



Degree Program in Global Management and Politics

Course of Organising for societal Impact

**Space Race 2.0:
Africa's Emerging Satellites and Europe's
Neo-Colonial Fears**

Prof. Antonio Daood
Supervisor

Prof. Manfredi Valeriani
Co-Supervisor

778711 Reda Gajjout
Candidate

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Contents

1	Introduction	1
1.1	The Puzzle: Cooperation or Dependency?	1
1.2	Research Question and Sub Questions	2
1.3	Relevance and Contribution	2
1.4	Case Selection and Scope	3
1.5	Method Overview	4
1.6	Thesis Structure	5
2	Literature Review	6
2.1	Scope and Purpose of the Review	6
2.2	African Space Programmes and Earth Observation	7
2.3	EU–Africa Space Cooperation and GMES & Africa	8
2.4	Governance and Institutional Design in Space Policy.....	10
2.5	Dependency, Digital Colonialism, and Data Sovereignty.....	11
2.6	Societal Diffusion and Uptake.....	12
2.7	Identified Gaps and Positioning of This Thesis	13
2.8	Bridge to the Theoretical Framework	14
3	Theoretical Framework	15
3.1	Postcolonial Political Economy and Technological Dependency.....	15
3.2	Complex Interdependence and Asymmetrical Cooperation.....	17
3.3	Institutional Design and Governance Mediation.....	18
3.4	Multi-Level Coordination in EU–Africa Space Cooperation	19
3.5	Conceptual Framework and Analytical Propositions	20
4	Methodology	23
4.1	Qualitative Documentary Design: Justification	23
4.2	Case Selection: Structured Variation	24
4.3	Document Inclusion and Exclusion Criteria.....	25
4.4	Documentary Analysis Protocol.....	26
4.5	Within-Case Process Tracing	27

4.6	Structured Cross-Case Comparison	28
4.7	Validity, Bias, and Limitations	29
5	Case Studies	31
5.1	Nigeria.....	33
5.1.1	Institutional Evolution of NASRDA.....	33
5.1.2	Governance Design and Dependency Configuration	36
5.1.3	Interim Analytical Assessment	38
5.2	Egypt.....	41
5.2.1	Institutional Evolution of the Egyptian Space Programme.....	41
5.2.2	Governance Architecture and Oversight.....	43
5.2.3	External Partnerships and EU Interaction	45
5.2.4	Intellectual Property, Data Sovereignty, and Technical Autonomy	48
5.2.5	Participatory Mechanisms and Institutional Coherence	48
5.2.6	Societal Diffusion of Earth Observation Services.....	49
5.2.7	Interim Analytical Assessment	50
5.3	South Africa.....	52
5.3.1	Institutional Evolution of SANSA.....	52
5.3.2	Governance Architecture and Oversight.....	53
5.3.3	External Partnerships and EU Interaction	55
5.3.4	Intellectual Property, Data Sovereignty, and Technical Autonomy	56
5.3.5	Participatory Mechanisms and Institutional Coherence	57
5.3.6	Societal Diffusion of Earth Observation Services.....	58
5.3.7	Interim Analytical Assessment	58
5.4	Cross-Case Comparative Synthesis.....	60
5.4.1	Governance Typology.....	61
5.4.2	Dependency Pathways	62
5.4.3	Diffusion Pathways.....	64
5.4.4	Mixed Outcomes	66
5.4.5	Theoretical Interpretation.....	67
6	Policy and Theoretical Implications	73
6.1	Governance as Mediator in Asymmetric Interdependence.....	73
6.2	Implications for African Institutional Design.....	75
6.3	Implications for EU Programme Structure.....	77
6.4	Design Principles for Non-Extractive Cooperation.....	79
7	Conclusion	82
7.1	Answer to the Research Question.....	82
7.2	Theoretical Contribution	83

7.3	Empirical Contribution.....	84
7.4	Limitations.....	85
7.5	Future Research.....	86

Bibliography

Chapter 1

Introduction

1.1 The Puzzle: Cooperation or Dependency?

The past quarter-century has witnessed a significant rise in African space initiatives. National space agencies have been established across the continent, earth observation capacity has expanded, and continental policy instruments articulate ambitions for indigenous capability and self-reliance.¹ Space applications are increasingly framed as tools for addressing development challenges: food security, disaster risk reduction, water resource management, and environmental monitoring.² This development occurs within a broader context of EU–Africa cooperation in earth observation, centred on the Copernicus programme and its continental extension, GMES & Africa.³ The European Union provides open-access Sentinel data, capacity-building, and technical support whilst African consortia participate as implementing partners under African Union Commission coordination. On the surface, this arrangement offers the prospect of technology transfer, skills development, and operational earth observation services for agriculture, disaster management, water resources, and land use planning. A truly fascinating outcome of the evolution of mankind’s technology and more than a lifetime of partnerships.

Yet cooperation unfolds within asymmetrical technological structures. Design authority, satellite fabrication, and launch services remain concentrated with external partners. The African Space Policy explicitly acknowledges that Africa does not have the full technical know-how to participate independently in space-related activities; the African Space Strategy notes that many space-derived services and products are outsourced.⁴ Open access to data does not dissolve dependence on European infrastructure for data generation,

¹The African Union adopted the African Space Policy and African Space Strategy to provide a continental framework for coordinating national efforts (African Union Commission, 2016).

²(Oyewole, 2020).

³GMES & Africa was agreed at the 2nd Africa–EU Summit in 2007 and aims to produce products and services relevant to African needs, implemented by African institutions and based on European Copernicus data; see (Lavaysse et al., 2020).

⁴(African Union Commission, 2016); (African Union Commission, 2019).

nor on European standards for interoperability. The question that motivates this thesis is whether such cooperation constitutes genuine capacity-building or reproduces structural dependency. The puzzle is thus framed: cooperation promises autonomy-enhancing outcomes yet operates within conditions that may entrench external reliance.

The empirical reality suggests mixed outcomes rather than a clear trajectory toward either full autonomy or permanent subordination. Some African space agencies have developed domestic processing capacity and linkages to end-user ministries; others remain heavily dependent on external technical support and project-based funding. Assessment of global space trends indicates that African countries have joined those with assets in space but often without adequate ground infrastructure.⁵ Understanding how governance and organisational models mediate this variation is the central objective of this research.

1.2 Research Question and Sub Questions

The central research question of this thesis is: how do governance and organisational models of African space initiatives affect societal impact and dependency dynamics within EU–Africa space cooperation?

Sub-questions structure the inquiry:

1. How do budget autonomy, participatory governance, and intellectual property arrangements vary across African space agencies participating in GMES & Africa?
2. To what extent does documentary evidence indicate that governance design mediates the relationship between structural technological dependency and societal diffusion of space-derived services?
3. How do continental (AU) and European (EU) programme designs interface with national governance arrangements in Nigeria, Egypt, and South Africa?

1.3 Relevance and Contribution

This thesis offers three contributions, each articulated without inflated claims.

Theoretical contribution. The thesis advances understanding of how governance mediates outcomes within asymmetric interdependence. Existing scholarship on EU–Africa space cooperation tends to treat dependency as a given condition or to emphasise structural asymmetry without specifying the mechanisms through which national institutional design may attenuate or amplify its effects. This thesis integrates postcolonial political economy, complex interdependence, institutional design, and multilevel coordination into a unified analytical framework. The central claim is that governance design

⁵(Abiodun, 2012).

functions as a mediating variable: the same external partnership can produce different outcomes depending on how the receiving state organises its space sector. This proposition is examined rather than asserted; the contribution lies in specification of the mechanism, not in causal proof. The framework directs attention to budget autonomy, participatory governance, and intellectual property arrangements as dimensions along which governance may filter structural dependency.

Empirical contribution. The thesis undertakes a comparative documentary mapping of governance, dependency, and societal impact across Nigeria, Egypt, and South Africa. It assembles and systematically analyses national legislation, strategy documents, agency reports, AU and EU programme documentation, and peer-reviewed literature. The result is a structured characterisation of how governance dimensions (budget autonomy, participatory governance, IP arrangements, institutional coherence) and dependency dimensions (outsourced maintenance, foreign technical reliance, limited integration capability) are represented across publicly available documents. No prior work has applied this comparative template consistently across these three cases within the GMES & Africa context. The documentary corpus reveals patterned variation in statutory foundations, stakeholder mechanisms, and evidence of societal diffusion.

Policy relevance. The findings carry implications for institutional design without activism or prescription. Programme design that interfaces with national governance structures and that supports institutional embedding of capacity-building may amplify societal impact; design that treats African partners as passive recipients may underachieve. The thesis does not prescribe specific reforms or advocate for particular policy positions. It offers analytical insights that may inform reflection on how EU–Africa cooperation can be structured to support rather than undermine African institutional capacity, within the constraints of structural asymmetry that neither European nor African actors can wish away. The implications are relevant to both European and African programme managers and policymakers.

1.4 Case Selection and Scope

Nigeria, Egypt, and South Africa are selected as cases to maximise structured variation along dimensions identified as analytically salient by the theoretical framework. They are chosen for analytical purposes, not as statistically representative of African space programmes. The logic of selection is purposive: the aim is to examine how variation in national governance design relates to dependency dynamics and documented societal impact under conditions of shared participation in EU–Africa earth observation cooperation. The three countries exhibit different patterns of institutional maturity, governance centralisation, external partnership configuration, and budget autonomy, permitting structured comparison.

Nigeria established its space agency (NASRDA) in 1999 and has pursued an ambitious domestic satellite programme with substantial external technical partnership. Egypt has a longer institutional history in space activities, with a more centralised governance structure tied to military and state security apparatuses. South Africa created SANSA in 2010 with an explicit mandate linking space applications to development priorities and multi-stakeholder coordination. Variation in institutional maturity allows the analysis to examine whether earlier establishment correlates with more entrenched governance arrangements; variation in governance centralisation permits comparison of closed, hierarchical models against more participatory structures. All three participate in GMES & Africa, ensuring a common reference point for EU–Africa cooperation whilst permitting comparison of how national governance filters that cooperation.⁶

The temporal scope spans the late 1990s to 2026, covering the period in which African space programmes have proliferated and EU–Africa earth observation cooperation has matured. This timeframe encompasses the establishment of national space agencies in the case countries, the adoption of continental policy instruments, and the rollout of GMES & Africa. The focus is on governance and earth observation: the thesis examines how national space agencies are structured, funded, and linked to continental and European programmes, and how these arrangements relate to documented dependency and societal diffusion. It does not address space science, astronomy, or telecommunications satellites except where they bear on governance design or earth observation capacity.

1.5 Method Overview

The thesis adopts a qualitative documentary comparative case study design. The unit of analysis is the national governance architecture: the legal basis of the space agency, its relationship to ministerial oversight, its funding structure, stakeholder participation mechanisms, and participation in AU and EU programmes. Data comprise legislation (founding acts, amendments), strategy documents (national space policies, white papers), agency annual reports and statutory disclosures, AU and EU programme documentation (African Space Policy and Strategy, GMES & Africa programme descriptions, Copernicus user policies), and peer-reviewed literature on African space governance and EU–Africa cooperation. Documents are selected for their relevance to governance design, technological dependency, and societal diffusion; inclusion and exclusion criteria are specified in the methodology chapter.

The design is interpretive rather than causal. Documentary evidence is used to trace how governance configurations and dependency patterns are represented across texts and to examine the extent to which such representations are consistent with analytical

⁶Satellite mission and industry data for the three cases are drawn from established databases and African space sector reporting (Space in Africa, 2025) (SANSA Annual Report, 2024).

propositions derived from the theoretical framework. The thesis does not test hypotheses or estimate causal effects; it traces patterns and assesses their fit with theory. Within-case process tracing reconstructs the institutional configuration of each country; cross-case comparison applies a common analytical template to identify patterned similarities and differences. Triangulation across document types (legislation, strategy, implementation reports) mitigates the risk of accepting a single source's self-presentation. Limitations include uneven documentary availability across cases, the impossibility of inferring causal relationships from textual evidence alone, and the potential for strategic self-presentation in official documents.

1.6 Thesis Structure

The thesis proceeds as follows. Chapter 2 reviews the scholarly and programmatic literature on African space programmes, EU–Africa cooperation, governance and institutional design, and dependency dynamics; it identifies gaps that justify the theoretical framework and case-study design. Chapter 3 constructs the integrated analytical framework, combining postcolonial political economy, complex interdependence, institutional design, and multi-level coordination, and derives the analytical propositions that guide the case studies. Chapter 4 specifies the documentary analysis protocol, case selection rationale, document inclusion criteria, and within-case and cross-case comparative procedures. Chapter 5 presents the comparative analysis of Nigeria, Egypt, and South Africa, applying the governance and dependency dimensions to documentary evidence from each case. Chapter 6 discusses implications for institutional design and programme coordination. Chapter 7 synthesises the findings, addresses limitations, and outlines directions for future research. The following chapter begins with the literature review.

Chapter 2

Literature Review

This chapter maps the scholarly and programmatic literature relevant to the central research question: how do governance and organisational models of African space initiatives affect societal impact and dependency dynamics within EU–Africa space cooperation? The review identifies key debates, synthesises findings, and identifies gaps that justify the theoretical framework and comparative case-study design developed in subsequent chapters. It does not restate the theoretical framework; rather, it prepares the reader by surveying what the literature has examined and where it falls short.¹

2.1 Scope and Purpose of the Review

The literature reviewed spans four interconnected domains: African space programmes and earth observation capacity; EU–Africa space cooperation and the GMES & Africa programme; governance and institutional design in space policy; and dependency, digital colonialism, and data sovereignty. A fifth strand addresses societal diffusion and uptake of space-derived services. The selection is guided by the thesis design: a qualitative comparative case study of Nigeria, Egypt, and South Africa based exclusively on documentary evidence, with no regression, quantitative modelling, or statistical inference.

The purpose is threefold. First, to situate the research question within existing debates about African space development, North–South technology cooperation, and the politics of earth observation data. Second, to identify how scholars and programme documents characterise governance, dependency, and societal impact, and where characterisations diverge or remain underspecified. Third, to justify why an integrated theoretical framework and comparative documentary analysis are needed. The review is deliberately selective: it emphasises sources that speak directly to governance arrangements, institutional capacity, EU–AU programme architecture, and dependency

¹The literature review thus functions as both a mapping exercise and a justification: it establishes what is known, what remains contested or underspecified, and why the theoretical and methodological choices of this thesis are warranted. This reflexive purpose distinguishes the chapter from a merely descriptive survey.

dynamics, rather than technical earth observation methodologies or space science as such.

The scope excludes quantitative impact assessments, regression-based studies, and composite indices of space sector development. Such approaches require data structures and measurement conventions that do not align with the documentary corpus available for Nigeria, Egypt, and South Africa.² The review focuses instead on conceptual and qualitative work that can inform interpretation of governance documents, policy texts, and programme reports.

2.2 African Space Programmes and Earth Observation

Scholarship on African space programmes has grown considerably in the past decade. (Oyewole, 2020) traces space research and development across the continent, noting the emergence of national space agencies and the uneven distribution of capability. The literature characterises African space programmes as development-oriented: earth observation for agriculture, disaster management, water resources, and land use planning features prominently in policy discourse.³ (Kganyago and Mhangara, 2019) examine the role of African emerging space agencies in earth observation capacity-building, linking EO to the implementation and monitoring of continental development agendas such as AU Agenda 2063. They identify bilateral and multilateral partnerships, open and free EO data, and open-source software as resources that can support national development priorities, with the South African National Space Agency (SANSA) cited as an example of leveraging partnerships for capacity-building.

Governance and institutional capacity are addressed but often at a high level of abstraction. (Ibrahim et al., 2022) explore sustainable Africa space governance, highlighting infrastructural deficiencies, limited funding, and workforce constraints alongside opportunities in agriculture, disaster management, and regional collaboration. (Froehlich, 2019) provides a comprehensive overview of legal and policy implementation of space in African countries, covering institutional frameworks and national programmes. (James et al., 2014) analyse the Nigerian space programme and its economic development model, documenting the public–private partnership structure, the establishment

²Composite indices of space sector maturity or development typically require standardised indicators across countries, reliable time-series data, and assumptions about comparability that are difficult to satisfy for African space programmes given uneven reporting. The qualitative documentary design adopted here does not purport to measure or rank; it traces governance configurations and their representation in text.

³The development framing is significant: it positions space as a tool for socio-economic progress rather than prestige or military capability. This framing aligns with continental policy rhetoric but may also reflect a strategic choice to legitimise investment in space activities to domestic and international audiences (African Union Commission, 2019b).

of research centres and commercial subsidiaries (GeoApps Plus Limited, NigComSat Limited), and the transition from short-term government investment to medium-term partial commercialisation. This work illustrates how governance design at the national level shapes the space sector's organisation, though it does not systematically link governance to dependency dynamics or societal diffusion.

(Abiodun, 2012) examine global space trends and Africa's response, noting that many African countries have joined those with assets in space but often without adequate ground infrastructure. The African Leadership Conference on Space Science and Technology and regional cooperation arrangements receive attention. (Offiong and Munsami, 2022) argue for an African Space Policy Institute to address the shortage of expertise in drafting space policies and analysing the global space policy context. Their analysis indicates that institutional capacity for policy development and advice is thin across the continent. Continental policy instruments such as the African Space Policy and Strategy articulate aspirations for self-reliance and indigenous capacity but do not specify how national governance arrangements should be designed to achieve these aims, nor how variation in national institutional design may affect realisation.

Documentation varies considerably across African space programmes. Where public documentation is sparse or unevenly distributed, assessment of governance arrangements and progress becomes constrained.⁴ This observation has direct implications for the thesis design: where public documentation is limited, the documentary corpus will reflect those constraints, and findings must be qualified accordingly. The literature thus characterises African space programmes as emergent, development-focused, and variably endowed with institutional and technical capacity. Governance is acknowledged as important, but the specification of how governance arrangements mediate dependency, affect value capture, or influence societal diffusion remains limited. Comparative work linking national governance models to outcomes within EU–AU programme architecture is sparse.

2.3 EU–Africa Space Cooperation and GMES & Africa

EU–Africa space cooperation is structured around the Joint Africa–Europe Strategy and implemented notably through the GMES & Africa programme.⁵ Programme documentation describes the cooperation as aimed at promoting development of local capacities and exploitation of earth observation-based services on an operational basis (African Union Commission, 2019c). The programme is funded by the European

⁴This is a reflexive as well as an empirical point: the researcher's access to knowledge is conditioned by what institutions choose to publish. The unevenness of documentation is itself a governance variable: transparency and accountability norms shape what becomes publicly available, and thus what can be studied.

⁵GMES (Global Monitoring for Environment and Security) was the precursor name for Copernicus; the GMES & Africa programme retains the earlier designation. Sentinel satellites are the space component of Copernicus, providing freely accessible earth observation data.

Commission and implemented through African consortia under African Union Commission coordination. Themes include natural resources management, marine and coastal areas, water resource management, climate variability and change, disaster risk reduction, and food security. GMES & Africa builds on the Copernicus programme and Sentinel data; it seeks to produce products and services relevant to African needs whilst implemented by African institutions (Lavaysse et al., 2020).

The African Space Policy and African Space Strategy provide the continental policy frame. The African Space Policy defines governance as the institutional frameworks, policies, regulations, and decision-making processes that guide space activities across Africa

(African Union Commission, 2019a). It acknowledges that Africa does not have the full technical know-how to participate independently in space-related activities. The African Space Strategy similarly notes that many of Africa's space-derived services and products are outsourced (African Union Commission, 2019b). These documents thus explicitly frame cooperation within a context of structural asymmetry and dependency, whilst articulating aspirations for capacity development, indigenous technologies, and self reliance.

The literature and programme documents describe capacity-building, training strategies, and user engagement with tools such as the eStation developed under GMES & Africa (Lavaysse et al., 2020). The GMES & Africa Forum emphasised the need to take pro- grammes to decision-makers and ministries (African Union Commission, 2019c). How this translates into implementation structures at the national level, and how variation in national governance affects realisation, is less fully documented. The programme operates through consortia of African institutions; national space agencies participate as implementing partners. The terms of participation, the allocation of resources within consortia, and the relationship between continental coordination and national agency mandates are described in programme documentation but have received limited analytical attention.⁶ Scholarship on international space cooperation suggests that emerging space agencies benefit from structured frameworks for evaluating cooperative initiatives (Adams, 2021), but comparative analysis of how Nigerian, Egyptian, and South African agencies participate in GMES & Africa and how their governance designs shape outcomes has not been systematically undertaken. The thesis fills this gap by examining documentary evidence on structure and participation across all cases.

⁶This multi-level structure creates coordination challenges: EU funding and standards meet African Union Commission oversight and national agency implementation. Mismatches between European funding cycles, continental priorities, and national institutional capacities may create friction that affects outcomes. The thesis examines how national governance design mediates these interactions.

2.4 Governance and Institutional Design in Space Policy

Governance arrangements in space policy have received attention from several angles. (Harding, 2013) examine space policy in developing countries, including the challenges of balancing central coordination with stakeholder inclusion in emerging space programmes. (Ostrom, 2015) develops institutional analysis emphasising the role of rules and organisational arrangements in shaping collective outcomes, a framework that has been applied to natural resource governance and that informs thinking about how institutional design affects space sector performance.⁷ (Breccia et al., 2023) distinguish between institutional governance (organisations and mechanisms) and normative governance (legal rules, national legislation, and policies) as core dimensions of space governance in Africa, with emphasis on capacity development, indigenous technologies, and self-reliance.

(Munsami and Nicolaides, 2021) investigate the perceptions and preferences of African experts on key elements of a governance framework for an African space programme, proposing a governance model based on survey responses. Their work indicates that governance architecture is a decision-making process with multiple steps and that choices made early can constrain later opportunities.⁸ The African Space Strategy defines governance structure as the anatomy and inter-relationship of administrative and managerial processes that guide the decision-making chains of the African Space Programme (African Union Commission, 2019b).

Funding, stakeholder inclusion, mandates, and accountability appear in the literature but are seldom integrated into a coherent analytical frame linking governance design to dependency and societal impact. Budget autonomy, participatory governance, and intellectual property arrangements receive scattered attention. (Adams, 2021) discuss funding models and cooperation structures for emerging space agencies, noting that project-based funding from external partners creates particular challenges for sustainability. (Ibrahim et al., 2022) emphasise limited funding as a constraint on African space endeavours. The literature does not, however, systematically examine how variation in budget autonomy across African space agencies affects their vulnerability to external funding cycles, or how participatory governance structures relate to diffusion of space-derived benefits to end-users. Mandates are often described in legislation or policy

⁷Ostrom's work focused on common-pool resources such as irrigation systems and fisheries. Space governance involves different collective action problems (spectrum allocation, orbital slots, data sharing), but the insight that institutional rules shape outcomes transfers: how space agencies are structured, funded, and held accountable affects what they can accomplish. (Ostrom, 2015) provides a generalisable logic of institutional analysis.

⁸This observation resonates with path dependency: initial institutional choices, once embedded in legislation and organisational routines, can be costly to reverse. For the case countries, the timing of agency establishment (Nigeria 1999, South Africa 2010, Egypt with a longer but differently structured history) may thus matter for how governance has evolved.

documents, but the linkage between formal mandates and actual institutional behaviour is rarely traced. Intellectual property and value capture arrangements in EU–Africa cooperation remain under-documented; the allocation of IP in programme agreements, licensing terms for Sentinel data and derived products, and implications for downstream integration capability are rarely analysed. The thesis incorporates these dimensions into its governance design framework and traces their representation in the documentary corpus.

