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Bogor Indonesia
Department of Resources and Environmental Economics

ECONOMIC VALUATION OF WATER PROVISIONING SERVICES IN THE RECHARGE AREA OF CIBURIAL SPRING, BOGOR REGENCY, INDONESIA

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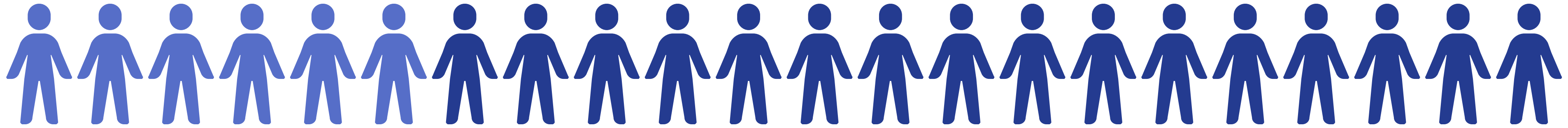
OUTLINES

1. INTRODUCTION
2. METHODOLOGY
3. RESULT AND DISCUSSION
4. CONCLUSION

INTRODUCTION (1)



6.14 billion → 7.95 billion

Global population (27%)

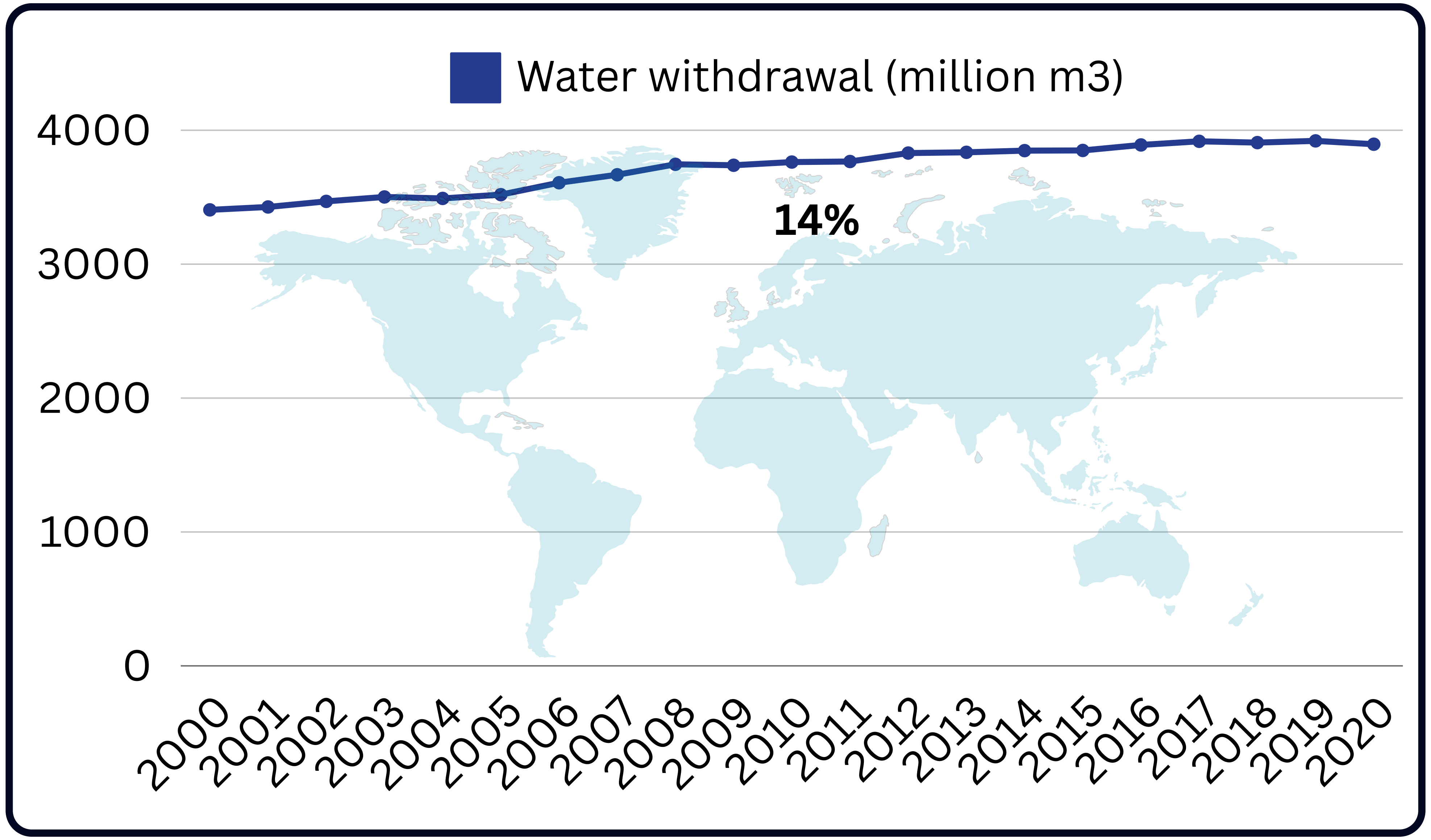
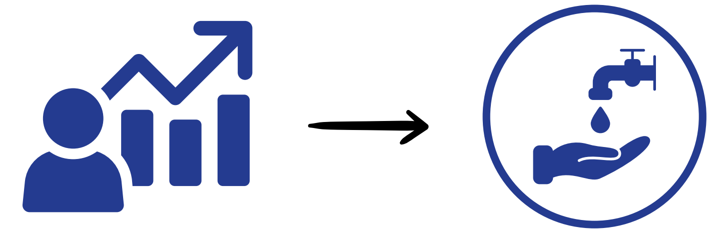
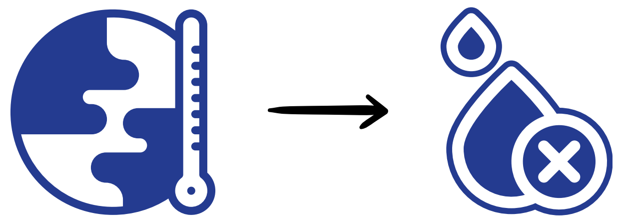


Figure 1. World population and water withdrawal 2000 - 2020

Source: World Bank (2023)



Growing population → increases food and infrastructure needs → changes in land use → affecting water **quantity** and **quality** (Jha, 2020).



