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Weighted Ensemble Prediction System Model for Monthly Rainfall Total in Indramayu District, West Java, Indonesia

Yunus Subagyo Swarinoto [a]*, Yonny Koesmaryono [b], Edvin Aldrian [c], Aji Hamim Wigena [d]

[a] *Meteorological Center, BMKG, Jl. Angkasa I/2, Jakarta 10720, Indonesia*
[b] *Bogor Agricultural University, IPB Campus, Darmaga, Bogor 16680, Indonesia*
[c] *Research & Development Center, BMKG, Jl. Angkasa I/ 2, Jakarta 10720, Indonesia*
[d] *Bogor Agricultural University, IPB Campus, Darmaga, Bogor 16680, Indonesia*
[a]*Email: yunusbmkg@live.com*
[b]*Email: yonny_ipb@yahoo.com*
[c]*Email: edvin.aldrian@gmail.com*
[d]*Email: ajiwigena@ymail.com*

Abstract

Water distribution is very crucial especially in regions vulnerable to the water availability. The events in the specific region of Indramayu District, West Java Province, Indonesia, has a sequential above normal monthly rainfall condition capable of causing flooding. This natural hazard occurs because Indramayu is a coastal lowland which receives water from adjacent districts especially during rainy season. Meanwhile the sequential below normal monthly rainfall is factually able to trigger drought occurrences. This condition proves Indramayu to be a very sensitive area to the water availability. Coping with this situation, the optimal rainfall prediction is urgently needed. The Weighted Ensemble Prediction System (WEPS) model based on several output of Single Prediction System (SPS) models such as ANFIS model, Wavelet-ANFIS model, Wavelet-ARIMA model, and ARIMA model of monthly rainfall, has been simulated in this district. The WEPS model was developed in order to minimize the inconsistent result of SPS models output. This WEPS is prepared based on the weighting values taken from each SPS models output.

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* Corresponding author.

The weighting values are computed based on the Pearson correlation coefficients (*r*) produced during the training period of 1991-2000 of observed data series. These *r* values are computed in order to understand the agreement of models output to its observed data. All the rainfall stations (total of 16 sites) in Indramayu District ran the SPS and WEPS models to get the output of monthly rainfall total prediction. After computing *r* and Root Mean Square Error (RMSE) of monthly rainfall prediction, the models' output were plotted spatially in order to provide thematic maps. The chosen spatial interpolation method to provide the thematic maps is the Inverse Distance Weighted (IDW) method. The prediction result of 2001-2009 SPS and WEPS models running shows; *r* = +0.45 - +0.75 for ANFIS; *r* = +0.20 - +0.46 for Wavelet-ANFIS;*r* = +0.43 - +0.86 for Wavelet-ARIMA; *r* = +0.24 - +0.64 for ARIMA; and *r* = +0.58 - +0.89 for the WEPS. The RMSE values of the WEPS model output have been computed in order to know the accuracy of model output in the field. Spatially, the output of WEPS model output of monthly rainfall total within Indramayu shows consistently better results in comparison to the output of original SPS models output used with higher value of *r* and lower value of RMSE. This is caused by the proper use of weighted values in WEPS equation to construct the WEPS model applied to simulate the prediction of monthly rainfall.

Keywords: Monthly Rainfall; WEPS; SPS model.

1. Introduction

1.1. Background

Rainfall as a climate element, plays an important role in tropical regions, a typical example is Indonesia [11]. The role is even bigger with the demography of the tropical region such as in Java Island, where there are relatively clusters of densed settlements compared to other major islands in Indonesia. Most notable is the northern low land of Java Island, where there are a lot of paddy plantations, the settlement and its surroundings continually rely on abundant water availability for their daily lives.

Indonesia is considered as a maritime continent [14], whose area is surrounded by more water body than land body. The total water surface may reach approximately 70% of the whole Indonesian territory. The Indonesian terrain has a complex topography that may anticipate complex water availability in the form of mountain and valley [13]. Indonesian area that is located around the equator also has high rainfall variability [1, 7, 8, 19]. Moreover, climate element especially rainfall influences various sectors [18] such as agriculture, forestry, maritime, infrastructure, etc.

Many locations in Indonesia are vulnerable to this rainfall condition [2, 20]. In the very specific location such as Indramayu District, West Java Province, Indonesia, the sequential occurrences of above normal rainfall condition may cause floods. As coastal lowland in Northern part of Java Island, this district has also received water from the adjacent districts especially during rainy season. On the contrary, the sequential occurrences of below normal rainfall condition may cause drought. This fact is merely caused by the sensitivity of surface environment to the water availability. As a matter of fact, the intensity and the length of rainfall occurrences are very important factors that influence those conditions. For example, severe long drought related to the forest and wild fire would affect air pollution condition.

