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Population Projection And Water Demand Forecasting In Nong District, Savannakhet Province, Lao PDR

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ABSTRACT

Water is an essential factor and pay a vital important role for the livelihood of the human, since, increasing of the people, it causes on high water demand either urban or sub-urban city, the objective of the study is to project the population and also forecast the water demand within Nong district, by employing the statical analysis and technical method to predict the water demand, therefore, the research found that with the 1.7% of population growth rate, in 2019, 2024, 2029, 2034 and 2039, average water demand is 279 m3/d, 324 m3/d, 360 m3/d, 399m3/d and 434m3/d and maximum water demand is 388 m3/d, 433 m3/d, 479 m3/d and 521m3/d, respectively.

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INTRODUCTION

Increasing of the population is directly affected on water demand, many cities are facing with water shortage for consumption and using in daily life due to water demand is higher than water supply (George et al., 2004; Phoummixay and Tabios, 2020), water supply is an essential of the livelihood, therefore, In Lao PDR, water supply is estimated and covered at 52 and 72 percent that covers in rural and urban areas, respectively (Lahiri and Chanthaphone, 2003), although urban water demand is definitely expected to increase at 80% by 2050, it is challenging to develop new water resources to support users(Chandaeng et al., 2024; Siharath et al., 2024). And water loss, which is often recognized and reported as non-revenue water (NRW), is high in many cities (Haque et al., 2018; Jun et al., 2021), currently, there are many cities and communities in Lao PDR have problem on water distribution less than demand (McCartney and Brunner, 2021; Sithiengtham, 2019).

METHODS

The study area.

The case study locates in Nong district, Savannakhet Province as indicated in Figure1, it is far from the urban city approximately 250 km (Adhikari et al., 2017; Pongvongsa et al., 2016; Siharath, Vilaychaleun, et al., 2023), water supply system was constructed in 2005, there were 400 households, was installed the water meters unit during that time the population in

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Nong had only 1751 people and the city do not have any infrastructures event the electricity and other accommodation(Siharath, Xayyamunh, et al., 2023; Xaiveeheuang et al., 2023), in the present, the city has developed and population are increased to 2687 people, the town has surrounding by hotels, guesthouses, also the infrastructures have improved but water supply system was not improved since construction completed (Tiwari and Adamowski, 2013), therefore the water supply in the city has facing with distribution less than water demand and it is necessary to find solution for now and future in the water supply system (Shah et al., 2018).

