Application of Online Information System for Delivering the Rice Planting Time Prediction in Indramayu

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Abstract:

One of the impact of rainfall pattern change is that farmers are difficult to determine the planting time. The solution to this problem is role of climate modeling improved to the highest resolution and accuracy to help farmers in determining the planting time accurately. This paper describes the research resulting the Geographical Information System (GIS) implemented to the planting time prediction that the prediction previously has been produced. A climate model using the stochastic approach and modifying the function of fourier and polynomial to be implemented in predicting the rice planting time in Indramayu has shown the higher accuracy, namely up to 0.85 of correlation in forward prediction and 0.82 of R-Square in backward prediction.

The information delivery system has been developed online and provides the information on rainfall and planting time prediction as well as the space for feedback from the agricultural stakeholders to evaluate the shown prediction in Indramayu. The method used to get this results including mapping on rice planting prediction, converting the format file, developing database system, developing website, and posting website. Because of this map was overlaid with the google map, the map files must be converted to the .kml file format.

The result is the online information delivery system providing the rice planting time and rainfall prediction in form of maps in highest resolution and accuracy to be used by farmers in Indramayu to make strategy for the forward planting time. In addition, the space of feedback is also provided to evaluate the results of prediction in order to improve the accuracy.

Keywords: accuracy, Indramayu, information delivery system, planting time prediction, rainfall prediction

Introduction

Climate change has been occurred in all parts of the world that impacts on almost all sectors, including economics, environment, health, agriculture, and others (Thomas, et al., 2006). The change of rainfall pattern is one of the impact of climate change and it's very difficult to predict using the simple modeling. Meteorological data such as rainfall became lost in its periodic nature due to the unstable and non-stationer variation.

The agriculture is one sector impacted by changing of rainfall pattern that was studied in this research and described on this paper. The variability of climate, including rainfall variation, is fitting using the complex climate model, therefore the model can predict in the forward time. The model in question is the mathematical modeling, where the data is processed with mathematical methods to produce an equation or function that can follow the data (Farhamsa, et al., 2008). The model was created to make quantitative predictions (deterministic or probabilistic), which can be used both to test and refine the previous model, or for practical use (Howison, et al., 2005). The predicted rainfall was then produced to be map that is needed to estimate rice planting time.

The modeling method used in this research was using stochastic climate approach that the resolution depends on the number of observation points in the climate of an area being studied. The more observation stations, the higher the resolution of the predicted outcome. In this study, it will be developed and evaluated one of the stochastic climate models to be implemented in local area coverage. Stochastic model in question is the climate models using Fast Fourier Transform and Non-Linear Least Squares. This is a function of climate model predictions choose the function that has the smallest error factor. In this study the rainfall data will be enumerated by the method of Fast Fourier Transform (FFT) to see the periodic nature then modeled by non-linear least square method. Results of rainfall prediction using the FFT method was evaluated against observational data to test their validity using correlation method.

Furthermore, the information on rainfall and rice planting time prediction will be uploaded to website server to produce the information system that is available for agricultural stakeholders, including agriculture agencies, extensions, and farmers in Indramayu. This region is the study area, because the region is one of the main production area in West Java Province.

Data and Method

The data used in this study is a secondary data obtained from observations of rainfall stations of the Meteorology, Climatology, and Geophysics Agency (BMKG). This data is in the form of daily rainfall observational data of 11 locations in the Indramayu district, over a period of 27 years (1982 to 2009). As for the implementation of the farm, the research also used a rice field maps in Indramayu region.

The climate model development using Fast Fourier Transform and Non-Linear Least Square method was processed by several steps that these measures are based on the inversion method to obtain the best model (Aster, et al., 2005). The daily rainfall data was set to be 10 days each months to be dasarian rainfall data and processed in the climate modeling.

Direct model analysis is the first step in modeling the climate. The goal is to find a stable and stationary initial model which this model reflects a pattern of weather data is pure without any interference and noise in the data. Rainfall data for one location was analyzed by least squares curve fitting to generate the corresponding function to the data. Function used as a fitting curve is taken out of the equation commonly used in modeling. Algorithms used in the Least Square method is Levenberg-Maquardt algorithm which is a standard algorithm for non-Linear Least Square processing.