With regard to this, water distribution management through irrigation is very important to be applied at certain locations [21]. If the location does not have or only has minimum irrigation infrastructure, the location will only depend on the natural rainfall. Some parts of Indramayu have no facility of technical irrigation so that the natural rainfall variability becomes a very important factor in controlling water availability. In this case, important parameters of this rainfall element among others are rainfall intensity, rainfall total, and number of rainfall occurrences [24].

Closely related to this water distribution, rainfall prediction becomes a necessity to be prepared and implemented [20]. Rainfall prediction is mainly required for operational purposes in various sectors in order to face short and medium term future planning. Rainfall prediction can be used as one method to anticipate the required or not required water availability condition from various sectors. For example, in the agricultural sector, forecasting of early rainy season is always related to early planting season, planting pattern, and even type of planting. In irrigation sector, rainfall prediction is related to water release from a dam, flood forecasting, flood early warning system, etc.

Rainfall prediction can be made using various approaches such as statistic and dynamic based approaches [21] or the combine approach. Statistical rainfall prediction relies on statistical data management, which is based on a quite long available data series [15]. Meanwhile dynamical rainfall prediction relies on the development of other atmospheric dynamic condition, sea surface temperature dynamic, sun position dynamic, and other dynamics. Some approaches combine between different statistical or dynamic models into an ensemble approach. The ensemble prediction shall minimize the bias from each individual model.

Since each single prediction model output has different reliability level, in this research it is in order to construct each SPS model into a WEPS model, Pearson correlation coefficient value (r) taken from each SPS are used during a certain training period to become weighted values. Every SPS model output is then compared to a corresponding field observed data.

1.2. Formulation of the Problem

An ensemble prediction system model is commonly implemented using global to regional scales of data grid with low spatial resolution. The result shows that global model output is often unable to show the atmospheric process complexity from meso to local scale [13]. Therefore, the prediction output of global to regional scale is not suitable to the local field condition. For this purpose, preparation of an ensemble prediction system model based on station data in meso to local scale with a high spatial resolution becomes a challenge.

Ensemble prediction system model of monthly rainfall total with weighting value for district area in Indonesia has never been conducted nationwide for operational purpose by Meteorology, Climatology and Geophysics Agency (BMKG) [3, 4, 5, 6]. Although various ensemble prediction system models have commonly been used in several world weather/climate prediction centers with output that can improve SPS model outputs. Therefore, ensemble prediction system model is necessary and interesting to be prepared for a tropical district area such as in Indonesia.

Each single prediction system model output for monthly rainfall total will have various reliability levels [25]. This level is reflected by variety of *r* obtained from each SPS model output after it was being evaluated by the respective field observation data. The result varies as obtained in review at several locations in Indonesia area [6]. The higher the *r* obtained, the closer the resemblance of rainfall distribution pattern of SPS to observation value.

1.3. Hypothesis

Hypothesis used in this paper are as follows: (1) Monthly rainfall total in Indramayu District, West Java, Indonesia can be predicted using a WEPS model; and (2) WEPS model output of monthly rainfall total for Indramayu District, West Java, Indonesia has better quality than original SPS models output.

1.4. Objective

Designing, constructing, and applying the Ensemble Prediction System (EPS) model with Weighted value (w) based on *r* taken from the application of the SPS models output for monthly rainfall total in Indramayu District, West Java, Indonesia. Indramayu district is prone to water availability problem in relation to food security. For example, the paddy fields rely on the water availability. If one is able to predict the water availability using models, then if the water availability is less than normal for certain paddy field, the paddy harvest will be less. Hence, food security depends on how accurate the rainfall prediction is.

Analyzing the spatial reliability of WEPS model output for monthly rainfall total in order to understand the capability of the model to predict monthly rainfall total in Indramayu District, West Java, Indonesia. The agreement of WEPS model output to the observed data and the performance of WEPS model output spatially can be understood.

