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| Forecasting Upwelling Events in Lake Maninjau Using a Hybrid Approach of Vector Autoregressive Time Series and Support Vector Machine Classification with an Interactive Dashboard |  |

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| ***Abstract***  *The abstract must contain 200-250 words written in a single paragraph. It should be clear, informative, descriptive, and clearly state the problem, the proposed approach or solution, and point out major findings and conclusions. The abstract should be written in the past tense. Standard nomenclature should be used, and abbreviations should be avoided. No literature should be cited. The abstract should be accompanied by keywords (keywords) below. This guide as a reference is required for the writing and delivery of writings in Journal SINERGI. This guide is written in a standard format for ease Journal SINERGI and guidelines in softcopy format can be directly used as a template for writers (Abstract 10 Italic). The abstract consists of 150-200 words written in a single paragraph. It should be clear, informative, descriptive, and clearly state the problem, the objective, the proposed approach or solution, and point out major findings and conclusions.*  *This is an open access article under the* [*CC BY-SA*](http://creativecommons.org/licenses/by-sa/4.0/) *license* | ***Keywords:***  *Guidance;*  *Writing; Format;*  *Title ;*  *(consist of 3-5 words, separated with semicolon, sort Ascending, 9 Italic)*  ***Article History:***  *Received: May 2, 2019*  *Revised: May 29, 2019*  *Accepted: June 2, 2019*  *Published: June 2, 2019*  ***Corresponding Author:***  *Andi Adriansyah*  *Electrical Engineering Department, Universitas Mercu Buana, Indonesia*  *Email:* [*andi@mercubuana.ac.id*](mailto:andi@mercubuana.ac.id) |

**INTRODUCTION (R: 31, G: 78, B: 121)**

Upwelling is a critical oceanographic process where deep, nutrient-rich waters rise to the surface, significantly influencing marine ecosystems by altering nutrient distributions and promoting biological productivity. Although commonly associated with ocean environments, upwelling can also occur in lacustrine systems, particularly in volcanic lakes such as Lake Maninjau in West Sumatra [1]. In these lakes, upwelling is driven by environmental factors including temperature gradients, wind patterns, and rainfall, impacting water quality and the distribution of aquatic organisms.

Lake Maninjau, formed within a volcanic caldera, presents a unique ecosystem where upwelling events have profound ecological and socioeconomic implications. These events can lead to sudden changes in water chemistry, such as increased turbidity and decreased oxygen levels, which adversely affect fish populations and biodiversity [2]. The lake's health is thus directly linked to the well-being of the surrounding communities, making the understanding and prediction of upwelling events a matter of significant importance.

The local communities around Lake Maninjau rely heavily on the lake for fisheries and tourism, both of which are sensitive to environmental changes induced by upwelling events [3]. Fisheries are a primary source of income, and fluctuations in fish stocks due to upwelling can have immediate economic consequences. Similarly, the lake's aesthetic appeal, crucial for tourism, can be diminished during upwelling events. Despite the critical need for accurate predictions to mitigate these impacts, existing forecasting methods face limitations in capturing the complex dynamics of upwelling in lake environments.

Current prediction methods predominantly employ either time series analysis or machine learning classification techniques independently. Time series models like the Vector Autoregressive (VAR) model are effective in modeling temporal dependencies within environmental data but lack the ability to classify specific events such as upwelling [4]. Conversely, machine learning classifiers such as Support Vector Machines (SVM) excel in categorizing events but often disregard temporal relationships that are essential for accurate forecasting in dynamic systems [5]. Previous research has demonstrated the potential of combining these methods in other domains, yet their application to lake upwelling prediction remains unexplored.

The main research problem addressed in this study is the inadequacy of existing models to accurately predict upwelling events in Lake Maninjau due to their inability to simultaneously capture temporal dependencies and event-specific characteristics influenced by local environmental factors. These limitations hinder effective decision-making and proactive management of the lake's resources by the local community and stakeholders.

