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The Paddy Cropping Calendar Map In Tidal Swampland Field Of South Kalimantan

Nur Wakhid [1,]*and Haris Syahbuddin[2]
[1] Indonesian Swampland Agricultural Research Institute
Jl. Kebun Karet, Loktabat Utara, Banjarbaru, Kalimantan Selatan
[2]Center for Assessment and Development of Agricultural Technology
Jl. Tentara Pelajar, Bogor, Jawa Barat
*Corresponding author e-mail: n_wakhid@yahoo.com

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Abstract

Tidal swampland is one of sub optimal land that potential as a backup of fertile field in Java island. However, due to the global climate change, negatively impact the paddy production including the cropping time that shifted year by year. Therefore, the objective of this study was to develop a cropping calendar map of tidal swampland in three conditions, i.e. dry, normal, and wet years. This map was developed by analyzing the relationship between precipitation and tide overflow data. Also, primary data from field survey and farmer questionnaire were used for verification. The area was delineated by cropping calendar combined with administration, climate, tidal swampland, and rice field map. Using this map, the cropping time in tidal swampland field can be potentially increased become twice a year. By proper cropping time, the paddy production in tidal swampland of South Kalimantan also potentially will increased directly.

Keywords: climate change, precipitation, overflow, dry, normal, and wet year

1. Introduction

The Indonesian government has targeted rice production in 2015 reached 73.40 million tons of dry milled grain. These targets can be achieved by varying strategies such as increase new rice field, increase agricultural production, and increase the cropping index (IP). The increasing of agricultural production by open new fields doesn't enough if only on irrigated land, but also need to utilize other suboptimal land such as swampland. Swamplands divided into two types: fresh water swampland and tidal swampland. Fresh water swampland affected by the local water and water shipments from the upstream area, whereas tidal swamp land was affected by the tide and or rivers, either directly or indirectly (BBSDLP, 2006). Swampland has a huge prospect for the future food storage. Moreover, it can be used as a reserve for alternative rice shortage in September, October, November and December where irrigated land on the island of Java suffered during the fallow season (Syahbuddin et al. 2010).

Swampland, especially tidal swamp land, is one of sub-optimal land that has great opportunities to be developed as an area of rice production (Sesbany and Vandalisna without year; Suprianto H. et al. 2010). Base on the topography and tidal overflow there are several class of tidal swampland i.e. (1) Type A: overflowed by high and small tidal (both in wet and dry season), (2) Type B: Overflowed by only high tidal (only in wet season), (3) Type C: Not overflowed, but has shallow water level, and (4) Type D: Not overflowed by tide, or independent from tidal influence (Suryadi 1996). Djamhari (2010) concluded that swampland requires the suitable planting season for rice crops. In addition, the cropping index (IP) of paddy in tidal swampland still low (IP 100). Whereas rice development in tidal swamps land can only be reached through two approaches, increasing the productivity for crop planting season I and increasing the IP 100 to IP 200 (planting seasons II) (Busyra, et al. 2014). Most farmers in South Kalimantan still plant rice once a year using local varieties with different physiological of age variation between 6-10 months with low productivity (2-3 t / ha).

The Agency for Agricultural Research and Development started making maps crops calendar from volume I- IV at 2007, i.e. crop calendar for irrigated agricultural land in Indonesia at the level review of scale of 1: 250,000. This map illustrated the potential for crop planting pattern based on the dynamics of climate resources (Las, et al. 2007, 2008, 2009a, 2009b, 2010; Lubis and Daya 2017). Another challenge that must be faced were changing of climate dynamics such as changes in rainfall patterns, the intensity and frequency of drought periods (El Nino) or wet (La Nina). Climate change was impacted on the shift of start and end of the growing season and have a negative impact on cropping patterns as well as crop productivity.

The cropping calendar map of tidal swampland were considering of the rainfall prediction, and the fluctuations of the overflow. Tidal swampland is special swampland where the irrigation type relies on the flow of river water. Besides that, the condition of soil and water also different from another land in general (Sesbany and Vandalisna, without date; Ma'as 2003; Nazemi D. et al. 2012; Alwi M. 2014; Lubis et al. 2017). This research was aimed to develop a cropping calendar map of tidal swampland in South Kalimantan in three conditions climate years i.e. dry year/ el nino (TK), normal year (TN), and wet year/ la nina (TB). The map was expected to be used as a guide to determine the potential of paddy rice planting time of tidal swampland in South Kalimantan, Indonesia.

