

WEATHER IMPACT INVESTIGATION IN INDONESIA (WIN-ID) PROJECT

The Weather Impact Investigation in Indonesia (WIN-ID) project was inspired by the need for scientific references for developing IBF in Indonesia which is a new weather forecast paradigm in Indonesia. A shifting paradigm in weather forecasting has been becoming the focus of the development of the forecasting system in Indonesia. Not only forecast of weather parameters which is displayed deterministically, but also forecasts of the impact of changes in weather parameters which are commonly called as Impact-Based Forecasts (IBF) are needed by the users. The designing program of IBF system in Indonesia has been started since 2018 by a collaborative program with NOAA, USAID/BHA and HRC called the Weather Ready Nations (WRNs) Program. WRNs is a series of coaching programs to prepare a country in facing the weather and moreover the hydrometeorological disasters caused by the weather. Indonesia through BMKG has gone through the entire WRN program which consists of 6 main phases. Therefore, IBF system is assessed and considered ready to begin its operationalization in Indonesia.

During the daily operational of IBF in BMKG, there are obviously many challenges to overcome. One of the biggest challenges is the vast and diverse landscape across Indonesia. Changes in weather parameters will results in different impact in each different location caused by the local condition (geographical condition, topography, land use, soil type, etc.) which are unique in every particular location. These conditions challenge the forecasters in BMKG when issuing the IBF warnings. Hence, a science-backed references is needed as the basis in decision making process. In order to develop the IBF System and increasing the capacity of forecasters, BMKG needs to initiate and encourage research regarding the impact of weather to the environment and social aspect in Indonesia. Beside that, research in non-technical field also needs to initiated as it could serve as the input for IBF system development considering the collaboration between BMKG and other stakeholders is also essential in the development process.

Objective

The initiation for research in IBF field is held to improve the quality of products related with IBF, increase the accuracy and more suitable impact forecast for the predicted area.

PRELIMINARY STUDY OF REMOTE SENSING DATA UTILIZATION FOR IMPLEMENTATION OF IMPACT-BASED WARNINGS

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ABSTRACT

Quantitative Precipitation Forecast (QPF) is one of the nowcasting products resulting from remote sensing data processing that has the potential to become a database in consideration of making impact-based warning (IBW). Model data and disaster risk index are used as the main data in impact-based forecast (IBF) implementation with a threshold limit of 100 mm for 24 hours rainfall accumulation. Those variables used can be developed by using QPF to calculate IBW in real time. This study aims to conduct an preliminary study of the utilization of remote sensing data for the implementation of impact-based warning. The initial study was carried out using weather radar and satellite data within 60 minutes sequence as input data for the 3-hour QPF with 20 mm as a threshold. The weighted overlay is carried out by weighting 50% of the QPF and 50% of the flood risk index to obtain the IBW category. Short Term Ensemble Prediction System (STEPS) nowcasting algorithm is used with 20 ensemble members as the preliminary study. For weather satellite, STEPS is implemented to the derived reflectivity of top cloud brightness temperature data derived by artificial neural network (ANN) method. Warning level at category 6-8 is used to calculate the accuracy. In the case of flooding in Bogor Regency on January 1, 2020, IBW calculation based on weather radar shows 42,7% area in category 6-8, while Himawari 8 results 35,7% area. Associated to the impact resulted, the calculation of IBW index using radar and weather satellite data are qualitatively able to provide the right warning level.



CONCLUSION and SUGGESTION



Figure: Conclusions

FLOOD MAPPING AND VERIFICATION OF IMPACT-BASED FORECASTING (IBF) USING GOOGLE EARTH ENGINE (GEE)

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ABSTRACT

The need for impact-based forecasting (IBF) information that has excellent quality to support public safety from the threat of hydrometeorological disasters. That quality improvement can be done through evaluation and verification of IBF BMKG products which are then used to determine the level of accuracy of IBF products. In addition, it is necessary to analyze the impact caused by the flood disaster which is then used to determine the area and number of affected populations. The purpose of this study are to determine the impact of flooding based on the area and population affected by the flood and the quality of the IBF BMKG product based on dichotomous verification in Makassar City in December 2020. The method used is flood mapping based on remote sensing and cloud computing in the form of Google Earth Engine (GEE) by adding the IBF BMKG product layer which is used to determine the verification component and split it into four flood determination periods. The verification components used are hits, false alarms, misses, and correct negatives. Dichotomy can be verified to determine the bias, accuracy, and skill index of the IBF BMKG product as well as an analysis of flood impacts based on the area and affected population in Makassar City in December 2020. The results of the impact analysis show that in periods II and III has the largest flood-affected area and population are 701 and 120 ha, and the affected population 26,797 and 8,132 people. The results of the dichotomous verification of the BMKG IBF product show that is not too good value of a verification, with a bias value of 1.0, accuracy 0.54 and skill 0.37.

