9.JBES-Vol-13-No-1-p-151-156 Utilization of global satellite mapping of precipitation

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Submission date: 12-May-2023 09:10AM (UTC-0400)
Submission ID: 2091321752
File name: 156_Utilization_of_global_satellite_mapping_of_precipitation.pdf (598.48K)
Word count: 2733
Character count: 14317

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 13, No. 1, p. 151-156, 2018
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Utilization of global satellite mapping of precipitation (GSMaP) for schmidt- Ferguson climate classification in South Kalimantan, Indonesia

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Article published on July 15, 2018

Key words: GSMaP satellite, Validation, Climate zone schmidt ferguson

Abstract

Distribution and density of unfamiliar observation post network, the lack of data and non-continuous data becomes problem in conducting analysis and making information of climate classification in South Kalimantan. One technique to obtain rainfall data today is by using satellite data. one of the rainfall prediction techniques using satellite data is GSMaP. Utilization of GSMaP data is an alternative data that needs to be studied to overcome the limitations of surface observation data. Data validation is done using statistical method by analizing the correlation value (r) and RMSE (Root Mean Square Error). Climation zonation based on climate classification Schmidt Ferguson. Schmidt Ferguson climate classification calculation from GSMaP data mapped spatially using Arc GIS software 10.2. GSMaP satellite rainfall data validation and surface rainfall showed a high correlation value for monthly average with correlation value 0,89 and RMSE 41,8mm/month (1,66mm/day). Schmidt Ferguson climate zoning based on GSMaP satellite data in southern Kalimantan is divided into 3 climate zones, namely type A, B and C.

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Introduction

Rainfall is a key element measured in the meteorological field as it affects various sectors, such as tourism, agriculture, forestry and public health. Limited distribution rainfall observation network becomes an obstacle in the analysis of rainfall data. Along with the advance of technology in remote sensings such as satellites and radar, rainfall measurements can be done using the technology. Therefore, it is possible to monitor rainfall over a large area even where the conventional equipment cannot be reached. Global Satellite Mapping of Precipitation (GSMaP) is a global rainfall prediction project using combination methods such as GPI-Core GMI, TRMM TMI, GCOM-W AMSR2, SSMIS DMSP, NOAA AMSU, MetOp AMSU and IR geostationary data. This method is used to obtain near-real-time global rainfall. The utilization of GSMaP data is due to some benefits of GSMaP rainfall data, such as advantages in wide area coverage, ability to map large spatial and temporal rainfall variations and their ability to provide rainfall data with spatial resolution up to 0.1° ~ 11.06km. This study aims to assess the accuracy level of GSMaP rainfall data compared to surface observation and GSMaP rainfall data for Schmidt - Ferguson climate classification in South Kalimantan. The data which used in climate classification is GSMaP_RNA because these have a record of over 10 years rainfall data which is a requirement for climate classification. Schmidt and Ferguson (SF) classification systems divide eight types of climates from wet climates to dry climates. The result of this classification will be known the type of vegetation that is usually used for agriculture and forest according to the type of climate in the region. Cluster mapping of Schmidt - Ferguson climate classification which is better and accurate evenly based on GSMaP data is expected to provide information for the benefit of natural resource management in South Kalimantan.

Materials and methods

Location and Time of The Research

The study was conducted from March to July 2018 in South Kalimantan area between 1°20 'LS - 4°10' LS and 114°19 'BT - 116°33' BT.

The research point for validation is divided into three points Syamsudin Noor Meteorology Station, Banjarbaru Climatology Station and Kotabaru Meteorology Station. Climate classification consists of 270 grids spread over 13 districts in the province of South Kalimantan.

Tools and materials

The research instrument used is a set of computers, Open GrADS software, Microsoft excell-spreadsheet and SPSS 23 software for easy data processing.