2. Methods

Compilation crops calendar map conducted in tidal swamp land in South Kalimantan from 2011 to 2012. The analysis was done until the district level. Algorithms and analysis used in crops calendar map of tidal swamp is combination analysis between the prediction of rainfall and fluctuations of overflow in tidal swampland. Therefore, the analysis conducted on the tidal swampland crop calendar is somewhat different with the existing irrigated crop calendar (Las et al. 2007, 2008, 2009a, 2009b, 2010). The method almost same with cropping calender map for fresh water swampland, but in here we used the tide overflow data (Wakhid et al., 2015).

The data collection consists of: 1) daily rainfall data over the last 30 years (1981-2010) in South Kalimantan tidal swampland. The data collected from 12 stations of climate stations Meteorology, Climatology and Geophysics (BMKG) in 7 districts, the Ministry of Public Works (PU), and the Center for Food and Horticulture Plant Protection (BPTPH); 2) Planting area data of paddy field at last 10 years (2000-2010) from the Central Statistics Agency (BPS); 3) Data prediction of rainfall characteristic at 2011/2012 of growing season from BMKG; 4) Data of tidal inundation overflow dynamics from Swampland Agricultural Research Center (2010); 5) Primary data of farmer questioner in tidal swampland (47 respondents, the main question including water level, peak planting dates, crops rotation and cropping intensity); 6) Map of earth form and map of administrative from the Geospatial Information Agency (BIG); 7) map of swampland and rice from the Central Agricultural Land Resources (BBSDLP); 8) isohyets map of South Kalimantan, which refers to the agro-climatic zone of South Kalimantan modified from agro-climatic map by Oldeman et al. (1977, 1980) and consists of 6 classes (Las et al. 2007)

The study was conducted in several stages of activities:

(1) Analysis of precipitation data. At this stage, analysis of precipitation prediction was appropriate with the criteria of onset (early season). Then determination of onset was done by changing the daily data into average data per ten days. Onset criteria using the 10 daily data, where every month has three criteria, i.e. onset I, II, and III. Criteria for onset based on the dynamics of atmospheric circulation patterns (Inter Tropical Convergence Zone). In the tropics region, most of Indonesia region began the rainy season at October and dry season at April. Criteria of onset are presented in Table 1.

Table 1. Decadal onset group of cropping calendar for paddy on tidal swampland

Group	Onset	Group	Onset
1	Sep I – II	10	Mar I – II
2	Sep III – Okt I	11	Mar III – Apr I
3	Okt II – III	12	Apr II – III
4	Nov I – II	13	Mei I – II
5	Nov III – Des I	14	Mei III – Jun I
6	Des II – III	15	Jun II – III
7	Jan I – II	16	Jul I – II
8	Jan III – Feb I	17	Jul III – Ags I
9	Feb II – III	18	Ags II – III

Source: Las et al. 2007

I, II, III identifier describe as the ten days class I, II and III in every month.

(2) Analysis of water level due to overflow in tidal swampland. Criteria for onset determination in tidal swamp land based on the water level due to the overflow that can be tolerated by the rice crop, which is about 35 cm from the ground. The criteria are: (1) based on the amount of rain that occur 50 mm/10 days 2 times, consecutively in tidal swampland type A and B, (2) the incidence of rainfall of 50 mm/10 days 3 times, consecutively for tidal swampland type C and D. These criteria determined based on the acidity of tidal swampland that reduced in the dry season. When the rain began and fill the soil pores, it is expected as compensation for water loss through evapotranspiration of rice plants. Tidal swampland types A and B need rainfall amounts smaller than the type of C and D because it is closer to the body of the river and the waterfront. Rainfall here is calculated in mm/10 days. Hydrological conditions of tidal swampland affected by: drainage, water retention, and water inputs (Ngudiantoro, 2010).