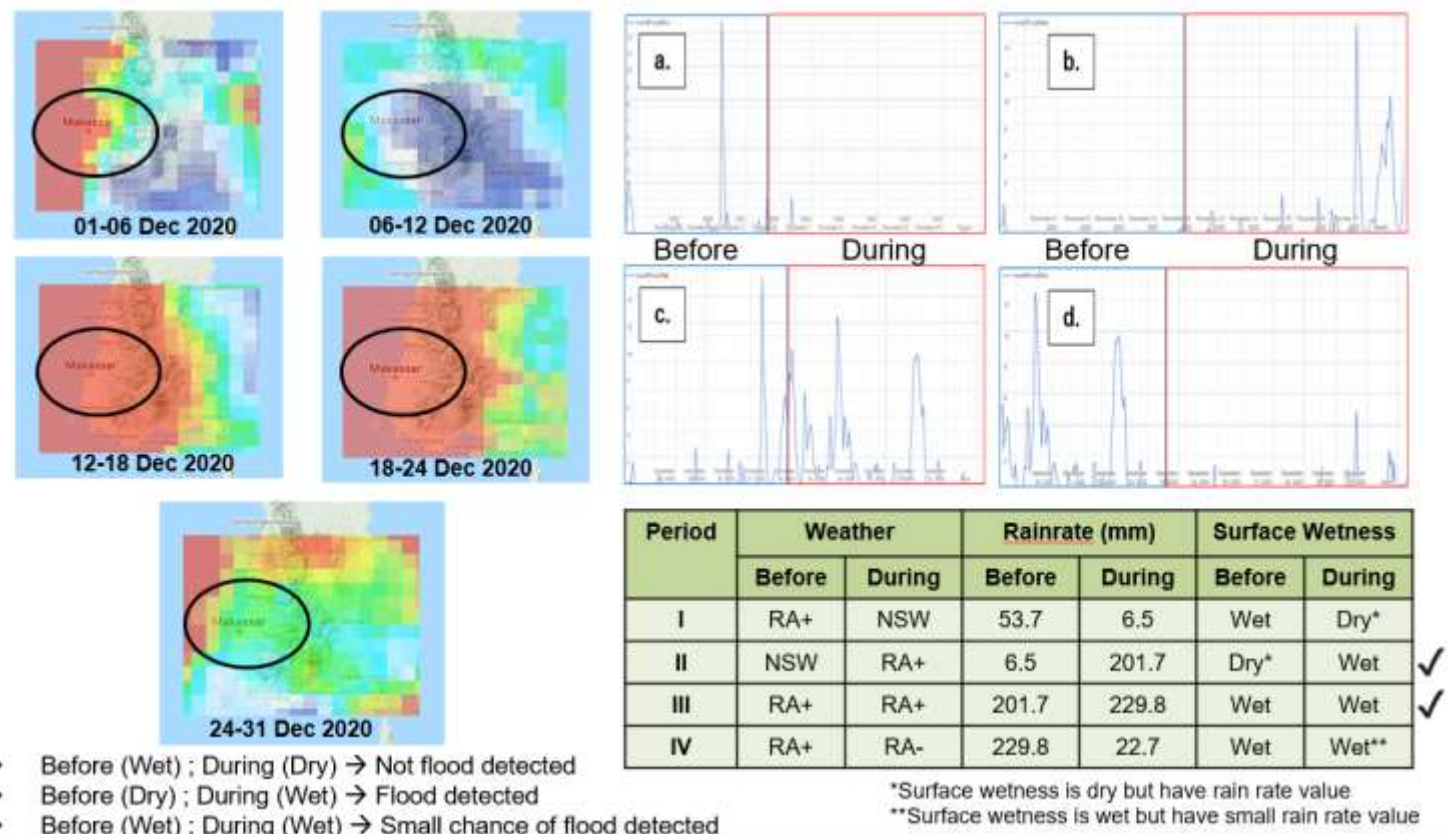


Figure: Rain rate before and during determination period

PREDICTION OF WIND GUST RISK BASED ON TIME LAG ENSEMBLE PROBABILISTIC FORECAST OF IFS-HRES OVER JAVA

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ABSTRACT

The wind gust is a natural phenomenon that can cause disasters in people's lives, with the highest frequency of reports on the Java island. This study investigated the prediction of high wind risk levels to support impact-based weather forecasting operations. Prediction of risk level was a combination of likelihood and impact parameters. The prediction technique used the slope processed from a digital elevation model (DEM) shuttle radar topography mission (SRTM) 30 m, the land use and land cover obtained from the Ministry of Environment (KLH), and the weather extreme vulnerability index (IKCE) from the National Disaster Management Agency (BNPB) as the impact parameters and the time-lag probabilistic prediction of the integrated forecast system high resolution (IFS HRES) model with a threshold of 25 knots as the likelihood parameter. The prediction results were tested with Indonesian disaster information data (DIBI) for cases on October 20, 2020, and February 26, 2021. The results showed that most reports of strong winds on October 20, 2020, and February 26 can be predicted by the risk level prediction of wind gust. For further studies, it is necessary to understand the thresholds of wind speed on the impact of wind gust based on DIBI and utilize the IFS ensemble prediction system (EPS) as a likelihood parameter.