2.5 Dependency, Digital Colonialism, and Data Sovereignty

Dependency and digital colonialism provide a critical lens for understanding North–South technology relations. World-systems theory situates dependency within the structural logic of the capitalist world economy (Wallerstein, 2004), with core–periphery relations constitutive of accumulation on a world scale. (Samoff et al., 1978) extend this logic to the social formations of peripheral capitalism. In *Accumulation on a World Scale*, (Amin, 1976) argue that dependency entails a structural relation in which the periphery is integrated into a global division of labour that perpetuates its subordinate position; transfer of technology under such conditions may reproduce rather than dissolve dependency when control over design, intellectual property, and downstream applications remains concentrated in the core.

The digital colonialism literature extends these concerns to contemporary technology flows. (Kwet, 2022) examines digital colonialism and infrastructure as debt, arguing that control over critical digital infrastructure by foreign entities leads to unequal data flow and asymmetrical power dynamics. In space and earth observation, the parallel is evident: ownership of satellite constellations and ground stations, control over data formats and dissemination platforms, and concentration of intellectual property in European space agencies and firms.⁹ The African Space Policy and Strategy explicitly acknowledge Africa’s dependence on external technical know-how and the outsourcing of space-derived services (African Union Commission, 2019).

Scholarship on dependency and digital colonialism has examined the politics of infrastructure, standards, and data flows. The literature indicates that structural asymmetry characterises EU–Africa space cooperation but tends to treat dependency as a given condition rather than as a variable that governance may mediate. The question of how institutional design at the national level affects the terms on which African actors participate in cooperation, the extent of value retention, and the vulnerability to

⁹The analogy is not perfect: Copernicus provides open data access, which mitigates some forms of exclusion. Yet open access does not dissolve dependence on European infrastructure for data generation, nor on European standards for interoperability. The question is how governance at the receiving end affects the terms on which African actors use that access.

external disruption remains under-specified. Complex interdependence theory suggests that asymmetrical cooperation can nonetheless yield mutual gains under certain institutional conditions (Keohane and Nye, 2012), but the literature has not systematically applied this lens to EU–Africa space cooperation or examined how governance design mediates the balance between dependency and autonomy.

2.6 Societal Diffusion and Uptake

The diffusion of space-derived services to public administration, agriculture, disaster management, and other sectors is a stated objective of African space policies and GMES & Africa. The African Space Policy and Strategy emphasise linking space applications to development priorities (African Union Commission, 2019). The GMES & Africa Forum stressed the importance of bringing programmes to decision-makers and ministries (African Union Commission, 2019). Documentary and scholarly accounts, however, seldom provide robust evidence of actual uptake. (James et al., 2014) note commercial activity (GeoApps Plus selling imagery, offering training) and the Integrated Mission for Sustainable Development as a framework for dissemination, but evidence of institutionalised diffusion to agriculture, disaster response, or public administration remains limited.

Conceptually, diffusion denotes the spread of space-derived benefits beyond the space sector to society at large. Diffusion can occur through multiple channels: direct provision of data or products to government agencies; training of personnel in end-user ministries; incorporation of space-derived information into policy processes; and commercial or non-commercial distribution to farmers, disaster managers, or local authorities. The literature has not standardised indicators for assessing diffusion, and measurement difficulties in qualitative work are significant: uptake by end-users may not be documented in publicly available reports; ministries may use space data without formal reporting; and the link between capacity-building activities and realised societal impact is often assumed rather than evidenced. The literature tends to describe stated objectives and programme structures rather than tracing diffusion pathways or documenting uptake. For a thesis based exclusively on documentary evidence, this implies that societal impact must be inferred cautiously from mentions of service delivery, linkages to sectoral ministries, and application cases where documented. The literature does not provide a well-developed conceptualisation of how to assess diffusion from documents alone, nor does it offer comparative benchmarks across African space agencies. The thesis therefore adopts a documentary tracing approach: it searches for evidence of diffusion in institutional reports, policy documents, and programme evaluations, whilst acknowledging that absence of documentation does not necessarily indicate absence of impact.

2.7 Identified Gaps and Positioning of This Thesis

The foregoing review identifies several gaps that this thesis addresses. First, **governance as mediator** is under-specified. The literature acknowledges that dependency exists and that governance matters, but it rarely treats governance design as the mechanism that mediates between structural dependency and actual outcomes. The thesis develops and applies a framework in which budget autonomy, participatory governance, and IP/value capture arrangements function as mediating variables.¹¹

Second, **comparative work** linking national governance models to diffusion outcomes within the EU–AU programme architecture is limited. Single-case or continental-level analyses predominate. This thesis undertakes structured comparative analysis of Nigeria, Egypt, and South Africa, examining how variation in national governance design relates to dependency dynamics and documented societal impact within a common programme context (GMES & Africa).

Third, **intellectual property and value capture arrangements** receive scant attention as governance variables. The allocation of IP in cooperation agreements, downstream integration capability, and the retention of value from space-derived applications are seldom examined. This thesis incorporates IP and value capture as dimensions of governance design and traces their representation in documentary evidence.

Fourth, **empirical documentation** is uneven across cases. Public documentation varies: South Africa produces annual reports and statutory disclosures; Nigeria has substantial legislative and policy documentation but gaps in funding and diffusion evidence; Egypt presents the most constrained evidence base. The thesis acknowledges these limitations whilst exploiting the available documentary corpus to the extent possible.

Fifth, the literature tends to treat dependency as a monolithic condition. This thesis distinguishes dimensions (outsourced maintenance, foreign technical reliance, limited domestic integration capability) and examines how governance design affects each, recognising that cooperation can simultaneously expand access and entrench reliance.¹² Open access to Sentinel data, for instance, may enhance African capacity to process and apply earth observation whilst alignment with EU standards and reliance on European infrastructure may reinforce structural dependence. The theoretical framework developed in Chapter 3 integrates postcolonial political economy, complex

occurred but was not reported. The thesis reports what documents indicate and refrains from inferring impact where documentation is absent.

¹¹The theoretical move here is from structure to mechanism: rather than treating dependency as a fixed outcome of North–South relations, the thesis asks whether and how national institutional design can attenuate or amplify its effects. This aligns with (Keohane and Nye, 2012)’s attention to how institutions shape the outcomes of asymmetrical interdependence.

¹²This paradox is central: the same cooperation that provides free Sentinel data and capacity-building can also lock African users into European standards and processing workflows. Governance design may determine whether the balance tilts toward enhanced autonomy (e.g. through domestic processing capacity and end-user linkages) or toward deepened dependence.

interdependence, institutional design, and multi-level coordination to address these gaps. It provides the conceptual apparatus through which the comparative documentary analysis of Nigeria, Egypt, and South Africa will be conducted.

2.8 Bridge to the Theoretical Framework

The literature review indicates that an integrated theoretical framework is needed to analyse how governance and organisational models affect societal impact and dependency dynamics within EU–Africa space cooperation. The existing scholarship maps the terrain but does not provide a coherent analytical apparatus that combines structural context (postcolonial political economy, world-systems), relational dynamics (complex interdependence), mediating mechanisms (institutional design), and multi-level coordination. Each of these perspectives appears in the literature, but they are not systematically integrated for the purpose of examining EU–Africa space cooperation.¹³ The next chapter constructs that framework. It defines technological dependency, societal impact, and governance design as conceptual constructs; derives analytical propositions to guide the comparative case study; and prepares the reader for the documentary analysis of Nigeria, Egypt, and South Africa that follows. The framework is built from the pillars identified in this review, synthesising them into an integrated lens through which the case-study evidence will be interpreted.

¹³The integration is deliberate: postcolonial political economy provides the structural backdrop; complex interdependence explains why cooperation occurs despite asymmetry; institutional design specifies the mediating mechanism; multi-level coordination addresses how continental, regional, and national levels interact. None alone suffices; together they frame the research question.

Chapter 3

Theoretical Framework

This chapter constructs the theoretical spine of the thesis. It integrates four pillars: post-colonial political economy, complex interdependence, institutional design, and multi-level coordination. Together they frame the central research question: how do governance and organisational models of African space initiatives affect societal impact and dependency dynamics within EU–Africa space cooperation? The chapter concludes with the conceptualisation of key constructs and the derivation of analytical propositions that guide the comparative case study of Nigeria, Egypt, and South Africa.

3.1 Postcolonial Political Economy and Technological Dependency

Postcolonial political economy furnishes the structural lens through which EU–Africa space cooperation is situated. Neo-colonialism describes how economic and monetary domination replaces direct colonial rule whilst perpetuating external control over nominally independent states.¹ The governance and organisational models of African space initiatives cannot be understood apart from these historical patterns of uneven exchange, knowledge hierarchies, and persistent asymmetry that characterise North–South technology relations. This section situates technological dependency within postcolonial and world-systems thought and engages the digital colonialism literature on contemporary data and technology flows.

Defining Technological Dependency

Technological dependency refers to a condition in which the capacity of a state or region to produce, control, and derive benefit from technology is systematically constrained by

¹The term was coined in the context of African anti-colonial thought to describe continued domination after formal independence.

external actors who own the requisite knowledge, standards, and infrastructure. It is not merely the absence of technical capability. As (Amin, 1976) argues in *Accumulation on a World Scale*, dependency entails a structural relation in which the periphery is integrated into a global division of labour that perpetuates its subordinate position. The transfer of technology under such conditions does not dissolve dependency; it can reproduce it when control over design, intellectual property, and downstream applications remains concentrated in the core.

For the purposes of this thesis, technological dependency is operationalised conceptually along three dimensions.² First, *outsourced maintenance* denotes reliance on external actors for the upkeep and operation of space systems and ground infrastructure. Second, *foreign technical reliance* describes dependence on external expertise, standards, or data for the delivery of space-derived services. Third, *limited domestic integration capability* refers to the absence or weakness of indigenous capacity to translate space data and applications into policy-relevant outcomes for domestic end-users. These dimensions inform the documentary analysis of governance arrangements in each case.

Postcolonial and World-Systems Foundations

The critique of Orientalism established that Western knowledge about the non-West has historically functioned as a form of power.³ The production of discourse about colonised peoples reinforced their subordination by defining them as objects of knowledge rather than as knowing subjects. In the domain of space and earth observation, an analogous dynamic operates. The framing of African space programmes as recipients of European expertise, data, and capacity-building can obscure the ways in which such arrangements reinforce epistemic hierarchies. Who defines what counts as capacity, whose standards govern data formats, and whose priorities shape the agenda of earth observation applications are questions that this framework directs us to ask.

World-systems theory situates dependency within the structural logic of the capitalist world economy (Wallerstein, 2004). The core–periphery relation is not accidental but constitutive of accumulation on a world scale. (Samoff et al., 1978) in *Unequal Development*, extends this logic to the social formations of peripheral capitalism. For space cooperation, the implication is that the benefits accruing to African partners are not determined solely by technical inputs but by the institutional design of cooperation itself. Where governance concentrates decision-making authority, standard-setting, and value capture in European hands, cooperation may reproduce rather than reduce dependence.

²The documentary tracing in later chapters draws on institutional documents, strategy papers, and programme reports for within-case evidence of each dimension.

³The concept refers to how Western discourse constructed the Orient as an object of knowledge rather than a knowing subject.

Digital Colonialism and Space Technology

The digital colonialism literature extends dependency theory to contemporary technology flows. (Kwet, 2022) examines digital colonialism and infrastructure as debt, arguing that control over critical digital infrastructure by foreign entities leads to unequal data flow and asymmetrical power dynamics. In space, the parallel is evident: ownership of satellite constellations, ground stations, and data processing infrastructure; control over data formats and dissemination platforms; and the concentration of intellectual property in European space agencies and firms. The African Space Policy acknowledges this reality when it states that Africa does not have the full technical know-how to participate independently in space-related activities (African Union Commission, 2019). The African Space Strategy similarly notes that many of Africa's space-derived services and products are outsourced (African Union Commission, 2019).

3.2 Complex Interdependence and Asymmetrical Co-operation

Complex interdependence theory provides a complementary lens for understanding EU–Africa space cooperation (Keohane and Nye, 2012). Where postcolonial political economy emphasises structure and domination, interdependence theory attends to the ways in which states and regions are bound together by multiple channels of contact, the absence of a clear hierarchy among issues, and the limited role of military force. In such conditions, cooperation is not zero-sum; gains from exchange are possible. Yet interdependence can be highly asymmetrical. The more dependent party faces greater vulnerability when relations are disrupted. The less dependent party enjoys greater bargaining power in shaping the terms of cooperation.

In EU–Africa space cooperation, asymmetry is pronounced. The European Union, through Copernicus and GMES & Africa, provides earth observation data, infrastructure, and capacity-building.⁴ African partners receive access to Sentinel data, training, and technical support. The EU retains control over the design and operation of the Copernicus programme, the definition of service standards, and the allocation of downstream development resources. African space agencies and consortia participate as implementing partners within a framework set by the European Commission and African Union Commission. This is not symmetrical interdependence but a structured relationship in which European priorities, timelines, and technical choices shape the possibilities for African agency.

The analytical value of complex interdependence lies in its attention to issue-linkage,

⁴GMES (Global Monitoring for Environment and Security) was the precursor name for Copernicus; the GMES & Africa programme retains the earlier designation. Sentinel satellites are the space component of Copernicus.

institutions, and the conditions under which asymmetrical cooperation can nonetheless yield mutual gains. Where governance design allows African partners meaningful input into agenda-setting, capacity to absorb and apply data locally, and retention of value from downstream applications, cooperation may support societal diffusion. Where governance design concentrates authority upstream and treats African actors as passive recipients, cooperation may reinforce structural dependence. The theory thus directs attention to the *institutional mediation* of structural asymmetry.

3.3 Institutional Design and Governance Mediation

Institutional design functions as the mediating mechanism between structural dependency and actual outcomes. Governance refers to the formal and informal rules, procedures, and organisational arrangements that shape how space activities are coordinated, decisions are taken, and benefits are distributed. The African Space Strategy defines governance structure as the anatomy and inter-relationship of administrative and managerial processes that guide the decision-making chains of the African Space Programme (African Union Commission, 2019). Institutional analysis, as developed by (Ostrom, 2015), emphasises the role of rules and organisational arrangements in shaping collective outcomes. At the national level, governance encompasses the legal basis of the space agency, its relationship to ministerial oversight, its funding autonomy, and its participation in international programmes.

The central theoretical claim of this thesis is that governance design mediates the effects of structural dependency. The same external partnership can produce different outcomes depending on how the receiving state organises its space sector. Three dimensions of institutional design are particularly salient.

First, *budget autonomy* concerns the degree to which the space agency or programme can secure stable, predictable funding from domestic sources rather than depending on project-based external grants. Agencies that rely heavily on EU-funded projects for operational budgets face greater vulnerability when funding cycles end or priorities shift. Those with a robust domestic appropriations base enjoy greater latitude to set their own agendas and negotiate as equals.

Second, *participatory governance* concerns the inclusion of domestic stakeholders (ministries, subnational authorities, universities, industry, civil society) in the definition of space application priorities and the use of space-derived data. Where governance is centralised and closed, diffusion of benefits to society is limited. Where governance creates channels for end-user input and multi-stakeholder coordination, the societal impact of space cooperation can be amplified.

Third, *intellectual property and value capture arrangements* concern who owns the data, algorithms, and applications produced under cooperation. Where IP remains with

European partners and African entities receive only limited licences, value capture is

externalised. Where agreements facilitate local ownership, adaptation, and commercialisation of outputs, cooperation can support indigenous capacity-building and economic spillovers.

The continental policy framework defines governance as the institutional frameworks, policies, regulations, and decision-making processes that guide space activities across Africa (African Union Commission, 2019). That framework emphasises capacity development, indigenous technologies, and self-reliance. The GMES & Africa programme illustrates the interplay of EU funding and African governance: the programme is funded by the European Commission and crystallises longstanding EU–Africa cooperation (African Union Commission, 2019). Whether it reduces or reproduces dependency depends on how African consortia are governed, how capacity-building is structured, and how intellectual property is allocated.

3.4 Multi-Level Coordination in EU–Africa Space Cooperation

EU–Africa space cooperation operates across multiple levels of governance. At the continental level, the African Union Commission coordinates the African Space Policy and Strategy and oversees GMES & Africa. At the regional level, consortia of national institutions implement programme components. At the national level, space agencies and research bodies execute projects and deliver services. At the European level, the European Commission, Copernicus programme, and ESA define the overarching framework.⁵ Coordination across these levels is not seamless. Mismatches between continental aspirations and national capacities, between EU funding cycles and African institutional timelines, and between European technical standards and African user needs create friction.

Multi-level coordination theory directs attention to how decisions at one level constrain or enable action at another. The EU’s insistence on open data policies for Copernicus, for instance, creates opportunities for African users to access Sentinel imagery without prohibitive costs. Yet the capacity to process and apply that data depends on national investments in ground infrastructure, training, and institutional arrangements that link space data to policy processes. Where national governance is weak or fragmented, continental and European initiatives may have limited impact. Where national governance creates coherent focal points and links space applications to development priorities, multi-level cooperation can amplify societal benefits.

The Joint Africa–Europe Strategy provides the political framework for EU–AU cooperation, including in space. GMES & Africa operates within this framework. The programme aims to promote development of local capacities and exploitation of EO-

⁵European Space Agency.

based services on an operational basis (African Union Commission, 2019).⁶ The translation of this aim into outcomes depends critically on how national space agencies are structured, funded, and linked to end-users. Comparative analysis of Nigeria, Egypt, and South Africa will examine the variation in national governance design and its implications for dependency dynamics and societal impact.

3.5 Conceptual Framework and Analytical Propositions

This section conceptualises the key constructs of the thesis and articulates analytical propositions that guide the case studies. No hypotheses are proposed; the design is qualitative and exploratory. The propositions are theoretical expectations to be examined through documentary evidence.⁷

Key Conceptual Constructs

Technological dependency. A condition in which a state or region's capacity to produce, control, and benefit from technology is constrained by external actors who own knowledge, standards, and infrastructure. Operationally examined through: outsourced maintenance, foreign technical reliance, and limited domestic integration capability.

Societal impact. The extent to which space-derived products and services reach end-users (government agencies, subnational authorities, farmers, disaster managers, civil society) and inform decisions that affect welfare. Evidence includes: diffusion of data and applications to non-space sectors; uptake by policy-making bodies; and use in addressing development challenges.

Governance design. The formal and informal rules, procedures, and organisational arrangements that structure space agency operations, funding, stakeholder participation, and participation in international programmes. Key dimensions: budget autonomy, participatory governance, and IP/value capture arrangements.

Diffusion. The spread of space-derived benefits beyond the space sector to society at large. Contrasted with concentration, where benefits remain confined to a narrow set of actors.

Analytical Propositions

The following propositions guide the comparative documentary analysis. They are not falsifiable hypotheses but orienting expectations. The case studies will examine the extent

⁶Earth observation.

⁷Including policy documents, strategy papers, agency reports, and programme evaluations.

to which documentary evidence supports, nuances, or qualifies them.

1. **Governance mediation.** Governance design mediates the relationship between structural dependency and societal impact. National space agencies with stronger budget autonomy, participatory governance structures, and favourable IP arrangements will exhibit lower vulnerability to external disruption and higher diffusion of benefits to society, *ceteris paribus*,⁸ than those with weak autonomy, closed governance, and externalised value capture.
2. **Budget autonomy and vulnerability.** Space agencies that depend heavily on external project funding for core operations will display greater vulnerability when funding cycles shift or donor priorities change. Agencies with stable domestic appropriations will display greater continuity and capacity to set independent agendas.
3. **Participatory governance and diffusion.** Governance arrangements that include domestic end-users and multiple stakeholders in defining priorities and using space data will support greater societal diffusion of benefits than arrangements that concentrate decision-making in a narrow agency hierarchy.
4. **Intellectual property and value capture.** Cooperation arrangements that retain IP and value capture with European partners will limit the extent to which African entities can build indigenous capacity and derive economic benefits. Arrangements that facilitate local ownership and adaptation of data, algorithms, and applications will support greater value capture and capacity-building.
5. **Institutional coherence.** National space governance that creates coherent focal points, clear mandates, and linkages between space agencies and development priorities will better translate continental and European cooperation into societal impact than fragmented or poorly coordinated arrangements.

Synthesis

The theoretical framework integrates four pillars. Postcolonial political economy provides the structural context: EU–Africa space cooperation occurs within historical patterns of uneven exchange and knowledge hierarchies. Complex interdependence explains why cooperation is not simply domination: asymmetry exists, but mutual gains are possible under certain institutional conditions. Institutional design functions as the mediating mechanism: governance arrangements at the national level shape whether cooperation amplifies or dampens dependency and whether benefits diffuse to society or remain concentrated. Multi-level coordination explains how continental, regional, national, and

⁸All other things being equal.

European layers interact: outcomes depend on the fit between EU programme design and African national governance.

The comparative case study of Nigeria, Egypt, and South Africa will examine documentary evidence on governance design, dependency dynamics, and societal impact. The analytical propositions direct attention to budget autonomy, participatory governance, IP arrangements, and institutional coherence as key dimensions along which cases may vary. The thesis does not claim to test causal hypotheses but to trace the ways in which governance and organisational models shape outcomes within the structured context of EU–Africa space cooperation.

Chapter 4

Methodology

4.1 Qualitative Documentary Design: Justification

Documentary analysis is appropriate for this thesis because the research question centres on governance and organisational models, dependency dynamics, and societal impact: phenomena that are inscribed in formal texts, institutional mandates, and programme documentation.¹ The central theoretical claim of Chapter 3 is that governance design mediates how structural technological dependency translates into societal impact. That claim cannot be examined through surveys or experiments; it requires systematic interpretation of the documents in which governance rules, funding arrangements, and cooperation terms are articulated.

National space legislation establishes the legal basis and mandate of agencies and thus directly evidences the institutional design dimension of the theoretical framework. Strategic plans and white papers encode institutional priorities, stakeholder inclusion, and links to development objectives, operationalising participatory governance and institutional coherence. AU and EU programme documents specify participation structures, intellectual property arrangements, and capacity-building modalities, thus bearing on complex interdependence and multi-level coordination. Agency annual reports and GMES & Africa documentation record how these arrangements operate in practice. Budget autonomy is evidenced in appropriation references, funding source descriptions, and statements on external grant dependency. Participatory governance appears in institutional charts, stakeholder lists, and consultation procedures. IP arrangements are codified in cooperation agreements, licences, and data access policies, and thus lend themselves to textual analysis. Technological dependency, as conceptualised in postcolonial political economy, surfaces in references to outsourced maintenance, foreign technical support, standards

¹The choice reflects an epistemological stance: governance rules, funding arrangements, and participation structures exist as formal artefacts that can be examined through textual interpretation. Documentary analysis treats documents as both records of institutional reality and as constitutive of that reality in so far as they establish authority and frame action.

adoption, and integration capacity. Societal impact is documented in descriptions of service delivery to agriculture, disaster management, and public administration. These constructs are inherently textual: they exist as formal decisions, policy statements, and institutional records that documentary analysis is designed to interpret.² The qualitative design does not purport to measure causal effects; it traces how governance configurations and dependency patterns are represented across documents and examines the extent to which such representations are consistent with the analytical propositions derived from the theoretical framework.

4.2 Case Selection: Structured Variation

Nigeria, Egypt, and South Africa are selected as cases to maximise structured variation along the dimensions that Chapter 3 identifies as analytically salient.³ The three countries exhibit different patterns of institutional maturity, governance centralisation, external partnership configuration, budget autonomy, and participation in EU-funded programmes, permitting comparison of how governance design relates to dependency and societal impact under varied conditions.