Climate change reducing soil moisture, river flow, and **groundwater recharge** through phenomena like **rainfall deficits**, **impacting water resources** (UN-Water, 2020).

INTRODUCTION (2)

CIBURIAL SPRING

INTRODUCTION (2)

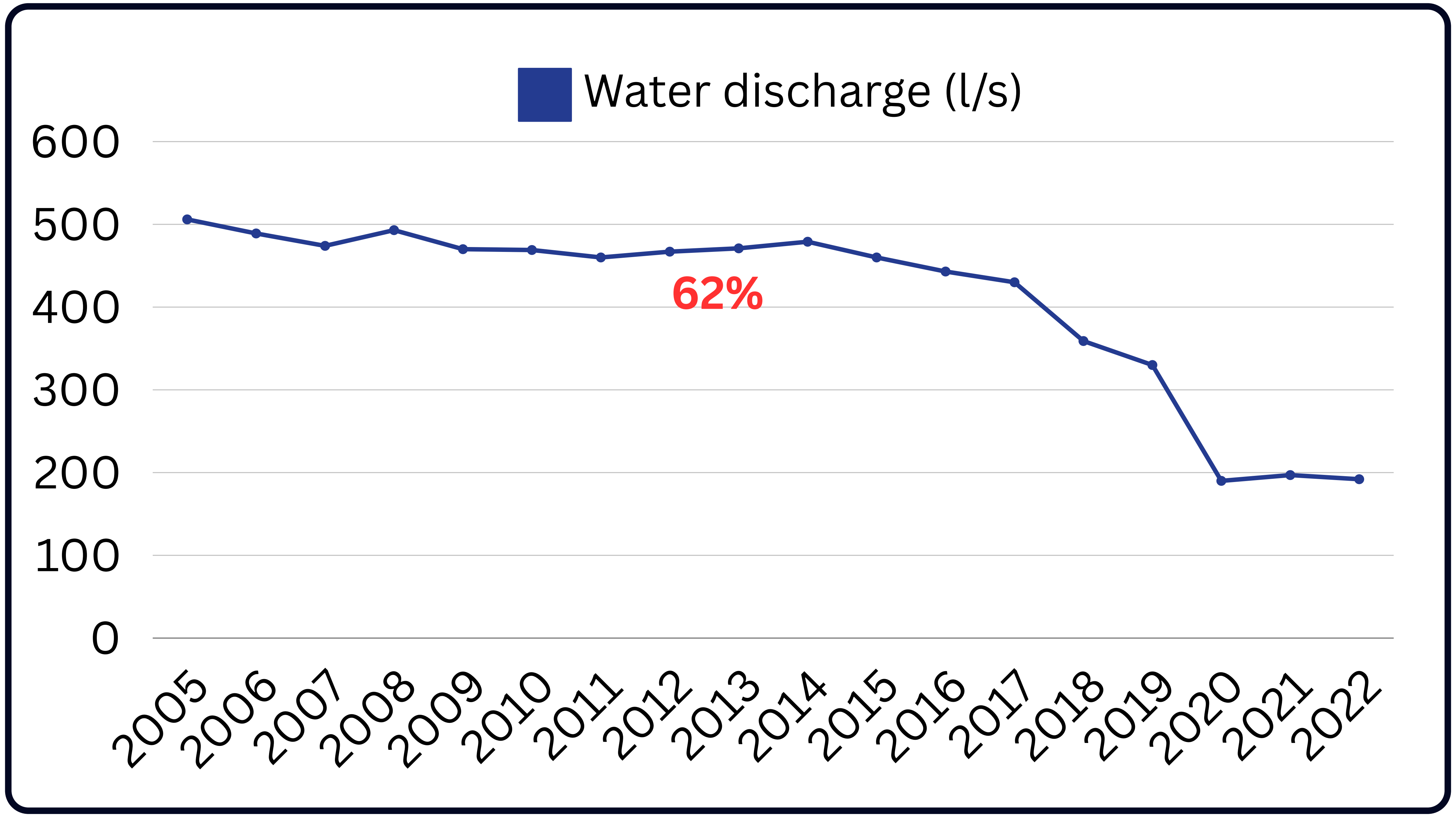


Figure 2. Ciburial Spring water discharge

Source: USAID (2020); Tirta Kahuripan Water Utilities (2023)

- **Changes in ecosystems impact watershed processes : groundwater recharge**, water flow, and erosion rates, leading to various human impacts that can be beneficial or costly (Lele, 2009).

- **Preserving vegetated ecosystems in recharged areas of spring is crucial** for maintaining **water quantity and quality** and **optimize regional protection functions** (Bogor Regency Government, 2021)

INTRODUCTION (3)

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- Estimating the **economic value** of **water provisioning services** is **crucial** for informed **management decisions to prevent degradation and highlight the magnitude of ecosystem service loss** (Chowdhury & Behera, 2021; Hackbart et al., 2017).
- **Prior to economic valuation** of ecosystem services, the **performance or availability of ecosystem services must be measured biophysically** (De Groot et al., 2010).

