates were calculated under two conditions: one without the integration of Kutai Kartanegara into IKN, and another with the integration of Kukar into IKN. Sub-districts like Loa Janan, Loa Kulu, and Sanga-Sanga will see partial integration into IKN, while Muara Jawa, Samboja Barat, and Samboja will be fully integrated into IKN. The administrative changes will occur in 2026. These changes will serve as a foundation for meeting water demands, with responsibilities being divided between Kutai Kartanegara Regency and the IKN Authority. The differences in water demand estimates, both with and without these administrative changes, are illustrated in Figures 5 and 6. Figure 5 shows water demand estimates under the current administrative structure, while Figure 6 illustrates the estimates once the region is integrated into IKN. The transition will result in a decrease in the estimated clean water demand that remains the responsibility of the Kutai Kartanegara government (as shown in Figure 6).

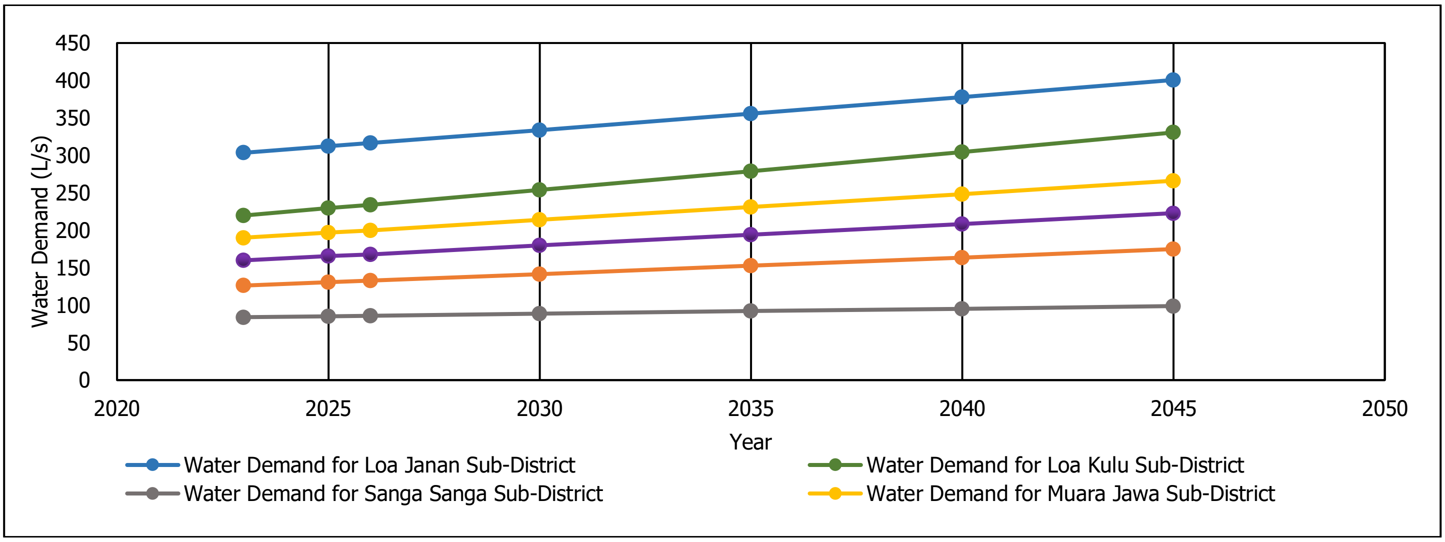


**Figure 5.** Water Demand Estimation for the Study Area Without Changes in Area

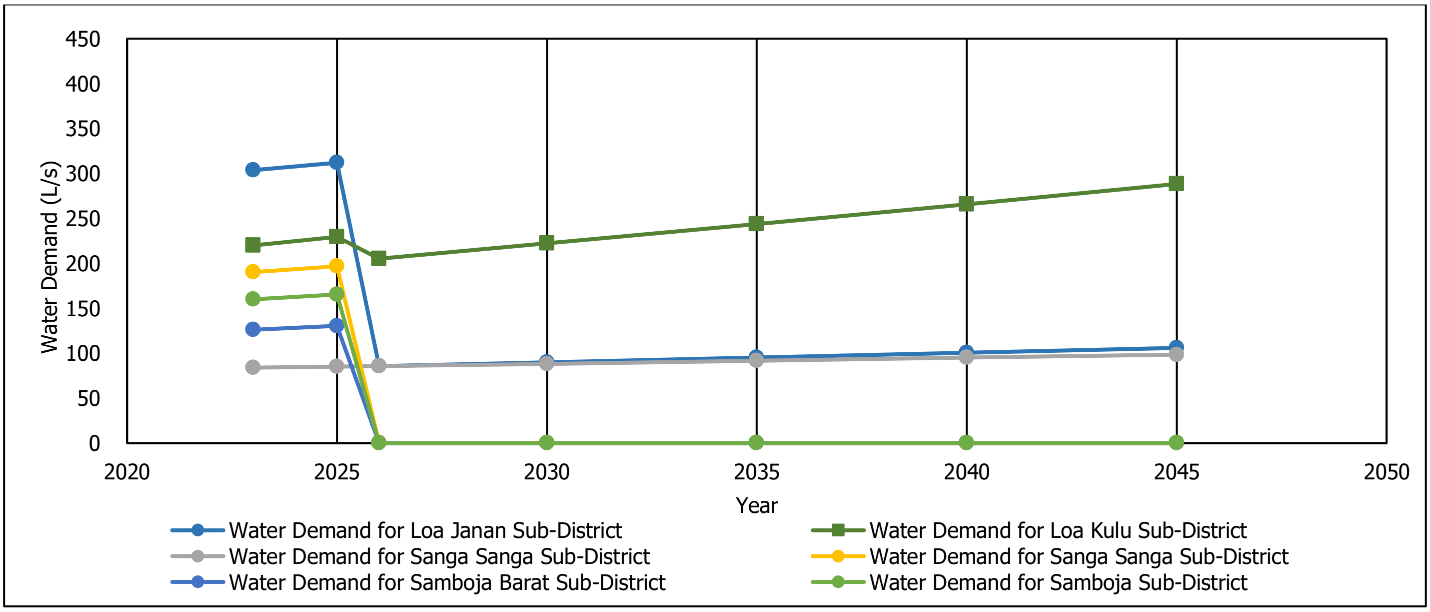


**Figure 6.** Water Demand Estimation for the Study Area with the Change of Kutai Kartanegara Regency to the National Capital City Area

The difference in water demand between the two conditions is clearly visible in Figures 5 and 6. In Loa Janan Sub-district, for example, the peak hourly flow in 2045 is projected to be 400.7 L/s under the condition without the transition to IKN, and 106 L/s when the IKN transition is taken into account. The significant difference between these two conditions is due to the large areas that will be incorporated into the IKN zone, including the sub-villages of Bakungan, Batuah, Loa Duri Ilir, Loa Duri Ulu, and Tani Harapan. These areas, which will be managed by the IKN Authority starting in 2026, will shift the responsibility for water management away from the Kutai Kartanegara Regency.

In contrast, the water demand in Loa Kulu Sub-district shows a smaller difference between the two conditions, as only two villages—Sungai Payan and Janggon Desa—will be included in the IKN zone. The peak hourly flow for the condition without IKN transition is 330.6 L/s, while the peak flow for the condition with IKN transition is 288.4 L/s.