Nigeria established its space agency (NASRDA) in 1999 and has pursued an ambitious domestic satellite programme with substantial external technical partnership. Egypt has a longer institutional history in space activities, with a more centralised governance structure tied to military and state security apparatuses. South Africa created SANSA in 2010 with an explicit mandate linking space applications to development priorities and multi-stakeholder coordination. Variation in institutional maturity allows the analysis to examine whether earlier establishment correlates with more entrenched governance arrangements or greater path dependency. Variation in governance centralisation permits comparison of closed, hierarchical models against more participatory structures. External partnership configuration differs: all three participate in GMES & Africa, but the mix of bilateral European partnerships, commercial arrangements, and continental initiatives varies. Budget autonomy differs across cases, with implications for vulnerability to external funding cycles. By selecting cases that vary along these dimensions rather than holding them constant, the design enables identification of patterned similarities and differences that may indicate how governance design mediates dependency and societal diffusion. All three cases are active participants in GMES & Africa, ensuring a common reference point for EU–

²A reflection: documents may underrepresent or overrepresent certain phenomena. Implementation gaps, informal practices, and power relations that operate outside formal documentation may not be captured. The design acknowledges that documentary evidence offers a partial window; findings are reported as patterns in documents, not as claims about unobserved reality.

³Structured variation implies selecting cases that differ along key dimensions (e.g., institutional maturity, governance centralisation) rather than maximising similarity. The logic is that patterned differences in outcomes across varied conditions can inform understanding of how governance mediates dependency; similarity across cases would offer less analytical leverage.

Africa cooperation whilst permitting comparison of how national governance filters that cooperation.⁴ The selection is purposive, not random; the aim is analytical generalisation to theoretically defined configurations, not statistical generalisation to a population of African space programmes.

4.3 Document Inclusion and Exclusion Criteria

Document inclusion criteria align with the conceptual constructs and multi-level coordination framework of Chapter 3.⁵ **National legislation** establishing or amending space agency mandates is included, as it encodes formal authority, institutional structure, and relationship to ministerial oversight. **Agency mandates**, founding acts, and organisational statutes define governance design at the national level. **Budget statements** and appropriations are included where referenced in agency reports or official documentation, as they bear on budget autonomy. **AU and EU programme documents** (African Space Policy, African Space Strategy, GMES & Africa programme descriptions, Copernicus user policies) are included to trace continental and European-level coordination and the terms of cooperation. **GMES & Africa documentation** (consortium agreements, training strategies, service delivery reports) is included as the primary EU–Africa earth observation programme through which dependency dynamics and societal impact can be examined. **Strategic plans**, white papers, and national space policies articulate stated objectives, stakeholder inclusion, and links to development priorities. **Peer-reviewed literature** on African space governance, EU–Africa cooperation, and the three case countries is included as secondary analysis that may corroborate or qualify documentary evidence.

Exclusion criteria: journalistic reportage, opinion editorials, and purely descriptive material that does not provide institutional or programmatic detail. Documents that lack clear provenance or that cannot be verified are excluded. The corpus is confined to materials available in English or for which authorised translations exist.⁶ Documents are not excluded on the basis of perspective; both official and critical sources contribute to the analysis, with source type recorded for interpretive context.

⁴The shared participation in GMES & Africa controls for the external cooperation context whilst allowing within-programme variation in how national governance structures receive, interpret, and implement the programme. Cases that did not participate would introduce confounding variation in the external partnership dimension.

⁵The criteria are deductive: they derive from the theoretical framework rather than emerging inductively from the documents. This ensures that the corpus is purpose-built to address the research question and analytical propositions.

⁶Offiong and Munsami note that institutional capacity for analysing space policy implementation and advising decision-makers is scarce across Africa, which affects both the availability of documents and the quality of secondary analysis; this limitation is acknowledged. (Offiong and Munsami).

4.4 Documentary Analysis Protocol

The documentary analysis protocol specifies how the conceptual constructs of Chapter 3 are traced in text and how interpretive distinctions are maintained. Four procedural stages structure the analysis: initial screening (Section 4.3), preliminary reading (provenance, audience, temporal scope), thematic coding, and contextual interpretation.⁷

Construct tracing. Governance design is traced through explicit references to budget sources, appropriations, and external grant dependency; to stakeholder bodies, advisory councils, consultation procedures, and end-user engagement; to IP, licensing, data ownership, and value capture in cooperation agreements; and to institutional coherence, mandate clarity, and coordination with AU and EU programmes. Technological dependency is traced through references to maintenance contracts, technical assistance, standards adoption, ground station ownership, and capacity to integrate data into domestic applications. Societal impact is traced through descriptions of service delivery to agriculture, disaster risk reduction, land management, water resources, and public administration. Keywords and governance indicators include: “appropriation”, “grant”, “donor”, “stakeholder”, “consultation”, “licence”, “ownership”, “capacity-building”, “outsourcing”, “maintenance”, “ground station”, “Sentinel”, “GMES & Africa”, “consortium”, “diffusion”, “end-user”, and sectoral references (agriculture, disaster, water, etc.). This lexicon is neither exhaustive nor rigidly applied; it serves as a heuristic to flag passages relevant to the conceptual constructs. Documents may use synonymous or context-specific terminology that the protocol captures through thematic coding.

Formal authority vs. rhetorical commitment. The protocol distinguishes passages that establish formal legal or contractual obligations (legislation, signed agreements, binding programme rules) from passages that articulate aspirational objectives or strategic intent.⁸ The former carry greater weight for inferring actual governance arrangements; the latter indicate institutional priorities but do not in themselves demonstrate implementation. Where documents state participatory governance as an objective, the protocol asks whether corresponding institutional mechanisms are specified. Where documents affirm local capacity-building, the protocol examines whether IP and value capture arrangements support that claim.

Stated objectives vs. implemented arrangements. Programme reports and annual reviews are read for evidence of how stated objectives translate into operational arrangements. Discrepancies between strategy documents and implementation reports

⁷Preliminary reading establishes the context of production: who produced the document, for whom, and when. This informs interpretation; a ministerial strategy paper and an agency annual report may describe the same arrangements differently based on their respective audiences and purposes.

⁸This distinction is methodologically crucial. Strategy documents frequently articulate ambitions that are never realised; legislation, by contrast, creates enforceable obligations. Treating both as equivalent evidence would overstate the extent of institutionalisation where rhetoric exceeds practice.

are noted as analytically significant. The protocol does not assume that stated objectives are realised; it treats implementation as an empirical question to be examined through documentary evidence. Findings are reported with measured phrasing: evidence *suggests*, *indicates*, or *is consistent with* theoretical propositions, not that it demonstrates causal relationships.

4.5 Within-Case Process Tracing

Within each case, the analysis traces how governance structures are established, how they evolve over time, and how they relate to dependency dynamics and societal diffusion. Process tracing here denotes the systematic reconstruction of institutional configurations and their representation in documents, not the testing of causal mechanisms through counterfactual logic.⁹

Mapping governance structures. For each country, the analysis maps the legal basis of the space agency, its relationship to ministerial oversight, its internal organisation (centres, departments, subsidiaries), and its formal mandate. Budget sources are identified from legislation, strategic documents, and reports. Participatory mechanisms (advisory bodies, stakeholder forums, inter-ministerial coordination) are traced from institutional descriptions and compared against the analytical proposition that participatory governance supports societal diffusion. IP arrangements in cooperation agreements are extracted and compared against the theoretical expectation that externalised IP limits value capture.

Tracking institutional evolution. Documents are read chronologically where temporal sequence is relevant. Changes in mandate, restructuring, and shifts in funding arrangements are noted. This allows the analysis to examine whether governance design has become more or less participatory, more or less dependent on external funding, over time.

Examining links between governance design and societal diffusion. The protocol asks: where governance documentation describes stakeholder inclusion and end-user links, do implementation reports indicate actual diffusion of services to agriculture, disaster management, or public administration? Where budget autonomy is weak, do documents indicate vulnerability when external funding cycles shift? Dependency dimensions (outsourced maintenance, foreign technical reliance, limited integration capability) are identified in programme documentation, cooperation agreements, and capacity-building reports. The within-case analysis produces a structured account of each country's governance configuration, dependency profile, and societal impact as

⁹The term is used in a configurational sense: reconstructing the sequence and structure of governance arrangements as documented, rather than establishing that governance design caused particular outcomes. The design does not employ counterfactual reasoning or mechanism-testing; it traces patterns and assesses their consistency with theoretical propositions.

evidenced in documents, forming the basis for cross-case comparison.

4.6 Structured Cross-Case Comparison

Cross-case comparison applies a common analytical template to all three cases. The template comprises the governance dimensions (budget autonomy, participatory governance, IP arrangements, institutional coherence), dependency dimensions (outsourced maintenance, foreign technical reliance, limited domestic integration capability), and societal impact indicators (diffusion to agriculture, disaster management, public administration) derived from Chapter 3. Each case is summarised against this template before systematic comparison.

Comparison proceeds dimension by dimension. Budget autonomy: how does the mix of domestic appropriations and external grants compare across Nigeria, Egypt, and South Africa? Participatory governance: which cases document formal stakeholder inclusion, and with what variation? IP arrangements: how do cooperation agreements allocate ownership and licensing across cases? Institutional coherence: which cases present clear focal points and linkages to development priorities? Dependency: where does documentary evidence indicate outsourced maintenance, foreign technical reliance, or limited integration capability? Societal impact: where does evidence of service diffusion to non-space sectors appear? Patterned similarities and differences are identified and related to the analytical propositions. Where cases that exhibit stronger budget autonomy or participatory governance also exhibit higher societal diffusion in documents, such patterns are noted as consistent with the governance mediation proposition. Where evidence is mixed or contradictory, such complexity is reported.

The design aims at **analytical generalisation**, not statistical generalisation.¹⁰ Findings are generalisable to theoretically defined configurations: under conditions of weak budget autonomy and externalised IP, documentary evidence may suggest greater vulnerability and limited diffusion; under conditions of participatory governance and coherent institutional design, evidence may suggest amplified societal impact. The thesis does not claim that the three cases represent a sample from which population inferences can be drawn. It claims that comparative documentary analysis of these cases can inform understanding of how governance and organisational models shape dependency dynamics and societal impact within EU–Africa space cooperation. The structured template ensures that comparison is systematic rather than impressionistic, whilst remaining sensitive to case-specific context that may qualify or nuance cross-case patterns.

¹⁰Analytical generalisation extends findings to theoretical propositions or configurations, rather than to a statistical population. The logic is: if the pattern holds in these varied cases, it may hold in other cases that share similar theoretical characteristics. The transferability of insights depends on the similarity of conditions, not on random sampling.

4.7 Validity, Bias, and Limitations

Documentary analysis faces several validity concerns that the design acknowledges without claiming to resolve. **Documentary bias** arises because documents are produced for specific purposes: legislation to establish authority, strategy papers to secure funding, annual reports to demonstrate performance. Policy texts often present institutional arrangements in a favourable light.¹¹ The protocol mitigates this by triangulating across document types (formal legislation, strategic rhetoric, implementation reports) and by noting discrepancies between stated objectives and reported arrangements. Strategic self-presentation in policy texts is expected; the protocol treats it as an object of analysis rather than as transparent evidence of reality.

Access limitations constrain the corpus. Not all relevant documents may be publicly available. Internal memoranda, draft agreements, and sensitive budget details may be inaccessible. The analysis is confined to documents that could be obtained; findings are qualified by the possibility that unavailable materials might alter the picture. Language and translation constraints may also limit coverage where documents exist only in Arabic or other languages without authorised translations.¹²

Non-causal design is explicit: the thesis does not test hypotheses or estimate causal effects. Documentary evidence can indicate consistency with theoretical propositions; it cannot establish that governance design *causes* particular dependency or societal outcomes. Confounding factors (economic conditions, political stability, historical legacy) are not controlled. The design traces patterns and examines their fit with theory, not causal mechanisms.

Generalisability limits follow from the purposive case selection and qualitative design. Nigeria, Egypt, and South Africa are not representative of all African space programmes. Conclusions are analytically generalisable to theoretically similar configurations, not statistically generalisable to a broader population. The contribution lies in rigorous comparative analysis of governance, dependency, and societal impact within these cases, generating insights that may inform future research and policy reflection rather than yielding definitive causal claims.

The methodological approach therefore mirrors the theoretical design of the thesis: structural dependency provides the contextual frame, institutional design provides the

¹¹Triangulation across document types does not eliminate bias but reduces the risk of accepting a single source's self-presentation. Where legislation, strategy, and implementation reports align, confidence in the pattern is higher; where they diverge, the discrepancy becomes analytically informative.

¹²Egypt and Nigeria have space documentation in Arabic and English; the corpus prioritises English-language and officially translated materials. This may underrepresent domestic policy discourse that has not been translated for international audiences.

mediating lens, and documentary analysis provides the empirical window through which their interaction is examined.¹³

¹³The design is coherent: the theoretical framework identifies governance as mediating variable; the methodology selects cases and documents that permit examination of that mediation; the analytical propositions operationalise the theoretical claims in terms that documentary evidence can address.

Chapter 5

Case Studies

This chapter examines documentary evidence on governance design, technological dependency, and societal impact in Nigeria, Egypt, and South Africa. It operationalises the analytical propositions derived in Chapter 3 and applies the methodological protocol set out in Chapter 4. The central theoretical claim under examination is that governance design mediates how structural technological dependency translates into societal impact.¹ Each case is analysed through the lens of budget autonomy, participatory governance, intellectual property arrangements, and institutional coherence, with attention to outsourced maintenance, foreign technical reliance, and limited domestic integration capability.

Before turning to the individual cases, a consolidated overview of satellite missions across the three countries is analytically necessary. The case studies examine governance design and documentary evidence in depth, but infrastructure dependence, foreign technical reliance, and upstream value capture are operationalised conceptually through specific partnerships: who builds the satellites, who launches them, and where design authority resides. A cross-country comparison of prime builders and launchers permits identification of patterned variation in dependency profiles before the narrative proceeds to national institutional detail. The table below assembles key satellites for Nigeria, Egypt, and South Africa from 1998 to 2026, drawing on verified satellite databases and African space industry reporting. It provides a reference point against which the dependency pathways discussed in each case section can be situated, and it supports the cross-case comparative synthesis that concludes the chapter.

¹For a comparative perspective on governance frameworks for African space programmes, see (Ibrahim et al., 2022).

Table 5.1: Key Satellites of Nigeria, Egypt, and South Africa
(1998–2026)

Sources: (29; 28).

Country	Satellite (Year)	Prime Builder	Launcher	Primary Use
Nigeria	NigeriaSat-1 (2003)	SSTL (UK)	Russia	Earth Observa- tion
	NigComSat-1 (2007)	CAST (China)	China	Telecom (Failed)
	NigComSat-1R (2011)	CAST (China)	China	Telecommunications
	NigeriaSat-2 (2011)	SSTL (UK)	Russia	Earth Observa- tion
	NigeriaSat-X (2011)	NASRDA/SSTL	Russia	Earth Observa- tion
	EduSat-1 (2017)	FUTA/Kyutech	USA (SpaceX)	Educational
Egypt	NileSat-101 (1998)	Matra Marconi	EU (Ariane 4)	Telecommunications
	EgyptSat-1 (2007)	Yuzhnoye (Ukraine)	Russia	Earth Observa- tion
	NileSat-201 (2010)	Thales Alenia	EU (Ariane 5)	Telecommunications
	EgyptSat-2 (2014)	Energia (Russia)	Russia	EO (Failed 2015)
	EgyptSat-A (2019)	Energia (Russia)	Russia	Earth Observa- tion
	TIBA-1 (2019)	Thales/Airbus	EU (Ariane 5)	Gov Telecom
	NileSat-301 (2022)	Thales Alenia	USA (SpaceX)	Telecommunications
	NExSat-1 (2024)	EgSA/BST (Germany)	China	Earth Observa- tion
	SPNEX (2025)	EgSA (Egypt)	China	Ionospheric Res.
South Africa	SUNSAT (1999)	Stellenbosch Uni.	USA (Delta II)	Research/EO

Country	Satellite (Year)	Prime Builder	Launcher	Primary Use
	SumbandilaSat (2009)	SunSpace (SA)	Russia	EO/Disaster Mgmt
	ZACube-1 (2013)	CPUT (SA)	Russia	Space Weather
	nSIGHT-1 (2017)	SCS Space (SA)	USA (Atlas V)	Research/EO
	ZACube-2 (2018)	CPUT (SA)	Russia	Marine/Fire Monit.
	MDASat-1 (2022)	CPUT (SA)	USA (SpaceX)	Marine Aware- ness

The table illustrates the distribution of prime builders and launch providers across the three cases and supports analysis of infrastructure dependence and upstream value capture. The distribution of prime builders suggests marked variation: Nigeria and Egypt rely predominantly on external contractors (SSTL, CAST, Yuzhnoye, Energia, Thales Alenia); South Africa exhibits a higher share of domestic or university-led fabrication (Stellenbosch University, SunSpace, CPUT, SCS Space). Launch provider patterns indicate that Russia, the European Ariane family, China, and the United States (SpaceX, Delta, Atlas) each feature across the cases, though the mix varies by country and mission type. Infrastructure dependence is evident in that no African country has yet achieved indigenous launch capability; all missions depend on external launch facilities. Foreign technical reliance is operationalised through the concentration of prime building with non-African entities for the majority of missions, with South Africa presenting the clearest exception. Upstream value capture remains concentrated with external builders and launchers; the table does not resolve questions of IP retention or training transfer, but it establishes the structural baseline against which governance mediation and diffusion pathways, examined in the following sections, must be understood.

5.1 Nigeria

5.1.1 Institutional Evolution of NASRDA

The National Space Research and Development Agency Act 2010 establishes NASRDA as a body corporate with perpetual succession and defines its governance structure, funding sources, and mandate.² The Act's institutional design shapes the conditions under which

²Primary source: National Space Research and Development Agency Act, 2010 (Act No. 9), *Official Gazette* of the Federal Republic of Nigeria, Vol. 97. For comparative analysis of Nigerian and South African national space legislation as unitary law frameworks, see (Arora et al., 1994).

budget autonomy, participatory governance, and dependency dynamics operate. Section 6 specifies the agency's functions, including capacity building in space science and technology, development of satellite technology for various applications, and operationalisation of indigenous space systems. The Act designates NASRDA as the government agency charged with building and launching satellites and as the repository of all satellite data over Nigeria's territory, with all collaborations and consultations in space data-related matters to be carried out by or with the agency. This formal authority centralises data governance at the national level and establishes a single focal point for international cooperation.³

The Council structure under Section 2 is composed of ex officio members (President as Chairman, Vice-President, ministers of Science and Technology, Defence, Interior, Planning, Information, Education, Justice) and three distinguished scientists drawn from the National Academy of Science and Council of Registered Engineers. The Council meets not less than four times each year and decides by consensus or majority vote. The composition suggests a hierarchical, executive-dominated governance model rather than broad stakeholder participation.⁴ The National Space Policy, approved in 2000 and referenced in the Act, establishes a Technical Advisory Committee and a Committee on International Cooperation, with membership including representatives from the armed forces, security agencies, organised private sector, and the academies of science and engineering. These committees provide advisory rather than decision-making functions; the Policy states that the Ministry of Science and Technology provides the secretariat for the National Space Council. The distinction between formal authority (vested in the Council and Agency) and participatory mechanisms (advisory committees) is significant for Proposition 3: governance that concentrates decision-making in a narrow hierarchy may limit diffusion of space-derived benefits to end-users.

The Act's financial provisions (Section 23) specify that the Agency's fund shall be credited with allocations from the Federal Government budget, foreign aid and assistance from bilateral and multilateral agencies, fees for services rendered, and gifts or voluntary contributions. This multi-source funding structure formally acknowledges dependence on both domestic appropriations and external grants. The National Space Policy preamble acknowledges that Nigeria "presently cannot claim to possess the technical know-how to participate actively and independently in space related activities as a service provider" and has "remained a nation of consumers of space-derived products". The Policy thus explicitly frames the initial condition of technological dependency.⁵ The policy document articulates aspirational objectives (transformation from consumer to

³On the role of African emerging space agencies in earth observation capacity-building and links to continental development priorities, see (Kganyago and Mhangara, 2019).

⁴For governance structures in emerging space programmes and the challenges of balancing central coordination with stakeholder inclusion, see Harding, 2013.

⁵On Africa's position in the global space arena and infrastructure gaps, see (Abiodun, 2012).

active participant within three years, indigenous competence in developing and building hardware and software) that are strategic intent rather than binding commitments; implementation evidence is required to assess whether these objectives have been realised. The 2010 Act establishes six Development Centres: National Centre for Remote Sensing (Jos), Centre for Space Science and Technology Education (Ile-Ife), Centre for Satellite Technology Development (Abuja), Centre for Space Transport and Propulsion (Epe), Centre for Geodesy and Geodynamics (Toro), and Centre for Basic Space Science and Astronomy (Nsukka). Each Centre has a specified mandate. The Centre for Satellite Technology Development is tasked with developing trained engineers and scientists in satellite technology building, launching, telemetry, tracking, and control. The National Space Policy programme section states that the Centre “shall collaborate with the Surrey Satellite Technology Limited (SSTL), the United Kingdom, in the fabrication and launching of Nigeria’s first orbital satellite, NIGERSAT-1”. Collaboration with SSTL is thus embedded in the strategic design; the Policy envisages that Nigerian engineers and scientists “shall contribute to the building of sensors and cameras” and that such facilities should initially be established at the SHEDA Science and Technology Complex. The institutional formation thus anticipates foreign technical reliance whilst framing it as a pathway to indigenous capability. The Centre for Space Science and Technology Education, Ile-Ife, operates as the African Regional Centre for Space Science and Technology Education (ARCSSTEE), a United Nations Office for Outer Space Affairs capacity development programme, indicating integration into continental and international training frameworks.⁶

The satellite mission timeline provides a consolidated view of NASRDA’s institutional evolution and its interface with external fabrication and launch partners. Figure 5.1 illustrates the sequence of missions and supports analysis of governance-mediated dependency. The configuration evident in Figure 5.1 is consistent with a governance design that centralises mandate and coordination at the national level whilst embedding foreign technical reliance in mission implementation. The figure thus supports Proposition 1 (governance mediation) by visualising the institutional trajectory through which dependency is structured.

NASRDA participation in GMES & Africa is documented in the Forum Report (AUC, 2019b), with NASRDA personnel serving as rapporteurs and participants in parallel sessions on natural resources management.⁷ The Centre for Space Science and Technology Education (CSSTE) is listed among participating institutions. Documentary evidence indicates that Nigeria engages with the EU-funded programme as an implementing partner within the continental framework. The institutional evolution thus reflects a governance

⁶On space research and development across Africa, including Nigeria’s place in continental initiatives, see (Oyewole, 2020).

⁷The GMES & Africa programme aims to promote development of local capacities and exploitation of EO-based services; see (Lavaysse et al., 2020) on user engagement with programme tools.