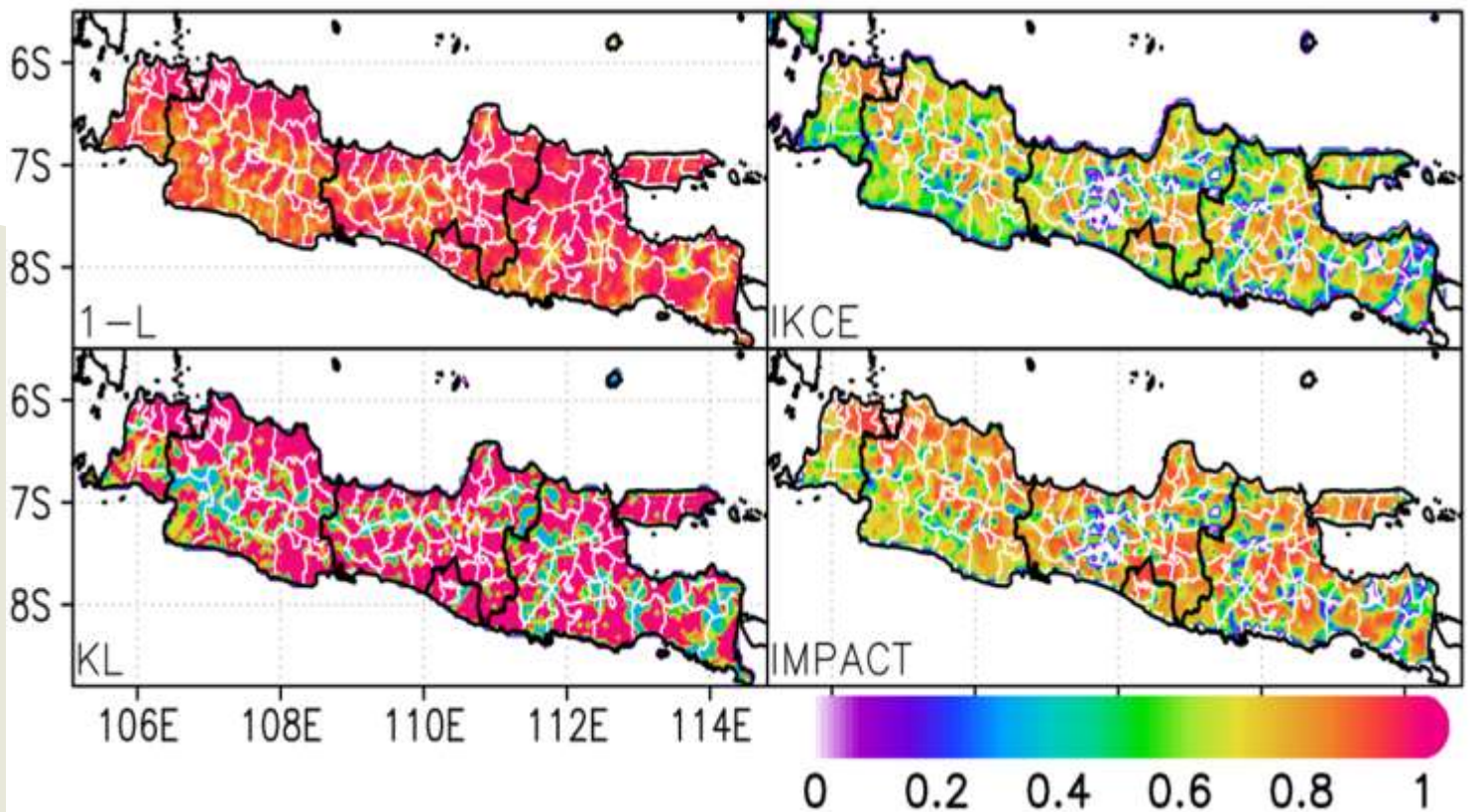


Figure: High impact areas are northern Banten, Jakarta, north and middle parts of West Java and Central Java, Yogyakarta, north, middle and east parts of East Java

DETERMINATION OF DAILY FLOOD VULNERABILITY MAP IN NORTH SUMATRA USING THE RAINFALL PREDICTION DATA OF WRF MODEL

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ABSTRACT

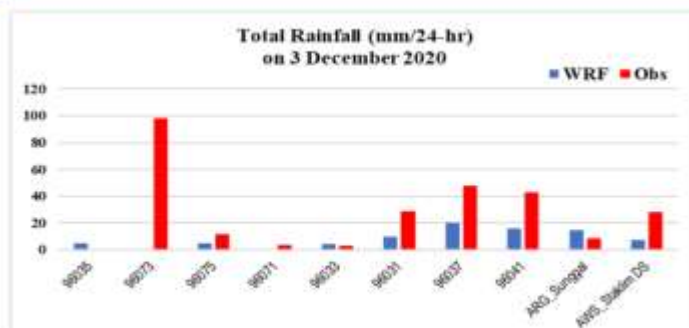
Flooding is one of the hydrometeorological disasters caused by extreme rainfall. Currently, the Deli Serdang Climatology Station has issued a Flood Hazard Map (PRB) based on the North Sumatra region based on statistical processing of historical rainfall data. Considering that flooding can be caused by heavy rain events within a few hours, it is necessary to make DRR per day for flood disaster mitigation. This study was conducted to test the accuracy of the utilization of the Weather Research and Forecasting Model (WRF) rainfall forecast data for daily DRR. The data used in this study include Global Forecast System (GFS) data, daily rainfall data from the BMKG Cooperation Rain Post in North Sumatra Province, rainfall data from weather observation stations, and flood event reports from BNPB. The weighting of the rainfall value is combined with the results of the weighting of the potential for flooding using a Geospatial Information System (GIS) to produce DRR. The case studies of flood events in this study are on January 28 and December 3, 2020. The results show that spatially the forecast for potential flood prone areas (WRF) has a pattern that corresponds to potential flood prone areas (observation). Rainfall prediction data from the WRF model can be used to make daily DRR in North Sumatra.

RESULTS AND DISCUSSIONS

3 December 2020

Verification

- The BNPB report shows that the floods on 3-4 December 2020 occurred in **Batubara, Binjai, Medan, Deli Serdang, Asahan, Langkat, Batubara, Tebing Tinggi.**



