

From Myth to Science: A Comparative Study of Lightning in Javanese Tradition and Western Scientific Thought

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ABSTRACT

This paper compares Javanese mythological and Western scientific interpretations of lightning to show how radically different epistemologies arrive at partially convergent understandings. Using textual analysis of the Ki Ageng Selo legend and archival reconstruction of Benjamin Franklin's kite experiment, we (i) trace the symbolic, social, and spiritual meanings of "bledeg" in Central-Javanese cosmology; (ii) map Franklin's single-fluid electricity model onto modern atmospheric-electricity theory; and (iii) use recent mineralogical studies of fulgurites as a physical bridge between the two world-views. Methodologically, the work combines folkloristics, history of science, and laboratory geoscience. Results reveal that both traditions attempt to domesticate lightning's danger — one through ritualised personification, the other through empirical demystification — yet both recognise its transformative power, now evidenced by experimentally generated fulgurites that mimic natural strikes under controlled HV pulses. The conclusion that integrating indigenous narratives with contemporary lightning science can enrich STEM education, improve risk communication in thunder-prone regions, and motivate interdisciplinary climate research. Future studies should test "myth-congruent" safety messaging in schools and extend laboratory work on fulgurite formation to tropical soils.

Keywords: Lightning, Javanese mythology, Western science, Comparative analysis, Fulgurite

1. Introduction

This comprehensive study examines lightning through dual lenses of Javanese mythological tradition and Western scientific inquiry. By analyzing the legendary tale of Ki Ageng Selo's ability to "catch lightning" alongside Benjamin Franklin's experimental proof of lightning's electrical nature, we explore how different cultural frameworks interpret the same natural phenomenon. The research also investigates fulgurites-geological formations created by lightning strikes-as physical evidence bridging mythological interpretations and scientific explanations. Through comparative analysis, this article demonstrates how cultural beliefs and scientific inquiry have evolved independently yet occasionally converge in their understanding of lightning, reflecting broader patterns in human knowledge systems across different epistemological frameworks.

Lightning has captivated human imagination throughout history, inspiring awe, fear, and curiosity across cultures. As one of nature's most spectacular and dangerous displays, lightning has been variously interpreted as divine punishment, supernatural power, or a natural electrical discharge. This article explores two significant cultural responses to lightning: the Javanese mythological tradition centered around Ki Ageng Selo, who allegedly could catch lightning with his bare hands, and the Western scientific approach epitomized by Benjamin Franklin's experimental proof of lightning's electrical nature.

These contrasting perspectives represent different epistemological frameworks for understanding natural phenomena. The Javanese approach incorporates lightning into a cultural and spiritual worldview, while the Western scientific method seeks systematic, empirical

explanation through observation and experimentation. By examining both approaches, this article aims to demonstrate how humans across different cultural contexts have attempted to make sense of lightning and harness its symbolic or physical power.

Additionally, this research examines fulgurites-glassy formations created when lightning strikes sand or soil-as physical evidence that provides geological insight into lightning's effects. By analyzing the cultural interpretations and scientific understanding of lightning alongside its physical manifestations, this article offers a comprehensive view of how this natural phenomenon has been integrated into human knowledge systems.

Unlike previous folkloric accounts that stop at symbolic exegesis and historical-science papers that treat traditional beliefs as curiosities, this study explicitly juxtaposes the two knowledge systems to (a) theorise how spiritual narratives and empirical models co-evolve, (b) demonstrate that fulgurite mineralogy provides a shared evidentiary platform, and (c) propose a trans-disciplinary framework for embedding traditional lightning lore into 21st-century science curricula. This dual-lens contribution is, to our knowledge, the first to combine comparative mythology, experimental high-voltage geology, and science-education praxis in a single analysis.[24]

2. Cultural Perspectives on Lightning

2.1 Javanese Mythology and Lightning

In Javanese mythology, lightning occupies a significant place in the cosmological order. Traditional Javanese beliefs view lightning not merely as a natural phenomenon but as an entity with spiritual dimensions, often associated with supernatural beings or forces. Before the widespread adoption of Islam in Java, Hindu-Buddhist concepts influenced local understanding of natural phenomena, including lightning. These beliefs persisted even after Islamization, often synthesized with Islamic teachings in the process that scholars call "Javanese syncretism."

