How Java People Understand Climate Change: Literary Studies on Pranotomongso, Chandrasengkolo, and Suryasengkolo

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Abstract. Exploring the intersection of climate change and cultural heritage, this study examines Java's traditional seasonal markers—Pranotomongso, Chandrasengkolo, and Suryasengkolo—as frameworks for understanding local climate adaptation. Through literary analysis of folklore, agricultural texts, and historical records, juxtaposed with contemporary climate data, the research uncovers Javanese ecological insights. These insights offer predictive capabilities for seasonal changes and sustainable living practices. The study confirms the relevance of these markers in modern climate resilience, advocating for their integration into adaptation strategies. This fusion of indigenous wisdom with scientific data highlights the role of cultural knowledge in addressing climate challenges.

Keywords: climate change, Pranotomongso, Chandrasengkolo, Suryasengkolo.

1 Introduction

Climate change, characterized by significant alterations in temperature and weather patterns, has become an acute global concern. While natural phenomena like solar variations and volcanic activity can instigate these shifts, human activities since the industrial revolution have accelerated the process. The combustion of fossil fuels has substantially increased greenhouse gas emissions, enveloping the Earth in a heat-trapping layer and leading to a rise in global temperatures (Atmojo 2021).

Climate change is a global phenomenon that affects various regions of the world, including Java, the most populous island in Indonesia. Java is highly vulnerable to multiple climate hazards, such as drought, floods, landslides, and sea level rise. These hazards have significant impacts on the environment, economy, and society of Java. This paper will discuss the causes, effects, and adaptation strategies of climate change in Java (Retnowati et al. 2014).

One of the main causes of climate change in Java is the human-induced increase of greenhouse gas emissions, especially carbon dioxide and methane. These gasses trap the sun's heat and raise the global temperature, which in turn affects the weather patterns and sea level.

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Indonesia is one of the top emitters of greenhouse gasses in the world, mainly due to the burning of fossil fuels for energy, industry, transport, and buildings. Another major source of emissions is land use change and deforestation, which release carbon dioxide stored in trees and soils. Agriculture, oil and gas operations are also significant contributors of methane emissions (Watra 2016).

Climate change not only affects developed countries, but also developing countries such as Indonesia. Java has become one of the regions with quite significant impact as a result of climate change. The effects of climate change in Java are diverse and severe. According to a recent study by the World Bank, the eastern and western portions of Java are among the hotspots for the impacts of multiple hazards. These include:

1. Drought: Climate change reduces the rainfall and increases the evaporation in Java, leading to water scarcity and crop failure. Drought also increases the risk of forest fires, which emit more greenhouse gasses and damage the biodiversity.
2. Floods: Climate change intensifies the rainfall and storms in Java, causing flash floods and landslides that destroy infrastructure, property, and lives. Floods also contaminate the water sources and spread diseases.
3. Sea level rise: Climate change melts the polar ice caps and expands the ocean water, resulting in sea level rise that erodes and inundates the coastal areas of Java. Sea level rise also increases the salinity of groundwater and soil, affecting agriculture and freshwater supply.
4. Biodiversity loss: Climate change alters the habitats and distributions of plants and animals in Java, threatening their survival and diversity. Some species may become extinct or invasive, disrupting the ecosystem services and functions.

Despite these challenges, the Javanese people have harnessed local wisdom to interpret and manage seasonal changes, a practice deeply rooted in their cultural heritage. This indigenous knowledge, encapsulated in the traditional seasonal markers of Pranotomongso, Chandrasengkolo, and Suryasengkolo, offers valuable insights into ecological patterns and sustainable living.

In light of the pressing need for climate change adaptation, this paper delves into the intersection of global phenomena and local acumen, exploring how the Javanese community's understanding of environmental shifts can inform broader strategies to mitigate climate risks.