Total Rainfall (mm/24-hr) 3 Dec 2020

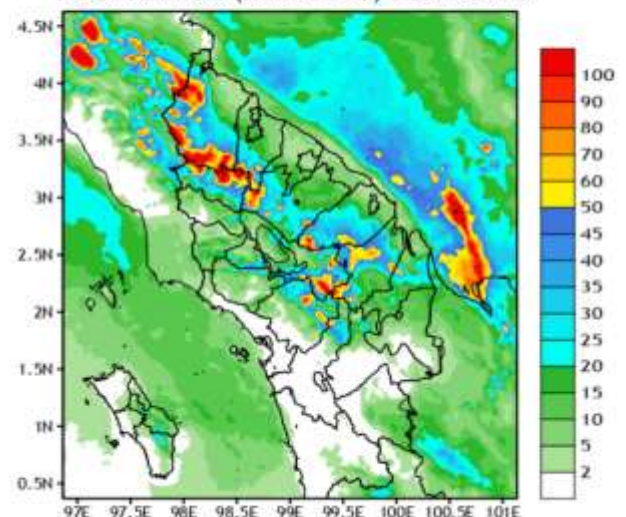


Figure: Results and discussion

SPATIAL ANALYSIS OF EXTREME RAINFALL THRESHOLD TO SUPPORT IMPACT-BASED FORECAST AND WARNING

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ABSTRACT

Flooding is one of the most frequent hydro-meteorological disasters in Indonesia. Flood events are generally related to heavy rain events that exceed the capacity of the river or drainage system. An early warning system for heavy rains triggered floods is very important due to the large number of losses. Prediction of flood events generally needs complex hydrodynamic models that require high computational cost and long processing time. A simplified approach to issue early warnings is by comparing rainfall forecasts with rainfall threshold data from previous flood events. In this study, we analyze the spatial rainfall threshold in Central Java Province using GSMaP rainfall data. We calculated the 75th, 90th, 95th, and 99th percentile values from the rainfall data and compared them with GSMaP rainfall data in previous flood events. The spatial variation of percentile values shows the highest values around the north and south coasts of Central Java. Generally, the 90th percentile value can be used as a threshold for rainfall that has the potential to cause flooding in Central Java. We created a rainfall threshold map using the threshold data combined with the flood risk map as a guide for preparing early warnings.

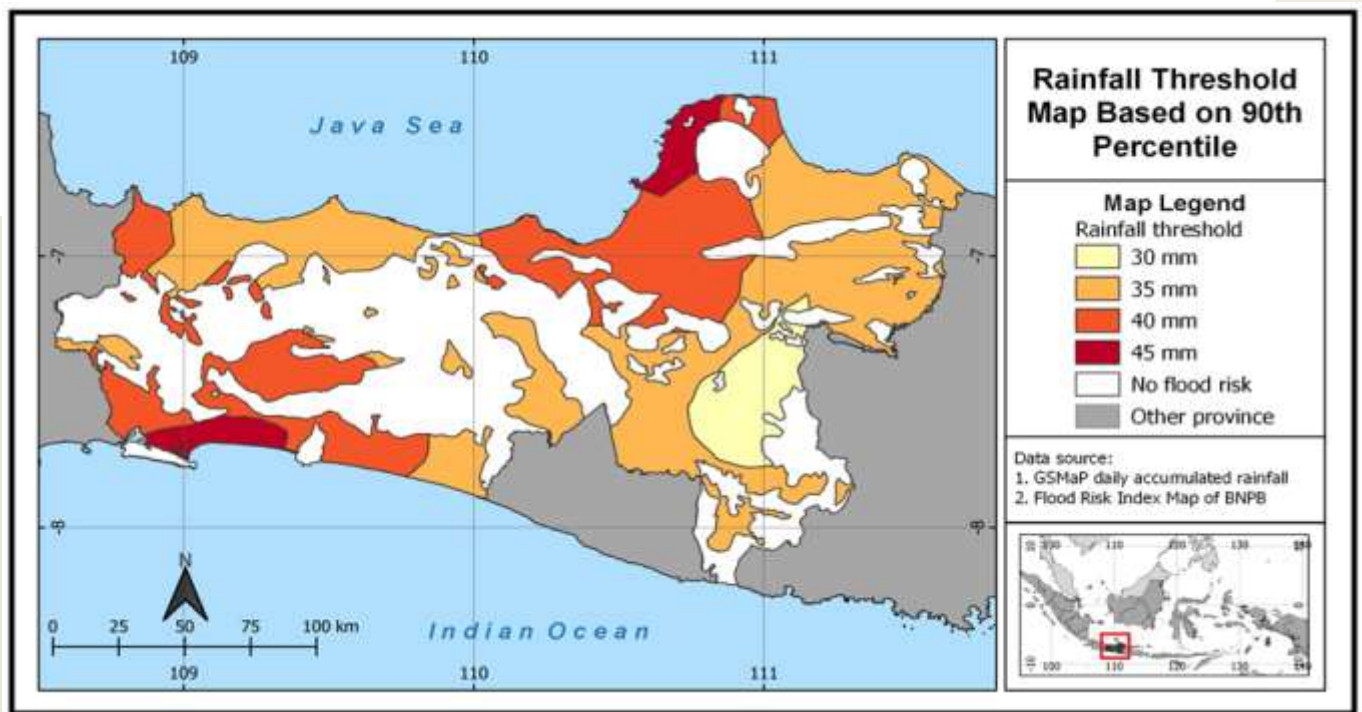


Figure: GSMaP rainfall map during the 2014 - 2020 flood events in Pemalang, Demak, Cilacap, and Klaten. Illustrating the 90th percentile values for each location, respectively.

IMPACT-BASED FORECAST ON AVIATION SECTOR USING SYSTEM OF INDONESIAN AVIATION METEOROLOGY (SIAM) DATA (CASE STUDY OF TROPICAL CYCLONE SEROJA)

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ABSTRACT

Aviation is a transportation sector that is very dependent on weather conditions and changes, when taking off, in the air and also at the time of landing. Impact-based forecast information is also needed in the aviation sector to anticipate aircraft accidents. In this study is focus to make an impact-based forecast for the aviation sector using data from System of Indonesian Aviation Meteorology (SIAM). Product of impact-based forecast still up to the forecaster's adjustment in determining the potential impact. In this study, the results of the existing product outputs in the SIAM, namely Cumulonimbus Cloud Prediction were used and then combined with the results of cumulonimbus cloud predictions based on Lability Index of ECMWF model that created using Machine Learning. Based on the results of this research, the potential for cumulonimbus clouds with the existing system in SIAM and the output of Machine Learning has good accuracy, and can be used as a forecaster reference for making impact-based forecasts for aviation sector. Based on the verification results using cumulonimbus cloud distribution data from the Himawari-8 satellite for 12 hours, this Impact-based Forecast product for the aviation sector has an accuracy of 90%.