The next step is to analyze the periodic characteristics of the climate and weather data anomalies. The goal is to get the information on the recurrence pattern of weather anomalies. This step is done with the assumption that the pattern is a periodic weather anomaly. Data anomaly is a deviation of weather data for weather models that are considered as pure pattern for the studied area. Weather models in question are early models produced in the first step. To get the values of frequency anomaly data, the method used is the discrete Fast Fourier Transform. This method serves to change the time domain of rainfall data into the frequency or period of rainfall data. The output of this step is the predominant frequencies of rainfall data that identifies an anomalous weather pattern that will recur.

The last step is to refine model that has been generated in the first step. With this refining, the model was able to reflect expected changes in weather patterns are non-stationary (Farhamsa, 2011). Verification of the model will be two steps, namely verification using R-Square comparing of the predicted monthly rainfall results against observational data during 1982-2007 and verification using R-Skill comparing of the predicted monthly rainfall results against observational data during 2008.

To verify the results of monthly rainfall prediction, we used the method of R-Square and R-Skill computation on every rainfall prediction in the same station. If the results of R-Square has not met the criteria received an outcome prediction, the modeling will be iterated from an early step to obtain the results of acceptable R-Square and R-Skill. The experts generally stated that a higher correlation of 0.8 is the most good, and less than 0.5 is weak (McLean, 2006).

In the case of R-Square and R-Skill is accepted, map of spatial predictions for rice planting time will be created based on criteria that monthly rainfall is greater than 50 mm per dasarian (Oldeman, et al, 1980). If the monthly rainfall is more than that amount, then the region has been allowed to start rice planting.

The rainfall and rice planting time prediction is then sent to web server. To build a web-based information systems, the programming was using PHP and using MySQL database. The prediction that have been generated by the model will then be directly in-entry into the database. Interface in the browser will display the time of prediction and climate, furthermore, the browser will be able to directly show the spatial map format in accordance with the desired prediction time. Website which will be built in the form of research that can display dynamic web content that can be changed automatically. This website will have a database to store contents that will be displayed. The database will be read by the server and displayed in an informative maps and easily understood by agriculture stakeholders (agriculture agencies, extensions, and farmers).

Result and Discussion

Firstly for the result, the validation results was shown in this paper. Table 1 show the result of verification at all stations indicated by R-Square, R-Skill, and RMSE. R-Square indicates the accuracy of backward model prediction to the historical rainfall data during 1982 to 2007. The highest R-square was obtained in Jutinyuat, namely 0.82. While R-skill indicates accuracy of the forward prediction model to the rainfall data in the same year. In this experiment, the rainfall data in 2008 was tested to the dasarian predicted rainfall, where the highest R-skill is obtained in Bondan station reaching 0.82. RMSE was also considered to indicate the error of predicted rainfall value to the rainfall data. The lowest RMSE is obtained in Bondan station, about 31.23

No	Rainfall Station	R-square (1982-1007)	R-Skill (2008)	RMSE (2008)
1	Anjatan	0.77	0.74	65.44
2	Bondan	0.76	0.82	31.23
3	Bugel	0.72	0.73	35.10
4	Cidempet	0.76	0.79	49.55
5	Cikedung	0.77	0.68	43.43
6	Gabuswetan	0.79	0.76	34.55
7	Indramayu	0.80	0.77	50.86
8	Jatibarang	0.74	0.70	46.03
9	Jutinyuat	0.82	0.65	65.11
10	Kedokan Bunder	0.81	0.73	44.60
11	Krangkeng	0.81	0.63	53.56
	Average	**0.78**	**0.73**	**47.22**

Table 1. Verification result of dasarian rainfall prediction in 2008

In general, there are three causes of local rainfall in Indonesia, namely orographic, convective, and convergence. An orographic rain occur due to the high topographic structure. A convective rain occur due to heating by the sun on the oceans. And, convergence rain occur due to air mass meeting at the center of low pressure.

Of the three types of causes rain because the local effects, there are two possibilities that occur in Indramayu district, namely convective and convergence, because Indramayu district does not have characteristics of a high topography variation.

Actual rainfall patterns in the area of Indramayu was normally only affected by monsoonal pattern (Estiningtyas, et al., 2011). There are two possible causes of the rainfall occurs in Indramayu district, namely convective and convergence factors. Because along the boundary line of Indramayu region bordering the ocean, this condition causes the rain is raised by the presence of convective clouds due to dominant solar heating to ocean. Mostly in the first 6 months (January to July), Indramayu region always occurs rain started in the north and further to the south. Shift in rainfall from north to south is also due to the high air pressure differences between land and ocean causing the sea breeze especially in the afternoon, the sea breeze blowing from sea to land and bring moist air mass to the mainland Indramayu. But as a whole, the Indramayu region occur a three wet month from December to February and four dry month from July to October (Slamet, et al., 2001).