Data retrieval

Surface rainfall data for 3 observation points from 2004 to 2013 were obtained from BMKG in South Kalimantan. GSMaP satellite data is downloaded from the following page http://sharaku.eorc.jaxa.jp/GSMaP_crest/html/data.html in binary format. GSMaP Satellite Data from 2004 to 2013 was extracted from the grid using GRADS (Grid Analysis and Display System) software.

Data analysis

To analyze the accuracy level of GSMaP rainfall and surface observation, statistical analysis was done by calculating correlation (r) and RMSE (Root Mean Square error) with SPSS program. Schmidt Ferguson Classification Calculations using an excel program. The results of Schmidt and Ferguson climate classification calculations of GSMaP data are mapped spatially using Arc GIS 10.0 and IDW method to create Schmidt and Ferguson climatic classification zones.

Results and discussion

Monthly Data Series Validation of GSMaP Satellite Rainfall and Observation

The value of correlation (r) series of GSMaP satellite monthly data with surface rainfall data at 3 points of observation in South Kalimantan has correlation value that ranged from 0,66 to 0,84 with the average value of the overall sampling correlation of 0,76. This shows that there is a strong and positive between GSMaP satellite data and Observation rainfall data. The least correlation value is 0,66 in Meteorological Station of Stagen-Kotabaru.

On the other hand the highest correllation value witnessed in Climatological Station of Banjarbaru, making up 0,84. The RMSE value ranges from 90,30 to 109,50mm/month with an average RMSE of 100.80mm/month (3.36mm/day). The smallest RMSE value can be seen in Banjarbaru Climatological Station making up 90,30 mm/month (3.01mm/day), while the largest RMSE value is 109,50mm/month (3,65mm/day) in Meteorological Station of Stagen-Kotabaru.

Table 1. Correlation value (r) and RMSE monthly data series of GSMaP satellite rainfall and observation.

No	Observation point	Monthly Series		
		r	RMSE (monthly	RMSE (daily)
1	Stamet syamsudin noor	0,78	102,80	3,43
2	Staklim banjarbaru	0,84	90,30	3,01
3	Stamet stagen	0,66	109,50	3,65
	Average	0,76	100,80	3,36

Monthly Average Data Series Validation of GSMaP Satellite Rainfall and Observation

The value of correlation (r) series of GSMaP satellite monthly data with surface rainfall data at 3 points of observation in South Kalimantan has correlation value that ranged from 0,78 to 0,96 with the average value of the overall sampling correlation of 0,89. This shows that there is a strong and positive between GSMaP satellite data and Observation rainfall data. The least correlation value is 0,78 in Meteorological Station of Stagen-Kotabaru. On the other hand the highest correllation value witnessed in Climatological Station of Banjarbaru, making up 0,96.

Table 2. Correlation value (r) and RMSE monthly average data series of GSMaP satellite rainfall and observation.

No	Observation point	Monthly average		
		r	RMSE (bulanan)	RMSE (harian)
1	Stamet syamsudin noor	0,95	40,57	1,35
2	Staklim banjarbaru	0,96	36,64	1,22
3	Stamet stagen	0,78	52,11	1,74
	Average	0,89	43,10	1,43

The RMSE value ranges from 36,64 to 52,11mm/month with an average RMSE of 43,10mm/month (3.36mm/day). The smallest RMSE value can be seen in Banjarbaru Climatological Station making up 36.64 mm/month (1,22 mm/day), while the largest RMSE value is 52,11 mm/month (1,74 mm/day) in Meteorological Station of Stagen-Kotabaru.

