

BEYOND THE GREEN ILLUSION: INTEGRATING INDIGENOUS KNOWLEDGE AND GEOSPATIAL EVIDENCE FOR SUSTAINABLE LANDSCAPE MANAGEMENT IN MATALE, SRI LANKA

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Abstract: Vegetation greenness does not necessarily indicate ecological or structural stability in landscapes exposed to landslide risk. This study examines this apparent divergence in Matale District, Sri Lanka, by bringing a 30-year Landsat assessment into dialogue with Indigenous Knowledge from the Rattota Divisional Secretariat Division. The study investigates how increasing vegetation greenness may coexist with landscape conditions that remain vulnerable to instability, highlighting the limitations of interpreting vegetation change solely through remotely sensed indicators. An explanatory sequential mixed-methods approach was adopted. Landsat imagery from 1995, 2015, and 2025 was used to assess vegetation dynamics through the Normalized Difference Vegetation Index (NDVI), while topographic information and landslide susceptibility data were used to examine the spatial context of landscape vulnerability. Qualitative evidence was subsequently obtained from 12 long-term residents and Indigenous Knowledge holders in the Rattota Divisional Secretariat Division through semi-structured interviews and field observations, with the data analysed thematically. The results show an overall increase in mean NDVI from 0.304 in 1995 to 0.327 in 2015 and 0.350 in 2025. However, increased spectral greenness does not necessarily correspond with ecological or structural stability. Indigenous Knowledge provides additional insight into traditional vegetation, soil, slope, and water-management practices that contribute to landscape stability, while also indicating a decline or disconnection of such practices. The findings highlight a “Green Illusion,” whereby increased vegetation greenness may conceal changes in vegetation composition and the weakening of traditional land-stewardship practices. Integrating geospatial evidence with Indigenous Knowledge therefore provides a more context-sensitive understanding of landscape vulnerability and supports the potential for IK-weighted geospatial monitoring and sustainable landscape management in Matale District.

Keywords: indigenous knowledge, GIS, remote sensing, NDVI, green illusion, landscape vulnerability, sustainable landscape management

Introduction

Matale District in the Central Province of Sri Lanka represents a vulnerable landscape because of its complex topography, ecological sensitivity and human settlement patterns. The district contains steep slopes and narrow valleys and is exposed to landslides and other environmental hazards. The vulnerability of the central highlands is associated with steep slopes, fragile geological conditions and high-intensity rainfall patterns (National Building Research Organisation, 2019; Centre for Excellence in Disaster Management and Humanitarian Assistance, 2024).

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The Matale District is also environmentally significant because it contains the Knuckles Mountain Range, a UNESCO World Heritage Site and biodiversity hotspot (UNESCO, 2010). The surrounding landscape has experienced increasing pressure from anthropogenic activities, including commercial crop-related agricultural expansion and shifts in livelihood patterns (Kottawa-Arachchi and Wijeratne, 2017; Dumbura Mithuro Environmental and Cultural Society, 2025). The district extends from approximately 49 m in the northern lowlands to 1862 m in the southern mountainous regions, creating a substantial elevational and ecological gradient (Lowe et al., 2022).

Within this landscape, vegetation is important to slope stability. The mechanical reinforcement provided by root systems is a basic determinant for the stability of steep slopes (Schwarz et al., 2010; Uang et al., 2025). Root–soil mechanical interactions can increase the shear resistance of soil, providing a scientific basis for understanding why vegetation composition and root structure matter in addition to surface cover. This distinction is important in a landscape where increasing spectral greenness may occur alongside continuing slope instability.

Indigenous Knowledge Systems (IKS) are cumulative and dynamic bodies of knowledge, know-how and practices maintained and developed by peoples with long histories of interaction with their natural environment (Bruchac, 2014; Gupta, 2015). Such knowledge is locally specific, intergenerational and holistic, and traditional communities in the central hills of Sri Lanka have developed sophisticated systems of land allocation, soil understanding and water management (Thennakoon and Gamachchige, 2020). Traditional Ecological Knowledge (TEK) therefore provides an important basis for interpreting environmental processes that may not be fully represented by technical datasets.

GIS and Remote Sensing (RS) provide powerful tools for capturing, storing, analysing and visualising geographically referenced information (Tripathi and Bhattarya, 2004; Omusotsi, 2019; Maurya and Kumar, 2024). A Landsat time series can identify long-term changes in vegetation through NDVI, while topographic and landslide-susceptibility information can identify spatial patterns of environmental vulnerability. However, a map can show where a landscape is greener without necessarily explaining the quality, historical meaning or functional role of that vegetation. This creates a need to place geospatial evidence in dialogue with local ecological knowledge.

