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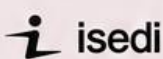
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A Review of Sustainable Business Models for Earth Observation-based Climate Services

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Abstract. *The rapid expansion of downstream space activities in the New Space era is reshaping how economic, environmental and social value is created from space infrastructures. Commercial applications of Earth observation (EO), satellite navigation and communication increasingly drive sectoral growth and redefine value chains (Bousedra, 2023; Baber & Ojala, 2024). Concurrently, downstream data-intensive services – particularly EO based climate monitoring and environmental applications – face growing expectations to contribute to sustainable and responsible business practice, integrating environmental stewardship, social justice and economic resilience.*

However, despite the acknowledged potential of satellite data to support climate adaptation, mitigation and sustainable development goals, we know relatively little about how sustainable business model innovation (SBMI) concepts and frameworks are applied to downstream space value chains. The mechanisms through which downstream intermediaries, platforms and service providers configure their value propositions, creation & delivery architectures and value capture logics to deliver triple-bottom-line outcomes remain fragmented and under-synthesised.

This work-in-progress paper presents the protocol of a planned literature review that aims to systematically map and critically synthesise existing knowledge on SBMI as applied to the downstream space economy, focusing on EO based climate and environmental applications. Building on the triadic conceptualisation of SBMI as sustainable value proposition innovation (SVPI), sustainable value creation & delivery innovation (SVCDI), and sustainable value capture innovation (SVCI) (Shakeel et al., 2020; Bashir et al., 2022), the review will examine business model configurations that transform satellite data into value added services for public and private users engaged in climate mitigation, adaptation and territorial management.

Methodologically, this work-in-progress outlines an initial plan to conduct a systematic literature review following Xiao and Watson (2019), using Web of Science and Scopus as primary databases. Recognising the emergent nature of New Space and downstream literatures, the design explicitly acknowledges possible methodological adaptation: depending on volume, diversity and maturity of identified evidence, the protocol may be refined toward a scoping review (Peters et al., 2020; Tricco et al., 2016) or an integrative review (Toronto & Remington, 2020).

The paper concludes by articulating expected theoretical and practical contributions – including development of a taxonomy of sustainable business models for downstream EO services – and detailing how the review will be further developed prior to and following the SIMA 2026 conference.

Keywords: sustainable business model; downstream space economy; earth observation; literature review

Framing of the research. *Over the last decade, the global space sector has undergone profound transformation associated with New Space: the liberalisation of space activities, entry of private actors and investors, adoption of novel business models oriented toward profit generation, and reorientation of space agencies toward market-oriented policies (Bousedra, 2023; Parrella et al., 2022). This shift has coincided with the digital evolution of the economy, fostering convergence between space technologies and data-intensive industries such as ICT, finance, agriculture and environmental monitoring (Bousedra, 2023). The downstream segment – encompassing value-added goods and services derived from space infrastructures including satellite communication, navigation and Earth observation (EO) – has experienced particularly rapid expansion. Opposed to the upstream segment (rocket and satellite manufacturing), downstream is where most economic value and societal impact can still be generated, interfacing directly with end-users across diverse sectors (Bousedra, 2023; Valente et al., 2025).*

Recent work on space business model value chains highlights that New Space is characterised by complex, multi-actor ecosystems where firms co-create value through interconnected data, hardware and intellectual property chains (Baber & Ojala, 2024). Intermediaries and platforms play crucial orchestration roles, bridging abundant but technically complex satellite data with operational needs of non-specialist users. In parallel, Sustainable and Responsible Business scholarship underlines the urgency of business models that simultaneously tackle climate change, social inclusion and economic resilience, leveraging data infrastructures to support sustainability transitions.

Within this context, downstream EO based services for climate adaptation and mitigation – precision agriculture, flood early-warning, infrastructure monitoring, forest management – offer promising yet under theorised arenas for sustainable business model innovation (SBMI). How value is proposed, created, delivered and captured sustainably across diverse public and private users, remains an open question. This working paper therefore designs a literature review protocol bridging SBMI scholarship with emerging work on the downstream space economy.