This study aims to:

1. Assess to what extent the presence of ecosystem provides the water supply in the Ciburial Spring recharge area
2. Provide an estimate economic value of this water provisioning services in the Ciburial Spring recharge area.

METHODOLOGY (1)

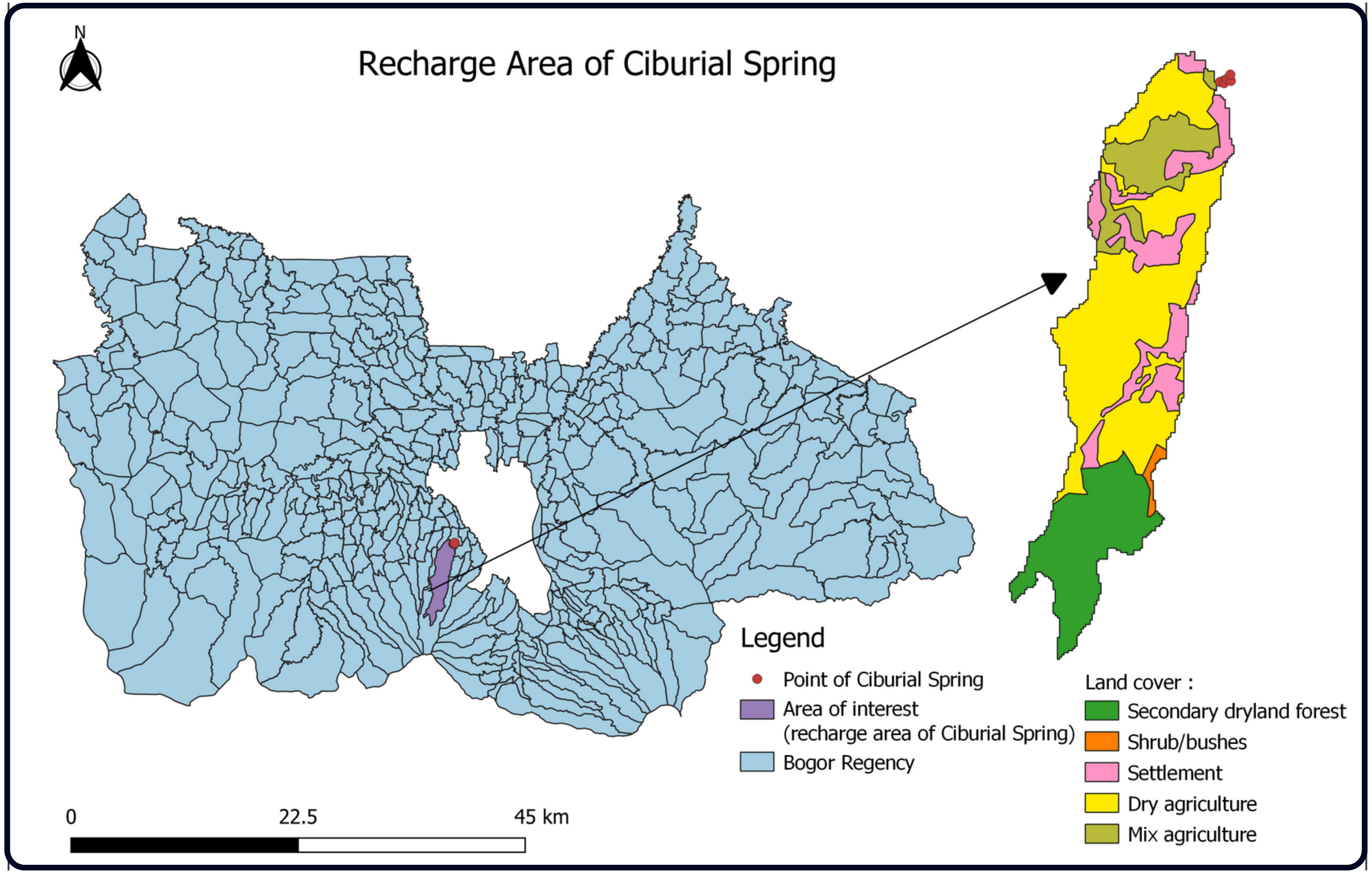

Figure 3. Area of interest: Recharge area of Ciburial Spring

- The **Ciburial spring recharge area** covers **seven villages in two sub-districts** in Bogor Regency, West Java Province, Indonesia.
- The total area is **1,163.39 hectares**, which is used as the **final boundary of all analysis outputs**.

METHODOLOGY (2)

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1. Measure the water supply provided by ecosystems in the Ciburial Spring recharge area

Method : Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Model

Analysis period : historical water supply (2011 - 2020) & future water supply (2021-2040) ⟶ Shared Socioeconomic Pathways (SSPs) scenarios : SSP370 & SSP585

Output : water yield (baseflow) (m3/year)