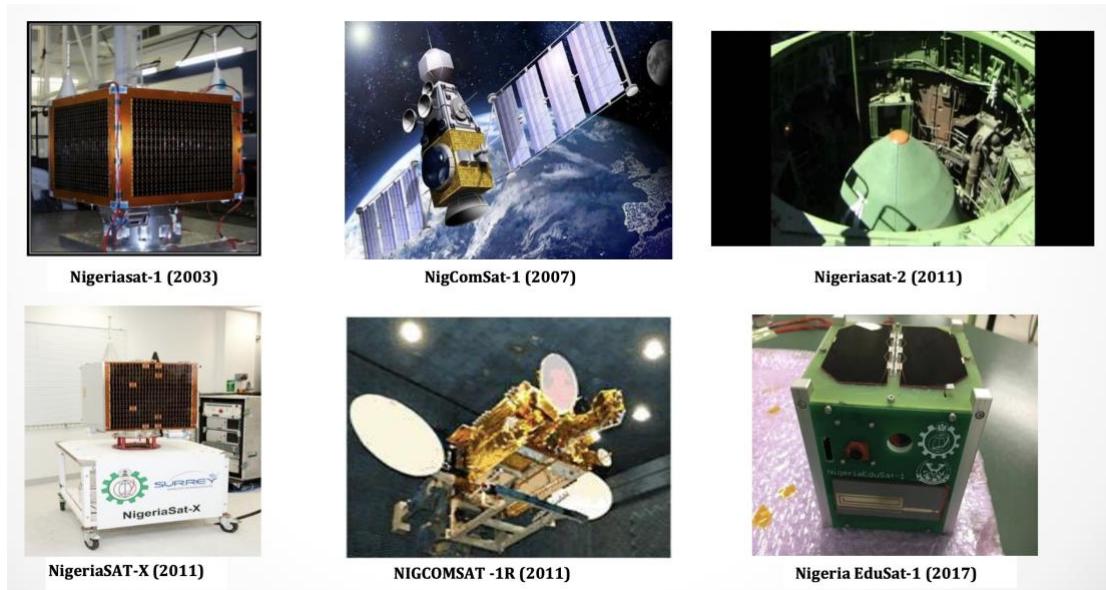


Figure 5.1: Nigeria’s satellite missions illustrate institutional evolution and reliance on external fabrication (SSTL, China) and launch providers (Russia).

Source: Dr. Godstime Kadiri James (NASRDA), World Bank presentation, 16 June 2022.

design in which a centralised agency structure coexists with formal reliance on external partnerships for satellite fabrication, launch, and capacity-building.

5.1.2 Governance Design and Dependency Configuration

The NASRDA Act and policy documents permit analysis of budget autonomy, IP arrangements, and dependency dimensions. The Act specifies that the Agency’s fund shall receive allocations from the Federal Government budget and foreign aid from bilateral and multilateral agencies. The policy document stipulates establishment of a Space Science and Technology Fund (SSTF) to be administered by the National Space Council through NASRDA. No documentary evidence in the corpus specifies the proportion of funding from domestic versus external sources, or the stability of appropriations over time.⁸ The James et al., 2014 study indicates that within the short-term economic development plan the government is responsible for all investments in space technology development, and that NASRDA is “currently implementing its medium-term economic development agenda”, which involves partial commercialisation of products and services.⁹ The establishment of GeoApps Plus Limited and NigComSat Limited as commercial arms suggests an intent to generate revenue; whether this reduces dependence on external grants is not evidenced in the available documents.

Foreign technical reliance is clearly documented. The National Space Policy programme states that Nigeria signed an agreement with SSTL of the United Kingdom

⁸On funding models and sustainability in emerging space agencies, see (Adams, 2021).

⁹(James et al., 2014).

for the design, construction, and launching of a micro satellite. James et al., 2014 report that the Centre for Satellite Technology Development collaborated with Surrey Satellite Technology Limited in the fabrication and launching of NigeriaSat-1, and that Nigerian engineers built NigeriaSat-X “using the facilities of SSTL in the United Kingdom”. NigComSat-1 was designed to meet telecommunication, broadcasting, and other needs but failed in orbit in 2008; a replacement contract was signed with the Chinese government for NigComSat-1R. The communication satellite segment thus exhibits outsourced maintenance and foreign technical reliance: fabrication abroad, launch from Russian and Chinese facilities, and replacement through external contracts. For earth observation, NigeriaSat-2 and NigeriaSat-X were launched from Yasny, Russia. DMC International Imaging Limited was appointed to market images from NigeriaSat-2 and NigeriaSat-X outside Africa, whilst GeoApps Plus Limited markets within Africa. This arrangement suggests that downstream value capture for international markets is partly externalised to a foreign entity.

The National Space Policy articulates extensive application objectives: agriculture (crop performance assessment, yield prediction), disaster prediction and mitigation, water resources management, land use planning, and defence and security. The Policy envisages establishment of a national ground receiving station, mobile receivers, and laboratories in each state for satellite data analysis. Documentary evidence of domestic ground infrastructure is illustrated by the receiving station for NigeriaSat-2 and NigeriaSat-X (Figure 5.2).

Domestic ownership of reception infrastructure supports the analytical point that data governance authority is retained at the national level, consistent with the NASRDA Act’s designation of the agency as repository of all satellite data over Nigeria’s territory. The operational laboratory network extends this picture of indigenous integration capability. Figure 5.3 maps the distribution of NASRDA laboratories across development centres.

The laboratory configuration in Figure 5.3 indicates that governance design has allocated resources towards domestic processing capability, supporting a mixed dependency profile in which downstream analysis and data exploitation can occur locally.

The Integrated Mission for Sustainable Development (IMSD) is described as the collation, analysis, and dissemination of satellite-derived environmental data to stakeholders.¹⁰ These are stated objectives; implementation evidence in the corpus is limited. The policy acknowledges that “all these need space technology to be effective” in relation to existing committees on ecological problems, soil erosion, and disaster reduction, but does not provide evidence of actual diffusion of space-derived services to agriculture, disaster management, or public administration. James et al., 2014 note that GeoApps Plus Limited sells images from NigeriaSat-1, NigeriaSat-2, and NigeriaSat-X in Africa and offers commercial

¹⁰The African Space Policy and Strategy similarly emphasise diffusion of space applications to development sectors; see (AUC, 2016) and (AUC, 2019a).



Figure 5.2: The ground receiving station for NigeriaSat-2 and NigeriaSat-X at NASRDA illustrates domestic ownership of data reception infrastructure (P4).

Source: Dr. Godstime Kadiri James (NASRDA), World Bank presentation, 16 June 2022.

training in Remote Sensing and GIS, indicating some downstream activity. An example of NASRDA applying satellite-derived products to end-user applications is illustrated in Figure 5.4.

Such evidence, where available, supports assessment of Proposition 3 (participatory governance and diffusion): application cases indicate a diffusion pathway from satellite data to societal use, though the extent of institutionalised uptake by agriculture, disaster management, or public administration cannot be confirmed from the corpus. The Centre for Basic Space Science and Astronomy has developed solar panel technology and a satellite-based tracking system as spin-offs. Documentary evidence of diffusion to non-space sectors (agricultural extension, disaster response agencies, subnational authorities) remains limited in the available corpus.¹¹

5.1.3 Interim Analytical Assessment

The Nigerian case permits an interim assessment against the analytical propositions (P1–P5) using measured phrasing appropriate to documentary evidence.

P1 (Governance mediation). Documentary evidence suggests that governance

¹¹On the shortage of institutional capacity in Africa for analysing space policy implementation and advising decision-makers, see (Offiong and Munsami, 2022); this gap may affect both documentation and diffusion.



Figure 5.3: Operational laboratories of NASRDA across development centres reflect institutional design for indigenous data processing and analysis capacity.

Source: Dr. Godstime Kadiri James (NASRDA), World Bank presentation, 16 June 2022.

design in Nigeria mediates the relationship between structural technological dependency and societal impact. The NASRDA Act establishes a centralised agency with a Council dominated by executive branch representatives and a mandate that formally positions the agency as the national focal point for space data and international cooperation. The configuration appears consistent with a model in which governance concentrates authority in a hierarchical structure. The extent to which this mediates (amplifies or dampens) dependency and societal diffusion cannot be determined from documents alone; the case indicates that formal institutional coherence exists at the national level, but that participatory mechanisms are advisory rather than decisive.¹²

P2 (Budget autonomy and vulnerability). The Act specifies multiple funding sources including Federal Government allocations and foreign aid from bilateral and multilateral agencies. The policy documents do not quantify the mix of domestic appropriations versus external project funding. The establishment of commercial subsidiaries (GeoApps Plus, NigComSat Limited) and the transition to medium-term partial commercialisation suggest an institutional response to sustainability concerns. The case indicates that budget autonomy cannot be confidently assessed from the available documents; the formal framework permits both domestic and external funding, with no documentary evidence of the actual balance or of vulnerability when external funding cycles shift.

P3 (Participatory governance and diffusion). The National Space Council includes a private sector representative and two distinguished scientists; the Technical Advisory Committee includes representatives from the armed forces, security agencies, organised private sector, and academics. These structures suggest limited but formal

¹²Proposition 3 (participatory governance and diffusion) posits that stakeholder inclusion supports societal diffusion; the Nigerian configuration suggests that advisory inclusion may be insufficient where decision-

making remains concentrated.

Spatial Distribution of Junior Secondary Schools in Nigeria

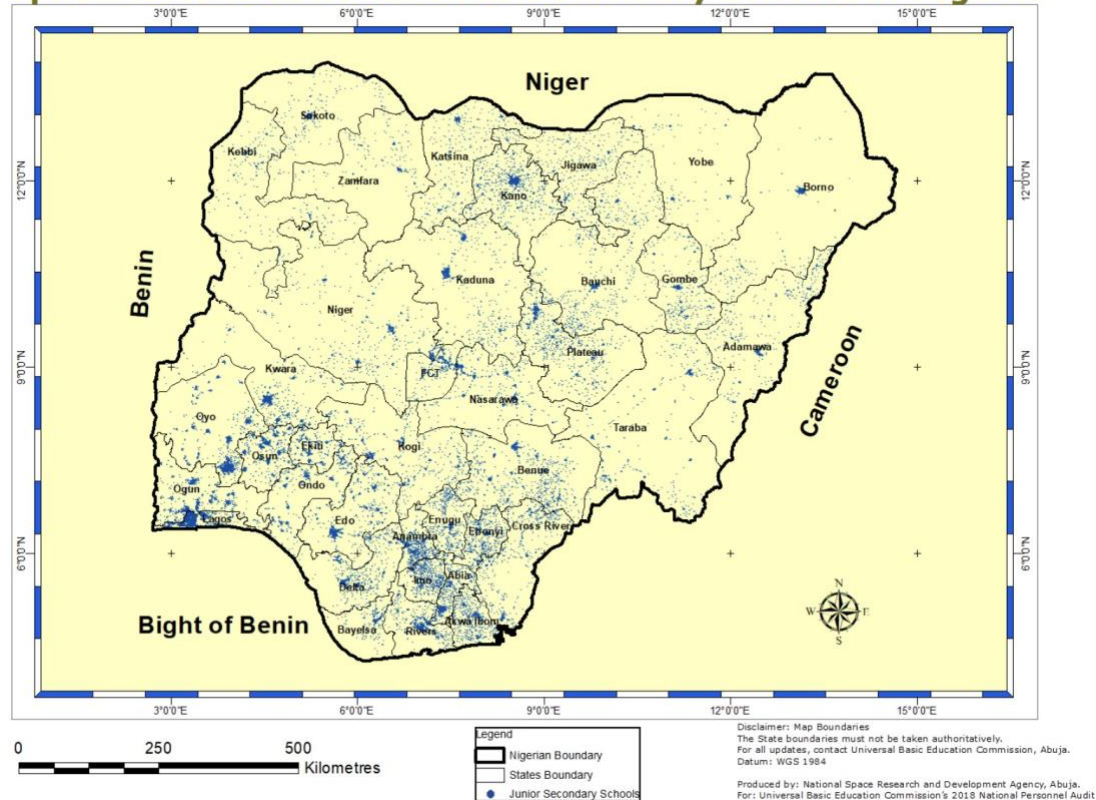


Figure 5.4: An example of NASRDA applying satellite-derived products to end-user applications illustrates the diffusion pathway envisaged by the National Space Policy (P3).

Source: Dr. Godstime Kadiri James (NASRDA), World Bank presentation, 16 June 2022.

stakeholder inclusion at the advisory level. The policy articulates ambitious objectives for diffusion of space applications to agriculture, disaster management, water resources, and education. Implementation evidence is sparse: GeoApps Plus markets imagery and offers training; the IMSD is described as a framework for dissemination to stakeholders. The case suggests that participatory governance is present in institutional design but concentrated in advisory rather than decision-making roles. Evidence of actual diffusion to end-users in agriculture, disaster management, or public administration is limited in the corpus.

P4 (Intellectual property and value capture). The NASRDA Act establishes the agency as repository of all satellite data over Nigeria's territory and requires that collaborations in space data matters be carried out by or with the agency. This formal provision supports retention of data governance at the national level. The collaboration with SSTL for satellite fabrication, the appointment of DMC International Imaging to market imagery outside Africa, and the Chinese contract for NigComSat-1R indicate that technical IP and elements of downstream value capture reside with external partners. The configuration appears consistent with a mixed arrangement: data repository authority

retained domestically, but fabrication know-how, launch services, and international marketing partly externalised.¹³

P5 (Institutional coherence). The Act creates a clear mandate, a single agency with six development centres, and an organisational structure with departments for Engineering and Space Systems, Strategic Space Applications, International Cooperation, Policy Planning and Research, and Mission Planning and Satellite Data Management. The Centre for Space Science and Technology Education serves as the UN-affiliated African Regional Centre. The policy links space applications to national development priorities (food security, disaster management, resource management). The case indicates that institutional coherence at the national level is relatively strong: a defined focal point, clear mandates, and linkage to development objectives. Coordination with continental (African Space Policy, GMES & Africa) and European programmes is evidenced by NASRDA participation in the GMES & Africa Forum.

In sum, the Nigerian case presents a governance configuration characterised by centralised formal authority, advisory stakeholder participation, multi-source funding (domestic and external), and significant foreign technical reliance for satellite fabrication, launch, and elements of downstream marketing. Documentary evidence suggests that institutional coherence is present and that the agency has established commercial arms to pursue revenue generation. Evidence of societal diffusion to agriculture, disaster management, or public administration remains limited in the available corpus. The configuration is consistent with a governance design that mediates dependency through a centralised national structure, whilst the extent of budget autonomy and the realised societal impact would require supplementary documentary or empirical evidence to assess more fully.¹⁴

5.2 Egypt

5.2.1 Institutional Evolution of the Egyptian Space Programme

The Egyptian space programme has evolved through a distinct institutional trajectory compared with Nigeria. Documentary evidence indicates that space activities were initiated under the Egyptian Academy of Scientific Research and Technology (ASRT) in the early 1970s through an American-Egyptian collaborative initiative.¹⁵ A Remote Sensing Centre was established shortly thereafter and transformed into the National Authority for Remote Sensing and Space Sciences (NARSS) in 1991. NARSS was

¹³This pattern aligns with dependency theory's emphasis on where value capture is concentrated; see Chapter 3.

¹⁴The African Space Policy acknowledges that Africa does not have the full technical know-how to participate independently; governance design mediates how this structural condition translates into outcomes. See (AUC, 2016).

¹⁵(Froehlich, 2019), Egypt chapter (OZ). The corpus draws on this peer-reviewed volume for institutional

and partnership details.

reorganised by presidential decree in 1992 and operates under the Ministry of Scientific Research. This sequence suggests that institutional formation preceded dedicated space legislation: unlike Nigeria, Egypt did not have a clear national space law at the time of the Integrated Space analysis, and several announcements since 2014 regarding establishment of a national space agency had not crystallised into a legislated agency.¹⁶

The governance implications of this trajectory are significant for the analytical propositions. NARSS functions as the primary implementing body for space activities but derives its authority from executive decree and ministerial oversight rather than from a dedicated parliamentary Act. Documentary evidence in the available corpus suggests that this creates a more centralised, executive-dominated structure: NARSS reports through the Ministry of Scientific Research, with political and financial support from the Ministries of State for Scientific Research and Higher Education. The absence of a legislated space agency with an independent Council structure, as in Nigeria, may indicate weaker formal institutionalisation and greater vulnerability to executive discretion.¹⁷

Egypt was selected as host for the African Space Agency (AfSA), with documentary evidence in the corpus indicating an allocation of ten million dollars towards its establishment.¹⁸ This positions Egypt at the continental coordination level and may shape how national governance interfaces with AU-level space initiatives. The interface with the African Space Agency hosting role is thus a documented element of Egypt's institutional positioning, though the implications for budget autonomy, participatory governance, and dependency dynamics require examination of operational arrangements not fully detailed in the corpus.

NARSS participates in GMES & Africa as part of the Northern Africa consortium. The GMES & Africa Forum Report documents NARSS representation, including Professor Islam Abou El-Magd as keynote speaker and session chair for coastal and natural resources management.¹⁹ Documentary evidence indicates that Egypt engages with the EU-funded programme as an implementing partner, with NARSS serving as the national focal point for earth observation within the Northern Africa regional consortium. The institutional evolution thus reflects a governance design in which a research authority (NARSS) under ministerial oversight coexists with delayed establishment of a legislated space agency, whilst playing an active role in continental and EU–Africa cooperation frameworks.

¹⁶The draft law to establish an Egyptian Space Agency was approved by the cabinet in August 2016; implementation timing remained unclear in the available documentary record. See (Froehlich, 2019), Egypt chapter. The corpus does not include the Egyptian Space Agency statute or EgSA founding decree; analysis relies on the pre-EgSA institutional configuration documented in Integrated Space.

¹⁷For comparative governance structures in developing country space programmes, see (Harding, 2013).

¹⁸(Froehlich, 2019), Egypt chapter.

¹⁹(AUC, 2019b).

5.2.2 Governance Architecture and Oversight

Documentary evidence permits partial reconstruction of the Egyptian space governance hierarchy. NARSS operates under the Ministry of Scientific Research, with oversight and financial support from the Ministries of State for Scientific Research and Higher Education.²⁰ No Council structure analogous to Nigeria's National Space Council is documented in the corpus; authority appears concentrated in ministerial and executive channels. Figure 5.5 illustrates the documented organisational structure of the Egyptian space sector.



Figure 5.5: The organisational structure of the Egyptian space sector illustrates the governance hierarchy under which NARSS operates (P1, P5).

Source: Egypt/EgSA submission to UN CSTD Intersessional Panel, 7 Nov 2019.

The structure in Figure 5.5 is consistent with executive-led, ministerial-dominated governance. The Egyptian Space Strategy, as referenced in NARSS documentation, articulates objectives including design and production of satellites, indigenous capabilities in space technology, establishment of human resource competences, regulation of collaboration between scientific-industrial institutions and space programmes, and utilisation of space applications for economic, social, educational, and agricultural purposes. These are strategic objectives rather than binding statutory provisions; the distinction between

²⁰(Froehlich, 2019), Egypt chapter.

formal authority and aspirational rhetoric is salient.²¹

NARSS is organised into divisions spanning Geological Applications and Mineral Resources, Agriculture Applications, Aviation and Aerial Photography, Environmental Studies and Land Use, and Space Sciences and Strategic Studies. The authority has established infrastructure including Assembly Integration and Test Facilities (AIT), special laboratories (Payload, Optics, Electric, Design, Engineering, Space Environment, Image Processing), and cooperation protocols with the General Authority for Industrial Development. Documentary evidence indicates collaboration with Egyptian universities and external institutions to improve human capital. The governance architecture thus suggests a research-focused authority with technical divisions, but the corpus does not specify statutory mechanisms for coordination across government departments, stakeholder representation on governing bodies, or budget approval procedures.²²

The draft law approving establishment of the Egyptian Space Agency (EgSA) was noted in the corpus as having been approved by cabinet in 2016, with the agency expected to improve Egypt's strategy and capacity in science, education, agriculture, and industry. Figure 5.6 illustrates the strategic goals and objectives articulated for EgSA.



Figure 5.6: EgSA strategic goals and objectives reflect the aspirational framework for Egypt's space sector post-establishment.

Source: Egypt/EgSA submission to UN CSTD Intersessional Panel, 7 Nov 2019.

The configuration in Figure 5.6 indicates strategic intent; implementation evidence was not available in the corpus. Public controversy surrounding the cost of space investment and the reputation of previous missions was documented. The relationship between NARSS and EgSA once established (funding flows, mandate overlap, hierarchical subordination) is not evidenced in the available documents. Documentary evidence

²¹The corpus does not include the full Egyptian Space Strategy text; summary objectives are reported in (Froehlich, 2019).

²²Documentary gap: no NARSS statute, decree, or organisational law was available in the corpus to confirm formal governance mechanisms.

in the corpus suggests that governance remains executive-led and ministerial-dominated, with no evidence of participatory structures such as advisory committees with formal stakeholder representation comparable to Nigeria’s Technical Advisory Committee.

5.2.3 External Partnerships and EU Interaction

Egypt’s external partnership configuration exhibits structured variation from Nigeria. Documentary evidence indicates cooperation at manufacturing, launching, and operating levels with multiple partners.²³ The Egyptian Space Strategy framework, where documented, illustrates how national objectives interface with continental and international cooperation (Figure 5.7).



Figure 5.7: The Egyptian Space Strategy framework illustrates the interface between national objectives and continental or EU cooperation initiatives.

Source: Egypt/EgSA submission to UN CSTD Intersessional Panel, 7 Nov 2019.

Figure 5.7 is consistent with Egypt’s engagement in EU–Africa and AU space cooperation whilst governance remains executive-led. For earth observation satellites: EgyptSat-1 was built jointly by NARSS and Ukraine’s Yuzhnoye Design Bureau (launched 2007);

²³(Froehlich), 2019, Egypt chapter; (Oyewole, 2020).

EgyptSat-2 by NARSS and Russian RKK Energiya (launched 2014, failed after approximately one year); EgyptSat-A built in collaboration between RKK Energiya and NARSS (launched 2019). Figure 5.8 illustrates EgyptSat-1 (2007), the first earth observation satellite in the series, built jointly with Ukraine.

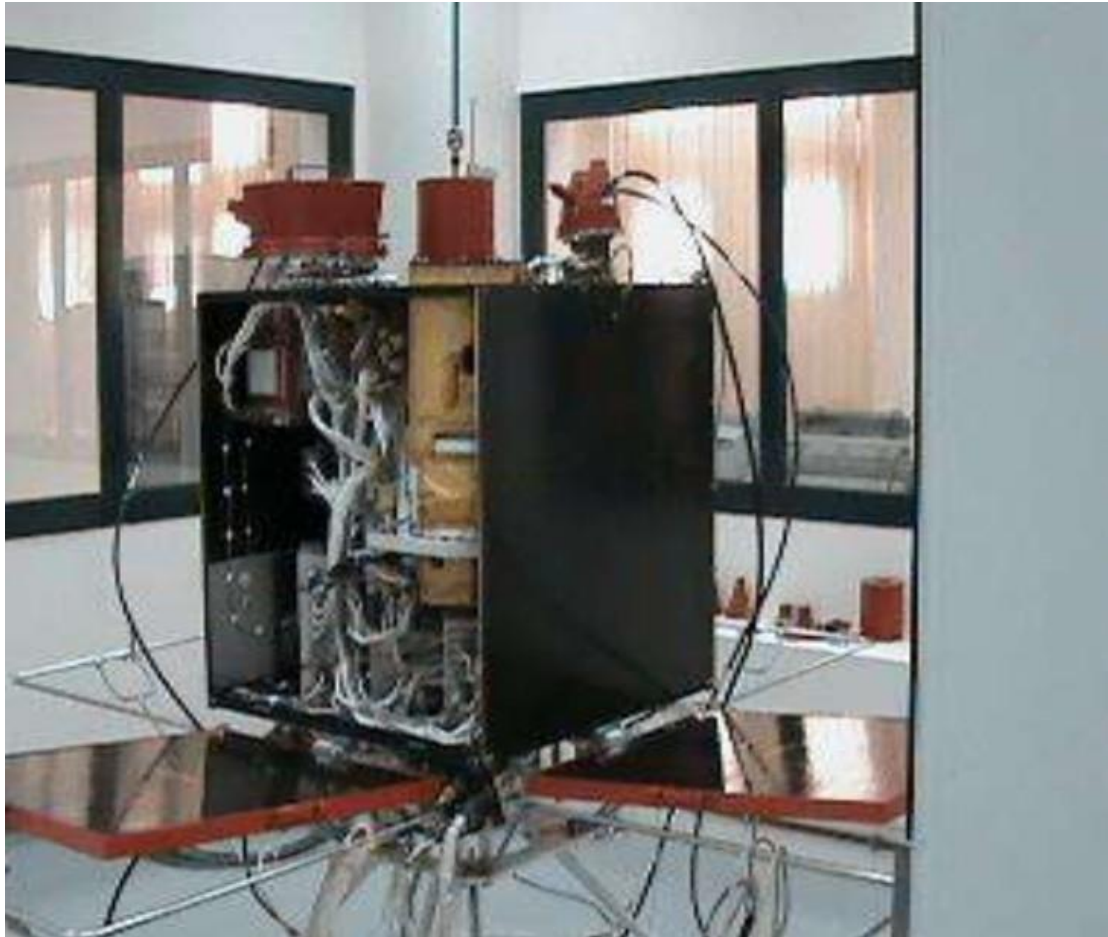


Figure 5.8: EgyptSat-1 (2007) illustrates the partnership model with Ukraine's Yuzhnoye Design Bureau (P4).