Research Gap and Rationale

The research gap addressed in this paper is the limited integration of long-term spatiotemporal vegetation analysis with Indigenous Knowledge concerning landscape management and slope stability in Matale. Existing studies have examined Indigenous Knowledge, traditional soil management and historical land-use practices in the central highlands (Ananda, 2021; Nayakekorala, 2010; Thennakoon and Gamachchige, 2020;

Weerawardhena and Russell, 2012), while GIS and Remote Sensing have been widely used to examine environmental change and landslide vulnerability. However, the integration of these knowledge inputs with advanced geospatial techniques has been notably absent.

This paper narrows the broad thesis into a distinct journal contribution. It does not attempt to reproduce every element of the undergraduate thesis. Instead, it focuses on one central analytical argument: increasing NDVI does not necessarily represent increasing landscape stability when the ecological quality and functional structure of vegetation are changing. The paper therefore uses the “Green Illusion” as its central interpretive concept and the “IK Gap” as the socio-ecological explanation for why conventional greenness indicators require place-based interpretation.

The rationale is consequently to connect the quantitative “reach” of the 30-year Landsat record with the qualitative “depth” of local ecological experience. This allows the study to examine the spatial divergence between surface spectral greenery and the structural stability maintained by historical sustainable practices, without treating either GIS or Indigenous Knowledge as a complete substitute for the other.

Aim and Focus of the Paper

The paper aims to demonstrate how the integration of geospatial evidence and Indigenous Knowledge can provide a more functionally meaningful interpretation of vegetation dynamics and landscape vulnerability in Matale District. The analysis concentrates on three linked questions: how vegetation greenness changed over the 1995–2025 period; why increased greenness cannot automatically be equated with structural stability; and how Indigenous Knowledge helps interpret this divergence in the context of traditional land-management practices.

This focused formulation deliberately differs from the four-objective structure of the undergraduate thesis. The full quantitative vegetation trajectory and the detailed Indigenous Knowledge inventory are not treated as separate papers within this manuscript. They are used here selectively as evidence for the central integration argument, thereby preserving analytical space for future papers on vegetation dynamics and on Indigenous land-management knowledge.

Conceptual Framework

Indigenous Worldview and Indigenous Knowledge Systems

The research is informed by an Indigenous worldview that emphasises the deep interconnectedness between human beings and the natural world (Gómez-Baggethun et al., 2013; Bruchac, 2014; Withanage et al., 2024). Within this perspective, people are embedded within ecological systems through relationships of responsibility,

reciprocity and respect (Gómez-Baggethun et al., 2013; Mbah et al., 2021). This orientation is important because the study does not treat the landscape as a purely physical surface to be measured. It considers the landscape as a socio-ecological system in which ecological processes, human decisions and inherited knowledge interact.

Indigenous Knowledge Systems are not static relics. They evolve through adaptation and innovation within specific local contexts (Bruchac, 2014; Gupta, 2015; UNESCO, 2003). In the present study, local knowledge concerning vegetation, soil, water and slope management is therefore treated as living knowledge. The concept of Traditional Ecological Knowledge (TEK) is used to describe knowledge, beliefs, traditions, practices, institutions and perspectives developed and sustained by indigenous, peasant and local communities as part of adaptation to their biophysical environment (Gómez-Baggethun et al., 2013).

Ethno-Ecological Knowledge and Social-Ecological Systems

Ethno-Ecological Knowledge (EEK) Theory provides an analytical lens for examining how different cultures understand their environment and manage ecosystems (Gómez-Baggethun et al., 2013). It is relevant to this study because local ecological classifications and management practices are connected to particular soils, plants, slopes and land-use patterns. In the central highlands, traditional soil taxonomies and management practices have been developed through experiential knowledge (Thennakoon and Gamachchige, 2020).

Social-Ecological Systems (SES) Theory provides the broader framework for understanding the dynamic and interdependent relationship between human and natural systems (Folke, 2006; Partelow, 2018). From this perspective, landslide susceptibility is not treated only as an external physical hazard. It can also be understood as an expression of underlying system vulnerabilities created through long-term human–environment interactions. The abandonment of traditional land-management practices, changes in vegetation composition and contemporary commercial land use can therefore be examined as components of a changing socio-ecological system.

