Rice Paddy Ecosystem services for Climate Change

using land use and climate change scenarios

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Source: https://wallhere.com/ko/wallpaper/209301/

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I. Introduction

Ecosystem Services

- Services provided by paddy fields

- Provisioning of habitat
- Water cycling
- Nutrient cycling
- Soil formation
- Biomass production

- Heritage
- Knowledge system
- Social relations
- Recreation and tourism
- Science and education
- Inspiration and aesthetic values

- Food product
- Raw materials
- Biochemical and genetic resources
- Fresh water

- Climate regulation
- Pollutant purification
- Carbon storage
- Natural disaster butter
- Temperature control
- Prevention of erosion and soil loss

Source: Oh et al. (1996); Kim et al. (2013); Yoo and Lee (2013); Jung et al. (2014); Nayak et al. (2019)

Land Cover Changes

- Land cover changes by time

%

	Urban	Agriculture	Forest	Grass	Wetland	Bare soil	Water
1980s	2.09	**23.58**	66.34	3.75	0.86	1.29	2.08
1990s	3.42	**21.62**	66.25	4.32	0.49	1.68	2.21
2000s	6.29	**19.34**	63.51	7.16	0.33	1.21	2.15

KEI(2019)

- Land transformation from agricultural land cover (1989-2009)

km^2 (%)

2009 / 1989	Urban	Agriculture	Forest	Grass	Wetland	Bare soil	Water	Changes
agriculture	2,752 (11.6)	**15,664 (65.8)**	3,358 (14.1)	537 (2.3)	303 (1.3)	605 (2.5)	568 (2.4)	-8,124 (34.2)

23,788

KEI(2016)

II. Method

ES and Models

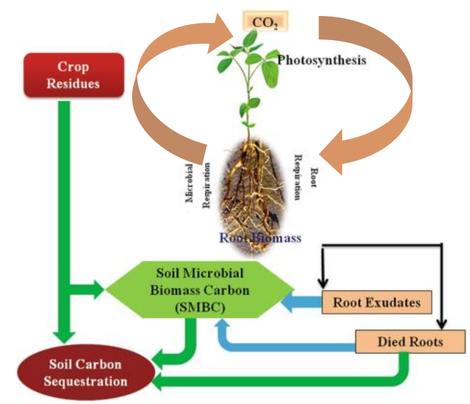
- Selected ecosystem services
  - Soil carbon storage
  - Fresh water provision

- Integrated Valuation of Ecosystem Services and Trade-offs (InVEST)
  - Carbon Storage model
  - Annual Water Yield model

InVEST: The Natural Capital Project, Stanford University et al. 2018. https://naturalcapitalproject.stanford.edu/