1.5. Usage

Taking advantage and empowering SPS model tools (ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, ARIMA) owned by Research and Development Center of BMKG Indonesia. Ensemble prediction system model is aimed at improving the weakness of SPS model output can be minimized [23][26]. Hopefully, model output will be more consistent and useful for operational purpose at the field. This study considers inconsistent accuracy of SPS model (ANFIS, Wavelet-ANFIS, Wavelet ARIMA, and ARIMA) after applying them in several different locations in Indonesia region such as in Balikpapan [17], in Bali [25], and in several other locations that have been reviewed by the Research Development Center of BMKG [6]. The last objective is to develop an ensemble prediction system model of monthly rainfall total obtained for operation purpose in meso-local scale in district area and understands the output quality of prepared ensemble prediction system model for monthly rainfall total.

2. Material and Method

In this paper, the monthly rainfall total prediction system model in a relatively narrow scale of district area using statistics approach commonly called “the Ensemble Prediction System” will be presented.

The Ensemble Prediction System (EPS) model [12] has an understanding as a model consisting of a group of two or more verified SPS models [9] at the same time.

2.1 Review Domain

The research was done in Indramayu District, West Java Province, Indonesia as a review domain. Indramayu District's orographically faces the Java Sea presented in Figure 1. Topography area of review domain in general is relatively low (as lowland) in northern part nearby the Java Sea and relatively high in southern part close to limestone mountains in Java Island [16]. Area of Indramayu District is located between 6°15' - 6°40' S and 107°52' - 108° 36'. Coverage area of 204,011 hectares and consisting of 118,513 hectares as paddy field and 85,498 hectares of dry land. The elevation of Indramayu District, West Java Province, Indonesia varies from 1,0 - 24,0 meter above mean sea level. There are 28 sub-districts with each range area of 17.99 - 25.41 km^2 approximation.

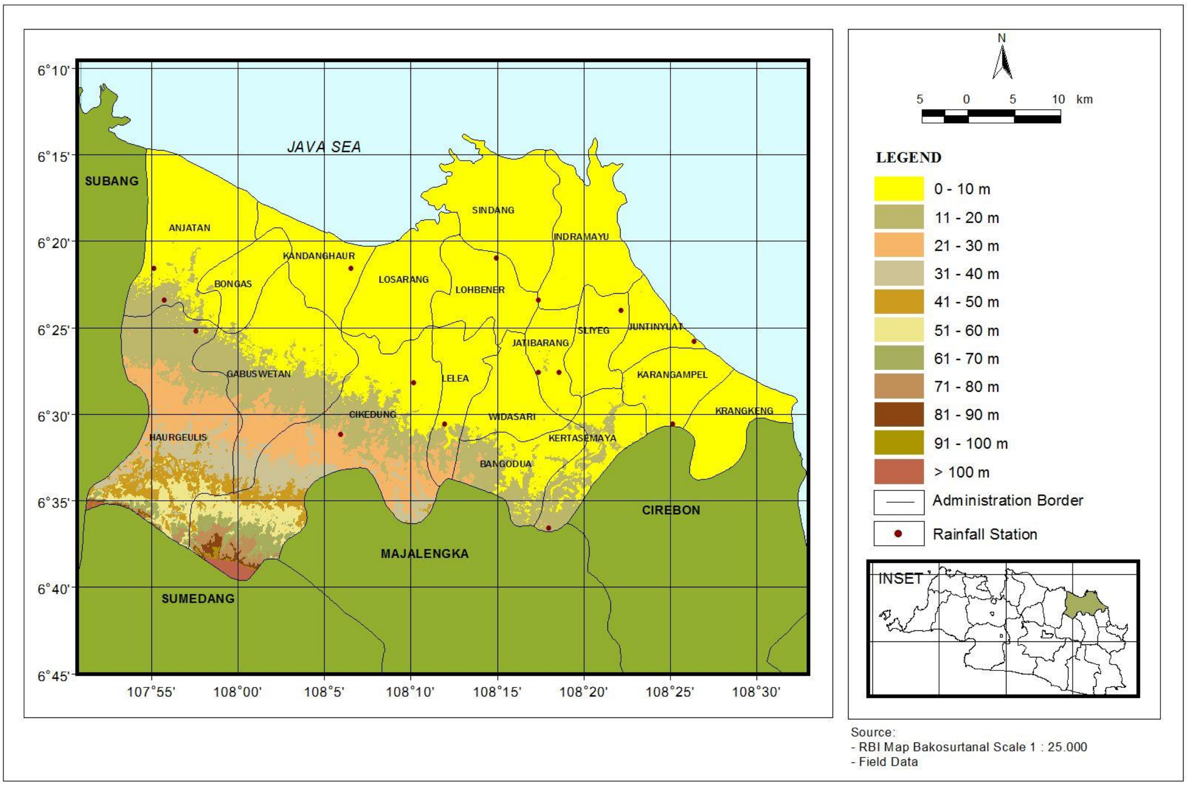


Figure 1: Indramayu District, West Java, Indonesia Administration Area, topography,and location of rainfall station used [16]