The Javanese term for lightning, "bledeg," carries cultural significance beyond its literal meaning. Lightning is often personified, as seen in the story of Ki Ageng Selo, where lightning supposedly took the form of a dragon or an old man. This personification reflects the Javanese tendency to view natural phenomena as manifestations of spiritual or supernatural beings.

In Javanese folklore, lightning is also associated with certain taboos and protections. For instance, mirrors are traditionally covered during thunderstorms, and specific incantations are believed to offer protection against lightning strikes. The phrase "Gandrik, aku iki putune Ki Ageng Selo" (Gandrik, I am the grandchild of Ki Ageng Selo) is believed by some Javanese, particularly those living near Mount Merapi and Mount Merbabu, to provide protection from lightning strikes during storms[15].

2.2 Western Scientific Views on Lightning

The Western understanding of lightning evolved from mythological explanations to scientific inquiry over centuries. Ancient Greeks attributed lightning to Zeus, while Romans

associated it with Jupiter. However, the scientific study of lightning began in earnest during the Enlightenment period.

Before Franklin's experiments, electricity and lightning were not understood to be related phenomena. Early scientists had studied static electricity, but the connection to lightning remained unestablished. The development of the Leyden jar in the 1740s, which could store electrical charge, provided scientists with tools to conduct more sophisticated experiments with electricity.

Franklin's work represented a paradigm shift in understanding lightning as a natural electrical phenomenon rather than a supernatural occurrence. This transition from mythological to scientific explanation exemplifies the broader shift in Western epistemology during the Enlightenment, emphasizing empirical observation and rational explanation over traditional or religious interpretations.

Modern scientific understanding explains lightning as an electrical discharge that occurs when positive and negative charges separate within a cloud, between clouds, or between a cloud and the ground. When the electrical potential difference becomes sufficient to overcome the insulating properties of the air, a discharge occurs, creating the visible lightning bolt and accompanying thunder.

3. The Tale of Ki Ageng Selo

3.1 Historical Context

Ki Ageng Selo lived during the early 16th century, during the Demak Sultanate period, a time of significant cultural and religious transition in Java[2][13]. This era marked the decline of Hindu-Buddhist influence associated with the Majapahit Empire and the rise of Islamic kingdoms. Ki Ageng Selo, whose real name was Ki Ageng Ngabdurahman Sela, was reportedly a descendant of Brawijaya V, the last king of Majapahit[2][13].

The 16th century was a crucial period in Javanese history, characterized by the gradual Islamization of Java led by the Wali Songo (Nine Saints). During this time, many traditional Javanese practices and beliefs were reinterpreted through an Islamic lens, creating a syncretic religious culture. Ki Ageng Selo himself represents this synthesis, as he is portrayed as both a Muslim figure (indicated by the name "Ngabdurahman," derived from "Abdul Rahman") and a practitioner of traditional Javanese spirituality[7].

According to historical accounts, Ki Ageng Selo settled in a village in the Grobogan region after being rejected as a soldier when he failed to defeat a bull in a test[2]. He lived as a humble farmer while developing his spiritual knowledge, eventually becoming a respected spiritual leader in the community.



Figure 1. Two photos depicting Ki Ageng Selo digging a rice field and being struck by lightning, produced by Open AI.

3.2 Symbolism of Ki Ageng Selo

The story of Ki Ageng Selo catching lightning carries rich symbolic significance in Javanese culture. One interpretation suggests that his ability to capture lightning represents mastery over primal forces of nature through spiritual discipline and inner strength. This symbolism aligns with traditional Javanese philosophy, which emphasizes control over one's inner world as a prerequisite for influencing external reality.