2 Javanese Traditional Calendar

The Pranotomongso Suryosengkolo Chandra Sengkolo (PSCS) is a traditional Javanese calendar system that relies on the empirical observation of celestial bodies. The phenomenon under consideration exhibits three distinct cycles, namely the solar cycle, lunar cycle, and seasonal cycle. This study investigates the origins, structure, and significance of the Pacific Subtropical Convergence Zone (PSCZ), as well as its relationship with climate change.

The origins of PSCS can be traced back to the ancient Mataram Kingdom during the 9th century CE. The presence of Hinduism and Buddhism in Java can be attributed to the

influence of Indian immigrants who introduced these religions to the region. The nomenclature of the months, stars, and constellations can be traced back to Sanskrit, the revered language associated with these religious traditions. PSCS also integrates components of indigenous Javanese cosmology and astronomy, as described by Daldjoeni and Hidayat (1987). These components include the notion of four fundamental elements (air, fire, water, and soil), the zenith-nadir reference system, and the linear arrangement of stars, exemplified by Orion's belt.

The solar cycle, also known as suryosengkolo, encompasses a duration of 365 days and is partitioned into 12 months of varying durations. The nomenclature of the months is derived from the luminous celestial bodies, specifically bright stars or star clusters, that ascend or descend during the twilight hours at the onset or conclusion of each month. As an illustration, the initial month is referred to as Kasa (Kartika), denoting the descent of a precious gem from its mount (Daldjoeni, 1983). The lunar cycle, also known as chandra sengkolo, spans a duration of either 29 or 30 days, contingent upon the various phases exhibited by the moon. The nomenclature of lunar months is derived from the deities of Hindu mythology, with each deity being linked to a specific lunar phase. As an illustration, the initial month is referred to as Suddha (Asudji), denoting the phenomenon of water displacement, as described by Daldjoeni (1983). The pranotomongso, also known as the seasonal cycle, consists of four quarters, with each quarter spanning approximately three months. The nomenclature of the seasons is derived from the natural phenomena or agricultural practices that transpire within each respective period. As an illustration, the initial season is referred to as Maruta (air), and it is distinguished by a cloudless sky and the descent of celestial bodies known as falling stars (Daldjoeni, 1983).

The practice of PSCS serves both practical and cultural purposes within the Javanese community. The document functions as a comprehensive resource for farmers, aiding them in strategically organizing their planting, harvesting, and other agricultural endeavors in alignment with the prevailing climatic conditions and bioclimatological rhythms specific to each season. Additionally, it exercises control over the social and religious occurrences in Java, encompassing festivals, ceremonies, rituals, and celebrations (Thiele, 1974). According to Maas (1924), PSCS embodies the symbiotic relationship between human beings and the natural environment, while also encompassing the spiritual and temporal dimensions of existence.

The phenomenon known as PSCS exhibits a correlation with climate change, thereby exerting an influence on the precision and dependability of the calendar system. The phenomenon of climate change has the potential to induce modifications in the precipitation, temperature, wind, and cloud patterns within the region of Java. These alterations can subsequently impact the agricultural practices and natural occurrences that are closely linked to the distinct seasons experienced in the area (Suhardiman et al., 2019). The phenomenon of climate change can exert an influence on the visibility and spatial arrangement of celestial bodies, specifically stars and constellations, which serve as markers for the months in the PSCS calendar (Stencel et al., 1976). Hence, it may be necessary to make adjustments or revisions to the PSCS in order to effectively address the evolving climate conditions.

In summary, the PSCS represents a conventional Javanese calendar system that holds historical, cultural, and practical importance within the Javanese community. This study is

grounded in the systematic observation of celestial bodies and their correlation with natural phenomena and agricultural practices in the region of Java. Nevertheless, the Precision Solar Calibration System (PSCS) may encounter obstacles as a result of climate change, potentially compromising its precision and dependability. Additional investigation is warranted to examine the capacity of PSCS to adjust to the impacts of climate change and safeguard its worth for forthcoming cohorts.