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SBMI sits at the intersection of business models (BM), business model innovation (BMI) and sustainable business models (SBM), emphasising joint creation of economic, environmental and social value for multiple stakeholders (Geissdoerfer et al., 2018; Shakeel et al., 2020). Geissdoerfer et al. (2018) define SBMI as the conceptualisation and implementation of sustainable business models, including creation of new models, diversification or transformation of existing ones to reduce negative impacts or generate positive ones. Shakeel et al. (2020) define SBMI as the transition from a conventional business model to a sustainable business model through modifications to its components to explicitly address sustainability issues and build durable competitive advantage, emphasising radical, systematic and holistic reconfiguration.

Shakeel et al. (2020) propose a triadic framework:

- *Sustainable Value Proposition Innovation (SVPI): redefining what value is offered, integrating economic, environmental and social benefits.*
- *Sustainable Value Creation and Delivery Innovation (SVCDI): reconfiguring how value is produced and distributed – resources, processes, partnerships, technologies – to minimise negative externalities.*
- *Sustainable Value Capture Innovation (SVCi): redesigning how value is monetised – pricing models, revenue streams – aligning financial sustainability with broader goals.*

Bashir et al. (2022) empirically validated this triadic structure, demonstrating that SBMI is a measurable organisational capability positively associated with economic performance and competitive advantage, even in high-uncertainty contexts. Complementary tools include sustainable business model archetypes (Bocken et al., 2014), the Triple-Layered Business Model Canvas (Joyce & Paquin, 2016), and a taxonomy of 45 SBM patterns (Lüdeke-Freund et al., 2018). Baldassarre et al. (2017) bridge SBMI and user-driven innovation through an iterative talking–thinking–testing process, particularly relevant for data-intensive services where user involvement in prototyping is essential.

The space economy spans upstream (launch, satellites) to downstream (applications/services) and enabling sectors. New Space represents a structural transformation: (1) entry of private firms and venture capital, (2) adoption of commercial business models, and (3) reorientation of space agencies toward market-enabling policies and public-private partnerships (Bousedra, 2023). A fundamental driver is convergence with the digital economy. Digital giants and start-ups now produce vast quantities of navigation, geolocation and imagery data in near-real-time. Downstream growth is driven by three domains: communications, Earth observation and satellite navigation (Bousedra, 2023). New actors – often not branding as "space companies" – provide space-based services across agriculture, transport, finance and other sectors. Baber and Ojala (2024) conceptualise emerging business model value chains in New Space, identifying distinct chains for data, hardware and intellectual property. The data value chain runs from satellite-based generation, through ground-station reception, to value-added processing and delivery to end-users. Intermediaries and platforms bridge the gap between technically complex satellite data and operational user needs.

Purpose of the paper. *Despite recognition that many downstream EO applications contribute to multiple Sustainable Development Goals (Valente et al., 2025), the SBMI and space economy literatures have remained separate. Valente et al. (2025) document substantial work linking space to sustainability outcomes but note that explicit engagement with SBMI frameworks is rare. Conversely, SBMI scholarship has proliferated across manufacturing, energy, mobility and food systems but has paid limited attention to data-intensive, multi-actor ecosystems characteristic of downstream space. Questions such as how sustainable value propositions are co-designed with public/private users, how usage-based pricing aligns value capture with accessibility, or how sustainable value creation is configured along complex data-hardware-IP chains remain largely unexplored. This constitutes a clear research gap: we lack consolidated understanding of (1) whether/how SBMI concepts apply to downstream space, (2) how SVPI–SVCDI–SVCi manifest in EO-based services, (3) which SBM archetypes/patterns are relevant, and (4) what sustainability outcomes are associated with different configurations. Addressing this gap is both theoretically and practically relevant. Theoretically, downstream space offers a novel empirical setting for SBMI research. Practically, insights could inform design of more effective, equitable business models for EO services, helping policymakers, agencies and platforms navigate the "paradox of abundance" – vast satellite data availability but limited utilisation due to accessibility, interpretability and affordability barriers.*

The overarching aim is to systematically map and critically synthesise existing scholarly knowledge on how SBMI and related SBM concepts have been applied to the downstream space economy, focusing on EO-based climate and environmental services. Hence, our Research questions are:

RQ1a: How has SBMI (and related SBM concepts) been applied to downstream space and EO-based service business models? RQ1b: How are SVPI, SVCDI and SVCi configured in business models transforming satellite data into value-added services for public/private end-users?