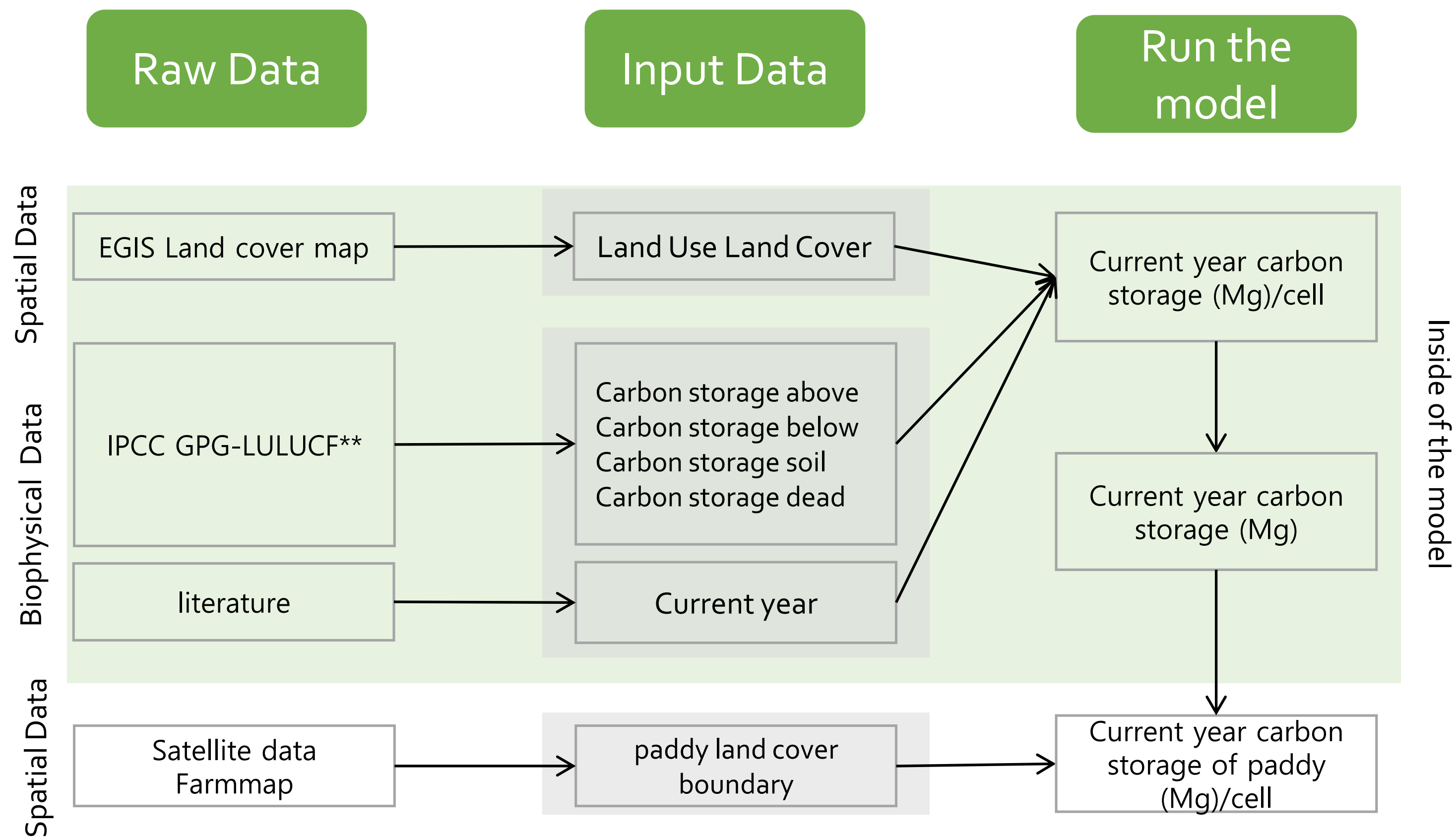
Soil Carbon Storage

- Fixes carbon dioxide in the atmosphere and converts it to biomass of rice, and stores carbon as biomass in soil and above-ground parts including roots
- $C_{(x,y,M)} = M \times (D_a + D_b + D_c + D_d)$
  - $C_{(x,y,M)}$: a given cell(x,y) with a land cover
  - D_a : carbon stored above ground
  - D_b : carbon stored below ground)
  - D_c : carbon stored as soil organic carbon)
  - D_d : carbon stored as dead organic matter carbon



Source: Kumar et al. 2018

Soil Carbon Storage



EGIS: Ministry of environment Korea, Environmental Geographic Information Service. 2018. egis.me.go.kr

** Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2006)

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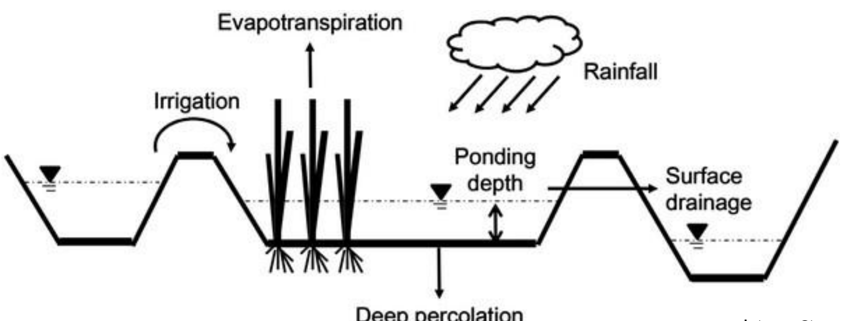
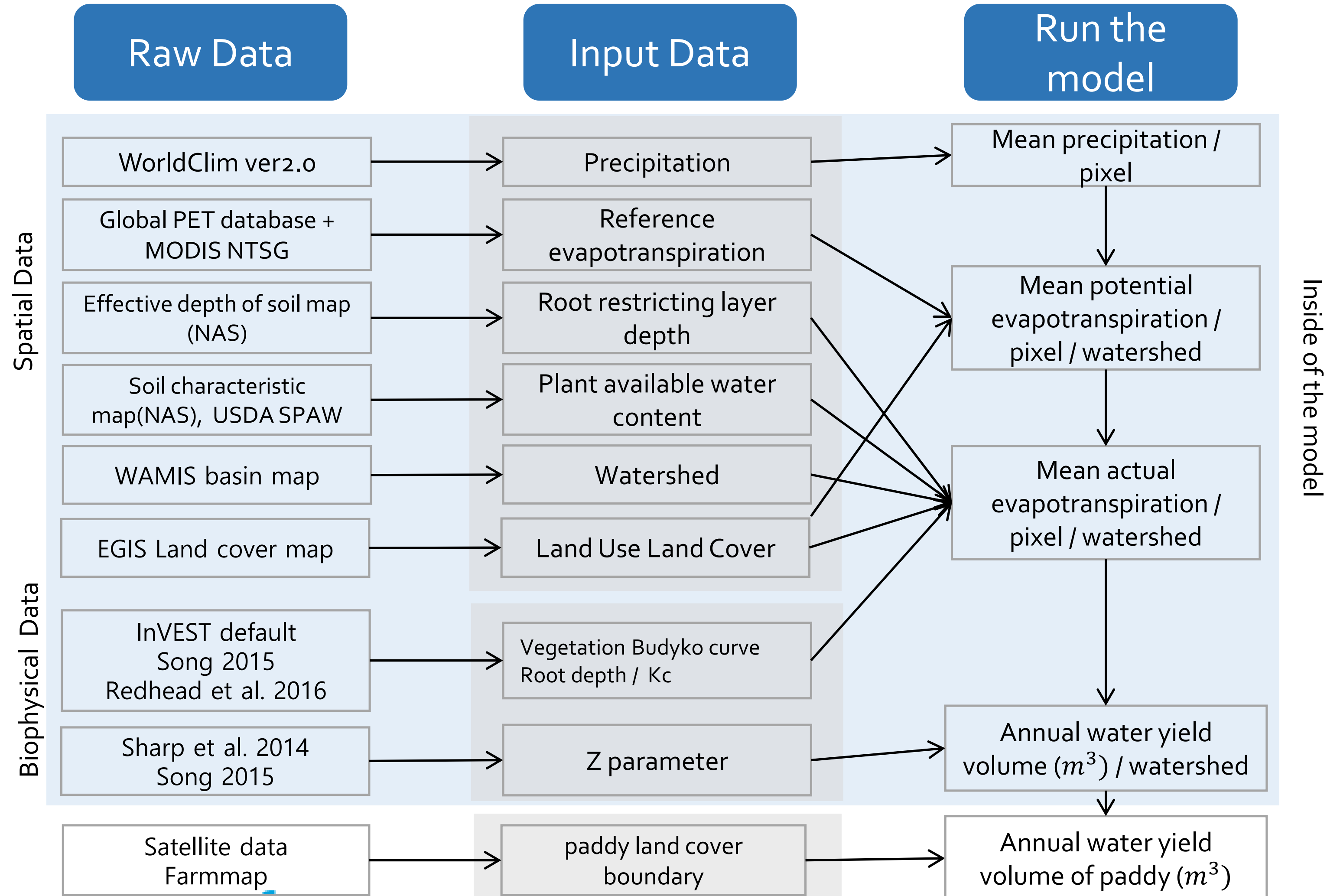
Annual Water Yield

- Annual water yield by excluding evapotranspiration and soil absorption from precipitation
- The amount of water are available depending on the amount of precipitation in the target area and hydro-sluice conditions, etc.
- $Y(x) = \left(1 - \frac{AET(x)}{P(x)}\right) \times P(x)$
  - $Y(x)$: water yield of each cell
  - $AET(x)$: annual actual evapotranspiration
  - $P(x)$: annual precipitation