The “Green Illusion” and the “IK Gap”

The concept of a “Green Illusion” is central to the paper. Soudani and Francois (2014) used the term in relation to situations where enhanced greenness can create an appearance that is not necessarily equivalent to broader environmental improvement. In the Matale context, the study applies the concept to the divergence between increasing spectral greenness and continuing terrain vulnerability. The Green Illusion does not mean that NDVI is invalid; rather, it means that NDVI should not be interpreted as a complete measure of ecological or structural stability.

The “IK Gap” is the second central concept. In the thesis, the IK Gap refers to the point at which traditional knowledge is losing value as a result of modernisation and commercialisation and where local ecological wisdom has been lost or ignored. The present paper uses the term more narrowly to describe the disconnect between geospatially visible vegetation conditions and the declining or reduced application of traditional knowledge concerning vegetation, soil and slope management.

Together, these concepts form the central analytical framework of the paper. The observed increase in geospatial greenness raises the question of whether vegetation greenness necessarily reflects ecological and structural stability. This distinction highlights the need for functional interpretation through Indigenous Knowledge and draws attention to the knowledge gap created by the decline of traditional land-management practices. The paper therefore emphasizes the value of incorporating Indigenous Knowledge into geospatial approaches to strengthen landscape assessment and monitoring.

Materials and Methods

Research Design

The study employed an explanatory sequential mixed-methods approach. The design allowed quantification of physical trends to be followed by explanation through human qualitative insights. The primary qualitative data were cross-sectional, collected during 2025–2026, while the environmental context was developed retrospectively through Landsat imagery covering 1995–2025. This structure enabled the current status of the Indigenous Knowledge Gap to be contextualised against a 30-year trajectory of environmental transitions.

Study Area

The quantitative component covered the entire Matale District, approximately 1,993 km², including its 11 agro-ecological zones (District Secretariat - Matale, 2022). The district’s elevation ranges from approximately 49 m to 1862 m, and its topographic complexity includes steep gradients and narrow valleys (Lowe et al., 2022; Environmental Foundation (Guarantee) Limited, 2018; National Building Research Organisation, 2019).

The qualitative case study was centred on the Rattota Divisional Secretariat Division (DSD). Rattota was selected because it is a high-relief and landslide-prone area and a gateway to the Knuckles Range (Selvanayagam, 2018). It therefore served as a critical “ground-truth” site for interpreting district-wide vegetation patterns through local experience.

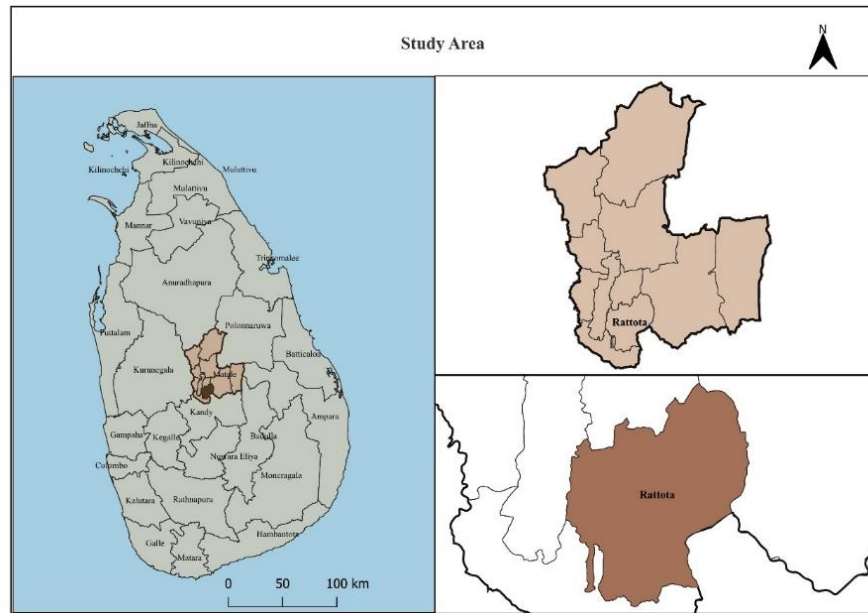


Figure 1: Study area: Matale District and Rattota DSD

Source: Prepared by the author using QGIS Desktop 3.44.8, Solothurn.