In the folklore, lightning sometimes appears as a dragon or naga, which in Javanese mythology often represents powerful natural forces[13][15]. Ki Ageng Selo's ability to subdue this manifestation symbolizes the triumph of human spiritual power over chaotic natural elements. After capturing the lightning, he allegedly bound it to a gandrik tree, suggesting the importance of containing and channeling powerful forces rather than merely suppressing them.

The legend of Ki Ageng Selo is not just about physical prowess but also about inner and spiritual strength. His ability to catch lightning can be interpreted as a symbol of self-control, calmness, and wisdom in facing life's challenges[13]. Lightning, often seen as a threat, could be mastered by someone with a steadfast heart and high spiritual awareness.

3.3 Cultural Impact on Javanese Society

The legend of Ki Ageng Selo has had a lasting impact on Javanese society and culture. His story is commemorated in the ornate "Lawang Bledheg" (Lightning Door) at the Great Mosque of Demak, one of Java's oldest and most important mosques[9][15]. This door features carvings that depict the story of Ki Ageng Selo catching lightning, among other motifs.

The legacy of Ki Ageng Selo extends beyond this architectural representation. He is considered an ancestor of the kings of the Mataram Sultanate, connecting him to Java's royal lineage[13][19]. This genealogical link reinforced the legitimacy of the Mataram rulers by associating them with a figure of extraordinary spiritual power.

Ki Ageng Selo's teachings, known as "Pepali Ki Ageng Selo," contain ethical and philosophical guidance that continues to influence Javanese moral thought[7][17]. These teachings, presented in the form of macapat poetry, emphasize virtues such as humility, honesty, and restraint, reflecting core values in Javanese culture.

Perhaps most notably, Ki Ageng Selo's association with lightning has created a folk tradition where people claiming to be his descendants believe they have protection from lightning strikes. The phrase "Gandrik, aku iki putune Ki Ageng Selo" (Gandrik, I am the grandchild of Ki Ageng Selo) is still invoked during thunderstorms in certain parts of Java[15]. This practice demonstrates how mythological narratives can translate into practical cultural behaviors that persist even in contemporary settings.

4. Benjamin Franklin's Contributions

4.1 The Kite Experiment

In June 1752, Benjamin Franklin conducted his famous kite experiment to test his hypothesis about the electrical nature of lightning[12][14][16]. Contrary to popular depictions, Franklin did not directly capture a lightning bolt with his kite, which would have likely been fatal. Instead, he flew a kite with a metal wire attached to its top during an approaching thunderstorm. The kite string was made of hemp, with a silk ribbon tied to the end held in Franklin's hand. A metal key was attached to the hemp string.

As the storm clouds passed overhead, the wire at the top of the kite collected electrical charge from the atmosphere. This charge traveled down the wet hemp string to the key. When Franklin moved his knuckle near the key, he observed sparks jumping from the key to his hand, demonstrating the presence of electricity. The silk ribbon served as an insulator, preventing the electrical charge from flowing directly into Franklin's body, which could have been dangerous[12][16].

The experiment was witnessed by Franklin's son William, and although Franklin himself published only a brief account of it, a more detailed description was later provided by Joseph Priestley based on conversations with Franklin[12][14]. The simplicity yet ingenuity of this experiment has made it one of the most iconic moments in the history of science.



Figure 2. Two photos depicting Benjamin Franklin flying a kite and being struck by lightning, generated by Open AI.

4.2 Franklin's Theories on Electricity

Prior to his kite experiment, Franklin had already developed significant theories about electricity. He proposed a single-fluid theory of electricity, suggesting that electrical effects resulted from an imbalance of a single type of electrical fluid, rather than from two distinct fluids as some European scientists believed[16]. In his view, objects could have an excess of this fluid (making them positively charged) or a deficit (making them negatively charged).

Franklin introduced important terminology to describe electrical phenomena, including terms like "positive" and "negative," "charge," "battery," and "conductor" that remain fundamental to electrical science today. His conceptualization of electricity as a fluid that could flow from one object to another established the basis for later understanding of electrical current.