To overcome these challenges, we propose a novel hybrid modeling approach that integrates VAR time series analysis with SVM classification. This hybrid model aims to leverage the strengths of both methods: the VAR component models the temporal patterns in environmental data such as temperature, wind speed, and rainfall, while the SVM classifier identifies and categorizes upwelling events based on the patterns extracted by the VAR model. This combined approach is anticipated to enhance prediction accuracy and provide more reliable forecasts of upwelling events.

The specific implementation involves collecting key environmental data from reputable sources, including NASA and local monitoring stations. The data undergo preprocessing to address any inconsistencies or gaps. The VAR model is then applied to uncover temporal dependencies, and its outputs serve as features for the SVM classifier. The SVM model classifies the events into upwelling or non-upwelling categories, effectively capturing both temporal and event-specific characteristics. This methodology builds upon previous research that has successfully utilized hybrid models in other environmental prediction contexts [6][7].

To ensure that the predictive insights are accessible and beneficial to the local community, we have developed an interactive dashboard using Python and Streamlit. The dashboard provides forecasts, visualizations of historical trends, and user-friendly interfaces for data exploration. By making the model's outputs readily available, the dashboard empowers stakeholders to make informed decisions, enhancing the practical impact of the research.

Despite the existence of studies employing hybrid models for environmental forecasting, there is a notable scarcity of research applying such approaches to lake upwelling prediction. Previous studies have largely focused on either time series analysis or machine learning classification in isolation, without integrating the two to capture the multifaceted nature of upwelling events [8][9]. This gap in the literature underscores the need for innovative models that can address both temporal dynamics and event classification, particularly in lake ecosystems where data characteristics may differ from oceanic environments.

The objective of this study is to develop and validate a hybrid VAR-SVM model to improve the prediction of upwelling events in Lake Maninjau, thereby addressing a critical research gap. Our hypothesis is that such a hybrid model will outperform traditional methods by effectively capturing both temporal dependencies and event-specific characteristics influenced by environmental factors. The novelty of this research lies not only in the hybrid modeling approach but also in the deployment of an interactive dashboard, which bridges the gap between complex predictive analytics and practical community applications. By enhancing the accuracy and accessibility of upwelling predictions, this study aims to support sustainable resource management and contribute to the socioeconomic well-being of the Lake Maninjau community.

**METHOD**

Material and Method contain primary materials used in the study and the methods used in solving problems, including methods of analysis [10, 11, 12].

**Material**

Material written here is only a main ingredient and must be equipped with the brand and its purity (for example, H2SO4 (Merck, 99%)). Equipment written in this section only contains the main equipment fitted with the brand (for example, electric Furnace (Carbonite)).

Ancillary equipment components do not need to be written. The main toolsets that should be presented in this section are equipped with image captions. Image captions are placed to be part of the figure caption instead of being part of the picture.

**Methods**

The methods used in the completion of the research are written in this section. The method includes research chronological, including research design, research procedure (in the form of algorithms, Pseudocode or other), instruments, and analysis techniques used in solving problems. In addition, the description of the course of research should be supported by references so that the explanation can be accepted scientifically [13].

**RESULTS AND DISCUSSION**

Results and Discussion should be an objective description of the results and should be in relation to the purposes of research. The discussion also needs to be supported by the reference list [14][15]. Results can be presented in figures, tables, and others that make the readers understand easily.

Figures may include images, charts, diagrams, maps, and photographs. Large figures and tables may span both columns. Figure captions should be centered below the figures, while table captions should be located at the top left of the tables. They should be written in Times New Roman 10pt. Avoid placing figures and tables before their first mention in the text. See the examples in Figure 1.

Avoid confusion due to the image axis labels, because figure axis labels are often confusing. Use words rather than symbols. For example, write “Velocity,” or “Velocity (v)” not just “v”. Put units in parentheses. Do not label axes only with units. For example, write “Velocity (m/s)” or “Velocity (ms-1)”. Do not label axes with a ratio of quantities and units.