Quantitative Data and Geospatial Analysis

Landsat imagery for 1995, 2015 and 2025 was obtained from the USGS Earth Explorer. Landsat 5 Thematic Mapper (TM) was used for 1995 and Landsat 8 Operational Land Imager (OLI) was used for 2015 and 2025. All imagery had a 30 m spatial resolution. The acquisition dates were 7 April 1995, 14 April 2015 and 30 July 2025, with cloud cover of 6.00%, 6.48% and 10.17%, respectively. Collection 2 Level 2 Surface Reflectance data were used to support continuity across satellite generations, with intercalibration considered in maintaining comparability (USGS, 2023; Vogelmann et al., 2016).

Radiometric Calibration and Atmospheric Correction were undertaken using the DOS1 algorithm through the Semi-Automatic Classification Plugin in QGIS 3.44.8 'Solothurn'. NDVI was calculated from the appropriate near-infrared and red bands. Zonal Statistics were used to obtain mean NDVI values within the administrative boundary of Matale District. A Digital Elevation Model was used to derive elevation and slope information, and official landslide zonation information obtained from the National Building Research Organisation (NBRO), subsequently replaced by the National Building Research Institute (NBRI) under the National Building Research Institute Act, No. 20 of 2025 (National Building Research Institute Act, No. 20 of 2025, 2025), was incorporated into the spatial assessment.

The purpose of the quantitative phase in this paper is not to reproduce the complete technical NDVI analysis as a stand-alone contribution. Instead, the resulting district-wide trajectory is used as the spatial evidence required

for the integration argument. The detailed pixel-level and temporal analysis can therefore remain available for a future dedicated vegetation-dynamics paper.

Qualitative Data Collection and Analysis

The qualitative phase involved 12 long-term residents and local knowledge holders in Rattota DSD, aged between 26 and 74 years. Participants were selected based on long-term residence and their reputation as holders and keepers of ecological wisdom. Seven interviews were initially conducted through field-based engagement. The remaining five interviews were conducted synchronously through remote communication because of logistical inaccessibility and safety concerns following the post-Ditwah disaster. The sample was retained at 12 participants based on the point of data saturation.

Semi-structured interviews and field observations focused on vegetation dynamics, perceived slope stability, traditional soil-conservation practices, land-use transitions and the decline or continuation of Indigenous Knowledge. The qualitative material was analysed thematically. For this paper, the qualitative evidence was selectively organised around two analytical functions: first, interpreting the difference between spectral greenness and vegetation quality; and second, identifying traditional land-management practices that help explain why the mapped landscape requires functional interpretation.

Methodological triangulation was used to cross-reference the quantitative 30-year Landsat analysis with semi-structured interviews, field observations and relevant literature. The purpose was to increase the depth of interpretation and to examine whether the “greening” trend identified through GIS was consistent with the qualitative evidence concerning the loss or reduced application of deep-rooted indigenous species and traditional land-management practices (Fielding, 2012; Bans-akutey, 2021).

Results

The District Became Spectrally Greener

The quantitative analysis demonstrates a clear increase in mean NDVI across Matale District. Mean NDVI increased from 0.304 in 1995 to 0.327 in 2015 and 0.350 in 2025. The result establishes a 30-year “Greening” trend in the district.

Table 1. Mean NDVI Values in Matale District, 1995–2025

Year	Mean NDVI
1995	0.304
2015	0.327
2025	0.350

Source: Author's calculations using Landsat imagery and QGIS.

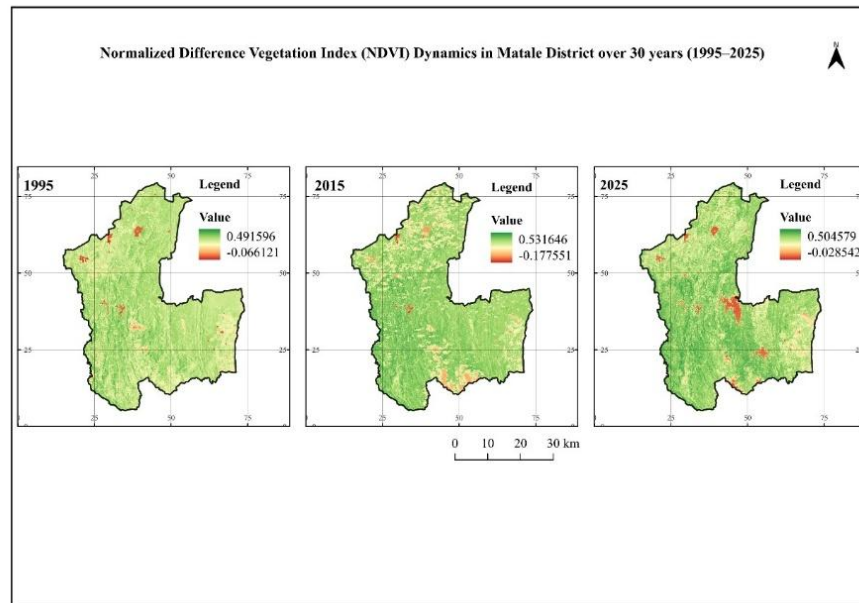


Figure 2: Normalised Difference Vegetation Index Dynamics (1995–2025)