Source: Egypt/EgSA submission to UN CSTD Intersessional Panel, 7 Nov 2019.

The EgyptSat series exemplifies the dependency profile documented in the corpus. Figure 5.9 presents the experimental satellite programme spanning 2015 to 2025, illustrating the trajectory of missions and their interface with external fabrication and launch partners.

Russian media attributed EgyptSat-2 failure to ground station complications; industry sources cited human error in the flight control centre. The pattern suggested in Figures 5.8 and 5.9 is one of outsourced fabrication and launch with foreign technical reliance for both design and operations, and limited indigenous capacity to maintain or recover from failures.

For communication satellites, Egypt's position is described as closer to Western organisations: Nilesat-101, 102, and 201 were built by Matra Marconi Space and Thales

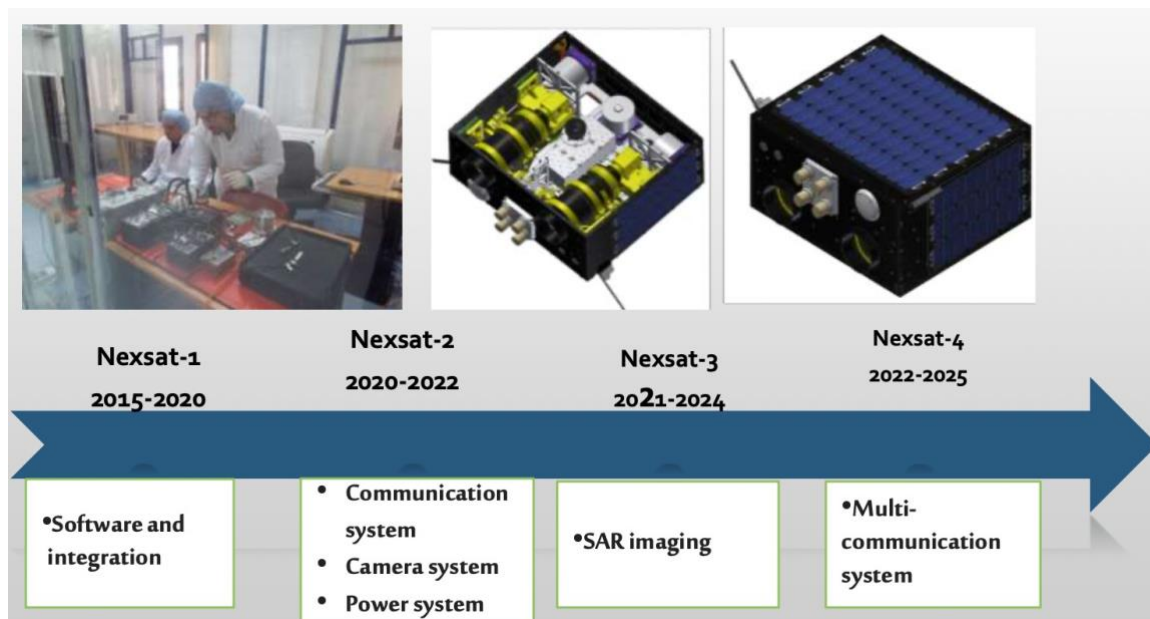


Figure 5.9: The series of experimental satellites (2015–2025) illustrates Egypt’s mission trajectory and reliance on Ukrainian and Russian partners.

Source: Egypt/EgSA submission to UN CSTD Intersessional Panel, 7 Nov 2019.

Alenia Space, with ESA involvement in launches. Nilesat receiving stations operate as commercial bases providing satellite, communication, and media broadcasting services. Control stations in Cairo and Alexandria maintain communication with satellites. The commercial segment thus exhibits a different dependency profile (European fabrication and launch) from the earth observation segment (Ukrainian and Russian).²⁴

NARSS participation in GMES & Africa places Egypt within the EU–Africa earth observation cooperation framework. The programme utilises Copernicus/Sentinel data and aims to promote local capacities and EO-based services. NARSS presented a framework for African Space Policy and Strategy at the 7th AU Space Working Group Meeting and is documented as prominent in financing development of the African Space Policy and Strategy. NARSS has participated in GMES (precursor to GMES & Africa) meetings. Regional cooperation includes the Water Information System Platform (WISP), a NASA-led initiative for water resources and agricultural management in the MENA region, with Morocco, Jordan, Lebanon, World Bank, USAID, and Arab Water Council as partners. Bilateral agreements are documented with the Italian Space Agency (COSMO-SkyMed, information and technology exchange in earth observation) and the Chinese Academy of Sciences (remote sensing applications, human capacity building, scientific information exchange, education and training).²⁵

The configuration appears consistent with asymmetrical interdependence: Egypt

²⁴Documentary evidence in the corpus does not specify IP arrangements, licensing terms, or data access provisions in these partnership agreements.

²⁵(Froehlich, 2019), Egypt chapter.

receives data, capacity-building, and technical support whilst external partners retain design authority, launch capability, and in some cases operational control. The diversity of partners (Ukraine, Russia, France, Italy, China, ESA, NASA) suggests a strategy of diversification, but each partnership embeds foreign technical reliance for core capabilities.

5.2.4 Intellectual Property, Data Sovereignty, and Technical Autonomy

Documentary evidence on IP, data ownership, and value capture in Egyptian space cooperation is limited in the corpus. No cooperation agreements, licensing clauses, or IP allocation provisions were available for direct examination. Inferences must be drawn from partnership descriptions and institutional mandates.

The Aswan Receiving Station is described as a state institution operating in parallel with satellites in orbit and providing data for industries in Egypt and for states and organisations in the region. This suggests retention of a domestic data reception capability. NARSS divisions include Image Processing Laboratory, indicating some indigenous capacity to process and exploit data. The COSMO-SkyMed agreement with Italy established a legal framework for collaboration and information exchange; the specific terms governing data ownership, licensing, or redistribution are not documented.²⁶

Platform dependence and standards adoption are not explicitly addressed in the available documents. The African Space Strategy notes that many of Africa's space-derived services and products are outsourced;²⁷ Egypt's procurement of satellites from Ukrainian, Russian, and European manufacturers, with training programmes for Egyptian personnel, suggests a model of technology transfer that may or may not include IP retention. Documentary evidence in the corpus does not permit confident assessment of whether fabrication know-how, algorithm ownership, or data rights are retained domestically or externalised. The Egyptian Space Strategy objectives include obtaining indigenous capabilities and establishing human resource competences; whether these aspirations have translated into contractual arrangements supporting local IP and value capture cannot be determined from the available documents.

5.2.5 Participatory Mechanisms and Institutional Coherence

Documentary evidence on participatory governance in the Egyptian space sector is sparse. NARSS collaborates with Egyptian universities and the General Authority for Industrial Development; cooperation protocols are documented. The authority engages with other industrial bodies to increase technical capabilities. No evidence was found in the corpus of formal stakeholder councils, end-user advisory bodies, subnational representation,

²⁶(Froehlich, 2019), Egypt chapter.

²⁷(AUC, 2019a).

or multi-ministry coordination mechanisms comparable to Nigeria's Technical Advisory Committee and Committee on International Cooperation.

The Egyptian Space Strategy objectives include regulating and enhancing collaboration between scientific-industrial institutions and space programmes within national policies and integrating user needs and databases. These are stated objectives; implementation evidence is absent. Whether ministries of agriculture, water resources, disaster management, or local government participate in priority-setting or receive space-derived services through institutionalised channels is not documented. Documentary evidence in the available corpus suggests that participatory mechanisms, if they exist, are not formalised in the same way as in Nigeria, and that institutional coherence may rely on executive coordination rather than statutory multi-stakeholder structures.²⁸

Institutional coherence at the national level is partially evidenced: NARSS serves as a single focal point for remote sensing and space sciences under the Ministry of Scientific Research. The relationship between NARSS and other space-related entities (Nilesat as commercial operator, potential EgSA) is not clarified in the corpus. Fragmentation between research (NARSS), commercial (Nilesat), and potential future agency (EgSA) structures cannot be ruled out. Coordination with continental (AU Space Working Group, African Space Policy drafting, AfSA hosting) and European (GMES & Africa) initiatives is documented.

5.2.6 Societal Diffusion of Earth Observation Services

The Egyptian Space Strategy articulates objectives to utilise space applications extensively for economic, social, educational, and agricultural purposes. NARSS divisions include Agriculture Applications, Environmental Studies and Land Use, and Geological Applications and Mineral Resources.²⁹ The Aswan Receiving Station provides data for industries in Egypt and for regional states and organisations. The Water Information System Platform (WISP) involves NARSS alongside regional partners for water resources and agricultural management through earth observation.

Documentary evidence of actual diffusion to end-users is limited. No agency reports specifying uptake by agriculture ministries, disaster response agencies, water authorities, or subnational governments were available in the corpus. The GMES & Africa Forum emphasised the need to take programmes to decision-makers and ministries to achieve results in public service;³⁰ whether NARSS has established such linkages is not evidenced. The Egypt chapter in Integrated Space notes that EgyptSat-1 connection was lost in 2010 and EgyptSat-2 failed after approximately one year, limiting the operational window for

²⁸Documentary gap: no NARSS annual reports, stakeholder engagement documentation, or inter-ministerial coordination agreements were available.

²⁹(Froehlich, 2019), Egypt chapter.

³⁰(AUC, 2019b).

service delivery. EgyptSat-A's post-launch status is not fully documented in the corpus. Documentary evidence in the available corpus suggests that diffusion objectives are stated but implementation evidence is scarce. The corpus does not include user surveys, service delivery reports, or ministerial uptake documentation. Where evidence is absent, the analysis notes the gap rather than inferring diffusion.

5.2.7 Interim Analytical Assessment

The Egyptian case permits an interim assessment against the analytical propositions (P1–P5) using measured phrasing appropriate to documentary evidence. Limitations of the corpus are acknowledged: the Egyptian Space Agency statute, EgSA founding decree, NARSS annual reports, and partnership agreements were not available; analysis relies on the Integrated Space volume, GMES & Africa documentation, and peer-reviewed literature.

P1 (Governance mediation). Documentary evidence suggests that governance design in Egypt mediates the relationship between structural technological dependency and societal impact. NARSS operates under executive decree and ministerial oversight rather than parliamentary legislation. The configuration appears consistent with a highly centralised, executive-dominated model. The absence of a legislated space agency with an independent Council during the documented period may indicate that governance concentrates authority in narrow channels. The extent to which this amplifies or dampens dependency and societal diffusion cannot be determined from documents alone; the case indicates that institutional coherence at the national level is partially evidenced through NARSS as focal point, but that participatory mechanisms and statutory safeguards are not documented.

P2 (Budget autonomy and vulnerability). The corpus does not include budget breakdowns, appropriation documents, or funding source proportions. NARSS receives support from the Ministries of State for Scientific Research and Higher Education; external partnership funding (GMES & Africa, bilateral agreements) is documented but not quantified. Egypt's ten million dollar allocation towards the African Space Agency suggests domestic fiscal capacity, but whether NARSS operations depend critically on external project funding is not evidenced. The case indicates that budget autonomy cannot be assessed from the available documents; vulnerability to external funding cycles is an open question.

P3 (Participatory governance and diffusion). Documentary evidence suggests limited participatory governance. No formal stakeholder councils, end-user advisory bodies, or multi-ministry coordination mechanisms are documented. NARSS collaborates with universities and the General Authority for Industrial Development; the Egyptian Space Strategy articulates objectives for integrating user needs. Implementation evidence

is absent. The case suggests that participatory governance, if present, is less formalised than in Nigeria, and that Proposition 3's expectation (stakeholder inclusion supports diffusion) receives limited support given the scarcity of evidence on both participation and diffusion.

P4 (Intellectual property and value capture). The corpus does not include cooperation agreements, IP clauses, or licensing terms. Partnership descriptions indicate that fabrication and launch are outsourced to Ukrainian, Russian, and European entities; training programmes for Egyptian personnel are documented. Whether IP, data rights, or value capture are retained domestically cannot be determined. The Aswan Receiving Station and NARSS processing infrastructure suggest some domestic data capacity. The configuration appears consistent with a mixed arrangement in which reception and processing capability exists alongside externalised fabrication and launch; the balance of value capture is not evidenced. The pattern of outsourced fabrication and reliance on foreign launch providers is consistent with the structural technological dependency framework outlined in Chapter 3, in which peripheral actors participate in global space value chains without full upstream control.

P5 (Institutional coherence). NARSS serves as a documented national focal point for remote sensing and space sciences, with technical divisions and infrastructure. Co-ordination with continental initiatives (AU Space Working Group, African Space Policy, AfSA hosting) and EU programmes (GMES & Africa) is evidenced. The relationship between NARSS, Nilesat (commercial), and EgSA (once established) is not clarified; potential fragmentation cannot be ruled out. The case indicates that institutional coherence is partially present at the NARSS level, with active continental and EU engagement, but that full coherence across the space sector depends on arrangements not documented in the corpus.

In sum, the Egyptian case presents a governance configuration characterised by executive-led ministerial oversight, absence of legislated space agency during the documented period, NARSS as primary implementing body, diverse external partnerships (Ukraine, Russia, France, Italy, China, ESA, NASA), and participation in GMES & Africa. Documentary evidence suggests that participatory mechanisms and IP/value capture arrangements are not adequately documented to assess P3 and P4. Evidence of societal diffusion is limited. The configuration appears consistent with a centralised governance design that interfaces with continental and EU cooperation, whilst key dimensions (budget autonomy, participatory governance, IP arrangements, diffusion) remain under-documented relative to the Nigeria case.

5.3 South Africa

5.3.1 Institutional Evolution of SANSA

The South African National Space Agency (SANSA) was established by the South African National Space Agency Act (Act No. 36 of 2008), promulgated following cabinet approval in 2008.³¹ The Act provides for the establishment of SANSA and mandates it to promote and use space, foster cooperation in space-related activities, advance research in space science, and support the creation of an environment conducive to industrial development in space technologies within the framework of national government policy. This statutory basis differs from both Nigeria and Egypt: Nigeria established NASRDA by parliamentary Act in 1999 (amended 2010); Egypt operated through NARSS under executive decree without a dedicated space agency law during the documented period. South Africa thus presents the clearest statutory foundation among the three cases, with SANSA established as a Schedule 3A public entity under the Public Finance Management Act (PFMA) and governed by the Department of Science and Innovation (DSI).³²

The National Space Policy (2009) and National Space Strategy (2008) preceded and informed SANSA's establishment.³³ The Policy states that the Department of Science and Technology (DST, now DSI) is the lead department for implementation of the National Space Programme, under which the national space agency resides. The DTI (Department of Trade, Industry and Competition) leads on policy and regulatory aspects, bilateral and multilateral agreements, and development of a Space Industrial Framework. The Space Affairs Act (No. 84 of 1993) provides the regulatory framework for space activities. This multi-departmental structure requires coordination; the Policy emphasises inter-departmental fora, focal points in government department clusters, and cooperative governance to optimise use of resources and deliver benefits of space capabilities to the nation. Documentary evidence suggests that SANSA's institutional formation was designed with explicit attention to coordination across the space arena, linking the agency to national development priorities and stakeholder inclusion.³⁴

SANSA operates five programmes: Administration, Earth Observation, Space Science, Space Operations, and Space Engineering. The organisational structure includes a CEO, Board, Executive Committee, and Managing Directors for each programme. The Board is appointed by the Minister of Science and Innovation (Executive Authority) for terms not exceeding four years, with eligibility for re-appointment. Section 9 of the SANSA

³¹(Harding, 2013); (Froehlich, 2019), South Africa chapter; (Kwet, 2022). For comparative analysis of South African unitary space legislation and the Space Affairs Act framework, see (Arora and Gambardella, 1994).

³²(Kwet, 2022).

³³(Republic of South Africa, 2020); (Harvey, 2013).

³⁴The Policy states that space-derived data procured by any sphere of government or agency shall be made available through a multi-government licence to government departments, agencies, and publicly-funded research and educational institutions. (Republic of South Africa, 2020).

Act stipulates the Board's functions: overseeing the Agency, monitoring research priorities, and ensuring compliance with the Act and PFMA.³⁵ The configuration indicates a formalised governance hierarchy with clear lines of accountability to the Executive Authority, statutory oversight mechanisms, and programme-based structure that supports institutional coherence. The institutional evolution thus reflects a governance design in which parliamentary legislation, ministerial oversight, and structured programmes combine to create a more robust institutional framework than documented for Nigeria or Egypt. Documentary evidence of SANSA's achievements in implementing this mandate is summarised in Figures 5.10 and 5.11. The SANSA Revised Strategic Plan 2020/25 identified nine outcome indicators; seven of the five-year targets were achieved and two were not. The achievement tables in Figures 5.10 and 5.11 reflect performance against those outcome indicators.

The achievements documented in Figure 5.10 indicate that SANSA has delivered against its mandate across earth observation, space science, and operational domains. A second summary of achievements extends this picture.

Figures 5.10 and 5.11 together illustrate the institutional coherence and diffusion capacity that distinguish the South African case. This configuration is consistent with the theoretical expectation that governance design mediates how structural dependency translates into societal impact.

5.3.2 Governance Architecture and Oversight

The SANSA Act and Annual Reports permit detailed reconstruction of the governance architecture. In the available corpus, SANSA's public annual reporting and disclosure practices suggest greater documentary availability and transparency than documented for Nigeria or Egypt, supporting more confident assessment of governance and diffusion. SANSA is a Schedule 3A public entity; the Minister of Science and Innovation is the Executive Authority with power to appoint and dismiss the Board. The Board constitutes the Accounting Authority and is responsible for oversight of the Agency's functions, monitoring of research priorities, and adherence to the SANSA Act and PFMA. Board committees include Audit and Risk, and the Board Secretary supports governance compliance. The Science and Technology Laws Amendment Act (No. 9 of 2020) amended establishment legislation of several DSI public entities including SANSA to harmonise governance arrangements of accounting authorities.³⁶ Figure 5.12 illustrates the organisational structure documented in the Annual Report.

The structure in Figure 5.12 indicates formalised internal coherence, with Managing Directors for each programme and Executive Committee oversight. Revenue and funding

³⁵(26).

³⁶(26).

OUTCOME	OUTCOME INDICATOR	BASELINE	2024/25 TARGET	ACTUAL ACHIEVEMENT AS AT 31 MARCH 2025	REASONS FOR DEVIATION	CORRECTIVE ACTION TO BE TAKEN IN THE NEXT PLANNING CYCLE
MTSF 2019-2024: Priority 2 – Economic transformation and job creation						
Outcome 1: Increased space-relevant knowledge that supports the developmental agenda	O1.1. Average research publication rate for South African researchers in direct space-related areas	New outcome indicator	Average annual research publication rate of 3 for South African researchers in direct space-related areas	11	The overachievement in the average annual research publication rate was due to increased cooperation with academic institutions, targeted research funding, and a strategic focus on producing high-impact space research	No corrective action required
MTSF 2019-2024: Priority 2 – Economic transformation and job creation						
Outcome 2: Stimulated and growing, inclusive space sector	O2.1. Average operational expenditure spend on SMEs	New indicator	Lower target: 20% Desired target: 30% Upper target: 40%	42%	A purposeful procurement strategy that prioritised inclusive sourcing and initiatives to promote local economic participation in accordance with national development priorities.	No corrective action required
MTSF 2019-2024: Priority 3 – Education, Skills, and Health						
Outcome 3: Increased human capacity for the implementation of key space initiatives	O3.1. Percentage of graduated students to registered students in postgraduate space-related fields nationally	New indicator	Up to 20% of all registered (in space-related fields) postgraduate students graduate with space-related degrees	29%	Focused academic support programme.	No corrective action required
	O3.2. Percentage students and interns mentored by SANSA absorbed by the formal labour market	New indicator	Up to 50% of all students and interns mentored by SANSA absorbed by the formal labour market	73%	The growing demand for space science and technology skills, enhanced mentorship quality, and strengthened partnerships with industry, improved the employability of programme participants.	No corrective action required

Figure 5.10: SANSA achievements (Table 1) illustrate institutional output under its statutory mandate (P5).

Source: SANSA Annual Report 2024/2025.

arrangements are documented in the Annual Report; Figure 5.13 illustrates the revenue structure relevant to budget autonomy (P2).

Figure 5.13 is consistent with the documented framework of domestic parliamentary appropriations. SANSA receives transfers from the Department of Science and Innovation for administrative functions and ring-fenced transfers for various projects. The 2022/23 Annual Report documents funding from DSI and the National Research Foundation.³⁷ The corpus does not specify the proportion of core administrative funding versus project-based transfers, but the framework of parliamentary appropriations, DSI as line department, and PFMA compliance suggests a budget structure more reliant on domestic appropriations than on external donor cycles. Documentary evidence indicates

³⁷(Kwet, 2022).

that SANSA has pursued a new business model to enhance sustainability; the Board has maintained governance oversight during this process. Budget constraints and delays with the Space Infrastructure Hub (SIH) and Assembly Integration and Testing (AIT) facility upgrades are documented, suggesting that domestic funding levels affect implementation tempo.³⁸

The National Space Policy mandates inter-departmental coordination and establishment of focal points in government department clusters. The Policy promotes utilisation of space-derived data through multi-government licences, facilitating access for government departments, agencies, and publicly-funded institutions. This formal provision for data sharing and cross-government coordination is not documented in equivalent form for Nigeria or Egypt. The governance architecture thus suggests stronger institutional coherence through statutory coordination mechanisms, Board oversight, and explicit policy linkages to national development frameworks (National Development Plan, Decadal Plan on STI, Economic Reconstruction and Recovery Plan).³⁹

5.3.3 External Partnerships and EU Interaction

South Africa participates in GMES & Africa as part of the Southern Africa consortium. The GMES & Africa Forum Report notes that SANSA has a network of Automatic Weather Stations for near real-time data offered free of charge, positioning SANSA as a service provider within the programme.⁴⁰ SANSA personnel (Oupa Malahlela, Dr Paidamwoyo Mhangara) are listed as participants. The Annual Report documents strategic collaborations with national stakeholders and regional and international partners, including NASA (Deep Space Network partnership at Matjiesfontein), Digital Earth Africa (DEA), and the Space Infrastructure Hub. BRICS space cooperation is documented.⁴¹

The dependency profile is mixed. Launch dependence persists: South African satellites (SumbandilaSAT, ZACUBE-1, ZACUBE-2) have been launched from Baikonur (Kazakhstan/Russia) and other external facilities. The Integrated Space volume notes that SumbandilaSAT was financed by the South African government and owned by the DST but built with industry partnership; it is no longer operational.⁴² The African Resource Management Constellation (ARM-C) partnership with Nigeria, Algeria, and Kenya involves each country developing an earth observation satellite; South Africa's EOS-1 has been in development. Fabrication and launch thus remain partly externalised. At the same time, SANSA operates ground infrastructure (Hartebeesthoek, Hermanus Space Weather Centre, Matjiesfontein Deep Space Network site), holds facilities for satellite

³⁸(Kwet, 2022).