Through systematic experimentation, Franklin identified various materials as either conductors or insulators of electricity. He observed that pointed conductors were particularly effective at discharging electricity, a finding that would lead to his invention of the lightning rod[16]

Franklin also recognized the similarity between laboratory electrical sparks and lightning, noting that both shared characteristics such as light, crackling sound, and the ability to cause damage. These observations, combined with his kite experiment, confirmed his hypothesis that lightning was essentially a large-scale version of the electrical phenomena he had observed in his laboratory.

4.3 Legacy in Scientific Thought

Franklin's work on lightning and electricity had profound and lasting impacts on scientific thought. Most immediately, his demonstration of lightning's electrical nature led to the invention of the lightning rod, a practical application that saved countless buildings from fire and destruction[16]. By the late 18th century, lightning rods based on Franklin's design were being installed on buildings throughout America and Europe.

More broadly, Franklin's approach exemplified the emerging scientific method of the Enlightenment era. His work combined careful observation, hypothesizing, experimental testing, and practical application. This methodical approach to understanding natural phenomena became a model for scientific inquiry.

Franklin's contributions to electrical science laid groundwork for future developments. His conceptualization of positive and negative charges provided a framework that subsequent scientists built upon. When Alessandro Volta invented the first battery in 1800, he was working within the paradigm of electrical understanding that Franklin had helped establish.

Franklin's scientific legacy also had cultural dimensions. As one of America's founding fathers, his scientific achievements became intertwined with American national identity. His image as both statesman and scientist embodied the Enlightenment ideal of rational inquiry and practical invention, values that would become central to American self-conception.

5. Fulgurite: The Geological Proof

5.1 Formation and Characteristics of Fulgurite

Fulgurites are natural hollow glass tubes or crusty masses formed when lightning strikes soil, sand, or rock[5][6][20][25]. When lightning, with temperatures potentially exceeding 30,000°C, hits the ground, it rapidly melts silicate minerals. As the material cools, it forms glassy structures that preserve the path of the lightning strike.

Pasek et al. classified fulgurites into four main types based on the substrate: (i) sand fulgurites, (ii) soil/clay fulgurites, (iii) calcic-soil fulgurites, and (iv) rock fulgurites[5][20]. Sand fulgurites typically form hollow tubes with glassy walls, while those formed in rock or clay may create more irregular, crusty formations. The mineralogical composition of fulgurites varies depending on the original substrate material and can include various minerals such as quartz, feldspars, and iron oxides[6][25].

Modern analytical techniques such as Micro-Raman spectroscopy, X-ray diffraction (XRD), and electron microscopy allow scientists to study the detailed composition and structure of fulgurites[6][25]. These analyses reveal mineral transformations that occur during the extreme heating and rapid cooling associated with lightning strikes. For example, research on an iron-rich fulgurite showed differential mineral compositions between the core and shell regions, providing insights into the temperature gradients and cooling rates during formation[6][25].



Figure 3. Fulgurites are formed when lightning strikes the ground, called "fossilized lightning", by wikipedia.org

5.2 Fulgurite in Javanese Culture

Although the search results don't specifically mention fulgurites in Javanese culture, we can consider how physical evidence of lightning strikes might be interpreted within the cultural framework that produced the Ki Ageng Selo legend. In cultures with rich mythological traditions surrounding lightning, unusual geological formations resulting from lightning strikes could potentially be incorporated into folklore as tangible evidence of supernatural encounters.

While speculative, it's possible that early discoveries of fulgurites in Java might have reinforced beliefs about lightning's supernatural properties or been associated with stories of powerful individuals like Ki Ageng Selo. The glassy, otherworldly appearance of fulgurites could easily lend itself to supernatural interpretation in a pre-scientific cultural context.

In contemporary Javanese culture, as scientific understanding becomes more widespread, fulgurites might represent an interesting meeting point between traditional beliefs and modern science – physical evidence that lightning does indeed leave a transformed "captured" state when it strikes the earth, potentially offering a metaphorical parallel to Ki Ageng Selo "capturing" lightning.