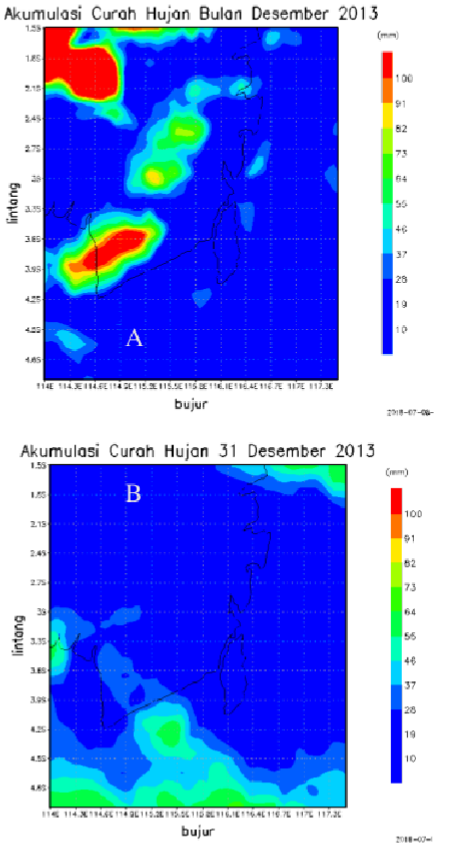

Fig. 1. Example of the GSMaP rainfall spatial plot of December 2013, (a) daily and (b) monthly accumulation.

Schmidt Ferguson Climate Classification Mapping

By utilizing excess GSMaP rainfall data which has a spatial resolution of 0.1° x 0.1° equivalent to 11.6km conducted the process of extracting rainfall data so

that obtained data distribution 270 grid for South Kalimantan Province. Using Arc Gis 10.2 software, spatial analysis is performed to create climate zonation maps based on Schmidt-Ferguson classification. climate zonation based on Schmidt - Ferguson classification of South Kalimantan region based on GSMaP rainfall data can be seen in Fig. 2.

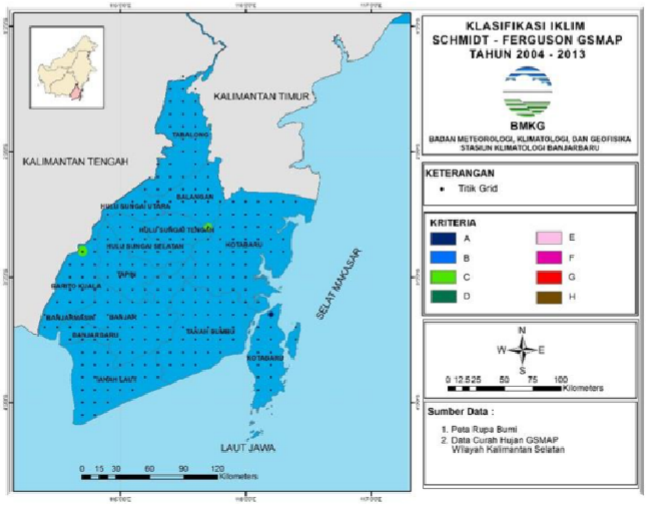

Fig. 2. Cluster Map of Schmidt - Ferguson GSMaP 2004-2013 in South Kalimantan.

Schmidt - Ferguson climate zonation of South Kalimantan based on GSMaP research point data shown in Fig. 2 is divided into 3 climate types namely type A, B, and C. In general, South Kalimantan is dominated by climate type B covering almost all regencies/cities in South Kalimantan. Climate Type A is located in Kotabaru. Type C climate exists in a small part of Barito Kuala, Hulu Sungai Tengah, and Balangan. Climate zonation mapping of Schmidt - Ferguson in South Kalimantan based on an observational data point and GSMaP data shows generally the dominant climate type in South Kalimantan is climate type B. But there are also some climate types A and C which are scattered in some parts of South Kalimantan. There are differences in the extent of climate type A distribution using observational rainfall data and GSMaP. Where the spread of Climate type A using observation rainfall data more widely than using GSMaP rainfall data. While for climate type C both using observation rainfall data and GSMaP same as just spread in a small part in South Kalimantan.

Climate zoning Schmidt - Ferguson South Kalimantan region based on GSMaP rainfall data presented in tabulation form shown in Table 3.

Table 3. Climate Zone Schmidt - Ferguson in South Kalimantan.