2.2 Framework of Thought

The equation form stage of monthly rainfall ensemble prediction system model as seen in Figure 2. It is based on 4 (four) single prediction system models (ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, ARIMA) owned by Research and Development Center of BMKG, to be applied to a series of monthly rainfall total data of 1981-1990 to provide monthly rainfall total prediction in 1991-2000.

After that *r* is calculated from each single prediction system model output based on a series of prediction output in 1991-2000. Based on the obtained r then the weighting values (w) were calculated in order to provide a proportion. This way is taken to compute appropriate weighted values of r. The bigger the value of obtained *r* is the better the value of contribution to the model equation.

Based on obtained weighting value (w) as mentioned above, mathematical equation has been established and prepared in the form of multi linear regression of ensemble prediction system model of monthly rainfall total for Indramayu District, West Java Province, Indonesia.

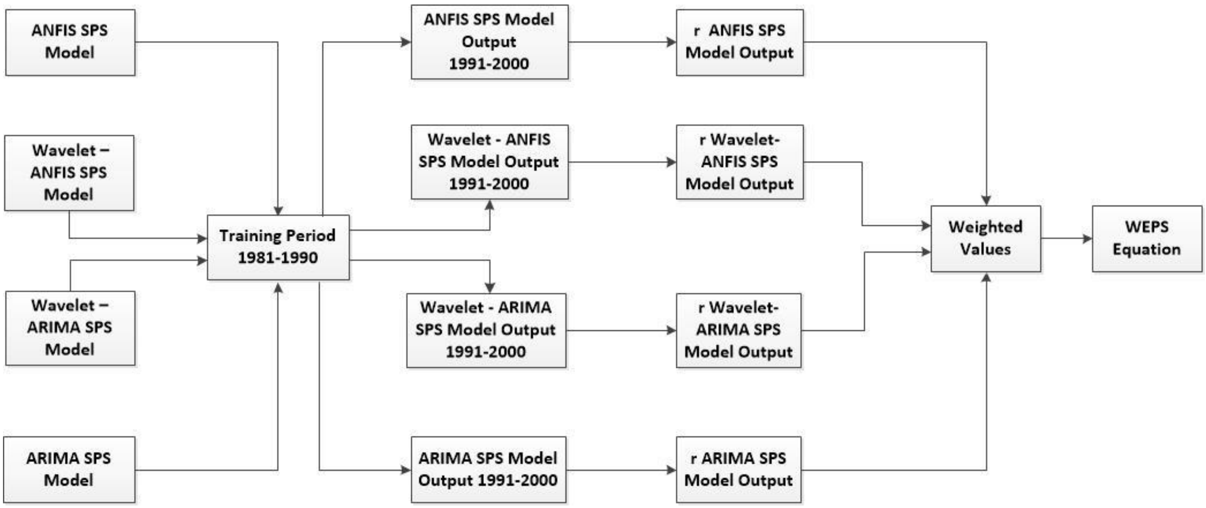


Figure 2: Flow Diagram of Providing the Ensemble Prediction System Model for Monthly Rainfall Total in Indramayu District, West Java, Indonesia

2.3 Ensemble Method with Weighting Value

However, for the planning operation purpose, then prediction activity in limited time is still necessary to be prepared and conducted, therefore, the prediction system model is used. Prediction system model consist of SPS model and ensemble prediction system (EPS) model.

Ensemble prediction system (EPS) model of monthly rainfall total in district area with correlation coefficient weighting values are made using the equation (1) while adopting what have been done previously [27] using the following equation:

$$\boldsymbol{F_e = \sum_{i=1}^{i=N} r_i F_i} \quad (1)$$

Where:

F_e = monthly rainfall total of ensemble prediction system model output (mm);

i = 1, 2, 3, N = Number of single prediction system model used;

r_i = the-iPearson correlation coefficient value of each single prediction system model; and

F_i = each monthly rainfall total prediction of single prediction system model output (mm).