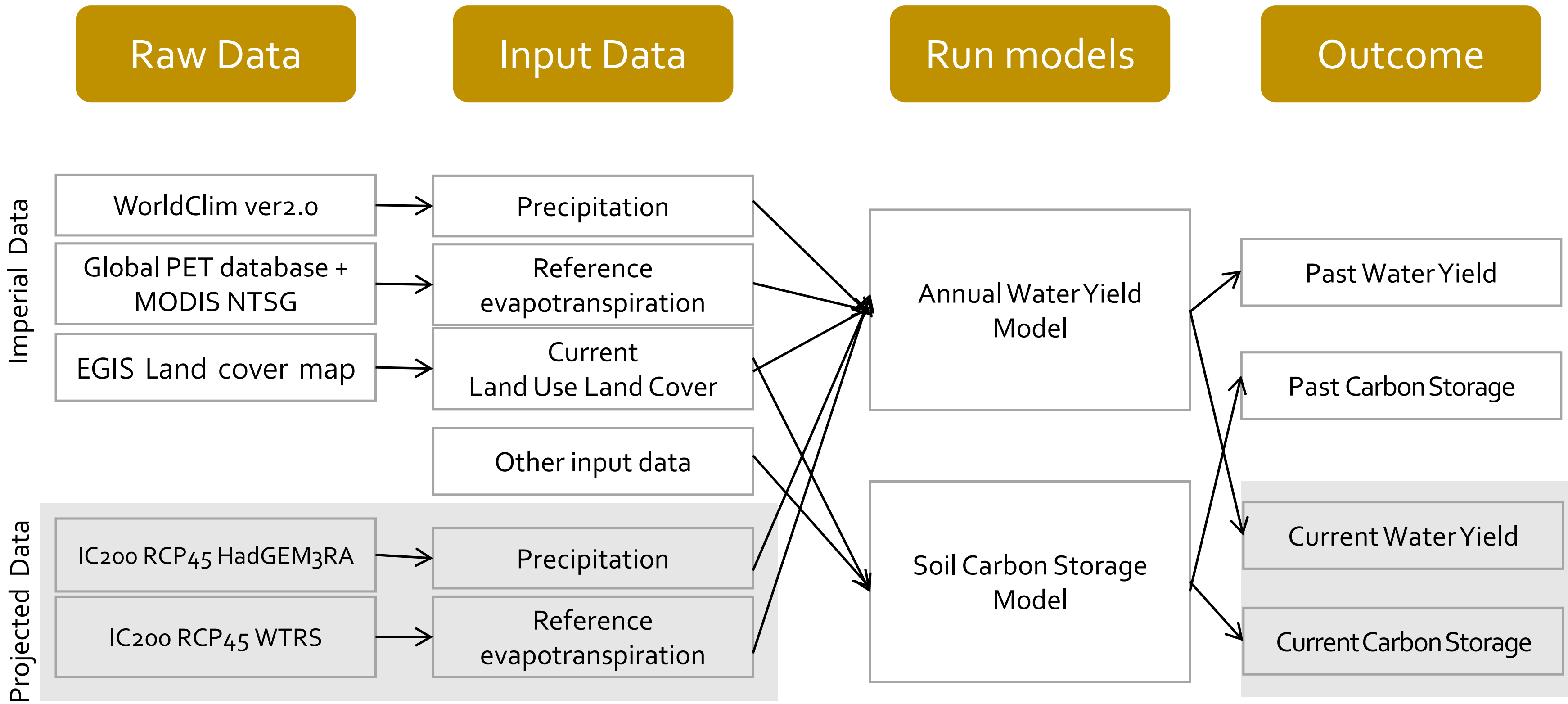


song et al.(2016)

Annual Water Yield



Temporal Comparison



- Past : 1980-1999 (20 years)
- Current : 2000-2020 (20 years)