Comparison of IBF vs HCAI Product for Cumulonimbus Cloud

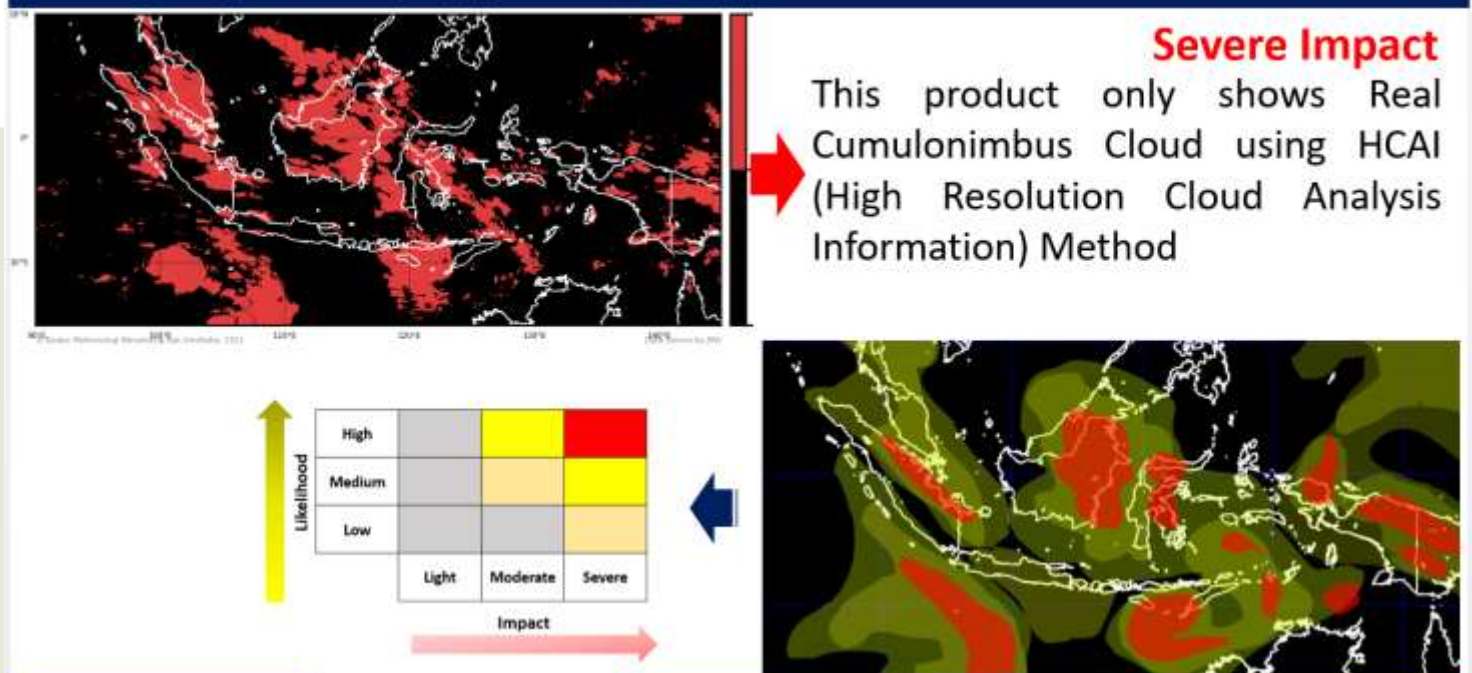


Figure: Cumulonimbus Prediction using Stability Index data from System of Indonesian Aviation Meteorology have a good enough when it predicts the cumulonimbus prediction for 12 next hours.

DEVELOPING AND IMPLEMENTING IMPACT-BASED FORECASTS IN MALUKA REGION

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ABSTRACT

The future of weather forecasting changes from conventional to Impact-based Forecast (IBF). In general purpose the conventional weather forecasting is still useable but if we compare to how people and stakeholders react about it since they get the information, unfortunately is not good enough. The IBF system will give detail information and provide in static or dynamic map. The specific information such as impact area, what should be done, people and stakeholders respond, and the matrix are the main output of the IBF. For the first step the essential thing is switching paradigm of forecaster, give their new knowledge about basic of IBF such as what is IBF, the main different with conventional weather forecasting, and how to set up the respond and impact matrix table. One of the main points in first step is developing IBF's map for our region uses GIS analysis, it is important because we will show for the stakeholders about our capabilities to use geospatial analysis. The next step after our forecaster ready and have new knowledge about the IBF is established the communication between regional BMKG station and Regional Disaster Management (BPBD) in Maluku Province, switching their paradigm in every meeting and show our work with display to them our result of the IBF Map as a prove that we are ready to build the matrix table with collaborate in many stakeholders.

