# OPERATIONALISING FIT FOR PURPOSE LAND ADMINISTRATION IN TRADITIONAL AREAS: DRONE ENABLED, COMMUNITY LED SPATIAL PLANNING FOR CLIMATE RESILIENT DEVELOPMENT

**Author: ALUWANI MATSILA, SOUTH AFRICA**
**Co–author: CLINTON HEIMANN, SOUTH AFRICA**

**Keywords:** fit for purpose land administration; traditional councils; spatial planning; drone remote sensing; participatory planning.

## SUMMARY

Governments face growing pressure to secure land rights, manage settlement growth, and integrate climate risk into local decision making, particularly in contexts where conventional land administration systems are incomplete or unevenly applied. In South Africa, these challenges are most acute in areas under Traditional and Khoi–San leadership, where customary land allocation practices coexist with statutory municipal planning mandates. This paper presents a fit for purpose operational model that integrates drone enabled spatial data with community led planning to strengthen land administration and spatial governance in such areas.

The model is derived from the implementation of a National Land Planning Programme and is structured around five interlinked stages: institutional entry and mandate alignment; rapid spatial data acquisition; community validation and tenure interpretation; municipal planning integration; and implementation sequencing linked to investment readiness. The technical workflow combines high resolution drone imagery, orthomosaics, elevation models, and three dimensional visualisation to establish a pragmatic spatial baseline in areas where cadastral records are fragmented or absent. These datasets are interpreted and validated through structured engagement with Traditional Councils and communities, ensuring that planning outputs reflect local tenure arrangements, development priorities, and cultural considerations.

Pilot application across multiple provinces demonstrates improved planning readiness, clearer recognition of land allocations, enhanced legitimacy of spatial decisions, and increased alignment between customary governance and municipal planning instruments under the Spatial Planning and Land Use Management Act. The paper concludes by outlining institutional embedding and scale out mechanisms required to transition from pilot implementation to routine land administration practice. The contribution demonstrates how applied geospatial innovation, when integrated with institutional design and participatory governance, can advance inclusive and climate resilient land administration in traditional areas.

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## 1. INTRODUCTION

Spatial planning and land administration in South Africa continue to reflect deep structural legacies shaped by colonial and apartheid governance. For decades, formal planning systems were designed to serve a minority of the population, while large areas under customary land tenure were excluded from systematic spatial regulation, infrastructure planning, and land recordation. Although the democratic transition ushered in significant reforms aimed at redressing these inequities, the spatial consequences of historical exclusion remain visible, particularly in rural and peri urban areas administered through traditional leadership structures.

Post 1994 reforms introduced a developmental planning paradigm that emphasised inclusivity, sustainability, and integration across sectors and spheres of government. Legislative instruments and policy frameworks progressively sought to unify spatial planning, land use management, and local government planning processes. Despite these advances, implementation has proven uneven. Areas under Traditional and Khoi–San leadership have remained among the most challenging spaces for effective land administration, often characterised by fragmented land records, limited representation in municipal planning instruments, and ongoing uncertainty regarding tenure recognition and development control.

The enactment of the Spatial Planning and Land Use Management Act (SPLUMA) marked a critical milestone in establishing a single national framework for spatial planning and land use management. SPLUMA explicitly recognises the need to include rural areas, informal settlements, and areas under traditional leadership within spatial planning instruments. However, the Act does not prescribe detailed operational mechanisms for reconciling customary land governance systems with statutory municipal planning processes. In practice, municipalities have struggled to apply conventional land use management tools in traditional areas, while traditional authorities have often operated outside formal planning systems, leading to parallel decision making processes and inconsistent development outcomes.

These challenges are compounded by rapid settlement growth, increasing demand for services, and heightened exposure to climate related risks such as flooding, erosion, and water scarcity. In many traditional areas, settlement expansion occurs incrementally and informally, without access to up to date spatial data or clear planning guidance. Conventional cadastral surveying and formal land registration processes, while legally robust, are frequently too slow, costly, or procedurally complex to respond to immediate planning and governance needs at the local level.