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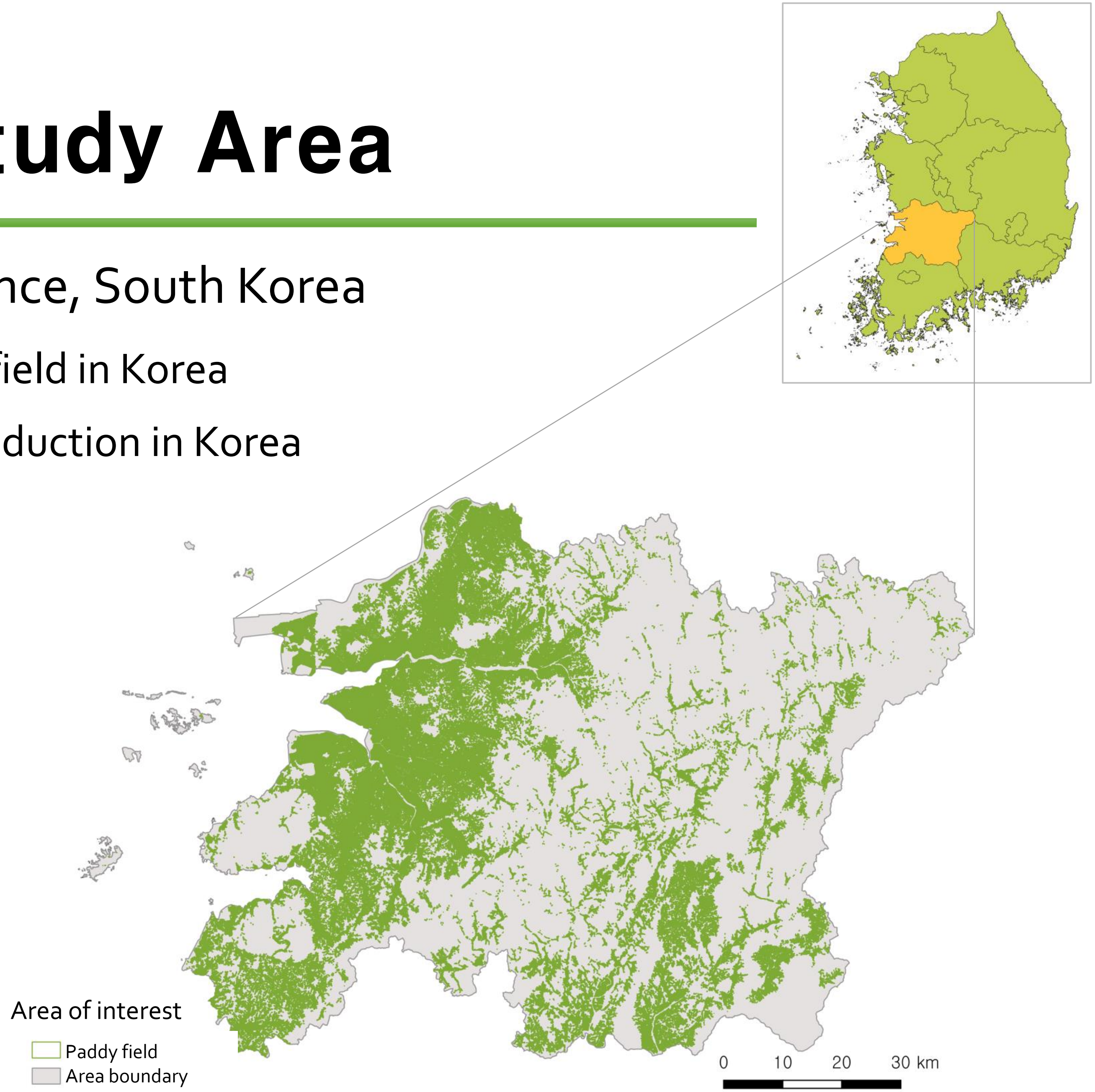
III.Results

Study Area

- Jeonbuk province, South Korea
  - 15.3% of paddy field in Korea
  - 16.2% of rice production in Korea

source: statistics Korea (2012)