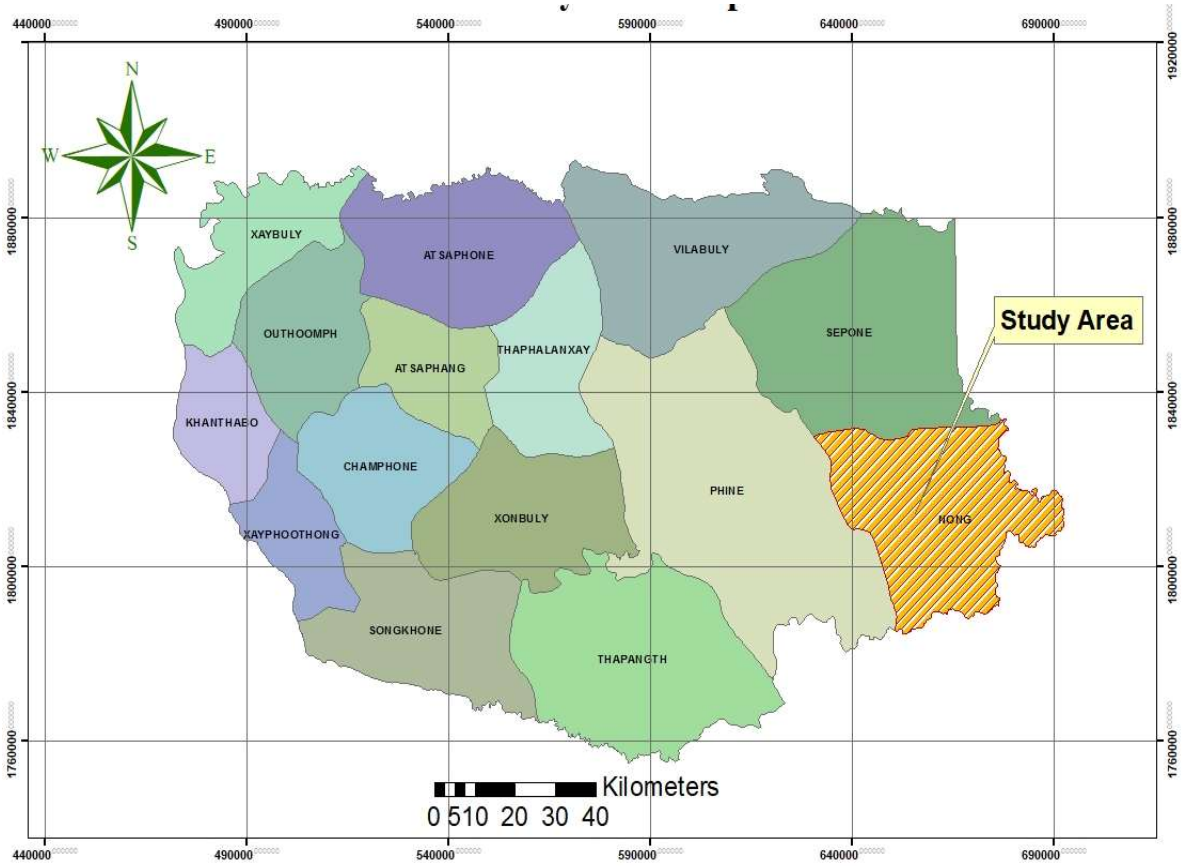

Figure 1: the study area

Formulas and Equations

The study was employed the Taro Yamane Formula(Yamane, 1973) (Chaokromthong and Sintao, 2021) to identify the sample size of the households and also number of population in order to project the population (George et al., 2004) employed formula(a), in addition, water demand was calculated to predict the future need as indicated in the formulas (b, c) (Wu et al., 2017).

Taro Yamane Formula

$$n = \frac{N}{1+N(e^2)} \quad \text{.....(a)}$$

Where

n: Sample size

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N: Population
error (0.05) reliability level 95%
e= level of precision always set the value of 0.05

Population forecasting

$$P_n=P_0(1+r)^n \quad \text{.....(b)}$$

Where
Po: the population in the launch year,
Pn: the population in the target year
r: the average geometric rate of change
n: the number of years in the projection horizon

Maximum water demand

Qmax= Qaverage x Peak factor.....(c)

Where
Q max: Maximum water demand
Q average: Average water demand
Peak factor: maximum water demand in a year