Source: Prepared by the author using QGIS Desktop 3.44.8, Solothurn.

The Green Illusion

The increase in NDVI creates an apparent environmental improvement when interpreted only through spectral greenness. However, the spatial relationship between greener areas and areas of high landslide susceptibility indicates that the increase in vegetation density does not automatically correspond with increased structural stability. This is the central empirical basis for the “Green Illusion” identified in the study.

The qualitative findings indicate that the vegetation responsible for high spectral values cannot be assumed to consist exclusively of deep-rooted, long-stemmed primary forest. Participants described the increasing presence of invasive and commercially associated vegetation, including *Alstonia macrophylla* (*Havari Nuga*) and Pine, while commercial cultivation has also changed understory conditions. Jayawardhana and Gunarathne (2022) reported the dominance of *Alstonia macrophylla* in disturbed Pine plantation contexts. In the present study, this evidence is important because a dense canopy can produce a strong NDVI signal while the ecological and mechanical characteristics of the vegetation may differ from those of the historical forest.

The community evidence further distinguishes between “protective green” and “degraded green”. Participants described vegetation that appears dense but does not necessarily provide the same root structure, understory protection or soil-binding function associated with traditional vegetation. Thus, the satellite image can measure the quantity of green, while local ecological knowledge helps interpret the quality of green.

High Greenness and High Susceptibility

The topographic and landslide-susceptibility analysis demonstrates that high-gradient terrain is concentrated particularly in the southern and Rattota areas of the district. The slope-based landslide susceptibility classification identifies extreme, high, moderate and low hazard zones, with the highest susceptibility concentrated in areas of high slope gradients (National Building Research Organisation, 2019).

The spatial comparison indicates that areas with high NDVI can occur within or near areas of high landslide susceptibility. This is an important result because it challenges a simple interpretation in which a greener landscape is assumed to be a safer landscape. In Rattota, the combination of high slope gradient, changing land use and vegetation conditions creates a landscape in which canopy cover alone is insufficient as an indicator of stability.

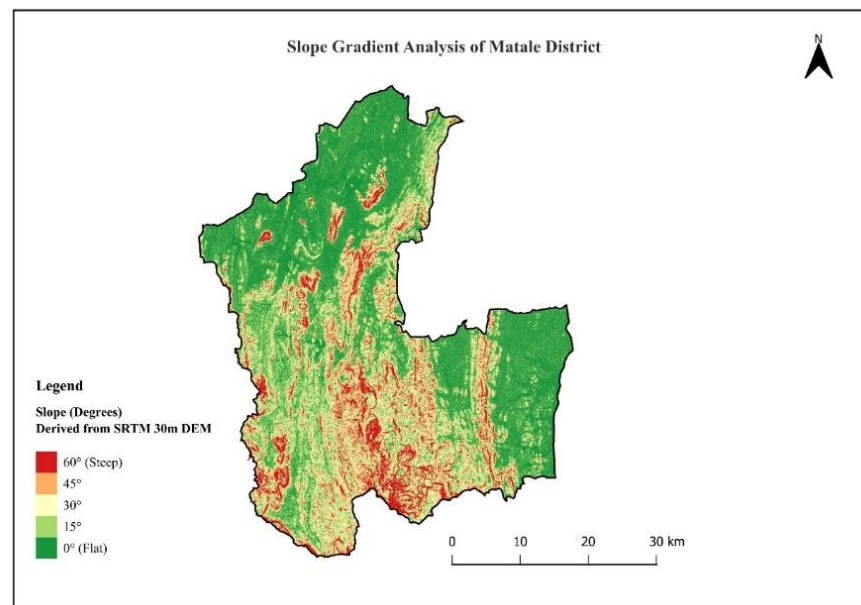


Figure 3: Slope Gradient Analysis of Matale District

Source: Prepared by the author using QGIS and NBRO landslide zonation information.