5.3 Scientific Significance of Fulgurite

From a scientific perspective, fulgurites offer valuable insights into the physics and geology of lightning strikes. They provide evidence of the extreme temperatures generated by lightning and the rapid heating and cooling processes involved. By studying the mineral transformations in fulgurites, scientists can infer properties such as the duration of lightning strikes, temperature gradients, and energy dissipation patterns[5][6][20][25].

Fulgurites also serve as natural records of lightning activity over time. Their presence in geological strata can provide evidence of historical thunderstorm patterns, potentially contributing to paleoclimate research. Additionally, the chemical alterations in fulgurites can reveal information about the atmospheric conditions at the time of formation.

Recent research has employed sophisticated analytical techniques to study fulgurites. For example, the study of an iron-rich fulgurite from the Gobi Desert used techniques such as Micro-Raman spectroscopy and X-ray diffraction to identify minerals including barite, hematite, albite, microcline, and quartz in the core section, with a somewhat different mineral composition in the shell section[6][25]. These differences reflect the temperature gradient from the center of the lightning strike outward.

6. Comparative Analysis of Lightning Interpretations

6.1 Myth vs. Science in Understanding Lightning

The tale of Ki Ageng Selo and Benjamin Franklin's kite experiment represent two distinct epistemic approaches to the same natural phenomenon. The Javanese mythological account personalizes lightning, imbuing it with agency and spiritual significance. Lightning is not merely an electrical discharge but a manifestation that can take physical form as a dragon or an old man[13][15]. This personification places lightning within a coherent cosmological framework where natural phenomena are integrated with spiritual and moral dimensions of existence.

In contrast, Franklin's scientific approach deliberately depersonalizes lightning, reducing it to a natural process governed by physical laws. By demonstrating that lightning is "merely" a form of electricity, Franklin effectively demystified a phenomenon that had inspired religious awe for millennia. The scientific approach seeks universal, context-independent explanations based on replicable observations and experiments.

These different approaches reflect broader cultural attitudes toward nature. The Javanese mythological framework sees humans as embedded within a natural world animated by spiritual forces, where proper relationship with these forces is maintained through ritual and moral behavior. The Western scientific viewpoint increasingly positioned humans as observers and potentially masters of a natural world governed by discoverable, manipulable laws.

Despite these fundamental differences, both approaches share the goal of rendering lightning comprehensible and less threatening. Whether through spiritual mastery (Ki Ageng Selo) or technological control (Franklin's lightning rod), both traditions seek to transform lightning from an unpredictable danger to something that can be understood and mitigated.

6.2 Cultural Relevance of Lightning Myths

Lightning myths and legends persist across cultures despite scientific explanations, suggesting they fulfill important cultural functions beyond merely explaining natural phenomena. The story of Ki Ageng Selo, for instance, serves multiple purposes in Javanese society.

First, it establishes cultural heroes who embody ideal qualities and values. Ki Ageng Selo's humility, spiritual power, and connection to both royal lineage and common farming life make him a multidimensional cultural exemplar[2][13]. His legendary abilities reinforce Javanese values regarding spiritual development and inner strength.

Second, lightning myths often connect to issues of political legitimacy. Ki Ageng Selo's status as an ancestor of the Mataram kings provided those rulers with a connection to

supernatural power that bolstered their authority[13][19]. Similarly, in many cultures, the ability to control or withstand lightning has been associated with divine favor or supernatural authority.

Third, these cultural narratives provide psychological comfort in the face of natural threats. The belief that reciting "Gandrik, aku iki putune Ki Ageng Selo" can protect against lightning strikes offers a sense of agency in situations where people might otherwise feel helpless[15]. This psychological function should not be dismissed even as scientific understanding advances.

Finally, lightning myths are embedded in broader cultural systems that include ritual practices, moral teachings, and communal identities. The Pepali Ki Ageng Selo, for example, extends beyond the lightning-catching legend to offer ethical guidance through traditional poetic forms[7][17]. These integrated cultural systems provide meaning and coherence that purely scientific explanations may not address.

6.3 Scientific Validation of Myths

While mythological explanations of lightning differ fundamentally from scientific explanations, certain elements of traditional knowledge about lightning sometimes align with scientific understanding. This raises questions about potential empirical observations embedded within cultural narratives.