The summation result of the obtained *r* for each single prediction system model can be written as follows:

$$\mathbf{1} \neq \sum_{i=1}^{i=N} \boldsymbol{r_i} \qquad (2)$$

In order for each obtained r of each SPS model output that forming EPS model can be calculated proportionally, then equation (1) is formulated so that total *r* as the forming of the multi linear regression equation has maximum value of +1. If the total r from each SPS model in equation (2) does not equal to +1, then a mathematical manipulation is used to calculate w_i as weighted values based on *r* in equation (3) to form the following EPS model:

$$\boldsymbol{w_1} = \frac{\boldsymbol{r_1}}{\boldsymbol{r_1} + \boldsymbol{r_2} + \boldsymbol{r_3} + \boldsymbol{r_4}}$$

$$\boldsymbol{w_2} = \frac{\boldsymbol{r_2}}{\boldsymbol{r_1} + \boldsymbol{r_2} + \boldsymbol{r_3} + \boldsymbol{r_4}}$$

$$\boldsymbol{w_3} = \frac{\boldsymbol{r_3}}{\boldsymbol{r_1} + \boldsymbol{r_2} + \boldsymbol{r_3} + \boldsymbol{r_4}}$$

$$\boldsymbol{w_4} = \frac{\boldsymbol{r_4}}{\boldsymbol{r_1} + \boldsymbol{r_2} + \boldsymbol{r_3} + \boldsymbol{r_4}} \qquad (3)$$

Therefore, as the result equation (3) can produce the following:

$$\sum_{i=1}^{i=N} \boldsymbol{w_i} = \mathbf{1} \qquad (4)$$

where:

i = 1, 2, 3, ...N = number of single prediction system model used; and

w_i= the-i weighting value based on *r* of SPS model output during certain training period of data.

Hence, based on equation (1), the formulation of EPS model can be written as follows:

$$F_e(i) = w_1F_1(i) + w_2F_2(i) + ... + w_NF_N(i) \qquad (5)$$

where:

$F_e(i)$ = monthly rainfall total i year of EPS model output with weighting value based on *r* of SPS model (mm);

w_1, w_2......w_N = weighting value based on *r* of each single prediction system model;

$F_1(i), F_2(i), \ldots F_N(i)$ = monthly rainfall total in the-i year of each SPS model output (mm); and i = 1, 2, 3, ..., 12 = i year of the related prediction.

Since a SPS model used in forming equation of EPS model of monthly rainfall total with this weighted correlation coefficient value is 4 (four), which are: ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, and ARIMA, then equation (5) can be written as follow:

$$F_e(i+1) = w_1F_1(i) + w_2F_2(i) + w_3F_3(i) + w_4F_4(i) \quad (6)$$

In which:

$F_e(i+1)$ = ensemble prediction system value of monthly rainfall total with weighted of *r* at i+1 year (mm); w_1 ... w_4 = weighting value based on *r* of the first to fourth single prediction system model; and F1(i)...F4(i) = monthly rainfall total of the first to fourth SPS model output of year-i (mm);

2.4 Procedures

Firstly, the selection of SPS models available at the Research and Development Center of BMKG, which are: ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, and ARIMA for monthly rainfall total of district area. Each SPS model applied in Indramayu District, West Java, Indonesia using the available data series of 1981-1990 will result in a single prediction value of each monthly rainfall from each station location of 1991-2000 series.

Secondly, calculating *r* [10][22] based on each SPS model output to field observed data, the series data can be obtained using each r. Thirdly, computing the weighted values (w) based on the obtained *r* during the training period of 1991-2000 data series. Total of weighted values used here should be +1.The 4 (four) single prediction system (SPS) models are then assembled by forming a multi linier regression equation in order to obtain its WEPS model value based on the previously obtained *r*. Lastly, preparing *r* of spatial field as the output of EPS model of monthly rainfall for Indramayu, as the reviewed domain.

2.5 Spatial Map Generation

Monthly rainfall data taken from 16 stations in Indramayu District have been run using 4 SPS models. Those SPS models are to compute data series for every station. Results of SPS models output then were used to construct the WEPS model. The WEPS model was run again to get the WEPS model output. After running both SPS and WEPS models and getting the models output, then the *r* and RMSE values are computing in order to understand the agreement and performance of models output. Both *r* and RMSE values taken are plotted using ArcView software to obtain the spatial thematic maps of *r* and RMSE fields in Indramayu District.

The interpolation method chosen for point values in order to provide this, the thematic map is Inverse Distance Weighted (IDW).