Sanga-Sanga Sub-district also has part of its area, specifically 91.96 hectares in the Jawa Sub-village, integrated into the IKN development. However, this is a small area, which results in a negligible change in water demand. In the condition without the IKN transition, the peak hourly flow in 2045 is 98.9 L/s, whereas, in the condition with the transition, it is 98.5 L/s. This small difference is consistent with the limited land area being incorporated into the IKN development.

For Muara Jawa, Samboja, and Samboja Barat Sub-districts, which will be entirely included in the IKN zone, the water demand responsibility for Kutai Kartanegara Regency will be 0 L/s from 2026 onwards. This is because the water supply for these areas will be managed by the IKN Authority after 2026. The estimated clean water demand calculations, with and without the changes to the Kutai Kartanegara Regency, can be used to analyze the infrastructure management for clean water provision (see Table 10 and Figure 7).

**Table 10**
Water Demand Estimation for the Study Area Based on the Change of Kutai Kartanegara Regency to the National Capital City Area

| Sub-District | Government for Water Supply Infrastructure Management | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kutai Kartanegara (L/s) | | | | | | Otorita IKN (L/s) | | | | | |
| | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 | 2025 | 2026 | 2030 | 2035 | 2040 | 2045 |
| Loa Janan | 312.0 | 85.7 | 89.9 | 95.2 | 100.6 | 106.0 | 0.0 | 230.6 | 243.7 | 260.4 | 277.4 | 294.7 |
| Loa Kulu | 229.4 | 205.2 | 222.2 | 243.9 | 265.9 | 288.4 | 0.0 | 29.0 | 31.7 | 35.1 | 38.6 | 42.2 |
| Sanga Sanga | 85.4 | 85.7 | 88.3 | 91.7 | 95.1 | 98.5 | 0.0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Muara Jawa | 196.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 199.9 | 213.8 | 231.0 | 248.5 | 266.2 |
| Samboja Barat | 130.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 132.9 | 141.5 | 152.5 | 163.7 | 175.0 |
| Samboja | 165.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 168.0 | 179.5 | 193.8 | 208.2 | 222.9 |
| Total (LPS) | 1119.6 | 376.6 | 400.5 | 430.8 | 461.6 | 492.8 | 0.0 | 760.8 | 810.5 | 873.1 | 936.7 | 1001.4 |