Against this backdrop, fit for purpose land administration has emerged internationally as a pragmatic response to contexts where conventional land administration systems are unable to deliver timely, inclusive outcomes. Fit for purpose approaches emphasise flexibility,

incremental improvement, and the use of appropriate technologies and institutional arrangements tailored to local conditions. Rather than prioritising immediate legal perfection, such approaches focus on establishing spatial certainty that is sufficient to support planning, service delivery, and tenure recognition, while allowing for progressive refinement over time.

In South Africa, the application of fit for purpose principles to areas under traditional leadership requires careful integration of technical innovation with institutional and governance realities. Customary land allocation practices remain central to social legitimacy and local authority, while municipalities retain statutory responsibility for spatial planning and land use management. Any effective approach must therefore operate at the intersection of these systems, enhancing coherence without undermining either.

This paper responds to this challenge by presenting an operational model that integrates drone–enabled spatial data acquisition with community led planning processes, embedded within existing legislative and institutional frameworks. Drawing on empirical experience from a National Land Planning Programme (NLPP) implemented in partnership with traditional leadership institutions, the paper moves beyond descriptive programme reporting to formalise a replicable model for fit for purpose land administration in traditional areas.

## 2. PURPOSE AND ANALYTICAL FRAMING

The purpose of this paper is to articulate and validate an operational model for land administration and spatial planning in areas under Traditional and Khoi–San leadership, derived from practical implementation experience. While the National Land Planning Programme provides the empirical foundation for the analysis, the focus of the paper is not on documenting the programme as an administrative initiative, but on extracting transferable methodological and institutional insights that can inform broader application.

Specifically, the paper seeks to address three interrelated questions. First, how can contemporary geospatial technologies, particularly drone enabled remote sensing, be used to establish a reliable spatial planning baseline in contexts where formal cadastral and land use records are incomplete or contested? Second, how can community led planning processes anchored in customary governance structures be structured to ensure both social legitimacy and compatibility with statutory planning requirements? Third, what institutional arrangements are required to embed such an approach within municipal planning systems and enable scale–out beyond pilot interventions?

The analytical approach adopted in the paper is grounded in applied policy and institutional analysis. The National Land Planning Programme is treated as a series of empirical test cases through which technical workflows, governance processes, and decision interfaces can be observed and synthesised. Rather than presenting each pilot as a standalone project, the paper

consolidates common patterns, outcomes, and constraints across cases to derive an explicit operational model.

The analysis distinguishes between three interconnected layers. The first is the technical layer, which encompasses spatial data acquisition, processing, quality assurance, and integration with existing datasets. The second is the governance layer, which includes community engagement, validation of land allocations, and decision making processes within Traditional Councils and municipalities. The third is the institutional layer, which concerns formal agreements, procedural interfaces, capacity development, and monitoring mechanisms required to sustain implementation.

By structuring the analysis in this way, the paper positions fit for purpose land administration not as a purely technical exercise, but as an integrated socio technical and institutional process. This framing is critical in traditional areas, where land administration outcomes depend as much on legitimacy, trust, and authority as on spatial accuracy or regulatory compliance.

## 3. SPATIAL SIGNIFICANCE OF TRADITIONAL LEADERSHIP AREAS

Areas under Traditional and Khoi–San leadership represent a substantial and strategically important component of South Africa's spatial landscape. Collectively, these areas comprise approximately twelve per cent of the national land surface and account for an estimated fifteen per cent of the country's coastline. More than seven hundred and eighty recognised Traditional Leadership Areas are distributed across eight provinces, encompassing a wide range of settlement types, land uses, and environmental conditions.

The spatial characteristics of these areas are highly diverse. In some provinces, traditional areas are predominantly rural, with dispersed settlements, extensive communal grazing lands, and limited infrastructure. In others, particularly in proximity to metropolitan regions, traditional areas are increasingly peri urban, experiencing rapid settlement expansion, land invasion pressures, and growing demand for housing and services. Coastal traditional areas introduce additional layers of environmental sensitivity and development complexity, including exposure to climate elated hazards and competing land use interests.