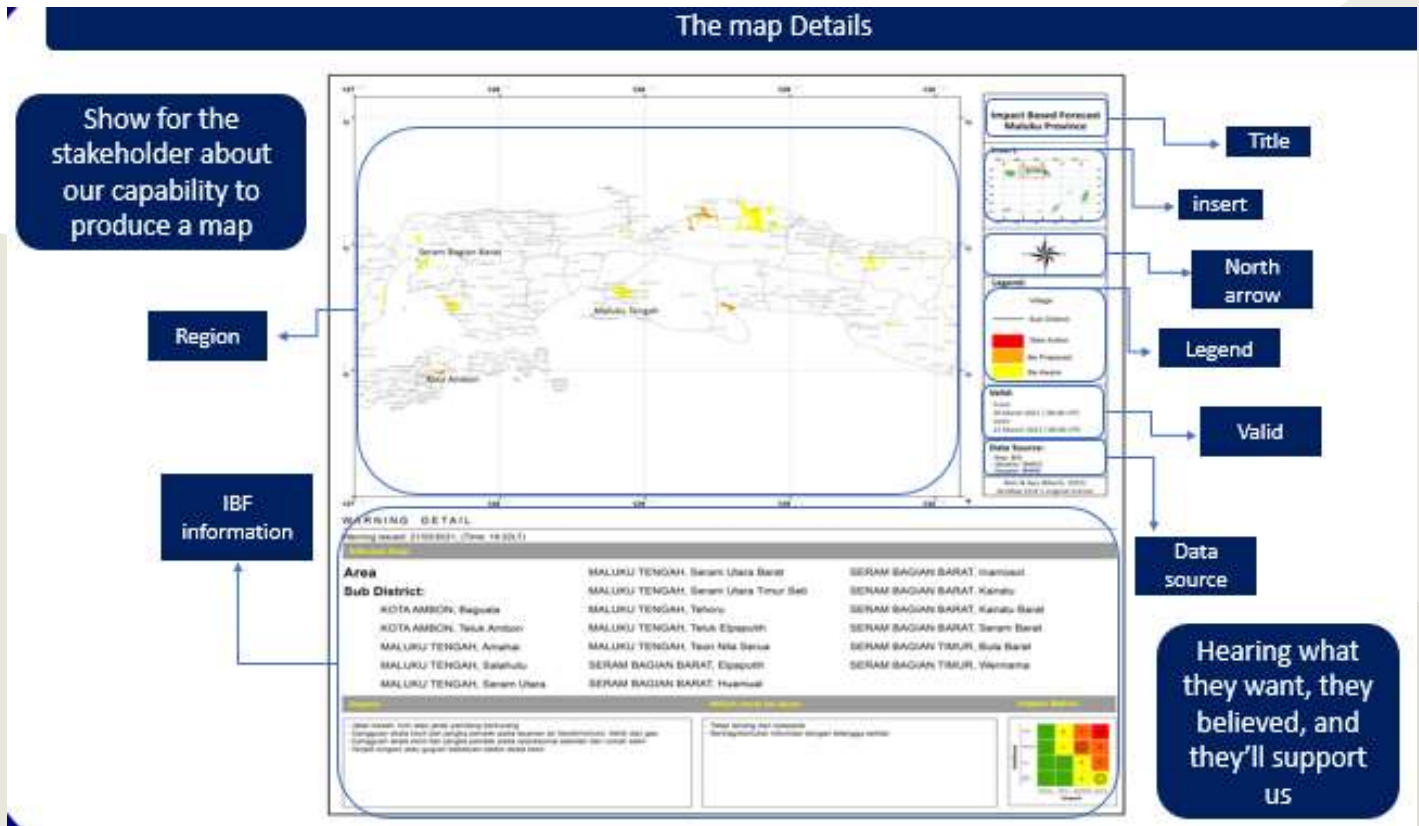


Figure: Map

CLIMATE CHANGE IMPACT ANALYSIS ON POTENTIAL PROJECTIONS OF METEOROLOGICAL DROUGHT IN CENTRAL LOMBOK IN 2031-2090

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ABSTRACT

Currently, global warming that has been felt shows that the climate has undergone changes which also have an impact on changes in situations and conditions including rainfall. The reduced availability of water due to reduced rainfall in an area can cause various problems in the community. To monitor the availability of water in a place, it can be seen from the meteorological drought index. The bad impact of this meteorological drought is felt by various sectors of life, especially in the agricultural sector. In this study, a meteorological drought will be projected that will occur from 2031 to 2090 as a result of climate change with a focus area in Central Lombok Regency, NTB. Previously, an analysis was carried out on how much climate change had occurred by looking at the rate of increase in air temperature. Principal Component Regression (PCR) method is applied to the projection data in order to obtain better data resolution. Meteorological Drought Levels are calculated using the Standardized Precipitation Index (SPI) in each season of December-February (DJF), March-May (MAM), June-August (JJA), and September-November (SON). The results obtained indicate the occurrence of climate change which is seen based on a significant increase in temperature (pvalue = 0.027142) in the last 20 years with an increase rate of 0.002°C/month. In Central Lombok, the SON period was the driest period, while the wettest period occurred in the DJF with the index reaching -5.2 and the largest being 4.5. Meanwhile, in the next 30-60 years, the meteorological drought level is projected to be lower than it is today, then in the 2060-2090 era it will increase again but the index only reaches -2.9 which occurred in the JJA period.