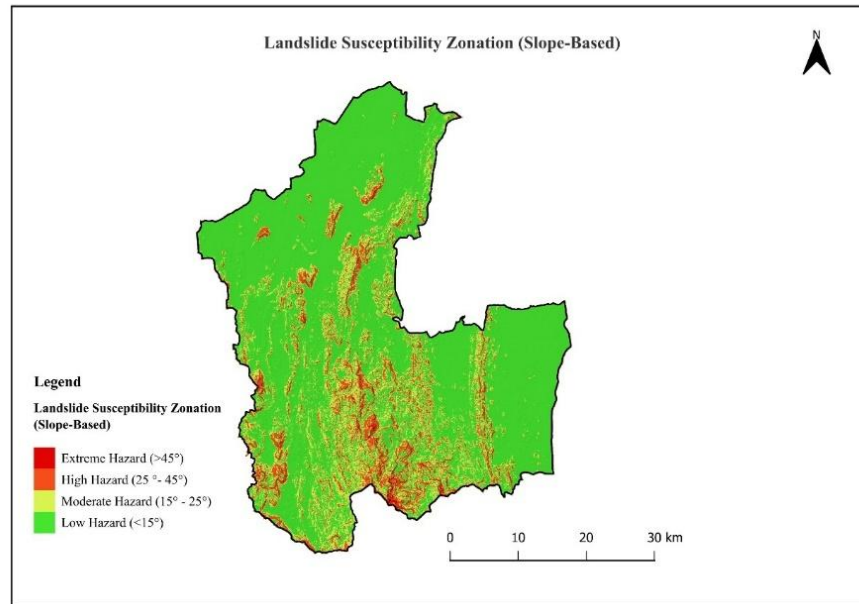


Figure 4: Integrated view of NDVI greenness in relation to landslide susceptibility

Source: Prepared by the author by overlaying the study's geospatial evidence using QGIS Desktop 3.44.8, Solothurn.

Indigenous Knowledge as Ground-Level Interpretation

The qualitative findings demonstrate that local ecological knowledge contributes information that cannot be obtained directly from satellite imagery. Participants differentiated between indigenous forest cover, invasive vegetation and commercial crops, and they described changes in traditional land-management practices. This “ground-level” information provides the functional interpretation needed to understand why a high NDVI value should not automatically be treated as evidence of a stable landscape.

One of the most important examples is the use of *Mana* grass (*Glyceria*) as a “living anchor”. A traditional farmer explained that ancestors used *Mana* grass to protect slopes because its roots penetrate deeply into the earth. This local explanation is consistent with scientific evidence that root bundling can increase soil shear resistance (Schwarz et al., 2010). The significance of the practice therefore lies not simply in the presence of a green plant, but in the relationship between species characteristics, root structure and slope management.

Participants also identified *Gal-veti* (stone fences), *Ini-vata* (living fences) and terrace farming as traditional land-management practices. These practices combine biological and physical forms of reinforcement. Thennakoon and Gamachchige (2020) show that traditional soil knowledge in the Knuckles Range was grounded in experiential understanding of soil degradation, while traditional terrace practices can reduce slope gradients and the driving force associated with potential landslide movement.

Multi-cropping and home-garden diversity were also described as important because different root systems contribute to soil strength and vegetation structure. Lowe et al. (2022) similarly identified the importance of tree diversity and above-ground biomass in Matale home gardens. For the present paper, these practices are used as evidence of functional interpretation rather than as a complete inventory of Indigenous Knowledge. A detailed analysis of the full Indigenous land-management system is reserved for a separate future paper.

The “IK Gap”

The qualitative evidence identifies an “IK Gap” between traditional land-management knowledge and contemporary land-use practices. The gap is not a “lack of knowledge”. Rather, it refers to the point at which traditional knowledge is losing value, being ignored or becoming disconnected from contemporary decision-making as a result of modernisation and commercialisation.

Traditional practices such as living anchors, stone fences, living fences and terrace farming were described as forms of protective land management. At the same time, the qualitative evidence indicated a shift toward commercial agriculture and practices that can remove functional understory vegetation. Cardamom cultivation has been associated with the clearing of forest understory, and previous research has documented its environmental and socio-economic dimensions in the Knuckles region (Dhakal et al., 2012; Jayasinghe and Rambodagedara, 2016).