³⁹(Kwet, 2022); (Republic of South Africa, 2020).

⁴⁰(AUC, 2019b).

⁴¹(Kwet, 2022).

⁴²(Froehlich, 2019), South Africa chapter.

assembly and testing, and delivers EO services using Sentinel data. The configuration suggests that governance design has supported development of indigenous integration capability (ground stations, processing, service delivery) whilst launch and upstream fabrication remain dependent on external providers. The GMES & Africa participation and access to Copernicus/Sentinel data illustrate EU–Africa cooperation; SANSA’s ability to process and disseminate data, and to offer Automatic Weather Station networks, indicates a higher level of domestic integration capacity than advanced for Nigeria or Egypt in the available documentation.⁴³

5.3.4 Intellectual Property, Data Sovereignty, and Technical Autonomy

The National Space Policy establishes that all space-derived data procured by any sphere of government or agency shall be made available through a multi-government licence to government departments, agencies, and publicly-funded research and educational institutions. This formal data policy supports domestic retention and diffusion of value from space data.⁴⁴ The Policy also promotes development of applications involving the merging of space and non-space data sources to maximise benefits. Documentary evidence suggests that South Africa has adopted a data governance framework that facilitates access and reuse, in contrast to arrangements where data access may be restricted by licensing or commercial terms. Domestic ownership of ground infrastructure underpins this data governance framework; Figure 5.14 illustrates SANSA’s ground receiving stations.

The ground infrastructure documented in Figure 5.14 (Hartebeesthoek, Hermanus, Matjiesfontein) indicates that governance design has supported development of indigenous reception and processing capability. The Digital Earth South Africa (DESA) platform, launched in beta form in October 2022, provides access to catalogues of satellite data from a portfolio of satellites for the benefit of policy-makers in government and for local industry development. SANSA partnered with industry to provide monthly surface water area and dam water volume data; the water monitoring product uses Sentinel 1 and 2 imagery. The EO4WQ (Earth Observation for Water Quality) tool development is documented.⁴⁵ These initiatives suggest retention of data processing and application development capability domestically, with use of open-access Sentinel data under Copernicus licensing. Platform standards adoption (Sentinel data formats) is evidenced; whether SANSA maintains proprietary processing capabilities or relies on external platforms is not fully specified in the corpus.

Revenue generation is documented: SANSA received funding from DSI and NRF;

⁴³(Kganyago and Mhangara, 2019) discuss SANSA’s role in EO capacity-building and links to AU Agenda 2063.

⁴⁴(Republic of South Africa, 2020).

⁴⁵(Kwet, 2022).

stakeholder satisfaction with products is reported. A new business model has been proposed to enhance sustainability. The corpus does not include detailed IP clauses from partnership agreements; the data policy and DESA platform suggest a framework oriented towards domestic value capture and diffusion rather than externalised data governance.

5.3.5 Participatory Mechanisms and Institutional Coherence

The National Space Policy mandates inter-departmental fora, focal points in government department clusters, and co-operative governance. The Policy encourages greater inter-disciplinary co-operation among public sector institutions and establishment of criteria for implementing the National Space Programme through stakeholder involvement. The DTI monitors and evaluates policy implementation.⁴⁶ Documentary evidence suggests a more formalised participatory framework than documented for Nigeria or Egypt.

The SANSA Annual Report documents stakeholder engagement: 270 stakeholders, clients, and government officials joined a SANSA event; targeted stakeholder engagement days for communities near the Hermanus facility; engagement with defence, education, and contractor stakeholders. The DESA platform was developed with user co-design to facilitate engagement with policy-makers and industry. Training was delivered to diverse teams from disaster management, infrastructure support, and spatial planning; the training attracted participants from multiple sectors.⁴⁷ The National Earth Observation and Space Secretariat (NEOSS) and linkages to the Department of Water and Sanitation, research institutions, and universities are documented. The configuration suggests institutionalised mechanisms linking SANSA to end-users in government, disaster management, and spatial planning, with evidence of multi-stakeholder participation in training and platform development.

Institutional coherence is strengthened by alignment with the National Development Plan, Decadal Plan on STI, White Paper on Science Technology and Innovation, and Economic Reconstruction and Recovery Plan. SANSA's five-programme structure (Administration, Earth Observation, Space Science, Space Operations, Space Engineering) creates clear internal coherence. The relationship between SANSA and the DTI (regulatory), DSI (implementation), and other departments is specified in the Policy. Documentary evidence suggests that South Africa presents the strongest institutional coherence among the three cases, with statutory coordination, participatory mechanisms, and alignment to national development frameworks.

⁴⁶(Republic of South Africa, 2020).

⁴⁷(KWET, 2022).

5.3.6 Societal Diffusion of Earth Observation Services

Documentary evidence of societal diffusion is more substantial for South Africa than for Nigeria or Egypt. The Annual Report documents support to the Mzansi Manzi project and the Digital Earth South Africa (DESA) platform, providing access to satellite data catalogues for policy-makers and local industry. The DESA platform facilitates user co-design and allows access to data for government and industry users.⁴⁸

Water resource management: SANSA provides monthly surface water area and dam water volume data for water bodies across South Africa, using Sentinel 1 and 2 imagery. The Department of Water and Sanitation is documented as a user. A web-based decision support platform provides access for governmental and private users. More stakeholders are now using the data, including government departments, research institutions, and universities.⁴⁹

Disaster management: SANSA supported flood disaster management during the KwaZulu-Natal floods and the Jagersfontein mine dam collapse in the Free State (September 2022). Data was analysed by SANSA to map the extent of damage, support post-flooding disaster quantification, and estimate overall damage. The training attracted teams from disaster management, infrastructure support, and spatial planning. Schools were engaged on natural and man-made disasters in the context of the Sendai Framework on Disaster Risk Reduction.⁵⁰

The National Space Strategy identifies application areas including food security, water resource management, integrated spatial planning and land reform, disaster management, peace and security, oceans economy, and global change.⁵¹ Documentary evidence suggests diffusion into water management, disaster response, and public administration (Department of Water and Sanitation, spatial planning, disaster management agencies). Evidence of agricultural diffusion is less direct; the EO4WQ tool for water quality may support agricultural water management. The configuration indicates stronger documented societal diffusion than Nigeria or Egypt, consistent with the theoretical expectation that governance design mediating participatory mechanisms and institutional coherence supports diffusion of space-derived benefits.

5.3.7 Interim Analytical Assessment

The South African case permits an interim assessment against the analytical propositions (P1–P5). South Africa is positioned as the strongest case on institutional coherence, participatory governance, and documented societal diffusion among the three cases, whilst

⁴⁸(Kwet, 2022).

⁴⁹(Kwet, 2022).

⁵⁰(Kwet, 2022).

⁵¹(Kwet, 2022).

retaining a mixed dependency profile.

P1 (Governance mediation). Documentary evidence suggests that governance design in South Africa mediates the relationship between structural technological dependency and societal impact. The SANSA Act establishes a statutory agency with Board oversight, ministerial accountability, and five-programme structure. The National Space Policy mandates inter-departmental coordination, data sharing through multi-government licences, and co-operative governance. The configuration appears consistent with a model in which governance creates coherent focal points, formal participatory mechanisms, and linkages to national development priorities. The case indicates that governance design can mitigate (though not eliminate) structural dependency by supporting indigenous integration capability, ground infrastructure ownership, and diffusion channels to end-users. The extent to which this mediation amplifies societal impact is supported by diffusion evidence documented in the Annual Report.

P2 (Budget autonomy and vulnerability). SANSA receives transfers from the Department of Science and Innovation and the National Research Foundation. The framework is one of domestic parliamentary appropriations through the DSI rather than project-based external grants. Budget constraints are documented (delays to SIH and AIT); the Agency achieved 85 per cent performance against targets despite challenges. The case indicates that budget autonomy is relatively stronger than in Nigeria or Egypt: funding flows through the national fiscus and line department, suggesting lower vulnerability to external funding cycles. The pursuit of a new business model for sustainability suggests awareness of resource constraints but does not imply dependence on external project funding for core operations.

P3 (Participatory governance and diffusion). Documentary evidence suggests more formalised participatory governance than in Nigeria or Egypt. The National Space Policy mandates inter-departmental fora and focal points; the multi-government licence for data facilitates access across government and research institutions. The Annual Report documents stakeholder engagement (270 participants, targeted engagement days, user co-design of DESA), training for disaster management and spatial planning teams, and linkages to the Department of Water and Sanitation and universities. The case indicates that Proposition 3 (participatory governance supports diffusion) receives support: institutionalised stakeholder mechanisms coexist with documented diffusion to water management, disaster response, and public administration.

P4 (Intellectual property and value capture). The National Space Policy establishes that space-derived data procured by government shall be made available through multi-government licence to domestic users. The DESA platform, water monitoring products, and EO4WQ development suggest retention of data processing and application development capability. SANSA uses Sentinel data (open access under Copernicus); value capture occurs through domestic processing, platform development, and service delivery.

Launch and fabrication remain externalised; the balance of value capture tilts towards domestic retention for downstream applications relative to Nigeria or Egypt.

P5 (Institutional coherence). The case indicates the strongest institutional coherence among the three cases. The SANSA Act provides clear statutory foundation; the Board structure ensures oversight; the five-programme structure creates internal coherence; the Policy specifies coordination with DTI, DSI, Treasury, and other departments; alignment with National Development Plan, Decadal Plan, and ERRP is documented. SANSA serves as the national focal point with defined relationships to regulatory (DTI) and implementation (DSI) functions. Coordination with continental (AU, GMES & Africa) and international (NASA, BRICS, Digital Earth Africa) programmes is evidenced. The configuration supports the analytical role of South Africa as the strongest case on institutional coherence.

In sum, the South African case presents a governance configuration characterised by statutory agency establishment, Board oversight, ministerial accountability, domestic appropriations framework, formalised participatory mechanisms, multi-government data licensing, and documented diffusion to water management, disaster response, and public administration. Documentary evidence suggests that governance design mediates structural technological dependency by supporting indigenous integration capability and diffusion channels, whilst launch dependence and upstream fabrication reliance persist. The configuration is consistent with a mixed dependency profile in which governance mitigates but does not eliminate structural technological dependency. South Africa exhibits stronger institutional coherence, more formalised participatory governance, clearer domestic integration capacity, and stronger documented societal diffusion than Nigeria or Egypt, consistent with the theoretical proposition that governance design mediates how structural dependency translates into societal impact.

5.4 Cross-Case Comparative Synthesis

The three cases exhibit distinct governance typologies that shape how structural technological dependency is mediated at the national level.⁵² Comparative analysis suggests that institutional design varies systematically across Nigeria, Egypt, and South Africa, with implications for Proposition 1 (governance mediation), Proposition 3 (participatory governance and diffusion), and Proposition 5 (institutional coherence).

⁵²The typology is heuristic rather than exhaustive; other African space programmes (e.g. Kenya, Algeria) may exhibit different configurations. The three-case comparison permits structured variation along the dimensions identified in Chapter 3.

5.4.1 Governance Typology

Nigeria presents a ministerial statutory model. The NASRDA Act 2010 establishes a body corporate with perpetual succession and vests centralised authority in a Council dominated by ex officio ministerial representatives, with the President as Chairman. The agency is designated as the repository of all satellite data over Nigeria's territory and as the single focal point for international cooperation. Participatory mechanisms exist in the form of the Technical Advisory Committee and Committee on International Cooperation, but these bodies provide advisory rather than decision-making functions; the Ministry of Science and Technology provides the secretariat for the National Space Council. This configuration indicates statutory authority concentrated in a narrow executive hierarchy, with formal stakeholder inclusion limited to an advisory role.⁵³ The typology is consistent with Proposition 1: governance design mediates dependency through a centralised national structure. It aligns with Proposition 5 in that institutional coherence is present at the national level (a defined focal point, six development centres, linkage to development priorities), though Proposition 3 receives qualified support given the advisory rather than decisive nature of participatory mechanisms.

Egypt exhibits an executive-centralised strategic model. NARSS operates under presidential decree and ministerial oversight rather than parliamentary legislation. No Council structure analogous to Nigeria's National Space Council is documented in the corpus; authority appears concentrated in ministerial and executive channels. The draft law to establish an Egyptian Space Agency was approved by cabinet in 2016, but the timing of implementation and the relationship between NARSS and EgSA once operational were not evidenced in the available documents.⁵⁴ NARSS serves as partial focal point for remote sensing and space sciences within the Northern Africa consortium of GMES & Africa. The absence of legislated agency status during the documented period distinguishes Egypt from both Nigeria and South Africa. Documentary evidence suggests that participatory mechanisms, if they exist, are not formalised in the same way as in Nigeria. The typology indicates that governance concentrates authority in executive channels. Proposition 1 receives support in that the configuration appears consistent with a highly centralised model; Proposition 3 receives limited support given the scarcity of evidence on both participation and diffusion; Proposition 5 receives partial support in that NARSS functions as a focal point but potential fragmentation between NARSS, Nilesat, and EgSA cannot be ruled out.

South Africa presents a board-based semi-participatory model. The SANSA Act

⁵³The distinction between advisory and decision-making participation is consequential for diffusion: advisory bodies may influence discourse but cannot allocate resources or mandate cross-government data sharing. See (Harding, 2013) on governance structures in emerging space programmes.

⁵⁴The Egypt case is characterised by documentary gaps relative to Nigeria and South Africa; interpretation should therefore be cautious. The absence of NARSS statute, EgSA founding decree, and annual reports constrains confident assessment of governance mechanisms.

establishes a statutory agency as a Schedule 3A public entity under the PFMA, governed by a Board appointed by the Minister of Science and Innovation. The Board constitutes the Accounting Authority with oversight of agency functions and PFMA compliance. The National Space Policy mandates inter-departmental fora, focal points in government department clusters, and co-operative governance. Critically, the Policy specifies that space-derived data procured by any sphere of government or agency shall be made available through a multi-government licence to government departments, agencies, and publicly-funded research and educational institutions. This formal provision for cross-government coordination and data sharing is not documented in equivalent form for Nigeria or Egypt.⁵⁵ The typology indicates statutory agency establishment with Board oversight, formalised participatory mechanisms, and explicit policy linkages to national development frameworks. Proposition 1 receives strong support: governance design appears to mitigate structural dependency by supporting indigenous integration capability and diffusion channels. Proposition 3 receives support through documented stakeholder engagement, user co-design of the DESA platform, and institutionalised linkages to end-users. Proposition 5 receives strong support through clear statutory foundation, five-programme structure, and alignment with National Development Plan and Decadal Plan.

The three typologies thus vary along dimensions of statutory foundation, participatory formality, and coordination mechanisms. Nigeria combines statutory authority with advisory participation; Egypt exhibits executive-led governance with delayed legislated agency formation; South Africa combines statutory agency status with the most formalised participatory and inter-departmental coordination structures among the three cases. Breccia et al. distinguish between institutional and normative governance of space activities, with the latter encompassing national legislation, space agencies, and policies; their analysis of unitary law in South Africa and Nigeria supports the comparative typology advanced here ([Arora and Gambardella, 1994](#)).⁵⁶

5.4.2 Dependency Pathways

Technological dependency manifests along multiple pathways across the three cases.⁵⁷ Comparative analysis indicates variation in infrastructure dependence, maintenance and technical reliance, standards alignment, and external funding exposure, with implications

⁵⁵The multi-government licence represents a design choice that lowers transaction costs for non-space sectors to access data; it may thus function as an institutional channel linking space agency outputs to end-user ministries.

⁵⁶Unitary law here denotes comprehensive national space legislation rather than sectoral or decree-based regulation. The contrast with Egypt's decree-led NARSS underscores the analytical salience of statutory foundation.

⁵⁷These pathways operationalise the three dimensions of technological dependency defined in Chapter 3: outsourced maintenance, foreign technical reliance, and limited domestic integration capability. The comparative lens reveals that the balance among them varies by case.

for Proposition 2 and the postcolonial political economy framing of structural constraints. Infrastructure dependence on launch and upstream fabrication is documented in all three cases. Nigeria relies on SSTL and China for satellite fabrication and on Russian (Yasny) and Chinese facilities for launch; NigComSat-1R was procured through a replacement contract with the Chinese government following in-orbit failure. Egypt's EgyptSat series was built jointly with Ukraine's Yuzhnoye Design Bureau and Russia's RKK Energiya; launches occurred from external facilities; EgyptSat-2 failed after approximately one year, with Russian media attributing the failure to ground station complications. South Africa has launched SumbandilaSAT, ZACUBE-1, and ZACUBE-2 from Baikonur and other external facilities; the ARM-C partnership envisages indigenous development but fabrication and launch remain partly externalised. The pattern is consistent with the postcolonial political economy thesis: upstream segments of the space value chain (design, fabrication, launch) remain concentrated with external partners, whilst African actors participate as recipients or junior collaborators.⁵⁸

Maintenance and technical reliance vary in documentation depth. Nigeria's NigComSat-1 failure and replacement through external contract, and the appointment of DMC International Imaging to market imagery outside Africa, suggest outsourced maintenance and limited indigenous failure recovery capability. EgyptSat-2 failure and the absence of documented indigenous recovery capacity indicate similar constraints. South Africa operates ground infrastructure (Hartebeesthoek, Hermanus, Matjiesfontein) and delivers EO services using Sentinel data; the configuration suggests stronger domestic integration capability for operations and ground segment management. Nigeria and Egypt retain domestic ground receiving stations (NASRDA for NigeriaSat-2 and NigeriaSat-X; Aswan Receiving Station for Egypt), supporting data reception at the national level. The balance between domestic reception capability and externalised launch and fabrication appears consistent across cases, with South Africa exhibiting more extensively documented operational integration.⁵⁹

Standards alignment with Sentinel and Copernicus formats is evidenced where programmes engage with GMES & Africa. All three cases participate in the programme; Nigeria and Egypt as implementing partners within regional consortia, South Africa as a service provider offering Automatic Weather Station networks. South Africa's use of Sentinel 1 and 2 imagery for water monitoring and the DESA platform indicates adoption of Copernicus data standards. The National Space Policy in South Africa establishes a formal framework for multi-government data licensing. Nigeria and Egypt do not provide equivalent documentary evidence of national data policies governing standards alignment

⁵⁸World-systems theory would characterise this as core-periphery integration; the African Space Strategy's acknowledgement that many services are outsourced (AUC, 2019a) reflects this structural condition.

⁵⁹Domestic ground stations enable data reception and thus partial retention of downstream value; they do not, however, substitute for upstream design and fabrication capability. The configuration illustrates that dependency is multi-dimensional rather than binary.

or cross-government access; the NASRDA Act designates the agency as repository of data over Nigeria's territory but does not specify licensing or standards provisions.

External funding exposure is unevenly documented. The NASRDA Act specifies that the Agency's fund shall receive allocations from the Federal Government budget and foreign aid from bilateral and multilateral agencies; the policy document does not quantify the mix. Egypt's allocation of ten million dollars towards the African Space Agency suggests domestic fiscal capacity, but NARSS funding proportions are not evidenced. South Africa presents the most documented budget structure: SANSA receives transfers from the Department of Science and Innovation and the National Research Foundation, with a framework of domestic parliamentary appropriations through the line department. Proposition 2 (budget autonomy and vulnerability) receives the strongest support in the South African case, where domestic appropriations suggest lower vulnerability to external funding cycles; assessment for Nigeria and Egypt remains qualified by documentary gaps.⁶⁰

5.4.3 Diffusion Pathways

The mechanisms and constraints governing diffusion of space-derived benefits to society vary across the three cases. Comparative analysis of agricultural integration, capacity-building modalities, institutional transparency, and end-user inclusion indicates that South Africa exhibits more extensively documented diffusion pathways, whilst Nigeria and Egypt present partial or sparse evidence. The patterns bear on Proposition 3 and Proposition 5, and on the multi-level coordination pillar.⁶¹

Agricultural integration is articulated as an objective in all three cases. Nigeria's National Space Policy envisages crop performance assessment and yield prediction; NARSS includes an Agriculture Applications division; South Africa's National Space Strategy identifies food security as an application area. Documentary evidence of actual uptake by agriculture ministries, extension services, or farmers is strongest for South Africa, where water monitoring products using Sentinel imagery support the Department of Water and Sanitation and where the EO4WQ tool may support agricultural water management. For Nigeria, the IMSD framework describes dissemination to stakeholders but implementation evidence is limited; GeoApps Plus offers commercial training. For Egypt, the corpus does not include evidence of institutionalised linkages between NARSS and agriculture ministries; the WISP platform involves water and agricultural management but documentation of end-user uptake is absent. The agricultural diffusion pathway thus remains

⁶⁰On the relationship between funding models and sustainability in emerging space agencies, see (Adams, 2021). The absence of quantified budget breakdowns in the Nigeria and Egypt corpus limits comparative assessment.

⁶¹Diffusion is here understood as the spread of space-derived benefits beyond the space sector to end-users; the concept is defined in Chapter 3. Evidence of diffusion is necessarily partial when relying on documentary sources, as uptake by farmers or local officials may be under-documented.

most extensively documented in South Africa; evidence for Nigeria is partial; evidence for Egypt is weak or absent.

Capacity-building modalities vary. Nigeria hosts the Centre for Space Science and Technology Education at Ile-Ife as the African Regional Centre for Space Science and Technology Education (ARCSSTEE), a UN-affiliated capacity development programme. South Africa documents training for disaster management, infrastructure support, and spatial planning teams; the DESA platform was developed with user co-design. Egypt's collaboration with universities and the General Authority for Industrial Development, and training programmes for Egyptian personnel in partnership agreements, are documented but the corpus does not specify the structure or scale of capacity-building interventions. GMES & Africa provides a common framework for training and capacity development across all three cases; the GMES & Africa Forum emphasised the need to take programmes to decision-makers and ministries. The multi-level coordination pillar directs attention to how continental programme design interfaces with national implementation: where national governance creates formal channels for end-user engagement, capacity-building may translate into diffusion; where such channels are weak, training may remain confined to space sector personnel.⁶²

Institutional transparency, as evidenced by availability of annual reports and documented service delivery, differs markedly. South Africa's SANSA Annual Report documents achievements, stakeholder engagement, revenue structure, and diffusion to water management and disaster response. Nigeria and Egypt do not provide equivalent publicly available annual reports in the corpus. The absence of NARSS annual reports, stakeholder engagement documentation, or inter-ministerial coordination agreements for Egypt constitutes a documentary gap that constrains assessment. Transparency appears consistent with institutional coherence (Proposition 5): South Africa's more formalised governance and PFMA compliance produce documented outputs that support evaluation of diffusion; the same cannot be said for Nigeria or Egypt with the available evidence.⁶³ End-user inclusion through formal fora, co-design, and inter-ministerial mechanisms is most formalised in South Africa. The National Space Policy mandates inter-departmental fora and focal points; the multi-government licence facilitates access across government and research institutions; the Annual Report documents engagement with the Department of Water and Sanitation, disaster management agencies, and spatial planning teams. Nigeria's Technical Advisory Committee and Committee on International Cooperation provide advisory channels; the extent of end-user participation in priority-setting or service

⁶²This interpretation aligns with the GMES & Africa programme aim to promote development of local capacities and exploitation of EO-based services; see (Lavaysse et al.) on user engagement with programme tools.