Despite their scale and diversity, traditional areas have historically been weakly integrated into formal spatial planning systems. Municipal Spatial Development Frameworks and Land Use Schemes have often focused on urban and formally proclaimed areas, with limited spatial resolution or policy guidance for areas under customary administration. Where traditional areas are referenced, they are frequently treated as homogeneous or residual spaces, rather than as dynamic landscapes requiring differentiated planning responses.

This marginalisation has tangible consequences. Infrastructure planning and service delivery are complicated by uncertainty regarding settlement layouts and land allocation patterns. Environmental risks are insufficiently assessed due to a lack of fine grained spatial data. Development proposals may proceed without clear alignment to municipal priorities or regulatory requirements, increasing the likelihood of conflict, delays, or legal challenges.

At the same time, traditional areas play a critical role in national development objectives. They support significant agricultural activity, host mining and tourism assets, and accommodate a growing share of the population. Many traditional communities are also among the most vulnerable to climate change impacts, underscoring the need for spatial planning approaches that integrate environmental risk considerations with development planning.

These characteristics highlight the limitations of attempting to extend conventional cadastral centric land administration systems into traditional areas without adaptation. The scale, complexity, and governance context of these areas require approaches that can deliver spatial certainty and planning guidance incrementally, while respecting customary land governance and aligning with statutory mandates.

The spatial significance of traditional leadership areas therefore provides both the justification and the testing ground for the operational model presented in this paper. Any approach that seeks to improve land administration and spatial governance in South Africa must engage meaningfully with these areas, not as peripheral exceptions, but as integral components of the national spatial system.

Table 1: Traditional Leaders Areas Key Stats

| Provinces | Total size of TLAs (km²) | No. of TLAs | % of TLA (per Prov) | Coastline | Area of Prov (km²) |
|---|---|---|---|---|---|
| Eastern Cape | 39 661 | 207 | 23% | **261 km** (33% of EC Coastline) | 168 966 |
| Free State | 1 343 | 12 | 1.03% | | 129 825 |
| Gauteng | 72 | 2 | 0.40% | | 18 178 |
| KwaZulu–Natal | 33 656 | 258 | 36% | **169 km** (37% of KZN Coastline) | 94 361 |
| Limpopo | 32 813 | 193 | 26% | | 125 754 |
| Mpumalanga | 6 774 | 49 | 9% | | 76 495 |
| Northern Cape | 9 732 | 9 | 3% | | 372 889 |
| North West | 19 312 | 58 | 18% | | 104 882 |
| Western Cape | 0 | 0 | 0% | | 129 462 |

| | | | | | |
|---|---|---|---|---|---|
| | **143 362** | **788** | **12%** | **2 800 km** (15% of RSA Coastline) | **1 220 812** |

Source: NGI 2017–2020 Topo data (2024)

## 4. METHODOLOGY AND OPERATIONAL MODEL FOR THE LAND PLANNING PROGRAMME

### 4.1 METHODOLOGICAL ORIENTATION

The Land Planning Programme (LPP) applies a fit for purpose methodological orientation designed for land administration contexts characterised by hybrid governance, incomplete land records, and uneven planning coverage. In areas under Traditional and Khoi–San leadership, land administration challenges are not primarily technical in nature; rather, they arise from the interaction between customary land allocation practices, statutory municipal planning mandates, and the absence of spatial data at a scale appropriate for settlement level decision making.

The methodology therefore prioritises the establishment of usable spatial certainty over immediate legal or cadastral finality. Spatial outputs are produced to a level of accuracy sufficient to support planning, infrastructure prioritisation, and risk screening, while explicitly identifying elements that require later adjudication, formal survey, or regulatory refinement. This incremental logic is central to the fit for purpose approach and underpins all subsequent stages of the operational model.

Equally important is the methodological emphasis on legitimacy. In traditional areas, planning outputs that are technically sound but socially disconnected are unlikely to be accepted or implemented. The LPP methodology therefore embeds community led validation and Traditional Council endorsement as core components, rather than treating consultation as a supplementary activity. Technical workflows and governance processes are developed in tandem, ensuring that spatial information is both accurate and institutionally recognised.