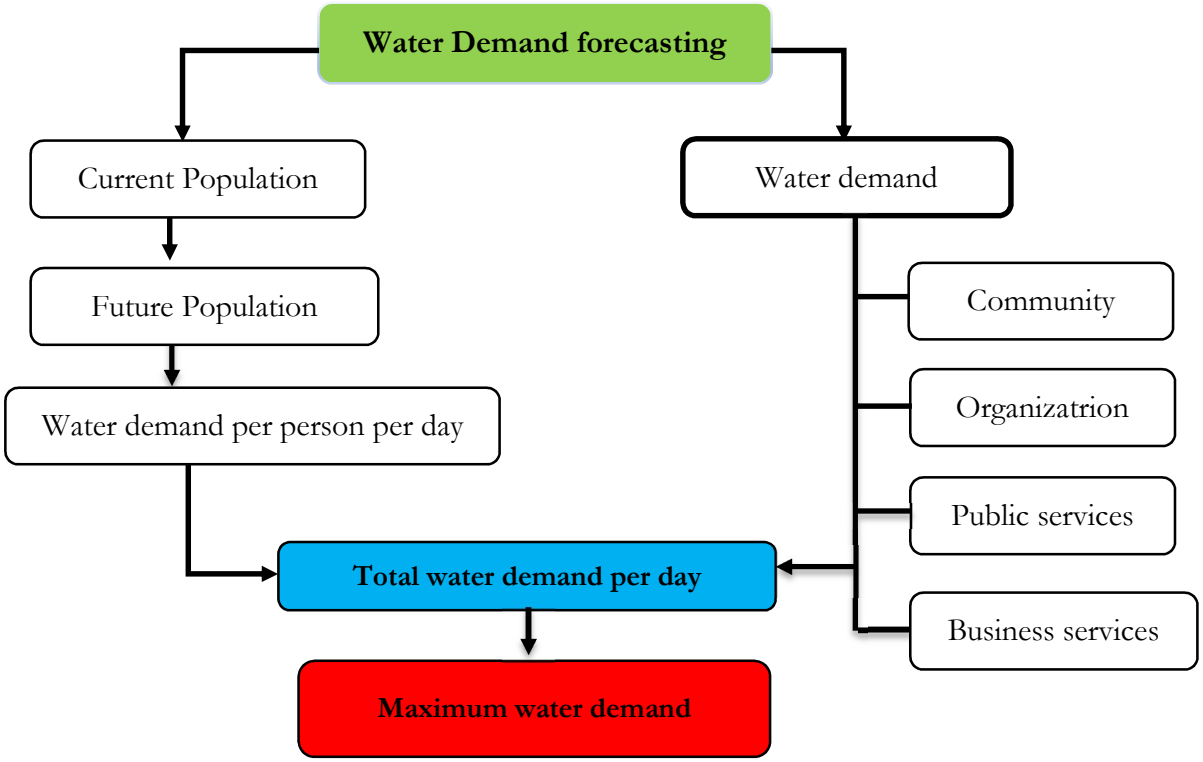

Figure 2. Water demand diagram

RESULTS AND DISCUSSION

Water demand is categorized into three types such as: households, public services (schools and hospitals) and business services (restaurants, guesthouses, hotels, markets), it is as below: The study was determined the water usage rate is 80 L/d/p and population increasing rate is 1.7. Hence. Figure3 indicates that water demand in several sectors are as below:

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a. Households: 2019 (198 m^3/d), 2024 (18.42 m^3/d), 2029 (21.4 m^3/d), 2034 (24.38 m^3/d), 2039 (26.36 m^3/d).
b. Public services: 2019 (15.54 m^3/d), 2024 (21.5 m^3/d), 2029 (23.4 m^3/d), 2034 (25.4 m^3/d), 2039 (27.7 m^3/d) and
c. Business services: 2019 (29.7 m^3/d), 2024 (36.52 m^3/d), 2029 (45.14 m^3/d), 2034 (53.76 m^3/d), 2039 (58.38 m^3/d).