⁶³Annual reporting requirements for South African public entities under the PFMA create an institutionalised documentation stream; the absence of equivalent requirements elsewhere does not necessarily imply weaker diffusion, but it constrains comparative assessment.

delivery is not documented. Egypt exhibits no equivalent formal structures in the corpus. Proposition 3 (participatory governance and diffusion) receives the strongest support in South Africa, where institutionalised stakeholder mechanisms coexist with documented diffusion; the Nigeria and Egypt cases suggest that advisory or absent participatory structures may limit diffusion, though the causal claim cannot be asserted from documentary evidence alone.⁶⁴

5.4.4 Mixed Outcomes

EU–Africa space cooperation can increase both autonomy and dependency simultaneously.⁶⁵ The three cases illustrate concrete mixed-outcome patterns that resist binary characterisation. These patterns bear on Proposition 1 (governance mediation) and Proposition 4 (intellectual property and value capture), and align with the complex interdependence thesis that asymmetry coexists with mutual gains under certain institutional conditions.

First, access to open Copernicus data expands domestic applications whilst entrenching reliance on EU standards and infrastructure. South Africa’s use of Sentinel 1 and 2 imagery for water monitoring, disaster response, and the DESA platform demonstrates that open data policies create opportunities for African users to access imagery with- out prohibitive costs. At the same time, adoption of Copernicus formats and platforms positions domestic applications within a technical ecosystem designed and controlled by the EU. Nigeria and Egypt similarly participate in GMES & Africa and thus benefit from Sentinel data access; the extent of domestic processing and application development varies. The pattern suggests that institutional design mediates the balance: South Africa’s multi-government licence and domestic processing capability support value capture through local platforms (DESA, EO4WQ), whilst dependence on EU data provision and standards persists.⁶⁶

Second, capacity-building increases integration capability whilst upstream fabrication and launch remain externalised. Nigeria’s collaboration with SSTL enabled Nigerian engineers to contribute to NigeriaSat-X fabrication; the Centre for Satellite Technology Development and ARCSSTEE support indigenous training. South Africa’s ground infrastructure,

⁶⁴Proposition 3 posits that participatory governance supports diffusion; the comparative gradient (South Africa > Nigeria > Egypt) is consistent with this expectation but documentary analysis cannot establish causation. See (Offiong and Munsami, 2022) on institutional capacity gaps affecting both documentation and diffusion.

⁶⁵This dual character aligns with Keohane and Nye (14) on complex interdependence: mutual gains are possible whilst asymmetry and vulnerability persist. The mixed-outcome framing avoids both technological determinism (dependency as inevitable) and voluntarism (governance alone can eliminate asymmetry).

⁶⁶Open data policies thus create a trade-off: they lower barriers to access (autonomy-enhancing) but embed African applications within EU-controlled technical ecosystems (dependency-reinforcing). Governance design mediates which effect predominates in practice.

processing capability, and service delivery to government departments indicate that capacity-building has translated into integration capability. Yet in all three cases, design authority, fabrication know-how, and launch services remain with external partners. The African Space Policy acknowledges that Africa does not have the full technical know-how to participate independently (AUC, 2016); the African Space Strategy notes that many of Africa's space-derived services and products are outsourced (AUC, 2019a). Capacity-building thus supports downstream absorption and application whilst upstream segments of the value chain remain externalised. Proposition 4 receives support in that value capture in design and fabrication is concentrated externally; governance design may nevertheless support retention of value in downstream processing and service delivery, as evidenced in the South African case.⁶⁷

Third, data sovereignty provisions coexist with external marketing and value capture. Nigeria's NASRDA Act designates the agency as repository of all satellite data over Nigeria's territory; DMC International Imaging markets imagery from NigeriaSat-2 and NigeriaSat-X outside Africa. The configuration indicates retention of formal data governance authority at the national level whilst elements of downstream value capture for international markets are externalised. South Africa's multi-government licence establishes domestic retention and diffusion; SANSA uses open-access Sentinel data. Egypt's Aswan Receiving Station suggests domestic reception capability, but IP arrangements and value capture terms are not documented. The pattern indicates that data sovereignty provisions (statutory repository status, domestic receiving stations, multi-government licensing) can coexist with externalised elements (international marketing agreements, reliance on external data providers, outsourcing of fabrication and launch). Complex interdependence theory directs attention to this coexistence: cooperation creates gains (data access, capacity-building, service delivery) whilst asymmetry persists (value capture upstream, standards set externally, infrastructure controlled by core actors).⁶⁸

5.4.5 Theoretical Interpretation

The cross-case patterns reconnect to the four theoretical pillars and clarify the analytical implications for institutional design and programme architecture.

Postcolonial political economy furnishes the structural lens. The cases indicate that value capture and control remain concentrated in upstream segments of the space value chain: design, fabrication, launch, and in some instances international marketing. African space agencies participate as implementing partners, recipients of capacity-building, and

⁶⁷The distinction between upstream (design, fabrication, launch) and downstream (processing, service delivery) value capture is central to Proposition 4. Governance cannot readily shift upstream control but can affect downstream retention.

⁶⁸The coexistence of data sovereignty provisions and externalised elements illustrates that formal authority (e.g. statutory repository status) does not entail de facto control over all value streams; partnership arrangements may externalise specific functions whilst retaining others.

users of open data. The African Space Policy and Strategy explicitly acknowledge this structural condition (AUC 2016 and 2019a) Governance design does not dissolve structural dependency; it mediates how that dependency translates into outcomes. South Africa's retention of downstream value through domestic processing and multi-government licensing indicates that institutional design can shift the balance within constraints; Nigeria's externalisation of international marketing to DMC International Imaging and Egypt's reliance on Ukrainian and Russian fabrication indicate persistent structural constraints. The periphery remains integrated into a global division of labour; governance affects the terms of that integration.⁶⁹

Complex interdependence explains the asymmetry and its institutional mediation. EU–Africa space cooperation is not zero-sum: African partners gain access to data, training, and technical support; the EU advances Copernicus utilisation and geopolitical engagement. Yet interdependence is highly asymmetrical. The European Commission and African Union Commission define the GMES & Africa framework; African consortia implement within that structure. The Joint Africa–Europe Strategy (JAES), adopted in 2007, established the political framework for EU–AU cooperation in space and grouped Science, Technology and Innovation with space in the so-called Eighth Partnership (Arora and Gambardella, 1994). Vulnerability to disruption (funding cycles, partnership changes, satellite failures) is greater for the more dependent party. The mixed-outcome patterns identified above indicate that institutional design at the national level can mediate this asymmetry: where governance creates coherent focal points, participatory mechanisms, and favourable data arrangements, cooperation may support societal diffusion; where governance concentrates authority narrowly or lacks formal structures, the benefits of cooperation may remain confined.⁷⁰

Institutional design functions as the mediating mechanism. Budget autonomy, participatory governance, IP arrangements, and coherence emerge as dimensions along which the cases vary. South Africa's domestic appropriations framework, Board oversight, multi-government licence, and inter-departmental coordination suggest that institutional design supports both continuity and diffusion. Nigeria's multi-source funding (domestic and external), advisory participatory structures, and statutory repository claims suggest a configuration that centralises authority but leaves budget autonomy and diffusion pathways partially undocumented. Egypt's executive-led governance, absence of legislated agency during the documented period, and scarcity of evidence on participatory and IP arrangements limit confident assessment. The proposition that governance mediates the

⁶⁹The dependency theory tradition, as applied to technology transfer, would emphasise that integration into global value chains under asymmetric conditions can reproduce rather than reduce structural dependence; governance mediates but does not dissolve this dynamic. See Chapter 3.

⁷⁰Vulnerability here refers to the greater sensitivity of the more dependent party to disruption; see Keohane and Nye (Department of Trade and Industry, 2009). The less dependent party (the EU) retains agenda-setting and standard-setting power within the cooperation framework.

relationship between structural dependency and societal impact receives support in the South African case; the Nigeria and Egypt cases indicate that the proposition is consistent with the evidence but that documentary gaps constrain stronger claims.⁷¹

Multi-level coordination explains how continental and European programme architecture interacts with national governance. GMES & Africa operates at the EU–AU level; implementation occurs through regional consortia and national institutions. Breccia et al. frame space governance as operating across international, regional, and national dimensions, with space ecosystems developed on multiple layers and States, regional bodies, and international organisations interacting within the framework provided by international space law (Arora and Gambardella, 1994). The cases indicate that national governance quality affects outcomes: South Africa’s formalised coordination and diffusion channels appear to translate continental engagement into documented societal impact; Nigeria’s centralised structure and Egypt’s partial focal point configuration suggest that the interface between continental programmes and national implementation may be less effective where participatory mechanisms and institutional transparency are weak. The GMES & Africa Forum’s emphasis on taking programmes to decision-makers and ministries aligns with this interpretation (AUC, 2019b): multi-level coordination depends critically on national governance creating channels for end-user engagement.⁷²

The comparative findings imply that institutional design and programme architecture matter for how EU–Africa space cooperation translates into societal impact. Statutory foundations, participatory governance structures, budget autonomy, and data arrangements emerge as dimensions that differentiate cases. The next chapter examines policy implications: what institutional reforms, programme design modifications, or coordination mechanisms might amplify the autonomy-enhancing aspects of cooperation whilst addressing the structural constraints that perpetuate dependency. The bridge between comparative analysis and policy prescription requires attention to the conditions under which governance mediates dependency, and to the limits of institutional design when structural asymmetry persists.⁷³

⁷¹The South African case provides the clearest support for the governance mediation thesis because institutional outputs (Annual Report, policy documentation) are more extensively documented. This may reflect both stronger institutionalisation and greater transparency.

⁷²The GMES & Africa programme structure (regional consortia, national implementing institutions) creates a multi-level architecture; the comparative evidence suggests that programme impact at the national level is conditioned by the quality of national governance rather than determined by programme design alone.

⁷³The bridge to policy implications in Chapter 6 requires caution: comparative evidence supports analytical generalisation to theoretical configurations but not mechanical transfer of institutional blueprints across contexts.

OUTCOME	OUTCOME INDICATOR	BASELINE	2024/25 TARGET	ACTUAL ACHIEVEMENT AS AT 31 MARCH 2025	REASONS FOR DEVIATION	CORRECTIVE ACTION TO BE TAKEN IN THE NEXT PLANNING CYCLE
MTSF 2019-2024: Priority 1 – A capable, ethical, and developmental State						
Outcome 4: SANSA positioned as a key enabler for the implementation of government's space-related policies	O4.1. Percentage of government departments and public entities that are using space products and services	42% of government departments and public entities that are using space products and services	80% of government departments and public entities that are using space products and services	74%	The deviation can be attributed to delays in the development of decision support tools, stemming from technical complexities, resource constraints, and the need for extended stakeholder consultations to ensure relevance and usability.	Deployment of decision-support tools and other solution-driven offerings.
	O4.2. External audit outcome	Unqualified audit opinion with material findings	Achieve and maintain an unqualified audit opinion with no material findings	Achieved and maintained an unqualified audit opinion with no material findings for 2021 -2025 FY	Improved financial governance practices, strengthened internal controls, and reinforced compliance monitoring.	No corrective action required
MTSF 2019-2024: Priority 2 – Economic transformation and job creation						
Outcome 5: Enabling infrastructure developed and upgraded to support the space sector value chain	O5.1. Percentage growth in the Rand value of the national infrastructure asset base	R473.7 million value of the national infrastructure asset base	Lower target: 25% Upper target: 50%	14%	The slower-than-anticipated implementation of infrastructure projects was primarily attributed to the multiyear nature of projects, which involve long-lead items, external dependencies and reliance on partner timelines.	Priorities for the next planning cycle include the rollout of key infrastructure projects under the SIH, such as EOSAT-1, the AIT upgrade project and the establishment of the Deep Space ground station in Matjiesfontein.
MTSF 2019-2024: Priority 7 – A better Africa and World / Priority 2 – Economic transformation and job creation						
Outcome 6: Increased participation of the national space programme in the regional and global space market	O6.1. Percentage growth in revenue generated from space products and applications	R405m from Space Operations (based on the previous five-year term)	Lower Target: 5% (primarily through space operations) Upper Target: 8% (Including potential new revenue streams from products and applications to be developed once the market analysis has been completed)	61%	Increased demand for space operations and other space-based value-added services, coupled with faster-than-anticipated market uptake.	No corrective action required
	O6.2. Percentage growth in products and services provided to the market	New indicator	Lower target: 20% Upper target: 40%	200%	Driven by higher-than-anticipated demand and strategic partnerships that enabled broader market reach.	No corrective action required

Figure 5.11: SANSA achievements (Table 2) extend the evidence of institutional output and societal diffusion (P3).

Source: SANSA Annual Report 2024/2025.

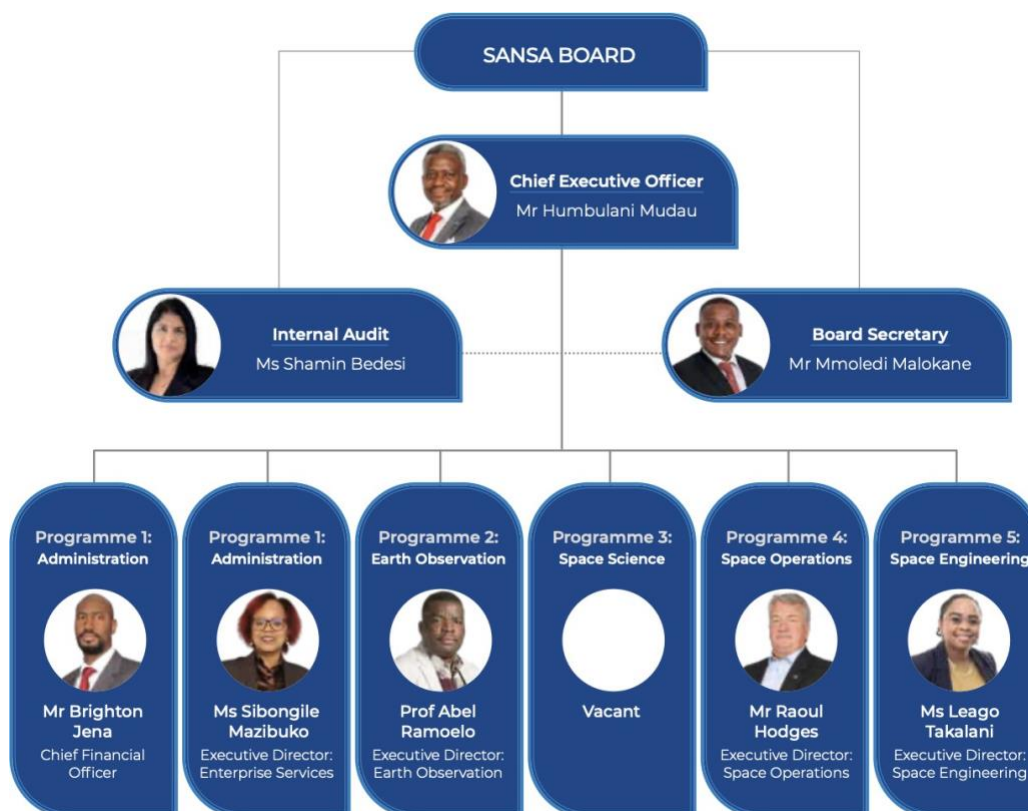


Figure 5.12: SANSA organisational structure illustrates the five-programme configuration and lines of accountability to the CEO and Board (P5).

Source: SANSA Annual Report 2024/2025.

SOURCES OF REVENUE	2023/2024			2024/2025		
	ESTIMATE R'000	ACTUAL AMOUNT COLLECTED R'000	(OVER) / UNDER COLLECTION R'000	ESTIMATE R'000	ACTUAL AMOUNT COLLECTED R'000	(OVER) / UNDER COLLECTION R'000
Contract Income: Public	18 686	23 511	(4 826)	29 659	27 930	1 729
Contract Income: Private	5 285	6 501	(1 216)	7 067	7 539	(471)
Contract Income: Foreign	92 826	130 926	(38 101)	100 339	132 232	(31 892)
Other Income	11 225	14 924	(3 700)	8 847	10 714	(1 867)
Total	128 021	175 863	(47 841)	145 913	178 414	(32 502)

Figure 5.13: SANSA revenue information illustrates the funding structure and sources (P2).

Source: SANSA Annual Report 2024/2025.



Figure 5.14: SANSAT ground receiving stations illustrate domestic ownership of data reception and space operations infrastructure (P4).

Source: SANSAT Annual Report 2024/2025.

Chapter 6

Policy and Theoretical Implications

The comparative analysis of Nigeria, Egypt, and South Africa yields implications for how governance mediates structural dependency, how African space institutions might be designed to support diffusion, and how EU–Africa programme architecture interacts with national governance.¹ This chapter synthesises those implications without re-narrating the case evidence. It derives design principles from the empirical patterns established in Chapter 5, maintains conceptual continuity with the theoretical framework of Chapter 3, and prepares the ground for the concluding chapter.

6.1 Governance as Mediator in Asymmetric Interdependence

The central finding of the comparative analysis is that governance design mediates the relationship between structural technological dependency and societal impact.² This finding provides support for Proposition 1: the same external partnership can produce different outcomes depending on how the receiving state organises its space sector. The three cases illustrate variation in mediation capacity. South Africa’s statutory agency structure, Board oversight, multi-government data licensing, and inter-departmental coordination appear to support both indigenous integration capability and documented diffusion to water management, disaster response, and public administration. Nigeria’s centralised ministerial model and statutory repository claims coexist with advisory participation and partially undocumented diffusion pathways. Egypt’s executive-led governance, with NARSS operating under decree rather than legislation during the documented period,

¹The implications are analytically derived rather than prescriptive; they reflect patterns observable in the three-case comparison and do not purport to exhaust the policy space for African space development or EU–AU cooperation.

²Mediation here denotes the mechanism through which governance arrangements intervene between structural conditions and observed outcomes; it does not imply that governance determines outcomes but that it conditions how structural dependency manifests in practice.

exhibits the thinnest evidence base for both participatory mechanisms and societal diffusion. The gradient across cases suggests that governance does not merely reflect structural conditions; it actively shapes how those conditions translate into outcomes.³

Governance mediates but does not eliminate dependency. In all three cases, design authority, fabrication know-how, and launch services remain concentrated with external partners. The African Space Policy and Strategy explicitly acknowledge that Africa does not have the full technical know-how to participate independently and that many space-derived services and products are outsourced (African Union Commission, 2019). Governance cannot dissolve this structural asymmetry; it can, however, affect the terms on which African actors participate in cooperation, the extent to which downstream value is retained domestically, and the channels through which space-derived benefits reach end-users.⁴ The South African configuration indicates that domestic appropriations, formal participatory mechanisms, and data governance arrangements can support retention of value in processing and service delivery whilst upstream dependence persists. The Nigerian and Egyptian configurations indicate that centralised or executive-led governance, without equivalent institutional embedding of diffusion channels, may limit the extent to which cooperation translates into societal impact.

Complex interdependence theory frames this mediation. EU–Africa space cooperation is asymmetrical: the EU retains control over programme design, standards, and infrastructure; African partners receive data, training, and capacity-building. Yet the relationship is not zero-sum. Mutual gains are possible when institutional design at the national level creates conditions for absorption and application. Where governance establishes coherent focal points, participatory mechanisms linking space agencies to end-user ministries, and favourable data arrangements, cooperation may support societal diffusion. Where governance concentrates authority narrowly or lacks formal structures for cross-government coordination, the benefits of cooperation may remain confined to the space sector.⁵ The comparative evidence thus supports the theoretical claim that governance functions as the mediating mechanism between structural dependency and actual outcomes.

³The comparative gradient (South Africa > Nigeria > Egypt on documented diffusion) is consistent with the governance mediation thesis; documentary analysis cannot establish causation, but the pattern supports the analytical claim.

⁴Dependency theory emphasises that structural asymmetry persists across governance configurations; the contribution of this thesis is to demonstrate that governance nevertheless differentiates outcomes within those structural constraints. See Chapter 3.

⁵Complex interdependence theory, as developed by (Keohane and Nye, 2012), emphasises that asymmetry and mutual gains coexist; institutional arrangements affect which effect predominates.

6.2 Implications for African Institutional Design

The comparative findings yield implications for institutional design that emerge from the evidence rather than from prescriptive activism.⁶ The cases suggest that several design dimensions distinguish configurations associated with stronger diffusion from those with weaker documented societal impact.

Statutory foundation appears consequential. South Africa and Nigeria both operate under parliamentary legislation establishing their space agencies; Egypt operated through NARSS under executive decree without a dedicated space agency law during the documented period. Statutory foundations provide clarity of mandate, accountability lines, and durability across administrative changes. They also enable formal linkages to other legislation (such as public finance management) and to national development frameworks. The implication is not that legislation automatically produces better outcomes, but that the absence of legislated agency status may leave governance vulnerable to executive discretion and may constrain the formalisation of coordination mechanisms.⁷ Where States are considering space sector institutionalisation, comparative evidence suggests that statutory establishment may support institutional coherence (Proposition 5) and provide a base for participatory and data governance arrangements.

Participatory governance emerges as a dimension that differentiates cases. South Africa's National Space Policy mandates inter-departmental fora, focal points in government department clusters, and multi-government licensing for data access. Nigeria's Technical Advisory Committee and Committee on International Cooperation provide advisory rather than decision-making functions. Egypt exhibits no documented equivalent of formal stakeholder councils or end-user advisory bodies. The comparative pattern suggests that formal participatory mechanisms, when embedded in policy and linked to diffusion channels, may support the translation of space-derived benefits to non-space sectors. Proposition 3 receives support: stakeholder inclusion, when institutionalised rather than merely advisory, appears consistent with stronger documented diffusion.⁸ The implication for institutional design is that governance arrangements that create channels for end-user ministries (agriculture, water, disaster management, spatial planning) to participate in priority-setting and to access data through formal licences may support societal impact. This is an analytical inference from the comparative gradient, not a normative prescription.

Budget autonomy bears on Proposition 2. South Africa presents the most documented

⁶The distinction between analytical implications and normative prescription is important: the thesis does not recommend specific reforms but identifies dimensions along which empirical variation predicts differential outcomes.

⁷For comparative analysis of unitary space law frameworks in Nigeria and South Africa, and the contrast with decree-based regulation, see (Egyptian Space Agency, 2019).

⁸For the challenges of balancing central coordination with stakeholder inclusion in emerging space programmes, see (Harding, 2013).

framework of domestic parliamentary appropriations through the Department of Science and Innovation; Nigeria's Act specifies multiple funding sources including domestic and external; Egypt's budget structure is not evidenced in the corpus. The implication is that dependence on project-based external grants for core operations may increase vulnerability when funding cycles shift. Domestic appropriations, where fiscally feasible, may support continuity and capacity to set independent agendas. The comparative evidence does not permit strong causal claims about budget sources and outcomes; it indicates that the dimension is relevant and that documentation of funding structure supports assessment of vulnerability.⁹

Data governance architecture differentiates the cases. South Africa's multi-government licence, establishing that space-derived data procured by government shall be made available to departments, agencies, and publicly-funded institutions, creates a formal framework for cross-government access. Nigeria's NASRDA Act designates the agency as repository of data over national territory but does not specify equivalent licensing provisions. Egypt's Aswan Receiving Station suggests domestic reception capability, but data access and licensing arrangements are not documented. The implication is that explicit data governance arrangements, when formalised in policy, may support diffusion by reducing barriers to access for non-space sectors.¹⁰ The DESA platform and water monitoring products in South Africa illustrate how such arrangements can facilitate application development and service delivery.