### 4.2 THE FIVE STAGE OPERATIONAL MODEL

Drawing from implementation across multiple provinces, the LPP methodology is consolidated into a five stage operational model. The stages are analytically distinct but operationally interdependent. Together, they translate geospatial data and local knowledge into implementable planning and land administration outcomes aligned with the Spatial Planning and Land Use Management Act (SPLUMA).

The five stages are:

1. Institutional Entry and Mandate Alignment

2. Rapid Spatial Data Acquisition and Quality Assurance
3. Community Validation and Tenure Interpretation
4. Municipal Planning Integration and Formal Referral
5. Implementation Sequencing and Investment Readiness

Each stage is described below, with reference to the technical and governance components that enable progression to the next stage.

### 4.3 STAGE 1: INSTITUTIONAL ENTRY AND MANDATE ALIGNMENT

Implementation begins with structured institutional engagement. This stage establishes the legitimacy and procedural foundations required for subsequent technical and planning activities. Engagements typically involve Traditional Councils, municipal planning officials, relevant provincial departments, and, where applicable, national stakeholders.

Key activities at this stage include confirmation of the Traditional Council's jurisdiction, clarification of municipal planning responsibilities under SPLUMA, and agreement on the scope and intended outputs of the planning process. Importantly, this stage defines the interfaces between customary decision making and statutory planning processes**,** including how planning outputs will be routed through municipal structures such as Spatial Development Frameworks, land use schemes, and Municipal Planning Tribunals.

By resolving mandate questions upfront, the programme reduces the risk of later contestation and ensures that planning outputs are positioned for formal recognition within municipal systems.

### 4.4 STAGE 2: RAPID SPATIAL DATA ACQUISITION AND QUALITY ASSURANCE

The second stage establishes a spatial baseline through drone enabled remote sensing. Traditional areas frequently lack up to date, high resolution spatial data capable of supporting settlement level planning. Existing cadastral maps, aerial photography, or topographic datasets are often outdated or insufficiently granular to capture incremental settlement growth, informal access routes, or emerging land use pressures.

Drone surveys are conducted using predefined flight plans to ensure full spatial coverage and adequate image overlap. Depending on terrain, settlement density, and area extent, different platforms and sensors may be deployed. From a single acquisition cycle, the programme typically generates a suite of spatial products, including:

- true orthomosaics for base mapping and land–use interpretation;
- elevation surfaces to support terrain and drainage analysis; and
- three–dimensional visualisations to aid stakeholder understanding and spatial reasoning.

Quality assurance is applied in a pragmatic manner consistent with fit for purpose principles. The objective is not to meet the full precision requirements of cadastral survey, but to confirm that spatial products are coherent, interpretable, and suitable for planning use. Where authoritative reference data are available, such as Surveyor–General inputs or as built verification, these are used to identify discrepancies, encroachments, or boundary ambiguities. Such findings are treated as governance signals to be addressed through community validation and planning processes, rather than as purely technical errors.

### 4.5 STAGE 3: COMMUNITY VALIDATION AND TENURE INTERPRETATION

Spatial data produced through drone surveys is interpreted and validated through structured community led processes. This stage is central to the operational model, as it anchors technical outputs in customary governance systems and local knowledge.

Engagements are facilitated through Traditional Councils and typically include community meetings, participatory mapping sessions, and targeted engagements with specific groups. During these sessions, spatial features such as settlement extents, access routes, community facilities, and environmentally sensitive areas are verified. Customary land allocation patterns and land use arrangements are documented, and areas of contestation or uncertainty are identified.

This process serves multiple purposes. It improves the accuracy of spatial interpretation, enhances community trust in planning outputs, and generates an interim administrative record of land allocations and land uses. Importantly, the validation process allows for the identification of vulnerable groups, service delivery priorities, and development pressures that may not be evident from spatial data alone.

Outputs from this stage typically include validated feature layers, annotated spatial maps, and structured inputs to a municipal compatible land use or tenure register.

### 4.6 STAGE 4: MUNICIPAL PLANNING INTEGRATION AND FORMAL REFERRAL

Validated spatial and tenure information is then integrated into municipal planning systems. This stage ensures alignment with statutory instruments and enables planning outputs to acquire formal status within municipal decision making processes.