(3) Determination of the dry year, normal year, and wet year. Those three of climate events were determined through analysis of rainfall data and compare the year rainfall with average of normal rainfall. Forecast of rainy season using 10 days unit was compared with average rainfall early in the season 1981-2010 period. Climate variability is characterized by the nature of rain below normal, normal and above normal, which is indicated by the forward and backward of the rainy season from normal condition. The criteria forward and backward per ten days using forecast issued by BMKG in each season zone in South Kalimantan for the 2011/2012 planting season.

(4) Preparation of tabular data crop calendar of tidal swampland including the results of onset, planting area, wide of tidal swampland and rice area in the tidal swampland. Preparation of tabular data

was done by analysis of rainfall data and data from BPS.

(5) Preparation of cropping calendar map. The crop calendar map was done by overlaying and overlapping administrative maps, tidal swampland maps, rice paddies maps, and the analysis of cropping calendar. Determination of potential planting calendar was done by analysis of rainfall data and water level due to overflow. Results of analysis then mapped based on the location with same onset. The process was followed by extracting these maps in tabular form. The process of onset mapping uses a combination of three climate scenarios and 4 types of tidal swampland. In other word there are 12 patterns of onset mapping.

(6) Repair tabular data on crop calendar based on data from mapping.

(7) Field verification. Verification was done by field survey and farmer interview. The survey was conducted based on maps that had created by deliberately choosing of paddy center in tidal swampland and then tagging with GPS. Then farmer interviews were conducted during the survey with a list of questions that had prepared.

(8) Repair maps and tabular data based on the verification field.

Following was a framework compilation of crop calendar map in South Kalimantan tidal swampland (Figure 1).

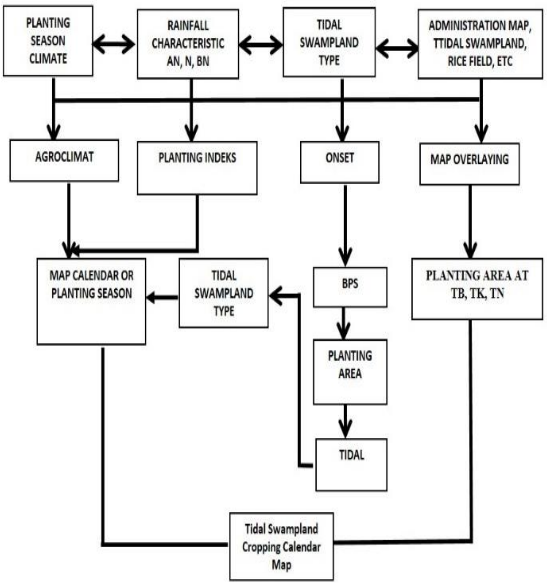


Figure 1. Flow diagram of crop calendar map development for paddy in south Kalimantan tidal swampland (modification from Wakhid et al., 2015)

3. Result and Discussion

Description of tidal swampland in South Kalimantan

Area of tidal swampland in South Kalimantan reached 168.826 ha (Table 4), with widest area of tidal swampland paddy fields located in the District Tabunganen, Barito Kuala that covering 12.517 ha. The peak of growing season in South Kalimantan occurred in March.

For crop calendar existing in tidal swampland, rice field in the area of swamp ecosystem is used as standard area of paddy field in each land typology. Due to wide fluctuations of rice field in swampland follows a pattern of high tide and tidal sea level, so the width of standard area also changes. In this paper, we use the wide standard of paddy field at 2010 per sub-district. The number of sub-districts in South Kalimantan, which has paddy field in tidal swampland can be seen in

Table 2.

Table 2. Amount of district in South Kalimantan Province that have paddy fields in tidal swampland typology

District	Paddy Field (ha)	Amount of Sub District
	Tidal Swampland	Tidal Swampland
Balangan	-	-
Banjar	33.272	6
Banjarbaru	1.634	1
Banjarmasin	1.755	4
Barito Kuala	94.970	16
Hulu Sungai Selatan	-	-
Hulu Sungai Tengah	-	-
Hulu Sungai Utara	-	-
Kota Baru	1.640	8
Tabalong	-	-
Tanah Bumbu	3.676	2
Tanah Laut	12.819	4
Tapin	19.060	2
Total	168.826	43

Source: Data analysis from BPS 2011.

