ASSESSMENT OF METEOROLOGICAL SUITABILITY MAPPING FOR CHINESE CABBAGE IN AUTUMN SEASON OF EAST ASIA FROM 2001 TO 2020

Shuai Shao and Wataru Takeuchi

Institute of Industrial Science, The University of Tokyo, Japan

Abstract: Chinese Cabbage has been an important daily vegetable supply for human or livestock's meals. As one of the bio-geophysical assessment of suitability, meteorological suitability focuses on temperature and precipitation. This study presents the meteorological suitability mapping of Chinese Cabbage across all over East Asia and a specific Kawakami village through a Google Earth Engine geo-visualization of remote sensing imageries products. MODIS Land Surface Temperature and Emissivity (MOD11) and Global Satellite Mapping of Precipitation (GSMaP) were all utilized for two decades' meteorological suitability mapping analysis in autumn season (September, October, November) from 2001 to 2020. The suitability classification range is parsed into five levels, individually as optimal, suitable, marginal, unsuitable, and pessimal. Meteorological suitability of whole East Asia presents no clear discipline within 2 decades because of potential climate changes and unpredictable meteorological events across large areas, while meteorological suitability of Kawakami village was mainly optimal and suitable while it became unsuitable and pessimal since 2016 because of the precipitation increase.

1.BACKGROUND
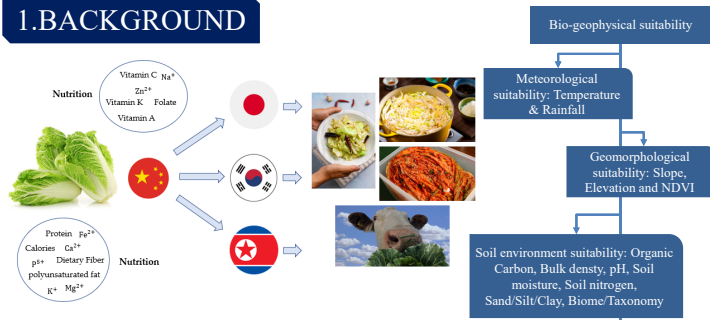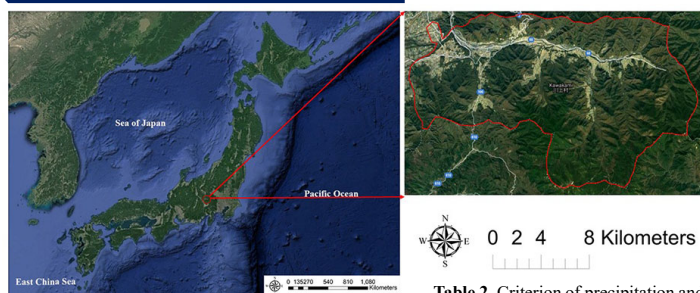

2.MATERIALS & METHODOLOGY

Fig1. Map of study area

Fig 2. Flowchart of this study

Table 1. Details about data products

Data	Precipitation	Temperature
Source	JAXA	NASA MODIS
Product	Near Real Time	MOD11A2 v006
Temporal Range	2000-01-01 to present	2000-02-18 to present
Temporal Resolution	1 hour	8-day
Spatial Resolution	0.1-degree	1-km

Table 2. Criterion of precipitation and temperature categorization

Criterion	Precipitation (°C)	Temperature (mm)
Optimal	10-20	200-375
Suitable	5-10 and 20-25	181.25-200 and 375-418.75
Marginal	0-5 and 25-30	162.5-181.25 and 418.75-437.50
Unsuitable	-5-0 and 30-35	143.75-162.5 and 437.5-456.25
Pessimal	< -5 and > 35	< 143.75 and > 456.25

$$\theta = \frac{(max - min)}{\sigma - 1} \quad (1)$$

$$optimal = \{x \in R | min + \theta < x < max - \theta\} \quad (2)$$

$$suitable = \{x \in R | min < x < min + \theta \text{ OR } max - m < x < max\} \quad (3)$$

$$marginal = \{x \in R | min - \theta < x < min \text{ OR } max < x < max + \theta\} \quad (4)$$

$$unsuitable = \{x \in R | min - 2\theta < x < min - \theta \text{ OR } max + \theta < x < max + 2\theta\} \quad (5)$$

$$pessimal = \{x \in R | x < min - 2\theta \text{ OR } x > max + 2\theta\} \quad (6)$$