Integration activities include alignment with municipal Spatial Development Frameworks and Integrated Development Plans, identification of implications for existing or proposed land–use schemes, and preparation of referral documentation for municipal consideration. Joint planning sessions involving municipal officials and Traditional Council representatives are often used to reconcile planning proposals with infrastructure availability, environmental constraints, and policy directives.

Development proposals are routed through established municipal approval pathways, including Municipal Planning Tribunals where required. This joint referral process ensures that

customary land administration decisions are recognised within statutory planning frameworks, while maintaining the authority of Traditional Councils in land allocation matters.

### 4.7 STAGE 5: IMPLEMENTATION SEQUENCING AND INVESTMENT READINESS

The final stage translates planning outputs into implementable actions. Area Plans produced through the previous stages are linked to implementation and investment frameworks that prioritise projects based on affordability, feasibility, and risk exposure.

Projects are sequenced to align with municipal budgeting cycles and infrastructure delivery programmes. In many cases, this stage results in a shortlist of “shovel ready” interventions, including basic services, access improvements, community facilities, and livelihood supporting infrastructure. Climate and environmental considerations are integrated through the use of elevation data and hazard overlays, supporting more resilient development outcomes.

## 5. OUTCOMES OF THE LAND PLANNING PROGRAMME PER PILOT TRADITIONAL COUNCIL

### 5.1 CROSS PILOT OUTCOMES AND SYSTEMIC FINDINGS

Application of the operational model across multiple pilot Traditional Council areas provides a basis for assessing its effectiveness and transferability. Although local contexts varied significantly, several consistent outcome patterns were observed.

First, drone derived spatial baselines substantially improved planning readiness. In all pilot areas, high resolution imagery provided a shared reference that enabled municipalities and Traditional Councils to engage with settlement realities at an appropriate scale. This reduced reliance on outdated or generalized datasets and supported more informed planning discussions.

Second, structured community validation enhanced both legitimacy and data quality. By anchoring spatial interpretation in customary governance structures, the programme reduced contestation over land use representations and improved acceptance of planning outputs. Communities were more willing to engage with planning proposals when they could recognise their lived environment in the spatial products presented.

Third, alignment with municipal planning instruments improved the feasibility of implementation. Area Plans that explicitly referenced municipal Spatial Development Frameworks and Integrated Development Plans were more readily incorporated into municipal processes, increasing the likelihood of funding and delivery.

Finally, the pilots highlighted recurring constraints, including capacity limitations within municipalities, mandate overlap, and fragmented legacy data systems. These constraints informed the embedding and scale out measures discussed in the following section.

### 5.2 RURAL CONTEXT VALIDATION: BOLATA TRADITIONAL COUNCIL

The Bolata pilot illustrates application of the operational model in a predominantly rural context characterised by dispersed settlements and significant service delivery backlogs. Drone based spatial products supported the identification of settlement patterns and infrastructure gaps, while community led validation ensured that planning proposals reflected local priorities.

The resulting Area Plan and Implementation Plan were formally endorsed by the Traditional Council and positioned for integration into municipal planning processes. The pilot demonstrated the importance of sequencing basic services ahead of more complex development interventions and confirmed the model's applicability in water constrained rural environments.

### 5.3 PERI–URBAN CONTEXT VALIDATION: AMANDEBELE NDZUNDZA (SOKHULUMI)

The Sokhulumi pilot, located within a metropolitan municipality, tested the operational model under conditions of high development pressure and cadastral complexity. Drone surveys enabled parcel level mapping and identification of encroachments, while community validation processes supported informal recordal of land allocations.

Close collaboration with municipal planning officials facilitated alignment with evolving spatial frameworks and land use scheme provisions. The pilot demonstrated the value of drone–enabled mapping in resolving boundary ambiguities and supporting integration of traditional areas into metropolitan planning systems.

### 5.4 MINING INFLUENCED RURAL CONTEXT: MABESKRAAL AND DEERWARD

Pilots in mining affected rural areas highlighted the model's flexibility in complex institutional environments. Drone derived spatial products improved stakeholder understanding of settlement layouts and land use pressures, while multi stakeholder engagement processes supported coordinated planning responses.