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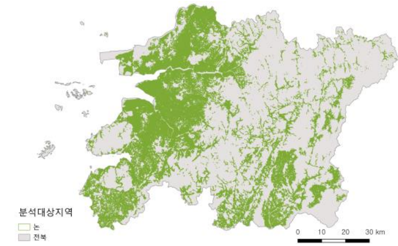
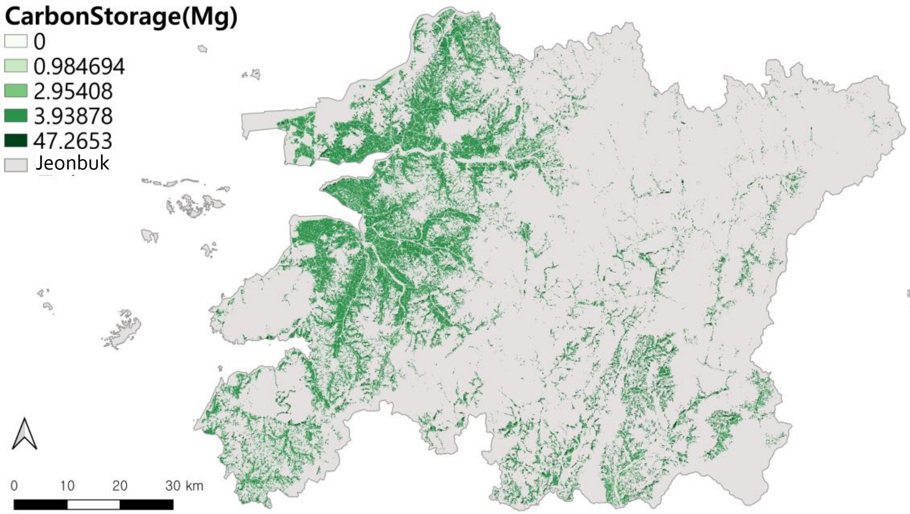
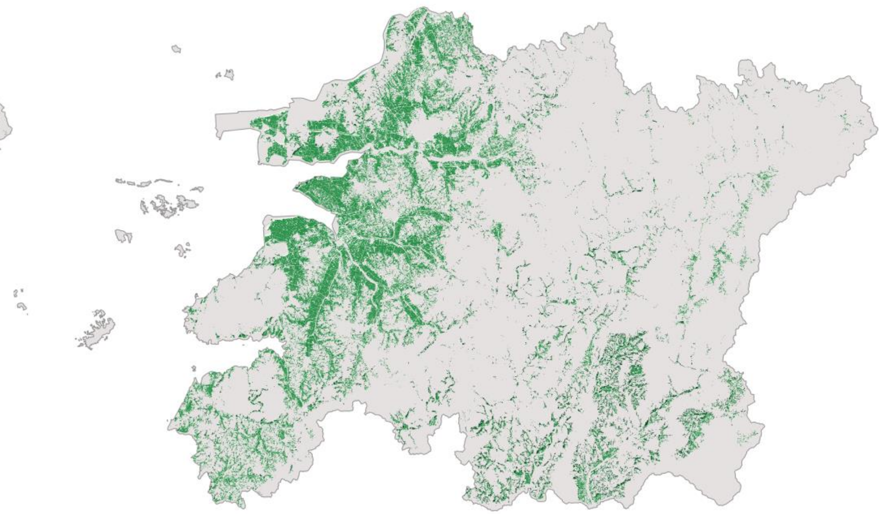
Rice paddies contribution



Jeonbuk rice paddies' **Soil Carbon Storage**





Past	Current
3,036,702ton C / yr	2,733,031ton C / yr
100.96ton C / ha / yr	90.25ton C / ha / yr