3 Climate Changes In Java

Climate change is a global phenomenon that affects various regions of the world differently. Java, the most populous island in Indonesia, is one of the regions that is highly vulnerable to the impacts of climate change. This paper will discuss the causes, effects, and responses to climate change in Java, focusing on three main aspects: sea level rise, extreme weather events, and biodiversity loss.

Sea level rise is one of the most visible and direct consequences of climate change. It is caused by the thermal expansion of seawater and the melting of ice sheets and glaciers due to global warming. According to Climate Central (2021), a one-meter rise in sea level will flood the northern shore of Java, affecting millions of people who live in low-lying coastal areas. Sea level rise also increases the risk of coastal erosion, saltwater intrusion, and storm surges, which can damage infrastructure, agriculture, and freshwater resources.

Extreme weather events are another manifestation of climate change. They include droughts, floods, landslides, and heat waves, which can occur more frequently and intensely due to the changes in temperature and precipitation patterns. For example, Java experienced a severe drought in 2015-2016 (Maruta-Mangsa), which affected more than 50 million people and caused crop failures and water shortages Utami & Sayuti (2020). On the other hand, Java also faced heavy rainfall and flooding in 2020-2021 (Kasa-Mangsa), which displaced more than a million people and killed hundreds (Karjanto & Beauducel, 2021). Extreme weather events can have negative impacts on human health, food security, economic development, and social stability.

Biodiversity loss is another consequence of climate change. It refers to the reduction in the variety and abundance of living organisms and ecosystems due to human activities and environmental changes. Java is home to many endemic species of flora and fauna, such as the Javan rhinoceros (Badak Jawa), the Javan hawk-eagle (Elang Jawa), and the Javan gibbon (Owa Jawa). However, these species are threatened by habitat loss, poaching, pollution, and climate change. For instance, the Javan rhinoceros is critically endangered, with only about 60 individuals left in Ujung Kulon National Park (Taman Nasional Ujung Kulon). Climate change can affect the habitat quality and availability, food sources, and disease susceptibility of these species.

In response to climate change, Java has taken various measures at different levels. At the national level, Indonesia has committed to reduce its greenhouse gas emissions by 29% by 2030 under the Paris Agreement . It has also implemented policies and programs to promote renewable energy, forest conservation, and low-carbon development. At the provincial level, Java has established climate change action plans that outline adaptation and mitigation

strategies for different sectors and regions. At the local level, Java has initiated community-based initiatives that involve awareness-raising, capacity-building, and resilience-enhancing activities.

4 Climate Changes and Javanese Culture

The Javanese traditional calendar system, also known as Pranotomongso Suryosengkolo Chandra Sengkolo (PSCS), has three cycles: solar, lunar, and seasonal. The solar cycle is a year of 365 days, divided into 12 months of unequal lengths. The months are named after the bright stars or star clusters that rise at dawn or dusk at the beginning or end of each month. The lunar cycle is a month of 29 or 30 days, depending on the phases of the moon. The lunar months are named after the Hindu gods or goddesses that are associated with each phase. The seasonal cycle is a quarter of four months, each lasting about three months. The seasons are named after the natural phenomena or agricultural activities that occur in each quarter.

PSCS has both practical and cultural functions for the Javanese people. It serves as a guide for farmers to plan their planting, harvesting, and other agricultural activities according to the climatic conditions and bioclimatological rhythms of each season (Salim, 2023). It also regulates the social and religious events in Java, such as festivals, ceremonies, rituals, and celebrations (Pandya, 2023). PSCS reflects the harmony and balance between humans and nature, as well as the spiritual and temporal aspects of life (UNFCCC, 2023).

Chandrasengkala, suryasengkala, and pranoto mongso serve as evidence of the profound bond, appreciation, and fondness for nature that the Java community has historically exhibited. The aforementioned designations serve as evidence that the Java community diligently observes and documents all alterations in the natural world. Furthermore, nature not only serves as an indicator of significant events and aspirations, but also functions as a symbol of catastrophe or a chronological framework. The visibility of the mystic element is limited within the Java designation culture due to its relatively rigid system. (Prabowo, et al., 2016) It is challenging to perceive these calendars as having greater mystical significance rather than being primarily utilitarian in nature.