2.6 Data Management

The review stage was started and conducted by collating daily rainfall data. 1981-1990 series data used need to be standardized. Considering that the initial data in the field is not similar to the operational establishment of station, then the 1991–2000 series data are used in training period as a prediction output of SPS model to obtain r. It means ensemble prediction simulation was not conducted before 2001. The series data of 2001 – 2010 was used to evaluate the output of WEPS model output.

Monthly rainfall total data managed by applying prediction technique of ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, and ARIMA to a group of training period data (1981-1990).SPS model simulation of 1991-2000 series data is required in order to obtain r. The prediction evaluation period selected for 9 (nine) year between 2001 and 2009. During the prediction period for each SPS model, then *r* is calculated, which will result in each value of r_1, r_2, r_3...r_N.

Next step is to conduct weighting value (w) calculation based on *r* obtained from SPS model output of 1991-2000, therefore *r* summation from four SPS models must show the same output which is +1 (one). Multi linear regression equation of EPS model is then formed using equation (6).

3. Result and Discussion

3.1 Preparing Weighted Ensemble Prediction Equation

Based on data processing result in the form of monthly rainfall (1991-2000), the SPS models of ANFIS, Wavelet-ANFIS, Wavelet-ARIMA, and ARIMA have been run to compute each r. Further, the tabulation of weighting value (w) based on *r* obtained from those SPS models output is presented in Table 1.

For each rainfall station or data location in Indramayu there are four weighting values, which are used to form ensemble equation as stated in equation (6). For example Anjatan (6,36 °S, 107,92 °E) has EPS model equation (7) as follows:

$$F_e(i+1) = 0,34*F_1(i) + 0,21*F_2(i) + 0,36*F_3(i) + 0,09*F_4(i) \quad (7)$$

The ensemble equation continues until every rainfall station available in Indramayu has respective equation of WEPS model of monthly rainfall total. All equations of WEPS model of monthly rainfall in Indramayu District consist of 16 equations. Based on equation (7), the contribution of SPS model ANFIS, Wavelet-ANFIS, Wavelet-ARIMA and ARIMA that includes into prediction outputs of monthly rainfall for example in Anjatan are 0.34, 0.21,0.36 and 0.09, respectively. Based on the weighted ensemble prediction system model equation above, it can be denoted that a SPS model that generates higher *r* will contribute more into WEPS value compared to the SPS model that generates smaller correlation coefficient value.

Moreover, WEPS model for other location can be written according to what was conducted in Anjatan by considering Table 2.

Table 1: The *r* value results for weighted ensemble prediction system model output of monthly rainfall total in Indramayu District, West Java, Indonesia along with single prediction system model output of its origin (using p-value of 0.95) based on 2001-2009 data series

Location	ANFIS	WANFIS	WARIMA	ARIMA	ENSEM
Anjatan	0.70	0.43	0.43	0.56	0.79
Bangkir	0.54	0.36	0.67	0.61	0.66
Bantarhuni	0.69	0.44	0.64	0.40	0.72
Bondan	0.64	0.31	0.67	0.51	0.71
Bugis	0.61	0.37	0.74	0.64	0.77
Bulak	0.54	0.31	0.58	0.42	0.66
Cidempet	0.57	0.46	0.59	0.41	0.67
Cikedung	0.66	0.38	0.65	0.32	0.69
Jatibarang	0.70	0.36	0.70	0.41	0.71
Juntinyuat	0.53	0.20	0.65	0.63	0.68
Kedokanbunder	0.45	0.30	0.65	0.26	0.62
Sudimampir	0.58	0.21	0.65	0.43	0.68
Sumurwatu	0.51	0.29	0.50	0.32	0.58
Tugu	0.63	0.38	0.62	0.50	0.69
Ujungaris	0.72	0.39	0.74	0.24	0.76
Wanguk	0.75	0.36	0.86	0.64	0.89