RQ2a: Which SBM archetypes, patterns or design tools are most used to design/analyse business models in downstream EO contexts? RQ2b: What sustainability outcomes – economic, environmental, social – are associated with different business model configurations in downstream space applications?

Methodology. *At this stage, the review is planned as a systematic literature review (SLR) following Xiao and Watson (2019), appropriate for assessing extent, patterns, quality and gaps in emerging knowledge transparently and rigorously. However, both New Space and SBMI literatures are characterised by disciplinary heterogeneity and rapid evolution, spanning management, policy, engineering, earth sciences and geography. The initial protocol starts with systematic*

search and screening but remains flexible in synthesis stages. Given this uncertainty, this work-in-progress explicitly acknowledges possible methodological adaptation:

- If evidence is mature, homogeneous and amenable to quality appraisal, proceed as full systematic review.
- If evidence is fragmented, conceptually rich but empirically sparse, a scoping review may be more appropriate (Peters et al., 2020; Tricco et al., 2016).
- If substantial work exists across multiple paradigms, an integrative review could enable interpretive synthesis (Toronto & Remington, 2020).

Table 1. Databases and search strategy

Core databases	<i>Web of Science and Scopus, chosen for comprehensive coverage across management, innovation, sustainability and applied sciences. Supplementary searches may include Google Scholar for grey literature</i>
Search strategies (three pillars)	1. SBMI/SBM concepts: "sustainable business model*", "business model innovation", "sustainable value proposition", "sustainable value creation/capture", "triple bottom line", etc. 2. Space/downstream terms: "space economy", "New Space", "downstream space", "Earth observation", "EO", "satellite data/service*", "geospatial service*", etc. 3. Climate/sustainability domains: "climate service*", "climate adaptation/mitigation", "environmental monitoring", "precision agriculture", "water management", "disaster risk", "SDG*", etc.
Example search string (to be refined)	<i>("sustainable business model*" OR "business model innovation" OR "sustainable value") AND ("space economy" OR "New Space" OR "Earth observation" OR "satellite data") AND ("climate" OR "environment*" OR "sustainab*")</i>

The review will follow a multi-stage screening process designed to ensure rigour and transparency. In the first stage, two reviewers will independently screen all retrieved records based on titles and abstracts, applying the predefined inclusion and exclusion criteria. Any disagreements between reviewers will be resolved through discussion or, if necessary, consultation with a third reviewer to reach consensus. Studies that pass the initial title and abstract screening will proceed to full-text screening, where they will be assessed in detail against the final inclusion criteria. At this stage, reasons for exclusion will be systematically documented to maintain a transparent audit trail and support future replication of the review. For studies meeting all inclusion criteria, data will be extracted using a structured form designed to capture key information including bibliographic details, type of downstream application (e.g., agriculture, water management, climate services), business model components discussed, SBMI frameworks or concepts employed, research methodology, reported sustainability outcomes, and principal findings. If the review proceeds as a full systematic literature review, quality appraisal will be conducted using adapted checklists appropriate for qualitative studies, case studies or conceptual papers. The synthesis phase will combine multiple approaches to maximise insight. A narrative synthesis will organize findings thematically according to the research questions, while a configurational synthesis will develop a taxonomy of sustainable business models for downstream EO services, mapping relationships among value proposition, creation, delivery and capture mechanisms. Additionally, descriptive statistics will be generated to identify publication trends over time, geographic distribution of research, and methodological approaches employed across the corpus.