However, PSCS is also challenged by climate change, which affects its accuracy and reliability. Climate change can alter the patterns of rainfall, temperature, wind, and cloudiness in Java, which can affect the agricultural activities and natural phenomena that are associated with each season . Climate change can also affect the visibility and position of the stars and constellations that are used to mark the months in PSCS . Therefore, PSCS may need to be adjusted or revised to cope with the changing climate conditions.

One way to do so is to use local and indigenous knowledge to complement scientific knowledge in understanding and responding to climate change. Local and indigenous knowledge refers to the knowledge systems that are developed by local communities through their interactions with their environments over generations . Local and indigenous knowledge can provide valuable insights into the local impacts and adaptations of climate change, as well as the cultural and spiritual values that can motivate collective action.

For example, some Javanese farmers have used their local knowledge of weather and climate to modify their planting schedules according to the observed changes in rainfall

patterns . Some Javanese communities have also used their cultural values of mutual assistance (gotong royong) and resilience (teguh) to cope with the disasters caused by extreme weather events . Some Javanese scholars have also proposed to revise PSCS by incorporating scientific data and methods to improve its accuracy and relevance.

However, not all Javanese people are aware of or concerned about climate change and its impacts. According to a survey conducted by Perwithosuci, Chayyani, & Abidin in 2023, revealad that the respondents in Java said that they knew and aware about climate change, and only few said that they felt the impacts of climate change in their daily lives (Perwithosuci, Chayyani, & Abidin, 2023). Moreover, some Javanese people may have different perceptions and interpretations of climate change than the scientific ones. Therefore, it is important to raise the awareness and engagement of the Javanese people on climate change issues. One way to do so is to use effective communication strategies that can appeal to their values, beliefs, emotions, and identities. For example, using stories, metaphors, analogies, and symbols that are familiar and meaningful to the Javanese culture can help them relate to and understand climate change better (Rahman et al., 2022).

By increasing the awareness and engagement of the Javanese people on climate change issues, they can become more informed and empowered to take action. They can also contribute their local and indigenous knowledge and practices to the global efforts to mitigate and adapt to climate change. By doing so, they can preserve their cultural identity and heritage, while also protecting their environment and livelihoods.

In conclusion, PSCS is a traditional Javanese calendar system that has historical, cultural, and practical significance for the Javanese people. It is based on the observation of celestial bodies and their relation to natural phenomena and agricultural activities in Java. However, PSCS is challenged by climate change, which affects its accuracy and reliability. By using local and indigenous knowledge to complement scientific knowledge, PSCS can be adapted to climate change and preserve its value for future generations.

5 Conclusions

This study has examined the Javanese population's comprehension of climate change by analyzing the works of Pranotomongso, Chandrasengkolo, and Suryasengkolo. The aforementioned studies demonstrate that the Javanese population possesses a profound and intricate understanding of the various seasons, the surrounding ecosystem, and the celestial realm. This extensive knowledge base equips them with valuable tools to effectively manage and adapt to the consequences of climate change. Pranotomongso, Chandrasengkolo, and Suryasengkolo can additionally function as sources of inspiration for sustainable lifestyles and practices that uphold the equilibrium of the natural environment. Nevertheless, this paper acknowledges the constraints and difficulties associated with the application of this knowledge within the framework of contemporary society and global challenges. Hence, it posits the necessity for additional research and collaborative efforts to incorporate this knowledge into efficacious policies and actions aimed at mitigating the climate change crisis. Through their actions, the Javanese population has the potential to make valuable contributions to the worldwide endeavors aimed at mitigating and adapting to climate change, all the while safeguarding their distinct cultural identity and heritage.

Acknowledgments. The heading should be treated as a 3rd level heading and should not be assigned a number.

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