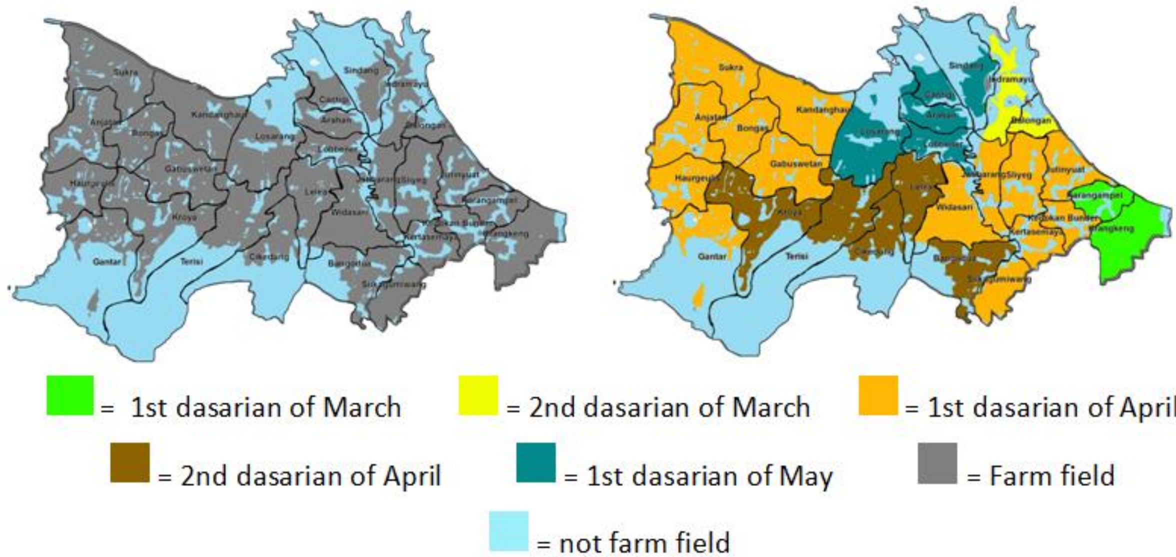

Figure 1: Prediction map of rice planting in the dry season 2013 in the Indramayu district: (a) farm field map of Indramayu, (b) map of Indramayu + rice planting predictions

The following is a map of the rice planting prediction in the district of Indramayu in the dry season 2013 showed in Figure 1. In the dry season 2013, the Indramayu district is divided into 5 time of planting. At 1st dasarian of March 2013, the beginning of the rice planting can be done for at Krangkeng and Karangampel. 2nd dasarian of March, the region can start planting in Balongan and Indramayu district. 1st dasarian of April 2013, the region can start planting in Sukra, Anjatan, Bongas, Haurgeulis, Gabuswetan, Gantar, Kandanghaur, Widasari, Jatibarang, Sliyeg, Jutinyuat, Kertasemaya, Sukagumiwang, and Kedokan Bunder. 2nd dasarian of April 2013, the region begin planting in Kroya, Terisi, Cikedung, Lelea, and Bangodua. 1st dasarian of May 2013, the region could begin planting in the district of Losarang, Lohbener, Arahan, Cantigi, and Sindang.

Then, the information on rainfall and prediction of rice planting time are included on the server to be a system of delivery system on agriculture. This system will be accessed by agricultural stakeholders, including agriculture agencies, extensions, and farmers. The figure 2 show the illustration of information agriculture that will update the rainfall and rice planting prediction in Indramayu. This interface is overlaid with several maps, such as google map, administrative map, and rice field map. The rice planting time prediction is created dynamically, therefore if there is updating on rainfall prediction, it will update automatically on rice planting time.