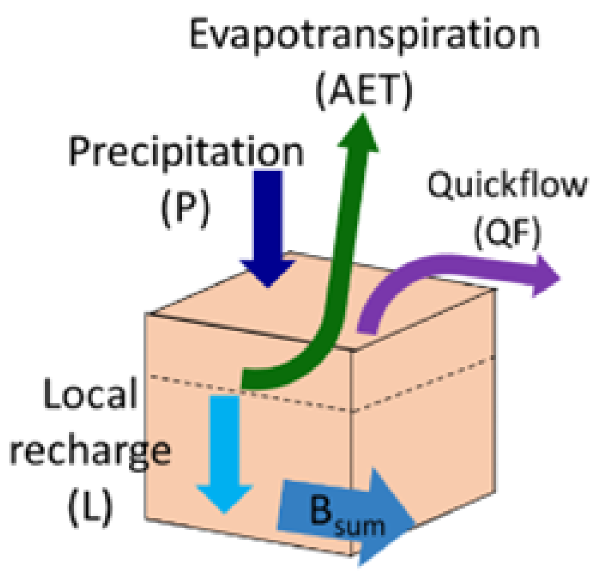
InVEST
Integrated Valuation of Ecosystem Services and Tradeoffs

Table 1. Data and source for InVEST modeling

Data	Source
Historical & future climate data	worldclim.org
Digital Elevation Model (DEM)	Geospatial Information Agency
Evapotranspiration data	Calculated by using climate data and crop coefficient
Soil information	Agricultural Land Resources Research and Development Center
Land use & land cover	Ministry of Environment and Forestry
Rain events	Meteorology, Climatology, and Geophysics Agency

$$B_i = P_i - QF_i - AET_i \quad \text{.............................(1)}$$

Bi : Baseflow (mm)
Pi : Precipitation (mm)
QFi : Quickflow (mm)
AETi : Actual evapotranspiration (mm)



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2. Estimate economic value of water provisioning services in the Ciburial Spring recharge area

Method : market price **Analysis period :** 2020 and 2021 - 2040

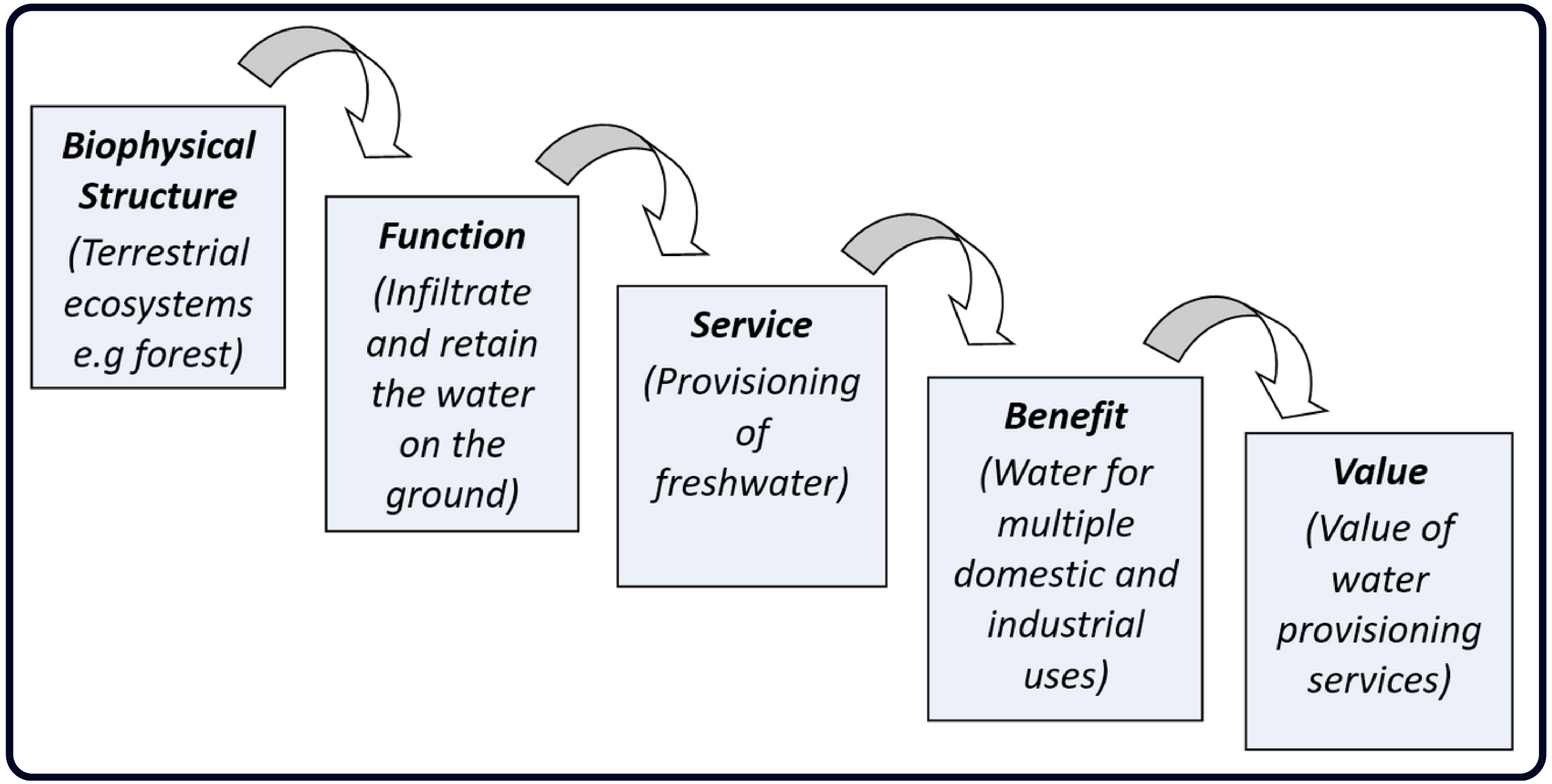

Figure 4. Cascade framework of water provisioning services

Source: Haines-Young & Potschin (2012)

Morgan & Orr (2015) :

$$VW = MP \times EV \qquad (2)$$

VW : Water provisioning value (USD/year)
MP : Water tariff (USD/m3)
EV : Water yield in recharge area (m3/year)

- Water tariff set by Tirta Kahuripan water utilities in Bogor Regency.