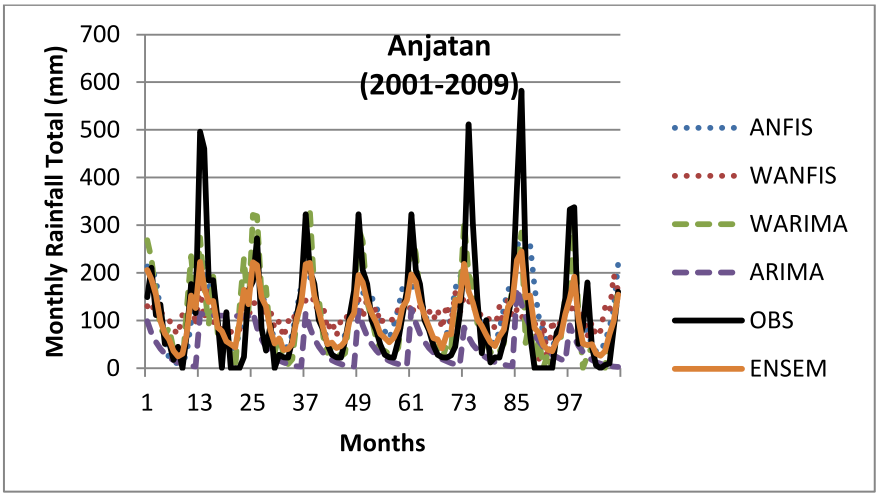
Table 2: Weighting value to construct WEPS equation for monthly rainfall total in Indramayu District, West Java, Indonesia

No.	Locations	ANFIS	WANFIS	WARIMA	ARIMA
1	Anjatan	0.34	0.21	0.36	0.09
2	Bangkir	0.29	0.20	0.43	0.08
3	Bantarhuni	0.31	0.24	0.32	0.13
4	Bondan	0.33	0.19	0.33	0.15
5	Bugis	0.35	0.20	0.35	0.10
6	Bulak	0.30	0.13	0.39	0.18
7	Cidempet	0.32	0.24	0.34	0.09
8	Cikedung	0.32	0.15	0.36	0.17
9	Jatibarang	0.33	0.20	0.39	0.08
10	Juntinyuat	0.31	0.10	0.47	0.12
11	Kedokanbunder	0.42	0.16	0.41	0.02
12	Sudimampir	0.40	-0.04	0.60	0.04
13	Sumurwatu	0.37	0.19	0.40	0.04
14	Tugu	0.34	0.22	0.38	0.06
15	Ujungaris	0.34	0.28	0.32	0.05
16	Wanguk	0.31	0.18	0.35	0.16

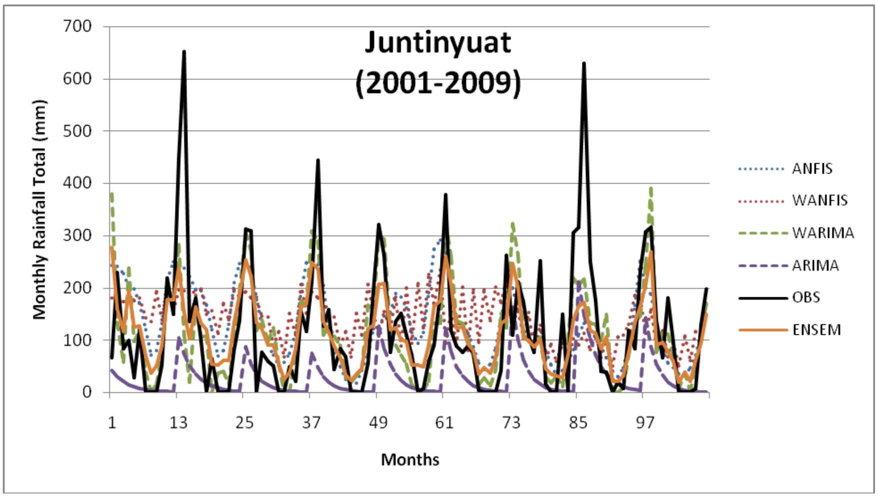
3.2 Prediction Output

The example of prediction output of WEPS model of monthly rainfall total in Indramayu presented in Figure 3.

Solid colors are black for observed data and orange for WEPS. Dash colors are for SPS ANFIS, SPS Wavelet-ANFIS, SPS Wavelet-ARIMA, and SPS ARIMA. For the prediction output of monthly rainfall total, WEPS model was used in Indramayu for 2 (two) locations (Figure 3a for Anjatan location and 3b for Juntinyuat location), it was found that WEPS model output of monthly rainfall total showed a good pattern that matched quite well in comparison to field observed data. This is shown by high value gained of *r* range of +0.79 - +0.89. However, the WEPS model is still unable to capture the extreme event because the WEPS model is not built based on extreme value analysis.



(a)



(b)

Figure 3: Prediction output validation of monthly rainfall total in Indramayu District, West Java, Indonesia uses equation of weighted ensemble prediction system model in (a) Anjatan location and (b) Juntinyuat location.

The WEPS model output of monthly rainfall total shows there is increase in *r* compared to the SPS model output of its origin. Based on calculation result of the *r* value, it is evident that WEPS model output of monthly rainfall in Indramayu provides more consistent results than each original SPS model output.