The IK Gap is therefore visible at two levels. At the community level, there is a generational and practical decline in the transmission and application of protective ecological knowledge. At the institutional level, local people who act as “silent custodians” are not consistently incorporated into formal disaster risk reduction and land-management processes. Munasinghe and Wijegunaratne (2015) similarly demonstrate that community-based assessments can reveal grassroots uncertainties that are missed in computer-based models.

Discussion

Why Increasing NDVI Does Not Equal Increasing Stability

The most important contribution of the study is the distinction between spectral greenness and functional stability. The mean NDVI increase from 0.304 to 0.350 provides strong evidence that the district became spectrally greener. However, NDVI is a representation of vegetation reflectance; it does not directly measure root depth, soil reinforcement, understory condition, species diversity or the mechanical response of a slope.

This distinction explains the Green Illusion. Where invasive vegetation or commercial monocultures produce substantial canopy cover, the satellite signal may indicate high greenness while the ground-level ecological function differs from that of deep-rooted forest systems. The result is not an argument against remote sensing.

Instead, it is an argument against treating a single spectral indicator as a complete measure of environmental health.

The concept is especially relevant in steep terrain. Root systems can contribute to slope stability through mechanical reinforcement (Schwarz et al., 2010). Therefore, the stability function of vegetation depends partly on vegetation structure and root characteristics. A landscape can consequently be green without being functionally equivalent to a deeply rooted, diverse forest.

GIS Provides “Spatial Width”; Indigenous Knowledge Provides “Functional Depth”

The study demonstrates a complementary relationship between GIS and Indigenous Knowledge. GIS provides the “spatial width” of the environmental change by allowing the researcher to observe vegetation patterns across the entire district and compare them with topography and landslide susceptibility. Indigenous Knowledge provides the “functional depth” by explaining how people distinguish between vegetation types, soil conditions, slope behaviour and traditional protective practices.

This distinction is consistent with the spatial nature of Indigenous Knowledge. Traditional soil classifications, land-use practices and resource-management systems are linked to specific geographical features (Thennakoon and Gamachchige, 2020; Weerawardhena and Russell, 2012). GIS can therefore serve not only as a tool for environmental measurement but also as a means of contextualising knowledge that is inherently place-based (Tripathi and Bhattarya, 2004).

The methodological value of the explanatory sequential design lies precisely in this connection. The quantitative phase identifies a pattern that requires explanation; the qualitative phase then provides a place-based interpretation. The two phases do not produce identical evidence, and they should not be forced into artificial statistical equivalence. Their value lies in analytical complementarity and triangulation (Fielding, 2012).

The Socio-Ecological Meaning of the IK Gap

The IK Gap suggests that landscape vulnerability cannot be understood only through physical variables. The socio-ecological system includes land-use decisions, community practices, vegetation dynamics and institutional arrangements. Social-Ecological Systems Theory emphasises that human and natural systems are inseparably linked and continuously co-evolve (Folke, 2006; Partelow, 2018).

Within this framework, the decline of traditional land-management practices represents more than cultural change. It can alter the available mechanisms through which communities interact with soil, water and vegetation. The loss of living anchors, traditional fences, terraces and other practices may therefore reduce the diversity of local responses to environmental stress. The study does not claim that the loss of Indigenous

Knowledge is a single causal explanation for landslides; rather, it identifies the IK Gap as a hidden socio-ecological factor that should be considered alongside topography, vegetation and land use.

From Green Illusion to IK-Weighted Geospatial Monitoring

The combined findings support an “IK-weighted” geospatial approach. Such an approach would not replace scientific measurements with Indigenous Knowledge. Instead, it would cross-reference satellite-derived indicators with qualitative indigenous markers and community observations. Potential markers include the presence of soil-binding vegetation, the condition of traditional land-management structures, local observations of water and soil behaviour, and knowledge concerning changes in vegetation composition.

The approach responds directly to the Green Illusion. If NDVI provides evidence of where vegetation has become greener, an IK-weighted framework can ask what kind of vegetation is responsible, what functions it performs, how local people understand its condition, and whether traditional protective systems are present or absent. In this sense, the framework moves from measuring the quantity of green toward interpreting the quality and function of green.

This proposed framework also gives practical meaning to the thesis conclusion that the “spirit of the forest,” its diversity and its complexity should be restored through a partnership between modern science and ancestral wisdom. The central requirement is epistemic equality: community observation should not be treated merely as anecdotal information when it provides place-specific knowledge that complements the scale of scientific mapping.