- **Economic valuation** integrates the **benefits generated by ecosystems into cost-benefit analysis and other standard policy evaluation** tools (Fisher et al., 2008).

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1. The potential of water supply in the Ciburial Spring recharge area

The **Ciburial Spring discharge has been decreasing** over 17 years due to human activities (**land use change**) and **climate change**, potentially leading to drought in the next 29 years (USAID, 2020).

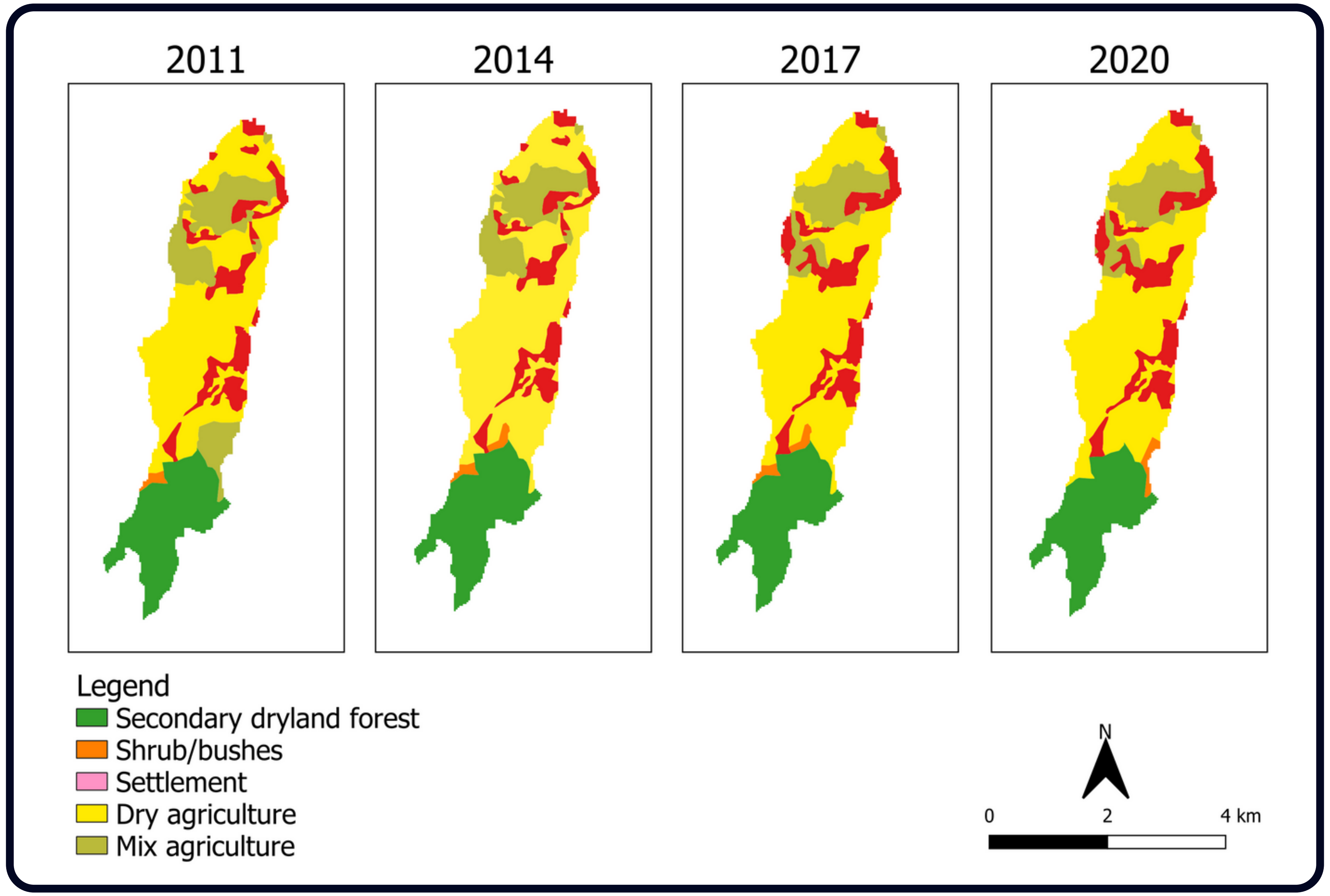

Figure 5. Transition of land cover in Ciburial Spring recharge area

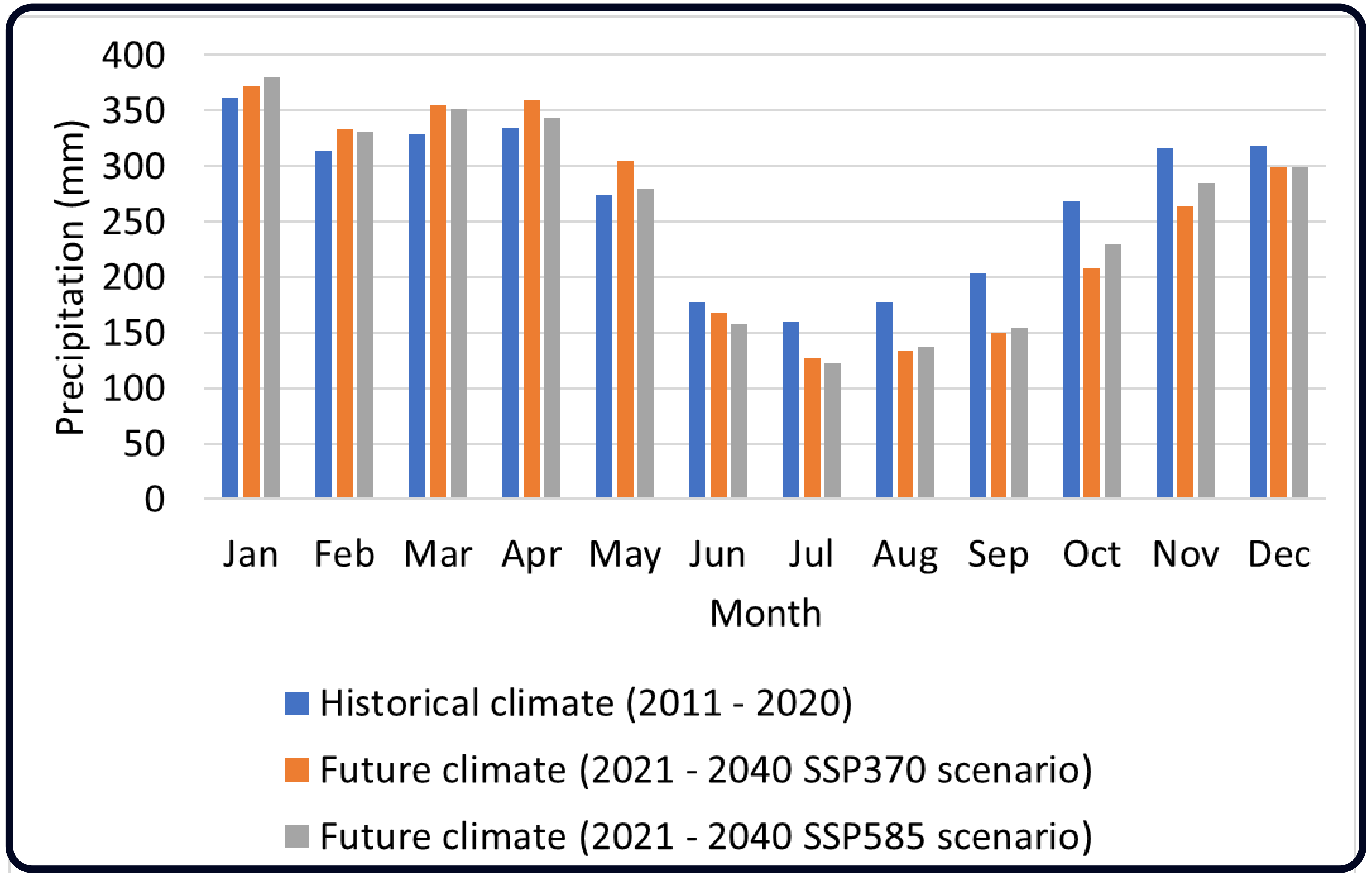

Figure 6. Monthly variation of precipitation for historical and future climate

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1. The potential of water supply in the Ciburial Spring recharge area

Baseflow represents **the portion of water that effectively infiltrates the ground and reaches streams during the dry season** (Halder et al., 2022; Natural Capital Project, 2024).