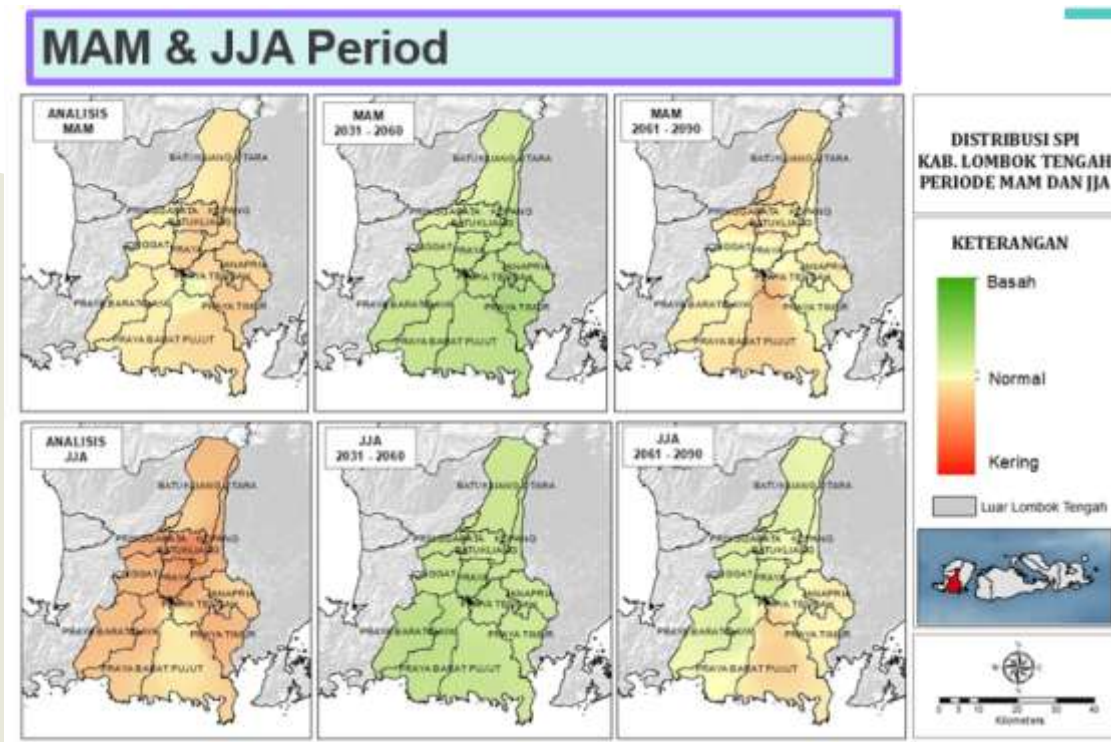


Figure: Map

BMKG MONTHLY SECTORAL IMPACT-BASED FORECAST CONCEPT: AGRICULTURAL SECTOR

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ABSTRACT

Climate information for agricultural sector is presented visually for staple food crops. Spatial analysis for monthly prediction of critical rainfall and temperature is required to determine areas with water stress, heat stress, and cold stress for staple food crops. Areas without climatic critical points have potential as agricultural land. This information can be employed in decision making process to farmer level, which is the goal of Impact-Based Forecast (IBF).

Conclusion

- ◇ IBF is delivered from crops stress threshold.
- ◇ Spatial analysis of crops critical rainfall and temperature can give the information of areas where water stress, cold stress, and heat stress of crops may occur.
- ◇ The crops with the most critical point areas in Indonesia for May 2021 is the maize.
- ◇ Non critical rainfall and temperature areas means potential.
- ◇ These information can be used to support decision-making, even for farmers, in line with the IBF purposes.

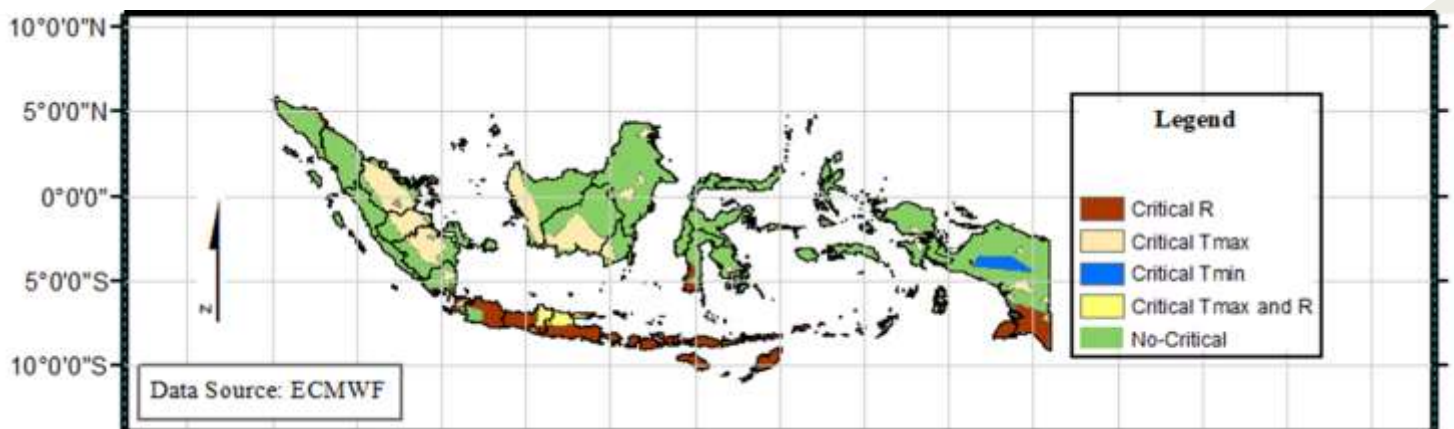
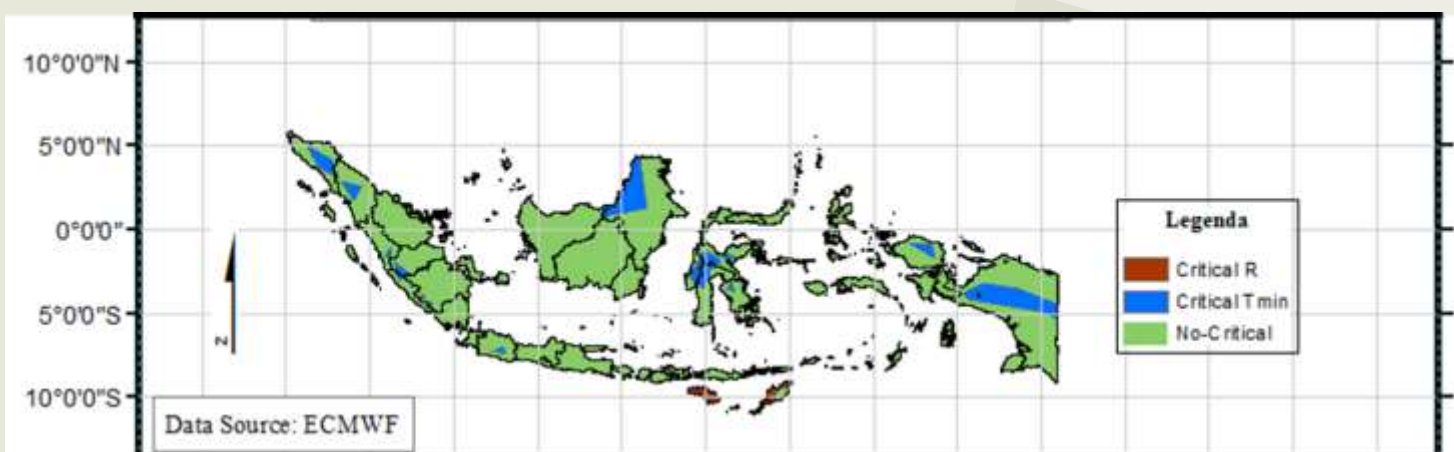