Table 2. Inclusion and exclusion criteria

Inclusion	• Peer-reviewed articles, conference papers, book chapters in English. • Studies discussing/analysing business models in downstream space economy, particularly EO services. • Studies engaging with sustainability, SBMI, SBM or related frameworks. • Climate-related or environmental applications.
Exclusion	• Exclusively upstream space (launch, manufacturing) without downstream perspective. • Space exploration/astronomy without business model focus. • Purely technical studies without business model/sustainability discussion. • Non-English publications.

Results. This research is a work-in-progress, hence we theorize expected contribution rather than results. First, our first expected contribution is to provide the first systematic map of SBMI/SBM use in downstream space and EO-based services. Organising findings along SVPI–SVCDI–SVCI will clarify which aspects have received attention and where blind spots remain. Second, we are willing to contribute to conceptual integration between SBMI scholarship and New Space/downstream space literature. Juxtaposing SBMI categories with space value chains (Baber & Ojala, 2024) will advance understanding of sustainable value creation in complex, multi-actor, data-intensive ecosystems. Third, lay groundwork for a theoretically grounded taxonomy of sustainable business models for downstream EO services, organising configurations by:

- Target user segments (public/private; large/small).
- Value proposition focus (monitoring, analytics, decision-support, predictive).
- Value creation mechanisms (in-house/platform; open-source/proprietary; cloud/on-premise).
- Value capture models (subscription, pay-per-use, freemium, outcome-based).

- *Sustainability levers (SDG alignment, environmental impact, social inclusion, governance).*

Research limitations. *As a work-in-progress, this paper will undergo substantial development before and after the Sinergie-SIMA 2026 conference. In the pre-conference phase (March–May 2026), the research team will finalise the review protocol and search strategy, conduct systematic searches in Web of Science and Scopus, and complete initial screening by two independent reviewers with inter-rater reliability checks. Based on preliminary findings, the review type will be confirmed or adapted toward scoping or integrative approaches. A structured coding framework aligned with the SVPI–SVCDI–SVCI triad will be developed and piloted, enabling preliminary mapping of studies by year, geography, application domain and methodology, as well as identification of early thematic patterns and archetypes.*

Conference presentation will provide opportunities to share the protocol and preliminary findings, receive critical feedback on conceptual boundaries and coding choices, and refine the emerging taxonomy through discussion with the Sinergie-SIMA community. Post-conference, the team will complete full data extraction and in-depth synthesis, develop a final taxonomy integrating SBMI dimensions with space value chains, and prepare a journal manuscript targeting innovation and sustainability outlets. The taxonomy will subsequently serve as conceptual foundation for empirical research on the Italian EO ecosystem (IRIDE, ASI, e-GEOS/CLEOS), involving qualitative case studies and interviews with public and private users, ultimately contributing to both scholarship and practice in sustainable space business.

Managerial implications. *We expect the following practical implications:*

- *For policymakers and space agencies (ESA, ASI, Copernicus, IRIDE), offer evidence-based insights into which configurations support successful uptake and sustainability outcomes, informing procurement, subsidies, capacity-building and partnerships.*
- *For downstream intermediaries and platforms (e-GEOS/CLEOS, Planet Labs, ICEYE), provide structured overview of sustainable value proposition/capture strategies, helping navigate trade-offs between accessibility and economic viability.*
- *For end-user sectors (agriculture, water, civil protection, urban planning), clarify available/emerging sustainable business models and their benefits/risks.*
- *For impact investors and venture capital, provide conceptual roadmap of SBM archetypes supporting due diligence and portfolio strategy.*

Finally, In the EO context – and many other settings – a paradox of abundance exists: vast high-quality satellite data (For EU/Italy: Copernicus, COSMO-SkyMed, IRIDE) but limited utilisation due to awareness, technical complexity, costs and capacity gaps. By reviewing SBMI frameworks for downstream EO, this work will contribute to understanding how intermediaries and platforms can bridge the gap between data abundance and effective use, designing business models that democratise access, lower barriers, provide user-friendly analytics and align incentives.

Originality of the paper. *To the best of our knowledge, no reviews are currently available on the topic of Sustainable Business Models for Earth Observation-based Climate Services. Therefore, this paper offers an original contribution by addressing this gap and providing new evidence from the literature, useful both for academia, policymakers and practitioners.*

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