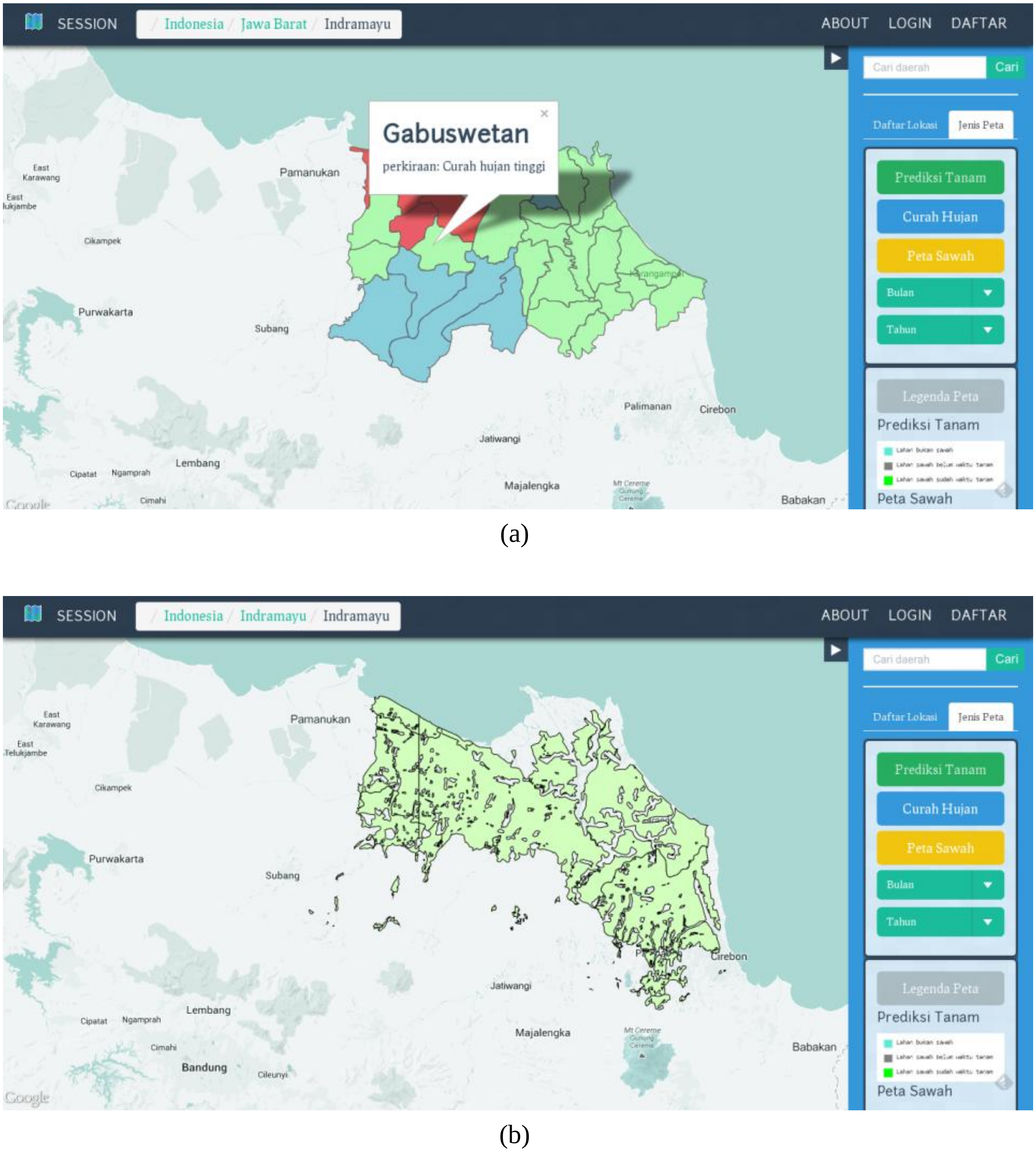

Figure 2: Illustration of information system on agriculture: (a) rice planting time prediction, (b) rice field in Indramayu

Conclusions

The information on agriculture, including rainfall and rice planting time prediction, is needed by farmers to solve the problem on difficulty of planting determination due to the impact of rainfall pattern. Therefore, the climate model that has already been developed, is very helpful for farmers with the highest accuracy and resolution. Based on the performed research, some results are as follows: (1) the results of the verification of rainfall prediction suggests that climate models is valid for use in Indramayu areas that have achieved average R-Skill of 0.73, (2) the highest R-skill achieved in the station Bondan, amounting to 0.82 with a RMSE of 31.23. At this region, the planting season in the dry season 2013 will begin on 1st dasarian of April 2013 and in the rainy season 2013 will begin in 3rd dasarian of October 2013, (3) dasarian rainfall prediction shows that average rainfall variability in the district of Indramayu will be more dominant caused by local factors, ie differences in land and sea, especially those occurring in the northern area of Indramayu, and (4) early planting of rice in Indramayu district is generally done after the collection of rainfall during the 2-3 dasarian with rainfall amount of 50 mm per dasarian. Website information system on agriculture in Indramayu must be updated with the newest information and should be embedded with the social factors that can effect to planting time changing.

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