By considering the lower *r* value range with bigger minimum *r* value with relatively the same maximum *r* value, the paper shows performance improvement by EPS model.

3.3 Spatial of Pearson Correlation Coefficient

SPS models output of ANFIS, Wavelet-ARIMA, ARIMA and WEPS model output of monthly rainfall generates maximum *r* for Wanguk. This location has an elevation range of 11 - 20 meters above sea surface and is located in the western part of Indramayu that has relatively wet climate condition. In the meantime SPS model Wavelet-ANFIS output generates maximum *r* in Bantarhuni. This location has an elevation range of 51-60 meters above sea surface. Bantarhuni is also located in the western part of Indramayu that has relatively wet climate condition.

The eastern part of Indramayu has relatively drier climate condition. Similarly, PS model output Wavelet-ANFIS generates the lowest *r* value for Juntinyuat is located in the eastern part of Indramayu with relatively drier climate condition, same condition also applies to Jatibarang from SPS model output ARIMA. This location is also in eastern Indramayu with relatively drier climate condition. Meanwhile, SPS model Wavelet-ARIMA output generates the lowest *r* value in Sumurwatu as well as the EPS model output. Sumurwatu has elevation range of 21-30 meters above sea surface. This location is located in the southern part of Indramayu.

The WEPS model output has a high agreement with respective observed data in Indramayu as shown by the value of r. The latter fact is caused by the proper use of weighted values in WEPS model that has been applied to simulate the prediction of monthly rainfall in Indramayu.

3.4 Spatial RMSE Maps

The RMSE field of WEPS model output is shown in Figure 4. The lowest value of RMSE is 143 mm/month in Jatibarang. Meanwhile, the best value of RMSE is 32 mm/month in Wanguk. The spatial average of RMSE value is 96 mm/month. Spatially, the area of Indramayu with light color, is more extensive than those with darker ones. This light colored area shows lower RMSE values with better result. Lower RMSE means higher agreement of model output to observed data.

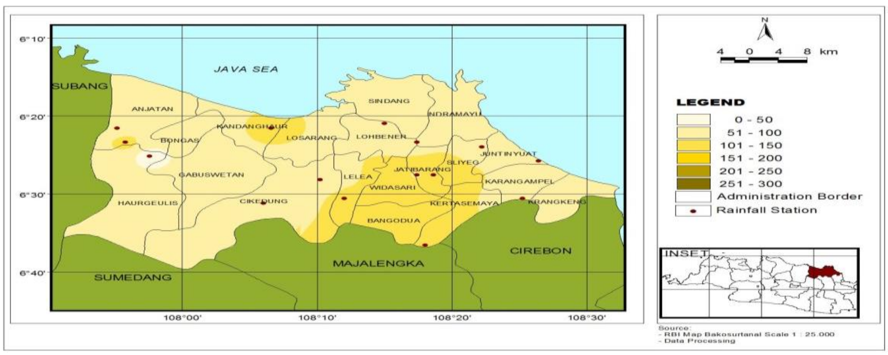


Figure 4: The RMSE value field of WEPS model output of monthly rainfall total prediction in Indramayu District, West Java Province, Indonesia

The WEPS model output shows relatively a high agreement to observed data. The appropriate weighted values to construct the WEPS model output are very useful so that the WEPS model has capability to capture the monthly rainfall in Indramayu District. This condition was confirmed by the average of RMSE values of less than 100 mm/month. The record of monthly rainfall total in Indramayu District is more than 600 mm/month for its maxima during wettest month and almost none for its minima during driest month.

4. Conclusion

Based on the description in the chapters above, several conclusions could be drawn as follows: The Weighted Ensemble Prediction System (WEPS) model for monthly rainfall total prediction has sucessfully been designed, constructed, and applied in Indramayu District, West Java Province, Indonesia to be dedicated to cope with the prone area of water availability by providing higher agreement of model output to its observed data in order to support the food security program; and the WEPS model output of monthly rainfall total applied in Indramayu District, West Java, Indonesia generates better output, higher performance, and is more consistent than Single Prediction System (SPS) models output as its origin during the validation period of 2001-2009. Range of *r* value obtained is smaller (the maxima of *r* value relatively the same, higher of *r* value minima, higher of *r* value average), and the improved performance of applied WEPS model in Indramayu is confirmed using RMSEs from the model outputs, which are relatively lower with the most reaching 51-100 mm/month.

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