The paddy field on tidal swampland usually have problems on soil fertility conditions, such as acidic, pyrite, and salinity at long dry season (Sesbany and Vandalisna, without date; Ma'as 2003; Nazemi D. et al. 2012; Alwi M 2014). But, to grow rice in the tidal swampland usually easier for farmer than the other land because the water inundation was shallow and faster on farmer adaptation (Goddess Yanti, N. et al., 2003; Fauzi Makki M. et al. 2012).

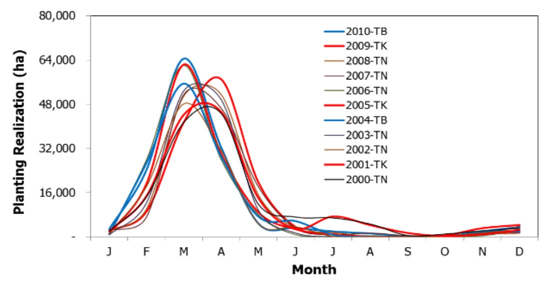
Rainfall and estimation of early planting season

Rainfall in South Kalimantan is significantly lower, varying between 1900 and 3000 mm per year with an overall average around 2800 mm (Ritzema, H., and Wösten, H. 2002). Season zone in South Kalimantan province was estimated occur in October 2011, i.e. between 10 days group I - III in October, 2011. While the characteristic of rainy season at 2011/2012, generally estimated to Normal (N) to Above Normal (AN).

Comparison of early season of 2011/2012 with monsoon zone in some regions of South Kalimantan have average forward 1-2 group of 10 days and in some other district decline with average 2 group of 10 days. The beginning of rainy season was in northern of Barito Kuala, middle of Barito Kuala, southern of Barito Kuala, western of Banjar and southern of Tapin with average forward 1 group of 10 days. While the beginning of the rainy season in northwestern part of Barito Kuala, middle part of Banjar, eastern part of Banjar, southern part of Banjar, Banjarbaru, northern part of Tanah Laut, Hulu Sungai Selatan/ eastern part of Tapin, northeastern part of Banjar, and northwestern part of Tanah Bumbu have average forward at 2 group of 10 days. The beginning of the rainy season in Tanah Laut area have average decline 1 group of 10 days. While southern part of Hulu Sungai Tengah, western part of Hulu Sungai Selatan, northern part of Tapin and southern part of Hulu sungai Utara have average decline 2 group of 10 days (BMKG 2011).

Realization of planting time existing

The realization of farmer planting time in tidal swampland made after sufficient of rainfall was predicted dissolve the iron content in the water. Realization of dominant planting in in South Kalimantan tidal swampland occur at group of 10 days 7 or about March (Figure 2).



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TB = Wet year, TK = Dry year, TN = Normal year.

Figure 2. Pattern of decadal planting area in south Kalimantan realization tidal swampland for 2000-2010.

The peak of growing season in tidal swampland was affected by many things. One of them is limited manpower, so the growing season shifted from the proper season. Monthly growing season presented in Table 5.

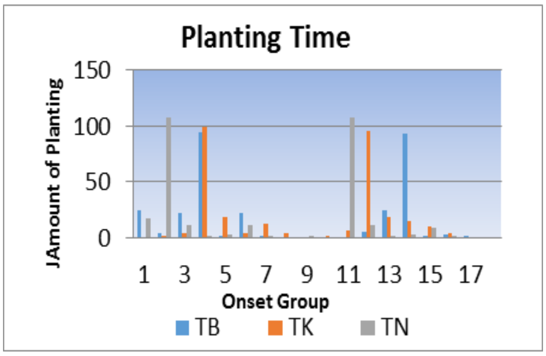
Table 5. Peak Realization of planting Decades (means of peak realization from 2000 to 2010).