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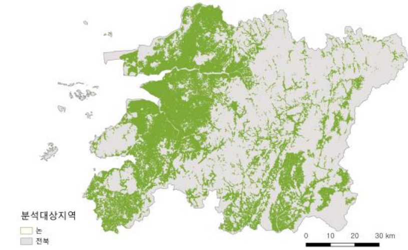
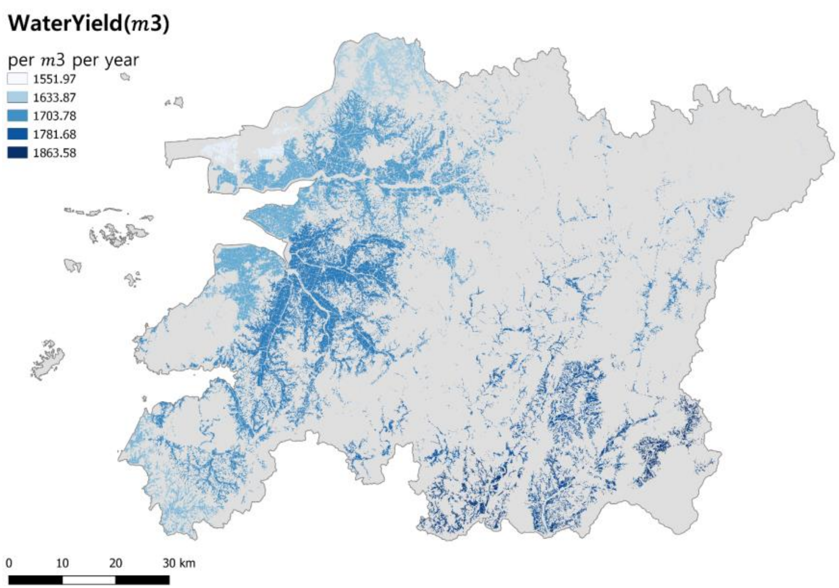
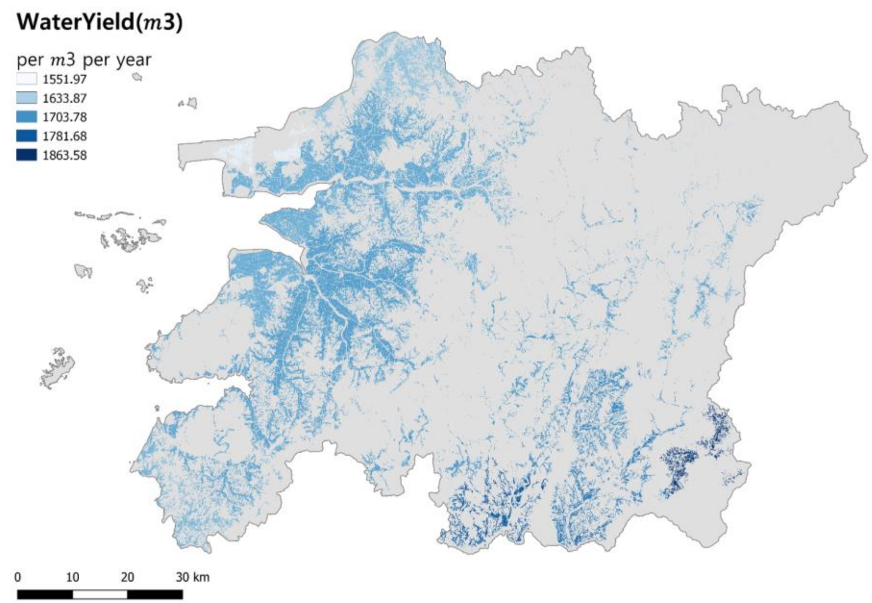
Jeonbuk rice paddies' **Annual Water Yield**

Rice paddies contribution







Past	Current
6,626,775 m^3	6,200,436m^3
1,349.7 m^3/ ha / yr	1,282.2 m^3/ ha / yr

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Soil Carbon Storage

- Rice paddies can capture greenhouse gases such as CO_2 and can be a potential natural carbon storage.
- CH_4 and N_2O emission from rice paddies can be reduced through sustainable management scheme

Annual Water Yield

- Water yield in rice paddies decreases mainly due to land cover change
- Climate change may have negative impact on water yield in rice paddies
- Rice paddy conservation is necessary for the sustainable water yield

Ⅳ. Conclusion

Conclusion

- Paddy fields not only produce rice but also provide various ecosystem services, and these ecosystem services can contribute to climate change mitigation and adaptation.
- The rice paddy ecosystem in the whole of Korea and in the Jeonbuk region, the target of the pilot analysis, is continuously decreasing.
- As a result of the analysis of ecosystem services for 'carbon storage' and 'Annual water yield' are decreasing.
- It is necessary to preserve the rice fields rather than develop them in consideration of not only future food security but also the various ecosystem services provided by rice fields.

Thank you