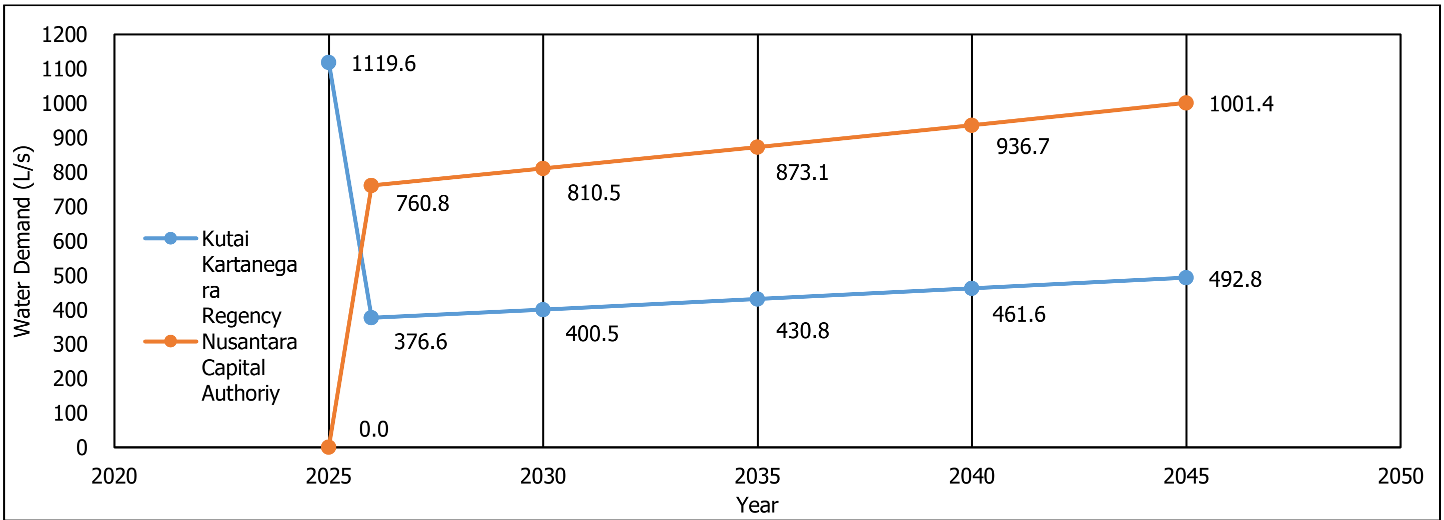

**Figure 7.** Infrastructure Management for Fulfilling Clean Water Needs in the Study Area

In Table 10 and Figure 7, it is shown that in 2026, the demand for clean water in Kutai Kartanegara Regency will decrease as part of the areas in Loa Janan, Loa Kulu, Sanga Sanga, and the entire districts of Muara Jawa, Samboja Barat, and Samboja will be incorporated into the IKN zone. This will result in a higher clean water demand managed by the IKN Authority to meet the needs of the areas transitioning into the IKN region. The clean water needs managed by the IKN Authority will exceed those of Kutai Kartanegara Regency starting in 2026. However, despite the shift in responsibility, the trend of increasing water demand will continue for both the Kutai Kartanegara Regency and the IKN Authority from 2026 to 2045, reflecting the growing population and infrastructure needs.

## CONCLUSION

The study highlights the increasing demand for water in line with the projected population growth in the partner areas of the IKN (National Capital Region) in Kutai Kartanegara Regency, which includes the sub-districts of Loa Janan, Loa Kulu, Sanga Sanga, Muara Jawa, Samboja Barat, and Samboja. The changes in these areas, with the inclusion into the IKN zone, will affect the water demand. Loa Janan, Loa Kulu, and Sanga Sanga, which will have only part of their area incorporated into the IKN zone by 2026, will experience a decrease in water demand by 2045, with the respective demands under two scenarios as follows: 400.7 L/s, 330.6 L/s, and 98.9 L/s for the scenario without IKN changes, compared to 106 L/s, 288.4 L/s, and 98.5 L/s with IKN changes. In contrast, the water demand in Muara Jawa, Samboja Barat, and Samboja, which will have their entire area become part of the IKN zone, will see a full transition. In 2045, their water demand will be 266.2 L/s, 175 L/s, and 222.9 L/s, respectively. These are the peak demands that must be managed by the IKN Authority starting in 2026. The results of this study provide important insights for analyzing water supply requirements for both Kutai Kartanegara Regency and the IKN Authority, given the changes in administrative boundaries.

## RECOMMENDATION

The estimation of clean water demand could be further developed by incorporating updated population data after the administrative transition of Kutai Kartanegara Regency into the IKN zone in 2026. This study serves as a foundation for determining water supply needs and can be used to assess water availability in the study areas in terms of quantity, quality, and continuity. It can also serve as a reference for the planning of clean water infrastructure development, both for the Kutai Kartanegara Regency Government and the IKN Authority.

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