Implications for Sustainable Land Management

The study has several implications for sustainable land management. First, NDVI-based monitoring should be interpreted together with topographic information, vegetation composition and local ecological knowledge. This would reduce the possibility of interpreting a rise in spectral greenness as an automatic sign of improved landscape stability.

Second, traditional land-stewardship practitioners can be recognised as “Silent Custodians” whose knowledge contributes to understanding local environmental conditions (Adom, 2016; Akalibey et al., 2024; Withanage et al., 2024). Their observations can be incorporated into decentralised agricultural, land-management and disaster risk reduction extension services. The objective should not be to romanticise every traditional practice, but to create mechanisms through which relevant local knowledge can be tested, documented, evaluated and appropriately integrated.

Third, the study supports nature-based and hybrid approaches to landslide risk management. The National Building Research Organisation (2019) has already identified the relevance of nature-based solutions for landslide risk reduction. The findings of the present study suggest that indigenous bio-engineering knowledge can contribute to this discussion, particularly where traditional vegetation and soil-conservation practices remain locally meaningful.

Fourth, an “IK-weighted” geospatial framework could provide a basis for future community-informed susceptibility assessment. Such a framework could cross-reference satellite data with qualitative markers rather than relying solely on NDVI-based interpretation. This would be particularly useful in high-gradient vulnerability zones where local observations of soil, springs, vegetation and slope behaviour can provide information at a scale that satellite imagery cannot directly capture.

Limitations

The quantitative analysis is based on three reference years 1995, 2015 and 2025 rather than continuous annual observations. The absence of suitable Landsat 7 data for the mid-2000s because of high cloud cover and “black patch” problems required reliance on these three reference years. The quantitative results therefore describe a long-term trajectory using selected temporal snapshots rather than an annual time series.

NDVI is also a spectral indicator and does not directly measure root strength, soil cohesion or mechanical slope stability. The Green Illusion is therefore an interpretive framework supported by the spatial comparison and qualitative evidence, rather than a claim that NDVI itself measures landslide stability.

The qualitative component is limited to 12 participants in Rattota DSD. Indigenous Knowledge is highly localised, and the qualitative indicators identified in Rattota should not be generalised automatically to other geographic regions (Petzold et al., 2020). The qualitative findings provide explanatory depth and place-based interpretation rather than statistical representativeness.

Finally, the paper does not establish a statistical causal relationship between the decline of Indigenous Knowledge and landslide occurrence. The study identifies a socio-ecological relationship and an interpretive “IK Gap” that should be examined through future spatially explicit and longitudinal research.

Conclusion

This paper examined the apparent contradiction between increasing vegetation greenness and continuing landscape vulnerability in Matale District. The 30-year Landsat analysis demonstrated a rise in mean NDVI from 0.304 in 1995 to 0.327 in 2015 and 0.350 in 2025. Yet the qualitative evidence demonstrated why this increase should not be interpreted automatically as increasing ecological or structural stability.

The concept of the “Green Illusion” captures the central finding: a landscape can become spectrally greener while remaining vulnerable when the vegetation responsible for that greenness does not provide the same ecological and mechanical functions as deep-rooted and diverse forest systems. The “IK Gap” further identifies the declining or reduced application of traditional knowledge concerning living anchors, soil conservation, terraces, *Gal-veti* and *Ini-vata* as part of the broader socio-ecological transition.

The study therefore argues that landslide susceptibility in Matale is not only a geological issue but also a socio-ecological one. GIS provides the “spatial width” required to identify patterns of environmental change, while Indigenous Knowledge provides the “functional depth” required to interpret what those patterns mean on the ground. The integration of these two knowledge systems offers a more context-sensitive basis for sustainable land management and disaster risk reduction.

Most importantly, the findings indicate that the future of landscape monitoring should not be limited to asking whether an area is green. It should also ask what makes it green, what ecological functions that vegetation performs, how the community understands the landscape, and whether the traditional systems that historically supported slope and soil stability remain in place. An IK-weighted geospatial approach provides a practical direction for moving beyond the Green Illusion toward a more functionally informed understanding of landscape vulnerability.

Author Contribution and Future Publication Separation

This manuscript is intentionally structured as an integration-focused paper derived from the undergraduate thesis. It concentrates on the Green Illusion, the IK Gap, and the complementary roles of geospatial evidence and Indigenous Knowledge. The manuscript does not reproduce the full technical vegetation-dynamics analysis or the complete Indigenous Knowledge inventory. These components can be developed as distinct future manuscripts, subject to appropriate disclosure of the thesis-derived dataset and the publication policies of the target publication avenues.

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