Inter-ministerial coordination appears consistent with stronger institutional coherence. South Africa's Policy specifies coordination between the lead department (DSI), the regulatory function (DTI), and other departments; the Policy mandates focal points in government clusters. Nigeria's Council structure includes multiple ministerial representatives but decision-making is concentrated in the Council rather than in horizontal coordination fora. Egypt's governance hierarchy is documented as ministerial and executive-dominated without equivalent coordination structures. The comparative pattern suggests that formal inter-ministerial coordination mechanisms may support the translation of continental and European programmes into national implementation and societal impact. Multi-level coordination depends on national governance creating channels for end-user engagement; where such channels are absent or weakly formalised, EU–AU programmes may have limited reach beyond the space sector.¹¹

⁹On funding models and sustainability in emerging space agencies, see (Adams, 2021).

¹⁰The African Space Policy and Strategy emphasise diffusion of space applications to development sectors; national implementation of such provisions varies.

¹¹The GMES & Africa programme operates through regional consortia; the comparative evidence suggests that national governance quality conditions how continental engagement translates into societal impact. See (Lavaysse et al., 2020) on user engagement with programme tools.

6.3 Implications for EU Programme Structure

The findings bear on how GMES & Africa and similar EU–AU programmes interact with national governance.¹² The analysis remains analytical rather than normative.

Access and integration are distinct. Open access to Copernicus data creates opportunities for African users to obtain imagery without prohibitive cost. Yet access alone does not guarantee integration into policy processes or service delivery. The comparative evidence indicates that integration depends on national governance: ground infrastructure, processing capability, institutional linkages to end-user ministries, and formal mechanisms for data sharing. Programmes that emphasise access without attention to the institutional embedding of that access at the national level may achieve diffusion only where recipient governance already creates favourable conditions.¹³ The implication is that EU programme design may benefit from explicit attention to how capacity-building and data provision interface with national coordination structures, rather than treating access as sufficient.

Institutional embedding of capacity-building emerges as a design dimension. Training and technical support that remain confined to space sector personnel may not translate into diffusion to agriculture, disaster management, or public administration. The GMES & Africa Forum emphasised the need to take programmes to decision-makers and ministries (African Union Commission, 2019). The comparative evidence supports this emphasis: South Africa’s documented diffusion coincides with institutionalised linkages to the Department of Water and Sanitation, disaster management agencies, and spatial planning teams; Nigeria and Egypt present weaker evidence of such linkages.¹⁴ The implication for programme structure is that capacity-building modalities that explicitly target end-user ministries and that are designed to connect with national inter-departmental coordination may support societal impact. This is a design consideration, not a claim that current programmes neglect such targeting.

Conditional coordination mechanisms merit attention. EU–AU cooperation operates through regional consortia and national implementing institutions. The cases indicate that outcomes depend on the fit between programme design and national governance. Where national governance is fragmented or lacks formal coordination channels, programme benefits may not reach beyond the space sector. Programme architecture could, in principle, incorporate conditions or incentives that encourage participating institutions to establish or strengthen national coordination mechanisms. Such design choices involve

¹²The Joint Africa–Europe Strategy (JAES) established the political framework for EU–AU cooperation; space is grouped with Science, Technology and Innovation in the Eighth Partnership. See (Breccia et al., 2023)

¹³Open data policies lower barriers to access but do not automatically create institutional channels for integration into policy processes; governance mediates the translation from access to application.

¹⁴The shortage of institutional capacity in Africa for analysing space policy implementation and advising decision-makers may affect both documentation and diffusion; see (Offiong and Munsami, 2022).

trade-offs: conditionalities may impose administrative burden or may be resisted; unconditional support may yield limited diffusion where governance is weak.¹⁵ The analytical point is that the interface between EU programme structure and national governance is not automatic; it is a design variable.

The risk of reinforcing standards dependence is inherent in cooperation that provides data, platforms, and technical support from the EU. Adoption of Copernicus formats and Sentinel data enables applications but also positions African users within a technical ecosystem controlled externally. The comparative evidence indicates that this dual character is structural: cooperation creates gains (access, capacity) whilst entrenching reliance on EU standards and infrastructure. Programme design cannot eliminate this tension; it can be attentive to it. Support for indigenous processing platforms, algorithm development, and data governance arrangements that retain domestic control over downstream applications may partially offset standards dependence.¹⁶ The African Space Policy and Strategy articulate aspirations for indigenous capability; realisation depends on both programme design and national governance.

Balancing asymmetry within complex interdependence is the overarching challenge. EU–Africa space cooperation is asymmetrical by structure: the EU funds, designs, and operates Copernicus; African partners implement within a framework set by the European Commission and African Union Commission. The Joint Africa–Europe Strategy frames the relationship as a partnership of equals (Breccia et al, 2023), but operational asymmetry persists.¹⁷ The comparative evidence suggests that institutional design at the national level can mediate this asymmetry: where African governance creates coherent focal points, participatory mechanisms, and favourable data arrangements, cooperation may support societal diffusion and retention of downstream value. Programme design that facilitates rather than substitutes for such governance may amplify the mediating effect. The implication is that EU programme structure and African institutional design are mutually conditioning; neither alone determines outcomes.

¹⁵Conditionality in development cooperation is politically contested; the analytical point here is that the programme–governance interface is malleable, not that specific conditionalities should be imposed.

¹⁶The tension between open data access (which embeds users in EU ecosystems) and indigenous platform development reflects the dual character of cooperation: gains and dependency coexist.

¹⁷Vulnerability to disruption (funding cycles, partnership changes) is greater for the more dependent party; complex interdependence does not imply symmetry. See (Keohane and Nye, 2012).

6.4 Design Principles for Non-Extractive Cooperation

The foregoing sections can be synthesised into design principles that connect comparative evidence to theory.¹⁸ Each principle is framed analytically; none makes utopian or moral claims.

Principle 1: Governance mediates structural dependency but does not eliminate it. Postcolonial political economy situates EU–Africa space cooperation within patterns of uneven exchange and knowledge hierarchies.¹⁹ Upstream segments of the space value chain (design, fabrication, launch) remain concentrated with external partners; African actors participate as implementing partners and users. Institutional design theory indicates that governance arrangements at the national level shape how this structural condition translates into outcomes. The comparative evidence supports Proposition 1: governance mitigates but does not dissolve dependency. Design principles for cooperation should therefore assume persistence of structural asymmetry whilst seeking to maximise the mediating role of governance. Programmes that treat governance as irrelevant or that design interventions without attention to national institutional capacity may underachieve; those that explicitly interface with governance structures may amplify diffusion within structural constraints.

Principle 2: Statutory foundation and participatory formality support institutional coherence and diffusion. The cases indicate that statutory agency establishment, when combined with formal participatory mechanisms and interdepartmental coordination, is associated with stronger documented diffusion. Proposition 3 (participatory governance and diffusion) and Proposition 5 (institutional coherence) receive support. The principle does not prescribe particular legal forms; it indicates that governance arrangements that create clear mandates, accountability lines, and channels for end-user engagement may support societal impact. For African States establishing or reforming space sectors, comparative evidence suggests that statutory foundations and formal participatory structures merit attention.²⁰ For EU programmes, the implication is that support for institutional capacity-building may yield greater societal impact when aligned with governance structures that create diffusion channels.

Principle 3: Data governance and budget autonomy affect vulnerability and value retention. Proposition 2 (budget autonomy and vulnerability) and Propo-

¹⁸These principles are heuristic rather than exhaustive; they capture patterns from the three-case comparison and may require refinement when applied to other African space programmes or different cooperation contexts.

¹⁹The African Space Policy explicitly acknowledges that Africa does not possess full technical know-how for independent participation (African Union Commission, 2019)

²⁰For a strategic decision support framework on African space governance, including opportunities and challenges, see (Ibrahim et al., 2022).

sition 4 (IP and value capture) point to dimensions that differentiate cases. Domestic appropriations, where feasible, may reduce vulnerability to external funding cycles. Formal data governance arrangements (multi-government licensing, domestic processing platforms) may support retention of downstream value whilst upstream dependence persists. The principle indicates that cooperation design should attend to how data access, licensing, and value capture are structured. Open data policies create opportunities; their realisation depends on national capacity to process and apply. Programmes that support domestic data governance infrastructure and processing capability may complement open access in ways that enhance value retention.²¹

Principle 4: Multi-level coordination depends on national governance quality. Continental and European programmes operate at the EU–AU level; implementation occurs through regional consortia and national institutions. The cases indicate that national governance quality affects outcomes: where formalised coordination and diffusion channels exist, continental engagement may translate into societal impact; where governance is centralised or fragmented, the interface may be weaker. The principle implies that programme design should incorporate explicit attention to the national level. Capacity-building, data provision, and technical support that assume capable national governance may succeed where such governance exists and may underachieve where it does not.²² Programme architecture that supports or incentivises national coordination mechanisms may strengthen the multi-level link.

Principle 5: Access and integration are distinct; both require institutional embedding. Provision of data and training constitutes access; translation into policy-relevant applications and service delivery constitutes integration. The comparative evidence indicates that integration depends on institutional linkages between space agencies and end-user ministries. Programmes that emphasise access without attention to embedding may achieve diffusion only where national governance already creates favourable conditions. The principle suggests that capacity-building and data provision should be designed with explicit linkage to national coordination structures, end-user ministries, and diffusion channels. Institutional embedding is a design variable, not an automatic consequence of access.

Principle 6: Asymmetry and mutual gains coexist; institutional design mediates the balance. Complex interdependence theory indicates that cooperation is not zero-sum: African partners gain access to data and capacity; the EU advances Copernicus utilisation. Yet asymmetry persists. The comparative evidence suggests that institutional design mediates the balance: where African governance creates favourable conditions, co-

²¹The distinction between upstream (design, fabrication, launch) and downstream (processing, service delivery) value capture is central; governance affects downstream retention more readily than upstream control.

²²Space governance operates across international, regional, and national dimensions; see (Breccia et al, 2023) on multi-level space ecosystems.

operation may support societal diffusion; where it does not, benefits may remain confined. The principle implies that neither structural determinism (asymmetry always dominates) nor voluntarism (governance alone can eliminate asymmetry) adequately describes the relationship.²³ Design principles should assume both persistence of asymmetry and the potential for governance to shift outcomes within structural constraints.

The comparative analysis of Nigeria, Egypt, and South Africa yields implications for institutional design, programme structure, and the conditions under which EU–Africa space cooperation may support societal impact whilst structural dependency persists.²⁴ The next chapter concludes the thesis by synthesising the central findings, revisiting the research question, and reflecting on the limits of the analysis and directions for further research.

²³This dual rejection aligns with the complex interdependence thesis: mutual gains and asymmetry coexist; institutional design mediates the balance. See (Keohane and Nye, 2012).

²⁴Comparative evidence supports analytical generalisation to theoretical configurations but not mechanical transfer of institutional blueprints across contexts; each national space sector operates within distinct political economies.

Chapter 7

Conclusion

7.1 Answer to the Research Question

The central research question of this thesis is: how do governance and organisational models of African space initiatives affect societal impact and dependency dynamics within EU–Africa space cooperation? The comparative documentary analysis of Nigeria, Egypt, and South Africa provides a disciplined answer. Governance design mediates the relationship between structural technological dependency and societal impact.¹ The same external partnership can produce different outcomes depending on how the receiving state organises its space sector. Where national governance creates statutory foundations, participatory mechanisms linking space agencies to end-user ministries, and formal data governance arrangements, documentary evidence suggests that cooperation may support societal diffusion and retention of downstream value. Where governance concentrates authority in narrow executive channels or lacks formal structures for cross-government coordination, the benefits of cooperation may remain confined to the space sector. Governance does not eliminate dependency; it shapes how structural conditions translate into outcomes.

Upstream dependency persists across all three cases. Design authority, fabrication know-how, and launch services remain concentrated with external partners. The African Space Policy and Strategy explicitly acknowledge that Africa does not have the full technical know-how to participate independently and that many space-derived services and products are outsourced (African Union Commission). This structural condition is not dissolved by governance. Yet the comparative evidence indicates that governance affects downstream absorption, data governance, and documented diffusion. South Africa exhibits the strongest documented institutional coherence and diffusion channels, with statutory agency structure,

¹Mediation here denotes that governance operates as an intervening variable: it does not supersede structural conditions but filters how those conditions are translated into observable outcomes. The concept avoids both determinism (structure dictates outcomes) and voluntarism (agency alone determines results).

Board oversight, multi-government data licensing, and linkages to water management, disaster response, and public administration. Nigeria presents statutory coherence with centralised authority and partial diffusion evidence; Egypt exhibits executive-centralised configuration with the thinnest documentary evidence for participatory mechanisms and societal diffusion. Across the three cases, the pattern found suggests that governance design mediates structural dependency rather than only reflecting it.

Mixed outcomes characterise EU–Africa space cooperation.² Access to open Copernicus data and capacity-building expand domestic applications and integration capability whilst entrenching reliance on EU standards and upstream control. Cooperation can thus increase both autonomy (in access, processing, and capacity) and dependency (in standards alignment and upstream segments of the value chain). The GMES & Africa Forum emphasised the need to take programmes to decision-makers and ministries (African Union Commission, 2019); the comparative evidence indicates that realisation depends critically on national governance creating channels for end-user engagement. The thesis finds that governance mediates this balance: it does not determine outcomes in a causal sense, but documentary evidence is consistent with the proposition that institutional design at the national level affects whether cooperation translates into societal impact within the constraints of structural asymmetry.

7.2 Theoretical Contribution

The thesis advances the integrated theoretical framework developed in Chapter 3 by demonstrating how institutional design functions as the mediator linking postcolonial dependency to societal impact under complex interdependence. The four pillars (post-colonial political economy, complex interdependence, institutional design, and multi-level coordination) are not merely juxtaposed; they are shown to operate in tandem. Post-colonial political economy furnishes the structural context: EU–Africa space cooperation occurs within historical patterns of uneven exchange and knowledge hierarchies. Complex interdependence explains why cooperation is not simply domination: asymmetry exists, but mutual gains are possible under certain institutional conditions. Institutional design functions as the mediating mechanism: governance arrangements at the national level shape whether cooperation amplifies or dampens dependency and whether benefits diffuse to society or remain concentrated. Multi-level coordination explains how continental, regional, national, and European layers interact: outcomes depend on the fit between EU programme design and African national governance.

What governance mediation adds relative to structural dependency alone is speci-

²The coexistence of autonomy-enhancing and dependency-reinforcing effects is consistent with complex interdependence theory: gains from exchange are possible even under asymmetry, but the distribution of benefits and the terms of integration remain uneven. See Chapter 3.

fication of the mechanism through which structure translates into outcomes.³ Structural dependency theory identifies that value capture and control remain concentrated upstream; it does not fully explain variation in downstream absorption and societal diffusion across cases that face similar structural constraints. The thesis demonstrates that governance design (budget autonomy, participatory governance, IP/value capture arrangements, institutional coherence) differentiates cases along dimensions that matter for societal impact. Proposition 1 (governance mediation) receives support: the same external partnership produces different configurations of dependency and diffusion depending on national institutional design. Proposition 2 (budget autonomy and vulnerability) is consistent with the South African case, where domestic appropriations suggest lower vulnerability; documentary gaps limit confident assessment for Nigeria and Egypt. Proposition 3 (participatory governance and diffusion) receives the strongest support in South Africa, where formalised stakeholder mechanisms coexist with documented diffusion; advisory or absent participatory structures in Nigeria and Egypt appear consistent with weaker diffusion evidence. Proposition 4 (IP/value capture) receives support: arrangements that facilitate local ownership and domestic processing (as in South Africa's multi-government licence) appear associated with greater downstream value retention. Proposition 5 (institutional coherence) differentiates cases most clearly: South Africa exhibits the strongest documented coherence; Nigeria presents statutory coherence with centralised authority; Egypt exhibits the weakest institutional formalisation in the corpus. The analytical propositions thus guide and receive support from the comparative analysis, whilst remaining non-causal orienting expectations rather than falsified or confirmed hypotheses.⁴ The chapter therefore consolidates, rather than extends, the theoretical architecture developed in Chapter 3.

7.3 Empirical Contribution

The thesis assembles documentary evidence across national legislation, strategy papers, agency reports, AU and EU programme documents, and peer-reviewed literature to produce a comparative mapping of governance, dependency, and diffusion configurations in Nigeria, Egypt, and South Africa. The contribution is not causal proof but systematic characterisation of how these dimensions are represented across publicly available documents.⁵ The analytical template (governance dimensions, dependency dimen-

³Structural dependency theory, as discussed in Chapter 3, identifies *that* asymmetry exists; governance mediation explains *how* and *under what conditions* that asymmetry produces variation in downstream outcomes.

⁴The propositions were conceived as theoretical expectations to be examined through documentary evidence, not as hypotheses subject to deductive testing. The qualitative design permits assessment of consistency but not of causal validity.

⁵The distinction between characterisation and causal proof is methodologically central: documentary evidence reveals patterns and permits inference of consistency with theory, but cannot isolate the effect

sions, societal impact indicators) derived from Chapter 3 is applied consistently across cases, enabling structured comparison rather than impressionistic narrative. The documentary corpus reveals patterned variation: statutory foundation, participatory formality, data governance arrangements, and institutional coherence differ systematically across the three typologies (ministerial statutory, executive-centralised, board-based semi-participatory).

The evidence was strongest for South Africa. Publicly available annual reports, the SANSA Act, the National Space Policy, and PFMA compliance documentation permit reconstruction of governance structure, budget framework, stakeholder engagement, and service delivery to water management, disaster response, and public administration. Nigeria presents a substantial documentary base (NASRDA Act 2010, National Space Policy, GMES & Africa participation) but with gaps: the proportion of domestic versus external funding is not specified, and evidence of societal diffusion to end-user ministries remains partial. Egypt presents the most constrained evidence base. The corpus relies heavily on the Integrated Space volume (Froehlich, 2019) and GMES & Africa documentation; NARSS operates under decree rather than legislation during the documented period; no equivalent of annual reports, stakeholder engagement documentation, or inter-ministerial coordination agreements was available. Assessment of participatory mechanisms and diffusion for Egypt is therefore qualified by documentary scarcity rather than by negative findings.⁶ This variation in evidence availability is reported carefully: it constrains comparison without invalidating the found “comparative” pattern indicated in the available documents.

7.4 Limitations

Several limitations bound the scope and claims of the thesis. Documentary availability gaps are pronounced, especially for Egypt. The corpus does not include NARSS statute, decree, organisational law, or annual reports; the draft Egyptian Space Agency law was noted but implementation timing and the relationship between NARSS and EgSA once operational were not evidenced. For Nigeria and Egypt, the inability to assess funding proportions (domestic appropriations versus external project grants) limits confident evaluation of budget autonomy and vulnerability. Internal agreements, memoranda of understanding, and IP clauses in bilateral or GMES & Africa contracts are generally not publicly available; value capture and licensing terms must be inferred from policy statements and programme descriptions rather than from contractual text. Publicly available

of governance from confounding variables or establish counterfactuals.

⁶Critical distinction: the absence of evidence is not evidence of absence. Weak documentation may reflect institutional opacity, linguistic barriers, or resource constraints rather than the actual non-existence of participatory mechanisms or diffusion pathways.

annual reports are uneven: South Africa provides detailed documentation; Nigeria and Egypt do not furnish equivalent materials in the corpus. Official documents are produced for specific purposes (legislation to establish authority, strategy papers to secure funding, reports to demonstrate performance) and may present institutional arrangements in a favourable light; the potential for self-presentation bias is acknowledged in the methodology.⁷ The thesis does not claim causal identification: documentary evidence can indicate consistency with theoretical propositions but cannot establish that governance design causes particular dependency or societal outcomes. Confounding factors (economic conditions, political stability, historical legacy) are not controlled. Generalisability is limited: Nigeria, Egypt, and South Africa are purposively selected cases; findings are analytically generalisable to theoretically similar configurations, not statistically generalisable to a broader population of African space programmes.⁸

7.5 Future Research

The following research directions follow logically from the thesis and its limitations.⁹ First, interview-based institutional ethnography could complement documentary analysis by examining how governance arrangements operate in practice. Interviews with agency personnel, end-user ministry staff, GMES & Africa consortium members, and EU programme managers would permit triangulation of documentary claims and identification of informal coordination mechanisms not captured in public texts. Second, archival access to memoranda of understanding, bilateral agreements, and GMES & Africa consortium contracts would enable direct examination of IP clauses, data licensing terms, and value capture arrangements. Third, process tracing of a specific GMES & Africa service chain from data provision through national processing to end-user application would illuminate the precise mechanisms through which governance mediates diffusion. Fourth, comparative expansion to additional cases (Kenya, Algeria, Morocco, or Ethiopia) would test whether the governance typologies and diffusion gradients identified here hold across a broader set of African space initiatives. Fifth, evaluation of end-user uptake in agriculture, disaster management, or water resources through survey or interview methods would assess whether documented diffusion translates into actual use by policy-makers

⁷The methodology (Chapter 4) mitigates this through triangulation across document types and through attention to discrepancies between stated objectives and reported arrangements. Nevertheless, the possibility that official documents overstate achievement or understate problems cannot be ruled out.

⁸Analytical generalisation extends insights to theoretically defined situations (e.g., States with executive-led space governance under conditions of external partnership); statistical generalisation would require random sampling and population-level inference, which the qualitative design does not support.

⁹Each direction addresses a specific gap: interviews address the gap between formal documents and practice; archival access addresses the opacity of contractual terms; process tracing addresses the black box between governance design and diffusion; case expansion tests external validity; end-user evaluation addresses the gap between documented and actual uptake; data governance extends the value capture analysis.

and practitioners. Sixth, study of data governance and platform sovereignty in African earth observation would extend the thesis's focus on value capture and domestic integration capability to questions of data localisation, algorithm ownership, and platform dependencies. Each direction is feasible within the scope of extended research and aligned with the thesis's theoretical framework and empirical findings.

The main message of this thesis is that governance design mediates how structural technological dependency translates into societal impact within EU–Africa space cooperation. Governance does not eliminate dependency; upstream segments of the space value chain remain concentrated with external partners. Yet the comparative evidence suggests that institutional arrangements at the national level affect whether cooperation amplifies or dampens downstream absorption and whether benefits diffuse to end-users or remain confined to the space sector. This finding has significance for EU–Africa cooperation: programme design that interfaces with national governance structures and that supports institutional embedding of capacity-building may amplify societal impact; design that treats African partners as passive recipients may underachieve. The sober implication is that neither structural determinism (asymmetry always dominates) nor voluntarism (governance alone can eliminate asymmetry) adequately describes the relationship.¹⁰ Cooperation creates gains and reinforces dependency simultaneously; institutional design mediates the balance within structural constraints that neither European nor African actors can wish away.

¹⁰This rejection of both extremes mirrors the theoretical synthesis of the thesis: postcolonial political economy provides the structural frame without foreclosing agency; complex interdependence allows for mutual gains without denying asymmetry; institutional design specifies the mechanisms without claiming that governance can overcome structural constraints.

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