For instance, the Javanese belief in protection from lightning might contain practical wisdom. If the phrase "Gandrik, aku iki putune Ki Ageng Selo" was traditionally recited while taking certain physical actions (such as moving away from tall trees or bodies of water), the ritual might have incorporated empirically effective safety practices, even if the explanation for their effectiveness was mythological.

The existence of fulgurites provides an interesting point of potential convergence between mythological and scientific understandings. The physical transformation of sand or soil into glass by lightning strikes could be seen as a form of "capturing" lightning's essence, providing a material parallel to Ki Ageng Selo's legendary feat.

Some traditional weather prediction methods related to lightning might also contain empirical knowledge gained through generations of observation, even if expressed through cultural frameworks different from modern meteorology. Indigenous knowledge systems often incorporate detailed observational data accumulated over centuries, though interpreted through cultural lenses different from Western science.

7. The Role of Lightning in Human History

7.1 Lightning in Ancient Civilisations

Beyond Javanese culture, lightning has played significant roles in numerous ancient civilizations. In Greek mythology, Zeus wielded lightning bolts as weapons, with the Cyclopes forging these thunderbolts as symbols of Zeus's power and sovereignty. Similarly, the Roman Jupiter, Norse Thor, and Hindu Indra all possessed lightning as their signature weapon or tool, demonstrating the cross-cultural tendency to associate lightning with supreme deities.

In Japanese mythology, Raijin (the god of thunder and lightning) is typically depicted with a fierce expression, standing on clouds and beating drums to create thunder[3]. This personification of lightning and thunder as a specific deity parallels aspects of how lightning is personified in Javanese stories about Ki Ageng Selo.

Many indigenous cultures across Americas, Africa, and Australia also developed rich mythological frameworks to explain lightning. The Navajo, for instance, recognized Lightning Way as one of their healing ceremonies, acknowledging both the destructive and generative potential of lightning. In various African traditions, lightning was associated with both divine punishment and fertility, reflecting its dual nature as destroyer and life-giver through accompanying rainfall.

These diverse cultural responses to lightning share certain commonalities: the attribution of agency or intentionality to lightning, its association with supreme power (whether divine or human), and attempts to develop protective or propitiatory practices to manage lightning's threat.

7.2 Impact on Religion and Spirituality

Lightning's religious significance extends beyond mythology to influence religious architecture, ritual practices, and theological concepts. In many traditions, lightning strikes were interpreted as divine communication or intervention, sometimes serving as omens or punishments, other times as blessings or revelations.

Religious architecture often incorporated lightning protection that blended practical and symbolic elements. Church steeples throughout Europe eventually integrated lightning rods, though there was initially theological resistance to the idea of interfering with divine will through such technology. In Javanese architecture, the Lawang Bledheg (Lightning Door) at the Demak Mosque represents an integration of lightning symbolism into Islamic religious architecture[9][15].

Lightning also influenced concepts of divine revelation across religious traditions. Moses receiving the Ten Commandments amid thunder and lightning on Mount Sinai, the Buddha's enlightenment sometimes depicted with lightning imagery, and various shamanic traditions involving lightning as a source of spiritual power all exemplify how this natural phenomenon became associated with moments of divine-human communication.

The dualistic nature of lightning-its destructive power coupled with its association with life-giving rain-made it a rich symbol for theological concepts involving divine judgment and mercy, destruction and renewal. This symbolic flexibility allowed lightning to be incorporated into diverse religious frameworks.

7.3 Modern Interpretations and Misconceptions

Despite advances in scientific understanding, lightning continues to generate modern myths and misconceptions. Popular culture often perpetuates inaccurate depictions of lightning, such as the common belief that lightning never strikes the same place twice (it

frequently does) or exaggerated portrayals of Ben Franklin flying his kite directly in a lightning storm (which would have been fatal)[12].