**Attention**

Try not to put all the pictures and tables in the middle of the writing on each page. However, images and text should appear at the beginning or end of each page.

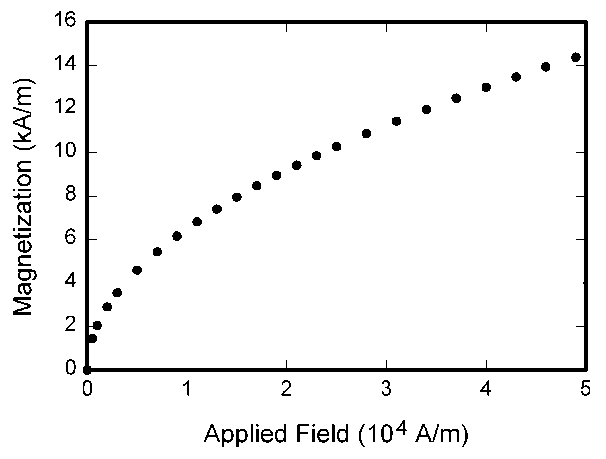


Figure 1. Number and Figure Caption

Put units in parentheses. Do not label axes only with units. For example, write “Velocity (m/s)” or “Velocity (ms-1)”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K),” not “Temperature/K.” Multipliers can be especially confusing. Write “Energy (kJ)” or “Energy (103 J).” Define abbreviations and acronyms the first time they are used in the text, even if they have been defined in the abstract.

Number equations consecutively with equation numbers in parentheses. Flush with the right margin, as in (1).

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|  | (1) |

Symbols of equations should be defined before the equation appears or immediately follows. Use “(1),” not “Eq. (1)” or “equation (1),” except at the beginning of a sentence, for example: “Equation (1) is …”.

Tables are presented center, as shown in Table 1 and should be cited in the manuscript. Table heads should appear above the tables. Insert figures after they are cited in the text.

Table 1. Table Caption

|  |  |  |
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| **Symbol** | **Quantity** | **Conversion from Gaussian and CGS EMU to SI a** |
| Φ | magnetic flux | 1 Mx → 10−8 Wb = 10−8 V·s |
| 4π*M* | magnetization | 1 G → 103/(4π) A/m |
| *m* | magnetic moment | 1 erg/G = 1 emu  → 10−3 A·m2 = 10−3 J/T |
| *m* | magnetic moment | 1 erg/G = 1 emu  → 10−3 A·m2 = 10−3 J/T |
| 4π*M* | magnetization | 1 G → 103/(4π) A/m |
| *m* | magnetic moment | 1 erg/G = 1 emu  → 10−3 A·m2 = 10−3 J/T |
| *j* | magnetic dipole  moment | 1 erg/G = 1 emu  → 4π × 10−10 Wb·m |

**CONCLUSION**

The conclusion summarises the results and discussion and should be written in paragraphs instead of numbering. Moreover, the prospect of developing research results and application prospects of further studies into the next (based on result and discussion) can also be added.

**ACKNOWLEDGMENT**

This research was supported/partially supported by [Name of Foundation, Grant maker, Donor]. In addition, we thank our colleagues from [Name of the supporting institution] who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations/conclusions of this paper.

**REFERENCES**

All references must refer to the most relevant and up-to-date sources arranged in the order they appear in the text using numbers [1], [2] and so on. The author must ensure that all citations in the article have been listed in the reference list and vice versa. Give all authors' names; use “et al.” if there are three or more authors.

Use IEEE Style for citations and references with all items completely (Authors, Title, Name of Journal/Conferences, vol., no., pp., year, and DOI). Use over 80% of references from primary sources (international journals/conferences) with at least five years of publication. Avoid using references in Bahasa Indonesia or technical/manual references. The references are at least 25 articles.

Examples:

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