In Deerward, high resolution imagery and elevation models informed a structured Implementation and Investment Plan aligned with municipal and district frameworks. The pilot demonstrated that even in sparsely populated contexts, drone enabled spatial data can support evidence–based infrastructure prioritisation and risk aware planning.

### 5.5 DEVELOPMENT PRESSURE AND RISK MANAGEMENT: NDZUNDZA–FENE

The Ndzundza–Fene pilot addressed challenges associated with land invasion, illegal resource extraction, and settlement expansion. Drone based surveys provided timely spatial intelligence, enabling the identification of pressure points and formulation of spatial directives aligned with municipal planning instruments.

Joint planning sessions reinforced shared accountability between the Traditional Council and municipality, illustrating the model's capacity to support proactive land use management in high risk contexts.

### 5.6 SYNTHESIS

Collectively, the pilots confirm that the operational model functions across diverse spatial, institutional, and development contexts. While local adaptation is required, the core sequence of technical acquisition, community validation, municipal integration, and implementation planning remains robust. These findings provide the empirical foundation for institutional embedding and scale out, addressed in the final section.

## 6.EMBEDDING THE PROGRAMME

### 6.1 EMBEDDING AS AN INSTITUTIONAL PROCESS

Embedding the operational model requires that the technical and governance workflows demonstrated through pilot implementation are translated into routine institutional practice. In traditional areas, embedding is not achieved through the introduction of new legislation, but through the formalisation of cooperative governance arrangements that enable customary land administration to interface consistently with statutory municipal planning systems.

At the core of this process is the establishment of joint coordination forums between municipalities and Traditional or Khoi–San Councils. These forums bring together municipal planners, infrastructure officials, Traditional Council leadership, and relevant provincial stakeholders. Their function is to provide a standing platform for information sharing, joint decision making, and the resolution of planning and land use issues arising in traditional areas. By institutionalising dialogue, these forums reduce reliance on ad hoc engagements and ensure continuity beyond individual projects.

### 6.2 FORMALISATION THROUGH AGREEMENTS AND PROCEDURAL INTERFACES

Cooperation is formalised through service level agreements or memoranda of understanding between municipalities and Traditional Councils. These agreements define roles and responsibilities relating to land allocation, spatial planning, development approvals, and recordal. They also specify documentation requirements, indicative timeframes, and dispute–resolution mechanisms.

Such agreements give procedural effect to the operational model by clarifying how planning outputs generated through community led processes are introduced into municipal systems. Once concluded, agreements are lodged with the relevant provincial department to support oversight and accountability. This step is critical in transitioning from pilot based cooperation to a repeatable governance mechanism capable of supporting scale out.

### 6.3 INTEGRATION OF CUSTOMARY LAND RECORDS INTO MUNICIPAL SYSTEMS

A central component of embedding is the integration of validated customary land records into municipal land information and planning systems. Traditional Councils verify land allocations and land use arrangements identified during community validation processes and submit this information for digitisation. Municipalities capture the data within their spatial planning, land use management, and mapping platforms, ensuring consistency between customary and statutory records.

Where land rights are unclear or contested**,** joint verification teams conduct site visits to resolve discrepancies through participatory processes. New land allocation decisions are recorded in both Traditional Council and municipal registers, progressively establishing a single authoritative planning and administrative record. This approach strengthens tenure visibility while allowing for incremental refinement over time.

### 6.4 ALIGNMENT WITH MUNICIPAL PLANNING AND APPROVAL PROCESSES

Embedding further requires that customary land allocation decisions are aligned with municipal planning instruments prior to development approval. Traditional Councils consult municipal Spatial Development Frameworks, Integrated Development Plans, land use schemes, and environmental overlays to assess land suitability and infrastructure availability.

Development applications in traditional areas follow a joint approval pathway. Applications include proof of Traditional Council consent and confirmation of municipal planning alignment. Decisions are considered through established municipal structures, including Municipal Planning Tribunals where applicable, with participation from both municipal and traditional representatives. This shared process reinforces legal compliance while preserving customary authority.