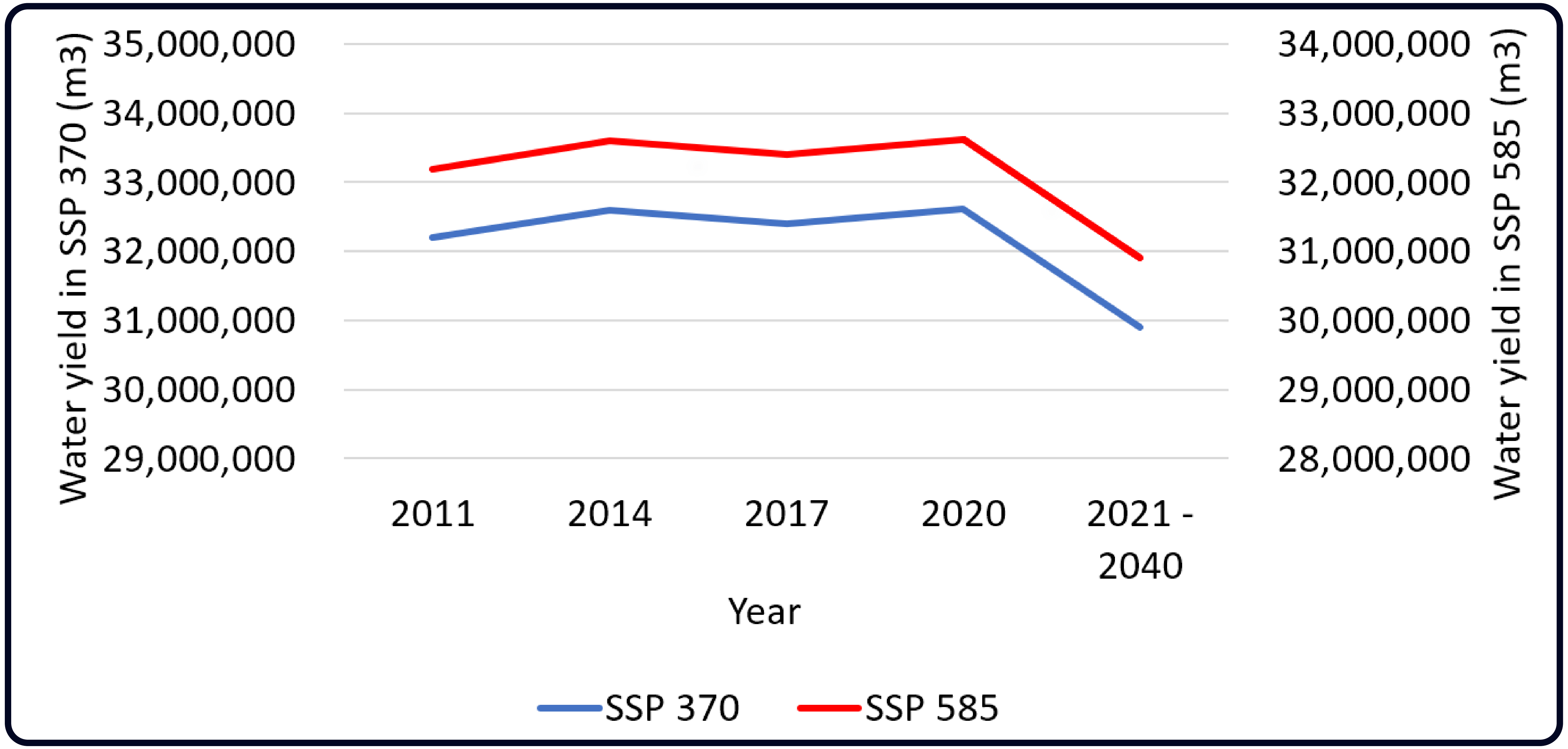

Figure 7. Trend of baseflow yield in the Ciburial Spring recharge area in 2011 – 2020 and 2021–2040 for the SSP 370 and SSP 585 scenarios

- The **water provided by ecosystems** in recharge area of Ciburial Spring **in 2020** : **32,613,565.97 m3/year**
- **Water yield decrease** in **2021 - 2040** :
  - 30,903,623.95 m3/year (SSP370)
  - 30,907,114.22 m3/year (SSP585)

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1. The potential of water supply in the Ciburial Spring recharge area

Average water yields in the the **Ciburial Spring recharge area** in the past 10 years and the next 20 years for SSP370 and SSP585 scenarios.

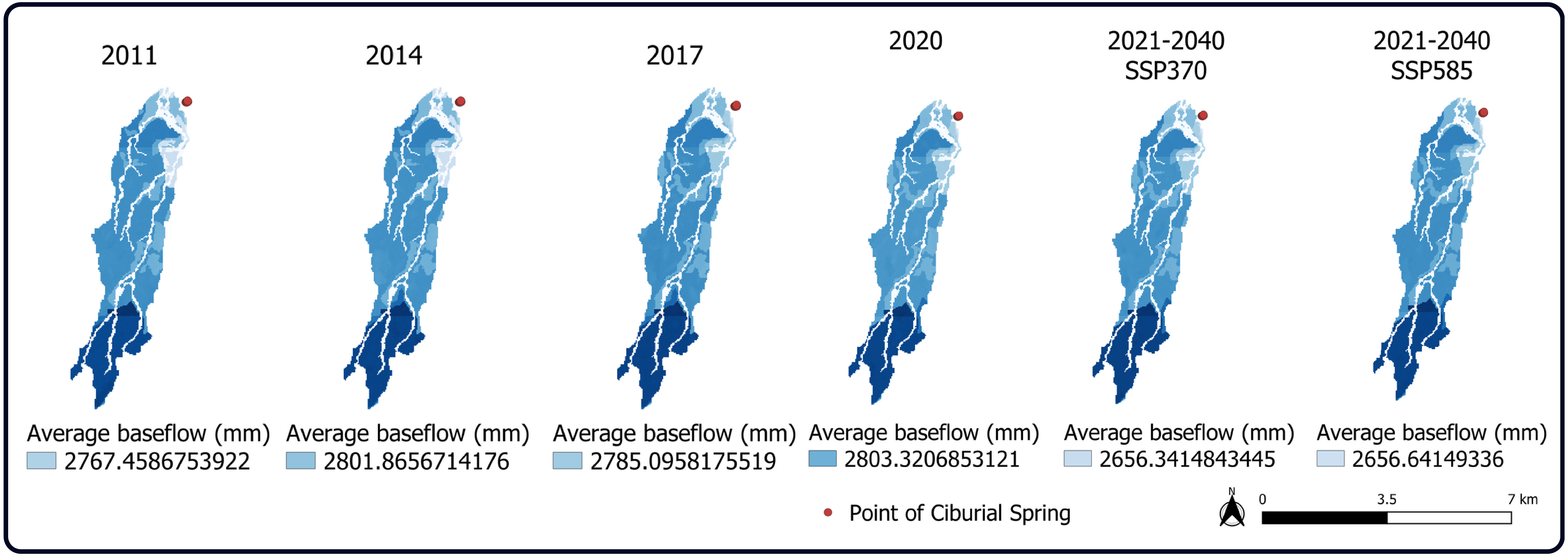

Figure 8. Average baseflow in the Ciburial Spring recharge area in 2010 - 2020 and 2021 - 2040 for SSP370 and SSP585 scenarios

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2. Economic value of water provisioning services in the Ciburial Spring recharge area