Swamp type	Overflow Type	Rainy Season		
		TK	TN	TB
Tidal Swampland	A	March	March	March
	B	March	March	March
	C	March	March	March
	D	-	-	-

The dominant varieties (95%) used in South Kalimantan were local varieties such as Siam which has aged about 10 months. Superior rice varieties only planted only on small fraction (5%). Mostly in the paddy fields of Transmigration Settlement Unit area, they plant local combine with superior varieties. Index of paddy cropping in South Kalimantan swampland is low or less than 1. It was seen in the dry season that total area of planting were less than the standard area. In the dry year total planting area dry ebb only 86% of the raw tides. Cropping index in normal and wet years is much lower, respectively 82% and 81%. Although the potential for planting in dry year wider than in normal and wet years, the rice cropping index in lowland swamp land in South Kalimantan is still low, at less than IP 100. It can be seen in dry years, where the IP is only 68.40%, while in normal and wet years are lower, 39.33% and 57.04% respectively. The opportunity for increasing the IP in tidal swampland is still huge, particularly in the second growing season because the inundation on tidal swampland began to decrease as well as rainfall reduction. In first and third growing season were difficult due to high rainfall or inundation, and dry soil condition, respectively.

Potential Crop Calendar (wet, normal, and dry years)

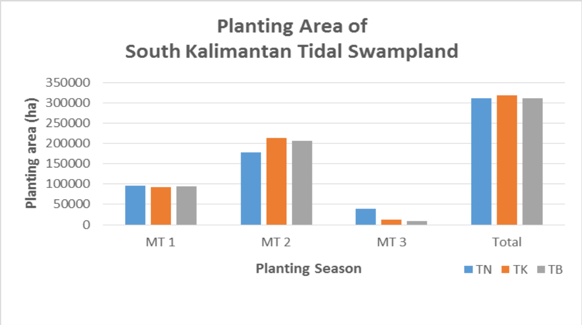
Based on the analysis of potential planting time (Figure 3), the time of rice planting in the South Kalimantan tidal swampland starting at end of September and end of March. It is normal because in September usually the rain already started and the soil was wet, while inundation in March is not too high.



Onset group 1: SEP I-II, 2: SEP III-October I, etc. according to Table 2

Figure 3. Graphs of the cropping calendar time for paddy in south Kalimantan tidal swampland

Standard area of tidal swamp paddy field in South Kalimantan is 325.007 ha. The widest planting area occurred in the dry area of 318.258 ha. While in normal and wet years are 310.521 ha and 310.522 ha, respectively. It suggests that rice cultivation in paddy fields of tidal swampland had a little effect of climate change, including normal year, wet year, and dry year. Tidal swampland showed substantiality in the face of climate change. This potential cropping patterns indicates that the tidal swampland paddy has a huge opportunity to increase the planting season become twice/year. Based on the analysis of crop calendar potential (Figure 4), the widest of planting area potential occurs during planting season 1 (MT 1, i.e. 2-8 group onset, or around end of September until early February), for dry, wet and or normal year.



MT = planting season
MT 1: Group Onset 1-6, September to December;
MT 2: Group onset 7-12, January to April; and
MT 3: Group onset 13-18, May to August
Figure 4. Area of cropping potential of crop calendar at season MT 1, MT 2 and MT 3.

Potentially, paddy field of tidal swamp land can be planted with rice twice a year. Therefore, it required effort to organize the drainage network, preparation of infrastructure at a time, and farmers' understanding of the behavior of tidal swampland, where upon the rainy season, the arrangement of soil fertility and seedling should be ready. The peak season of planting time by farmers in all typology of tidal swampland paddy field occurs in March and April. The peak of planting season that obtained from farmer interview was similar to the results of analysis of existing planting season with an average time of planting was in March. While, the results of analysis of potential growing season also showed that the growing season can be started in March until April at MT 2. The result of this verification shows that the existing planting season (BPS data and interview farmer interviews) and the potential growing season showed a similar pattern in peak planting i.e. from March to April.

Conclusion

Crop calendar map in South Kalimantan tidal swampland successfully prepared based on three climate conditions and expected can be useful as a guide to determine the potential timing of planting in tidal swampland to increase the rice production. Using this crop calendar, paddy planting time in tidal swampland potentially could be increased from 1 to 2 times/year on three climatic conditions. Potential of largest planting area in tidal swampland occurs in conditions of dry years, although it is not too different from the wet and normal years. This map can be open online as a part in www. katam.litbang.pertanian.go.id.

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