No	Regency/City	Climat type of Schmidt - Ferguson
1	Tabalong	B
2	Balangan	*B dan C
3	Hulu Sungai Utara	B
4	Hulu Sungai Tengah	*B dan C
5	Hulu Sungai Selatan	B
6	Tapin	B
7	Banjar	B
8	Tanah Laut	B

No	Regency/City	Climat type of Schmidt - Ferguson
9	Tanah Bumbu	B
10	Kota Baru	A dan *B
11	Barito Kuala	B
12	Banjarbaru	B
13	Banjarmasin	B

Description: * The dominant climatic type

The type A or Very Wet Basin region has a wet month period of 11 to 12 months and dry month period of 0 to 1 month. Climate Type B or Wet has a wet month period of 9 to 11 months and dry month period of 1 to 3 months. Climate Type C or fairly wet has wet period of 7 consecutive 9 months and dry month period of 3 to 5 months. According to Rachmat *et al.*, 1999, the oil palm plant (Elaeis guineensis) is most suitable to be planted in areas with a dry season criteria <1 and the ideal annual rainfall is 1750-3000 mm. Kotabaru that has a climate type A suitable for oil palm plantation.

Table 4. Recommended hardwood / plantation based on climatic type in South Kalimantan.

No	Regency / City	Climat type SF	Recommended Plant
1	Tabalong	B	Karet, Sengon
7	Balangan	*B dan C	Karet, Sengon, Jati
3	Hulu Sungai Utara	B	Karet, Sengon
7	Hulu Sungai Tengah	*B dan C	Karet, Sengon, Jati
5	Hulu Sungai Selatan	B	Karet, Sengon
6	Tapin	B	Karet, Sengon
7	Banjar	B	Karet, Sengon
8	Tanah Laut	B	Karet, Sengon
9	Tanah Bumbu	B	Karet, Sengon
10	Kota Baru	A dan *B	Kelapa Sawit, Karet, Sengon
11	Barito Kuala	B	Karet, Sengon
12	Banjarbaru	B	Karet, Sengon
13	Banjarmasin	B	Karet, Sengon

Description: * The dominant climatic type

According to Endert in 1949, in Djikman, (1951) the rubber plant (Ficus elastica) is most suitable to be planted in an area with a dry season between 0-3 and the ideal annual rainfall is 2500-5000 mm, South Kalimantan with climate type A - B is suitable for rubber plant. In addition, Sengon plant also matches the climate type B. This tree has a very high evapotranspiration rate that requires a wet climate with annual rainfall 2000 - 3500 mm in order to grow optimally. In its natural habitat, annual rainfall that occurs between 2000 mm to 2700 mm.

Climatic type C indicates the condition of Fairly Wet. The suitable vegetation types in this climate are jungle vegetation, wet months periods 7 - 9 months and dry period 3 - 5 months. Vegetation of the jungle forest include the type of vegetation that leaves fall in the dry season. Teak plants are one of the plants that abort leaves in the dry season. According to purwowidodo in 1991 teak plants need a climate with a minimum rainfall of 750mm/year, optimum in rainfall 1000 - 1500 mm/year and maximum 2500 mm/year. According Suryana in 2001, physical rainfall and physiology affect the nature of leaf fall and quality teak wood products.

Conclusion

Validation of GSMaP satellite rainfall data and surface rainfall for monthly data series showed a strong and positive correlation value with an average correlation value of 0.76 and RMSE of 100.80 mm/month (3.36 mm/day). As for the average monthly average correlation value of 0.89 and RMSE of 43.10 mm/month (1.43 mm/day). This shows that GSMaP satellite data is very possible to be used as data replacement of surface rainfall data with spatial resolution reaching 11.6 km. The Schmidt - Ferguson climate zonation mapping based on GSMaP satellite data in southern Kalimantan is divided into 3 climatic zones of climate types A, B and C. In general, South Kalimantan is dominated by climate zones B. Plantation management planning based on Schmidt - Ferguson climate zonation analysis is recommended

for Type A climate zone can be done planting activities of Oil Palm and Rubber. Type B climate zone can be done planting activities of Rubber and Sengon. Type C climate zone can be done teak planting activities.

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