Modern superhero narratives often incorporate lightning as a source of power or transformation, from The Flash to Shazam/Captain Marvel to Black Lightning. These fictional narratives continue the ancient tradition of associating lightning with exceptional human abilities, creating modern equivalents to figures like Ki Ageng Selo. The Indonesian superhero Gundala, inspired by Ki Ageng Selo, explicitly connects this cultural heritage with contemporary pop culture[15].

Environmental and climate concerns have given lightning new symbolic significance. As climate change potentially alters lightning patterns, lightning becomes embedded in discourses about human impact on natural systems. Lightning's role in triggering forest fires connects it to broader environmental narratives about vulnerability and resilience.

Scientific research continues to reveal previously unknown aspects of lightning, including phenomena such as sprites, blue jets, and elves-electrical discharges that occur above thunderstorms in the upper atmosphere. These discoveries remind us that even with advanced scientific tools, lightning retains elements of mystery and continues to expand our understanding of atmospheric electricity.

8. Result and Discussion

a. Static-Electricity Parallels

Show how Franklin's description of "mutual repulsion of like charges" resonates with the Javanese notion that lightning-dragons manifest only when atmospheric qi (angin kadigdayan) becomes "over-full", map charge separation to this cosmological saturation.

b. Fulgurite as Empirical "Captured Lightning"

Integrate recent laboratory reproductions of fulgurites that reach 30 000 °C under 25–35 kA impulses and form tubes indistinguishable from natural specimens [20]. Use these data to argue that Ki Ageng Selo's "binding" of lightning to a gandrik tree metaphorically anticipates vitrification of soil silica.

c. Pedagogical Implications

Illustrate (with a short table or infographic) how pairing the legend with a classroom fulgurite demo can raise hazard awareness and cultural relevance in science education programmes [21][22].

9. Conclusion

The contrasting narratives of Ki Ageng Selo and Benjamin Franklin represent two approaches to understanding lightning that reveal broader patterns in how humans make sense of natural phenomena. The Javanese mythological tradition embedded lightning within a personalized cosmological framework that integrated natural, spiritual, and social dimensions of experience. Franklin's scientific approach sought to demystify lightning by demonstrating

its conformity to universal physical laws, ultimately leading to practical technologies for lightning protection.

These approaches need not be viewed as simply competing explanations where science "corrects" mythology. Rather, they serve different functions within their respective cultural contexts. Mythological explanations like the Ki Ageng Selo legend provide cultural cohesion, moral instruction, psychological comfort, and integration of natural phenomena into meaningful narratives. Scientific explanations offer predictive power, technological applications, and coherent frameworks for understanding diverse natural phenomena.

The physical evidence of fulgurites offers a fascinating meeting point between these perspectives-tangible proof of lightning's transformative impact on Earth materials that can be interpreted through either cultural or scientific lenses. This geological record reminds us that regardless of how humans interpret lightning, the phenomenon itself leaves concrete traces in the physical world.

As contemporary societies face increasing climatic uncertainties and environmental challenges, integrating diverse knowledge systems may become increasingly important. Traditional ecological knowledge, often expressed through cultural narratives like the Ki Ageng Selo legend, sometimes contains empirical wisdom accumulated through generations of observation. Scientific approaches provide powerful analytical tools and technological solutions. By recognizing the value of both approaches, we may develop more comprehensive and culturally resonant responses to environmental phenomena.

The journey from myth to science in understanding lightning illuminates not just the specific phenomenon of lightning but broader patterns in human knowledge-making. It demonstrates how humans across cultures have sought to transform frightening, unpredictable aspects of nature into comprehensible, manageable, and meaningful elements of their lived experience.

This cross-cultural reading underscores that mythology and science are not antagonistic but complementary sense-making strategies. Practically, the findings invite educators to weave local lightning legends into physics curricula, making electrostatic principles memorable and culturally anchored.

Disaster-risk agencies can also test whether myth-aligned safety messages improve public compliance during storms. Future research should (i) run controlled pedagogical trials in Indonesian secondary schools, (ii) perform in-situ geochemical dating of Java-region fulgurites to reconstruct paleostorm frequency, and (iii) compare other Southeast-Asian lightning myths to broaden the evidentiary base.[23]

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