### 6.5 CAPACITY DEVELOPMENT AND INSTITUTIONAL LEARNING

Sustainable embedding depends on ongoing capacity development across governance spheres. Municipalities, provincial departments, and national partners provide continuous training on spatial planning legislation, land administration procedures, geospatial data interpretation, and community engagement methodologies. At least one joint training session is conducted annually and formally reported, creating an institutional learning loop that supports adaptation and improvement of the operational model over time.

### 6.6 MONITORING AND SCALE OUT INDICATORS

To support national replication without imposing excessive administrative burdens, a lightweight monitoring framework is proposed. Indicative monitoring dimensions include:

- Coverage: number of Traditional Council areas with validated spatial baselines and Area Plans;

- Decision cycle efficiency: indicative timeframes for planning review and development approvals;
- Rights recordal: completeness and consistency of customary land records captured in municipal systems;
- Investment readiness: proportion of spatial proposals translated into funded or implementable projects; and
- Institutional alignment: existence and functionality of formal agreements and coordination forums.

These indicators support adaptive management and provide evidence for policy refinement as scale out progresses.

## 7. CONCLUSION

This paper has demonstrated that fit for purpose land administration in areas under Traditional and Khoi–San leadership in South Africa can be operationalised through the integration of drone enabled spatial data, community led planning processes, and institutional alignment under existing legislative frameworks. Drawing on empirical experience from a National Land Planning Programme, the paper moves beyond descriptive reporting to articulate a replicable operational model that bridges customary governance and statutory municipal planning systems.

International examples in Epworth settlement in Zimbabwe has also shown how informal communities can transition to structured land governance systems using digital tools. In Tanzania, a village land use planning tool provided a practical example for reducing land conflicts, clarifying boundaries, and guiding sustainable development. In this example community members mapped their own land, identified environmentally sensitive areas, and agreed on current and future land uses with government only overseeing such processes.

The five stage LPP operational model consolidates institutional entry, rapid spatial data acquisition, community validation, municipal integration, and implementation sequencing into a coherent methodological framework. Pilot application across diverse contexts confirms that high resolution drone imagery provides a pragmatic spatial baseline where conventional records are incomplete, while structured community engagement enhances legitimacy and accuracy of planning outputs. Alignment with municipal planning instruments improves implementation feasibility and investment readiness, even in complex peri urban and resource constrained rural environments.

Importantly, the paper shows that the principal barriers to effective land administration in traditional areas are not technological, but institutional. Embedding the operational model requires formalised governance interfaces, integrated record systems, and sustained capacity development rather than new regulatory instruments. By focusing on incremental improvement, cooperative governance, and pragmatic spatial certainty, the approach advances inclusive and climate resilient land governance without undermining customary authority or statutory mandates.

The contribution of this paper lies in demonstrating how applied geospatial innovation, when combined with institutional design and participatory governance, can transform land administration practice in contexts historically excluded from formal planning systems. The operational model provides a practical pathway for municipalities, traditional authorities, and national governments seeking to strengthen land governance, service delivery, and climate resilience in traditional areas.

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## BIOGRAPHICAL NOTES

**Aluwani Matsila** is a registered Professional Planner with over 21 years of experience in government spatial planning, currently registered for a PhD in Town and Regional Planning at the University of KwaZulu–Natal (UKZN). Expertise in integrated spatial planning, spatial coordination, and development planning support, with a strong focus on planning policy within areas under traditional leadership in South Africa.

**Clinton Heimann** is the Acting Director General at the Department of Land Reform and Rural Development, a registered Town and Regional Planner and a PhD candidate at the University of the Free State, specialising in adaptive planning, land administration, and national spatial policy.

## CONTACTS


Aluwani Matsila
Department of Land Reform and Rural Development, 600 Lillian Ngoyi Street Pretoria, TEL: +27828276203, aluwani.matsila@dlrrd.gov.za, www.dlrrd.gov.za

Clinton Heimann
Department of Land Reform and Rural Development, 600 Lillian Ngoyi Street Pretoria,
Tel: +27829284123, clinton.heimann@dlrrd.gov.za, www.dlrrd.gov.za