Figure: Critical points of rainfall (R) and Temperature (T) for Maize (upper) Cassava (lower)



MULTI INSTRUMENTAL REAL-TIME WEATHER EARLY WARNING SYSTEM

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ABSTRACT

Public safety from natural and hydrometeorological disasters is an absolute thing, this is stated in the mission of the Meteorology, Climatology and Geophysics Agency. However, in reality, Indonesia's geographical location has put people in natural and hydrometeorological disasters, so this has encouraged BMKG to innovate products in order to provide services and weather information as well as real-time early warnings. In supporting this safety, an integrated system is needed that can provide information quickly, precisely, accurately and easily understood by the wider community so that it can provide weather information dissemination to increase zero accidents. Currently, every region of Indonesia is equipped with sophisticated weather equipment, but the principle of these equipment still works with their respective systems so that a system is needed that can provide complete information in an integrated information system. In this study, a multi-instrument-based real-time weather early warning information system will be designed by utilizing meteorological instrumentation located in the operational area of the Juanda Meteorological Station, such as Weather Radar, Automated Weather Observing System (AWOS), and also Himawari Satellite data. Equipment data will be integrated into one ergonomic and informative web to be further processed into real-time information in the form of images and warning alert with notification and voice information in the event of significant weather. With this multi-instrument-based real-time weather early warning information system, it makes it easier for BMKG observers and forecasters on duty to provide fast, precise, accurate and easy-to-understand weather information.

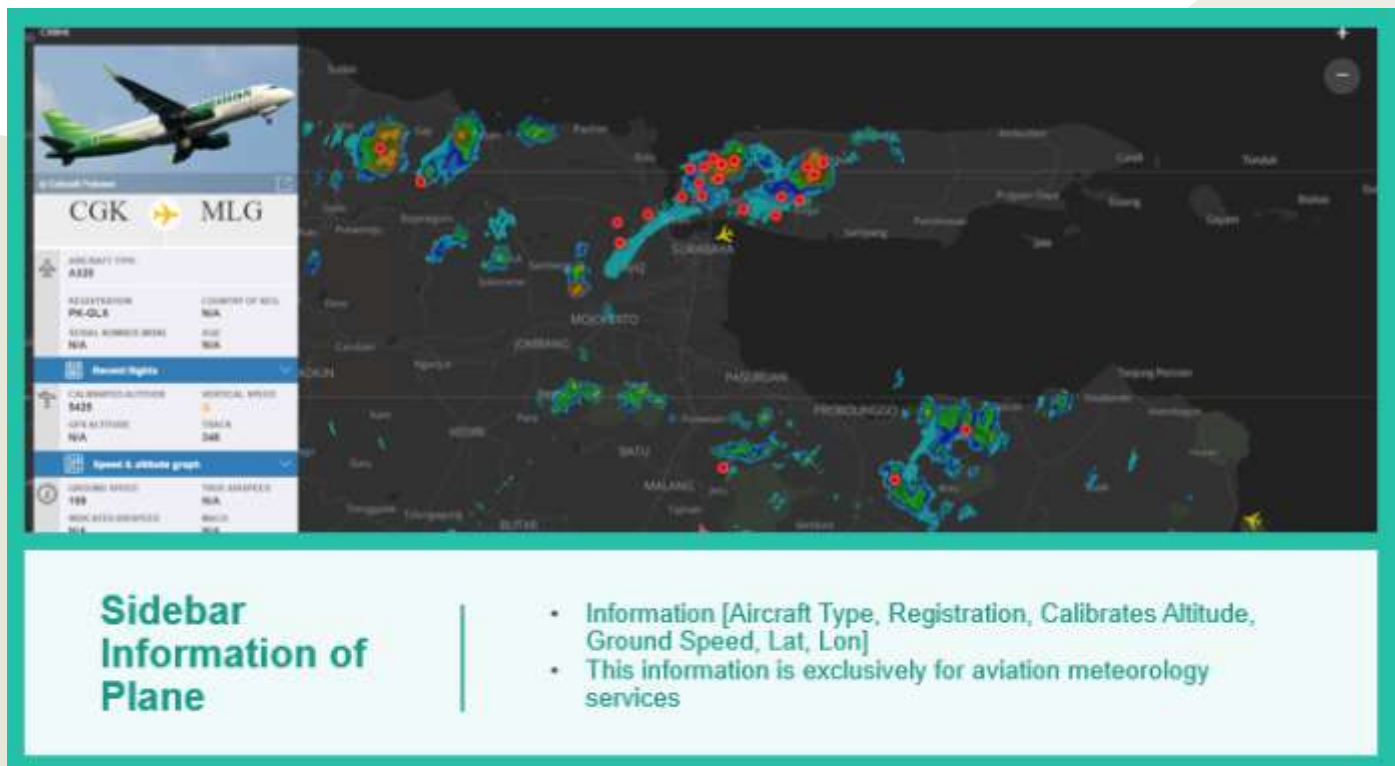


Figure: Complete web view of multi-instrument-based real-time weather early warning information system.