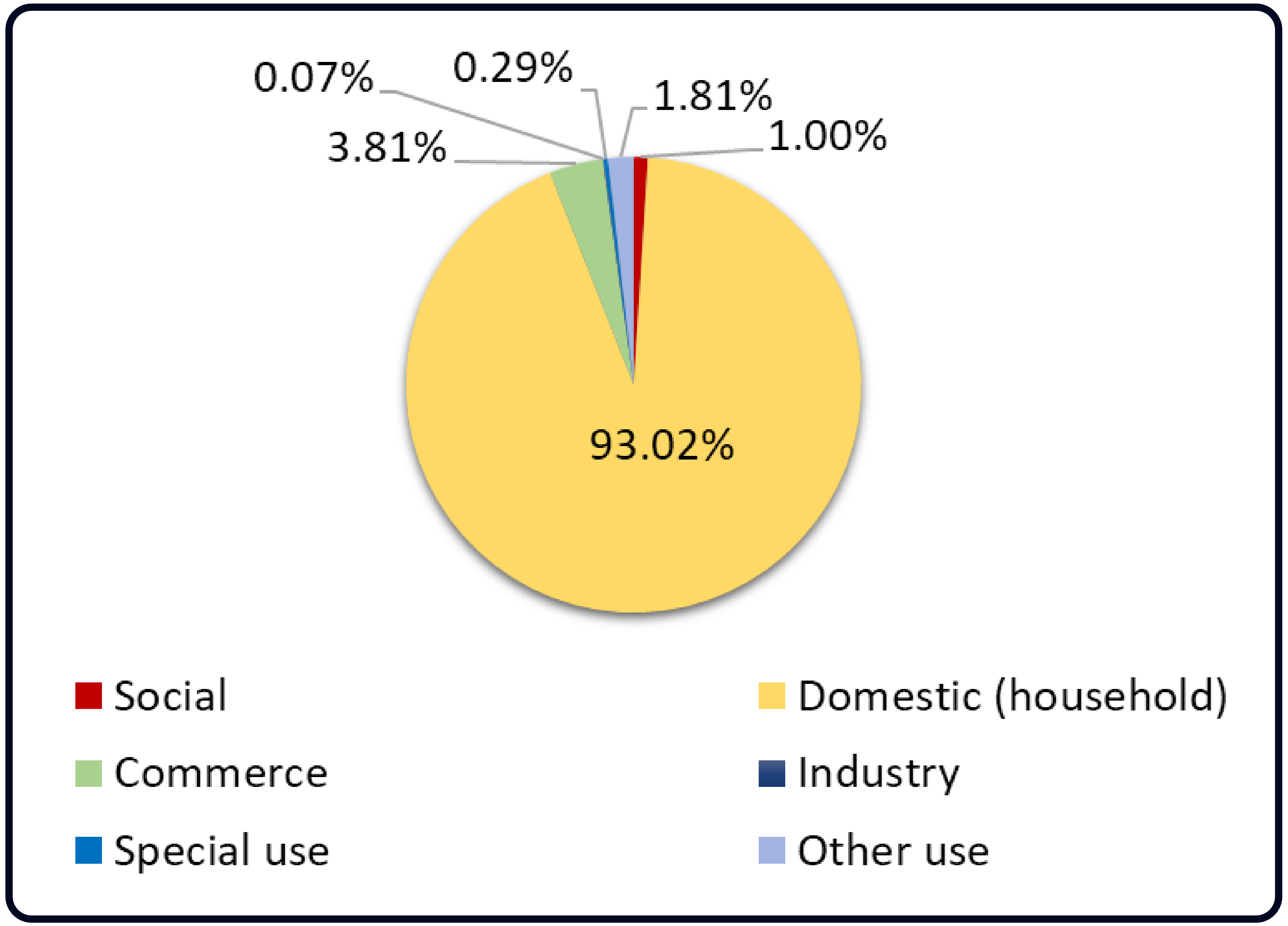

Figure 9. Water user connections of Tirta Kahuripan water utilities in Bogor Regency
Source: Tirta Kahuripan water utilities (2024)

- Market price : **water tariff** set by **Tirta Kahuripan Water Utilities**
- The **tariff** was based on the **average household group tariff** as **most user connections** belong to households
- **Average water tariff** for the household group was **USD 0.49/m3** (IDR 7,763/m3)
- The research eliminated inflation impact by maintaining a **consistent price level**, similar to Zhang et al., (2021) in valuing freshwater services.

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2. Economic value of water provisioning services in the Ciburial Spring recharge area

Table 2. Economic value of water provisioning services in Ciburial Spring recharge area in 2020 and 2021-2040 under SSP 370 and SSP 585 scenarios

Year	Water yield (m^3)	Water price (USD/m^3)	Economic value (USD/year)
2020	32,613,565.97	0.49	15,980,647.32
2021-2040 (SSP370)	30,903,623.95		15,142,775.73
2021-2040 (SSP585)	30,907,114.22		15,144,485.97

- The **economic value** resulted makes it crucial for **water policy implementation**, as policy-makers must demonstrate how their decisions will lead to improved welfare.
- By using **this information**, it may be possible to **develop a policy that is more efficient in terms of resource allocation**, taking into account the benefits of **better water distribution** across different sectors and regions (Karabulut et al., 2016).

CONCLUSION

- **Consistent yearly water volume of 32 million m3/year over the past decade** with minimum changes**.**
- **Possible decrease to 30 million m3/year in the next 20 years due to climate change,** signaling a shift in water-provisioning dynamics.
- **The economic assessment in 2020 valued water yield at USD 15,980,647.32/year**, showing its economic importance.
- With **unchanged water prices, the value** is expected to **decrease due to climate change for SSP370 and SSP585 scenarios,** indicating potential economic impacts of water yield changes.
- The findings of this study have the potential to **raise awareness about the value of protecting the ecosystems in Ciburial Spring recharge area** among the general public, local government agencies, and academic institutions.
- The findings could be a **basic for actions aimed at preserving the Ciburial Spring catchment area and its surrounding environment, in line with** the optimization of regional protection functions outlined in the **Bogor Regency Regional Regulation**.

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THANK YOU

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