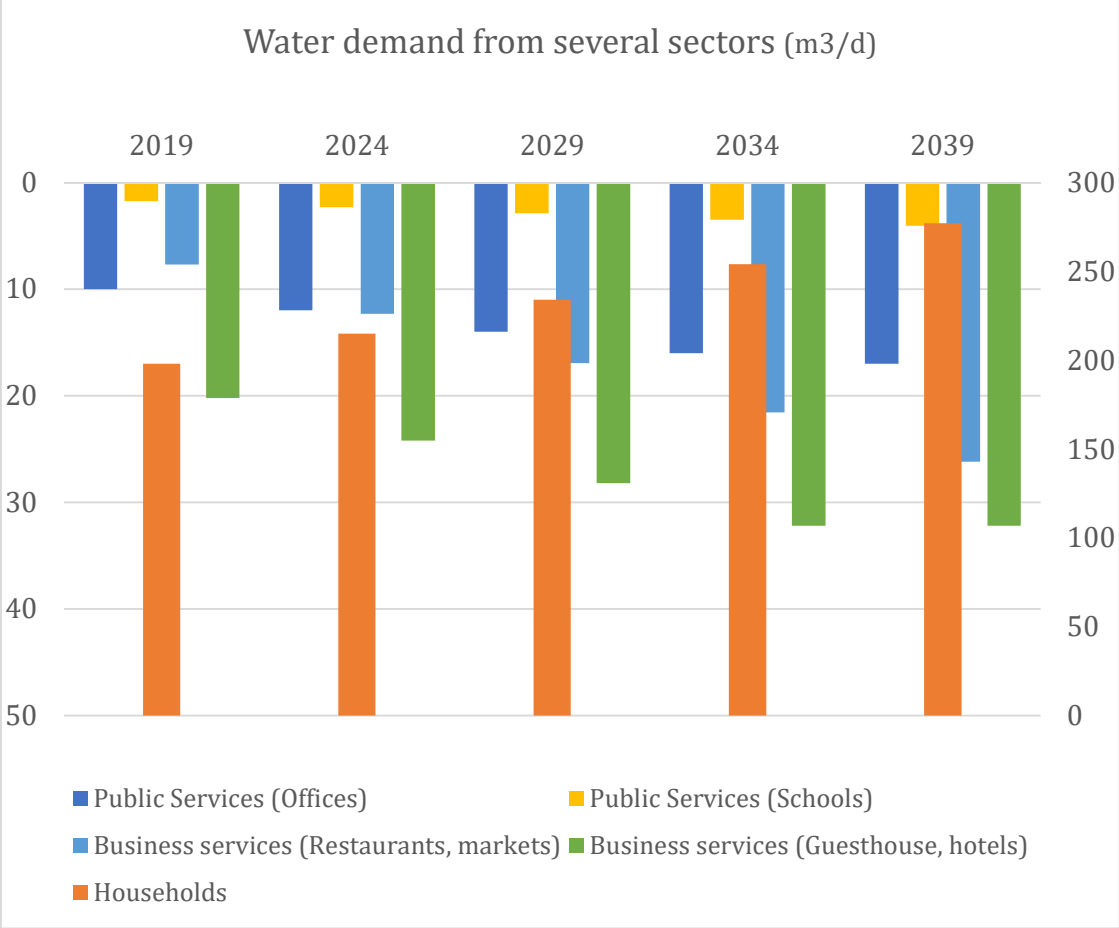

Figure 3.Water demand from several sectors

In principle, based on the technical guidelines of the water supply department, water loss will be in arrange 10-25 %, an average water demand was calculated and estimated that as indicated in Figure4, the average water demand is continuously increasing in 2019 (279 m^3/d), 2024 (324 m^3/d), 2029 (360 m^3/d), 2034 (399 m^3/d) and 2039 (434 m^3/d), currently, water supply could be distributed to people at 137 m^3/d, hence, 2019 (49.1 %), 2024 (42.28 %), 2029 (38.05 %), 2034 (34.33%) and 2039 (31.56), it means that average water demand is still high requirement in order to support the need of local people. On the other hands, the water loss in 2019 (38 m^3/d), 2024 (54 m^3/d), 2029 (60 m^3/d), 2034 (67 m^3/d) and 2039 (72 m^3/d).

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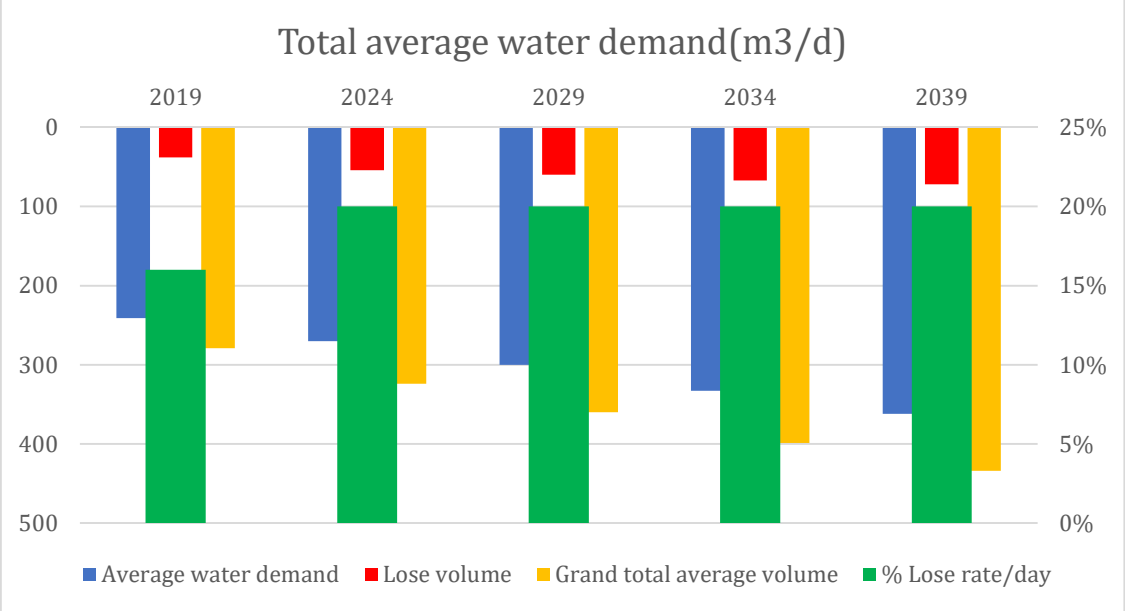