Where θ = calculation constant

σ = the number of suitability level

optimal = the optimal level of suitability

suitable = the suitable level of suitability

marginal = the marginal level of suitability

unsuitable = the unsuitable level of suitability

pessimal = the pessimal level of suitability

min = the minimum value for particular variate

max = the maximum value for particular variate
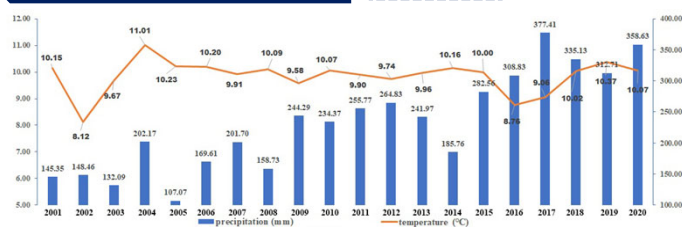
3.RESULTS & DISCUSSIONS

East Asia

Fig 3. Precipitation and temperature time-series characteristics of East Asia
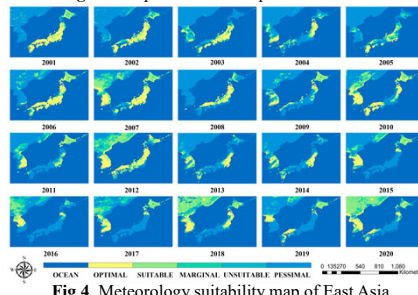

Fig 4. Meteorology suitability map of East Asia

1. **Average precipitation** has been keep **increasing** except abnormal sheer drop in 2005, 2008 and 2014; the temperature has been relatively stable, stays around 10℃ up and down.
2. Except for parts of northern China and Southern Russia areas in 2002 and 2016, the temperature suitability of East Asia **Nearly all optimal and suitable.**
3. There's **no obvious trend** of changes probably in 2 decades probably because of climate changes and meteorological events happening including occasional heavy rain or typhoon.
4. Because of the unpredictable changes of precipitation, the changing trend of meteorology also cannot be explained with discipline.
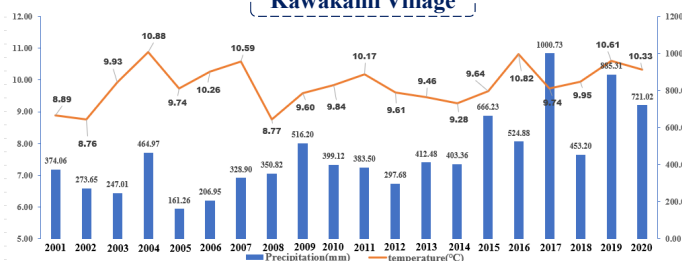
Kawakami Village

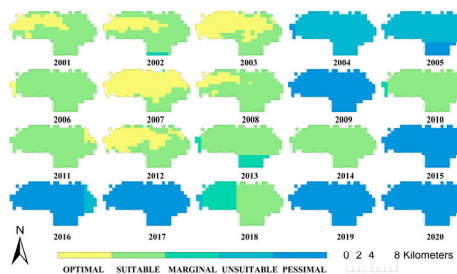**Fig 5**. Precipitation and temperature time-series characteristics of Kawakami village

Fig 6. Meteorology suitability map of Kawakami village

1. From 2001 to 2015, the average precipitation of autumn season is basically **below 500mm** which is **suitable** for Chinese Cabbage to grow except particular year as 2004, 2005, 2009 and 2015. Since 2016, the precipitation rises **above 600mm, making the precipitation suitability deteriorate.**
2. The integrated meteorological suitability also presents similar trend as precipitation suitability, over rain since 2016 may lead to Chinese Cabbage **roots corrupted** or **attract pests** in natural farmlands, **moisture-proof facilities** may used in Kawakami in autumn season.

4.CONCLUSIONS

1. A meteorological suitability methodology was constructed to assess for Autumn Chinese Cabbage from 2001 to 2020 by integrating land surface temperature (MOD11A2) and precipitation (GSMaP_nrt) datasets.
2. For general East Asia, the temperature almost stays the same in 20 years while the precipitation varies with no discipline, therefore the integrated meteorological suitability shows no clear trend.
3. For Kawakami village, the temperature suitability shows climate in this place in the past 20 years was all suitable for Autumn Chinese Cabbage to grow, however, as precipitation started to increase since 2016, the precipitation suitability of Kawakami village turned out to be "unsuitable" whereas previous years' precipitation suitability was mainly optimal and suitable.