Figure 4.Total average water demand

Based on data set of the population number, it is increasing in 2019 (2,470 persons), 2024 (2,687 persons), 2029 (2,924 persons), 2034 (3,181persons), 2039 (3,460 persons). Therefore in order to do estimation on maximum water demand, the study was employed the peak factor is 1.2, then the maximum water demand was calculated and projection, therefore. Figure 5 depicts that in 2019 (335 m^3/d), 2024 (388 m^3/d), 2029 (433 m^3/d), 2034 (479 m^3/d) and 2039 (521 m^3/d), it elaborated that the maximum water demand in 2019 (40.89%), 2024(38.03 %), 2029 (31.64 %), 2034 (28.61 %) and 2039 (26.27 %).

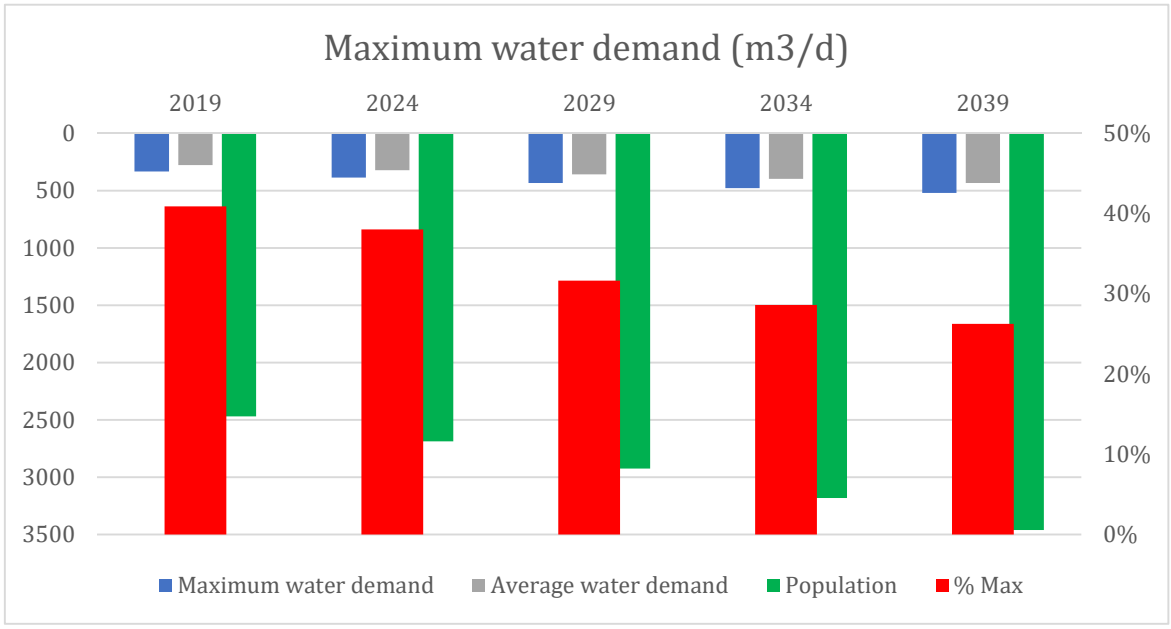

Figure 5. maximum water demand

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CONCLUSION

In conclusion, based on the study found that water demand is high expectation from local community when comparing between water supply and water demand from 2019-2039, therefore, for short-term and long term sustainable water demand on the study area, increasing the water supply from 137 m^3/d to 521 m^3/d is needed, due to the insufficient water demand, it would also need more water distribution network to provide water to local community and water resources (Xelanong river) is a high potential water resource that could be an alternative for resource, on the other hand, water storage tank needs to be upgraded from 46 m^3 to 156 m^3.

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