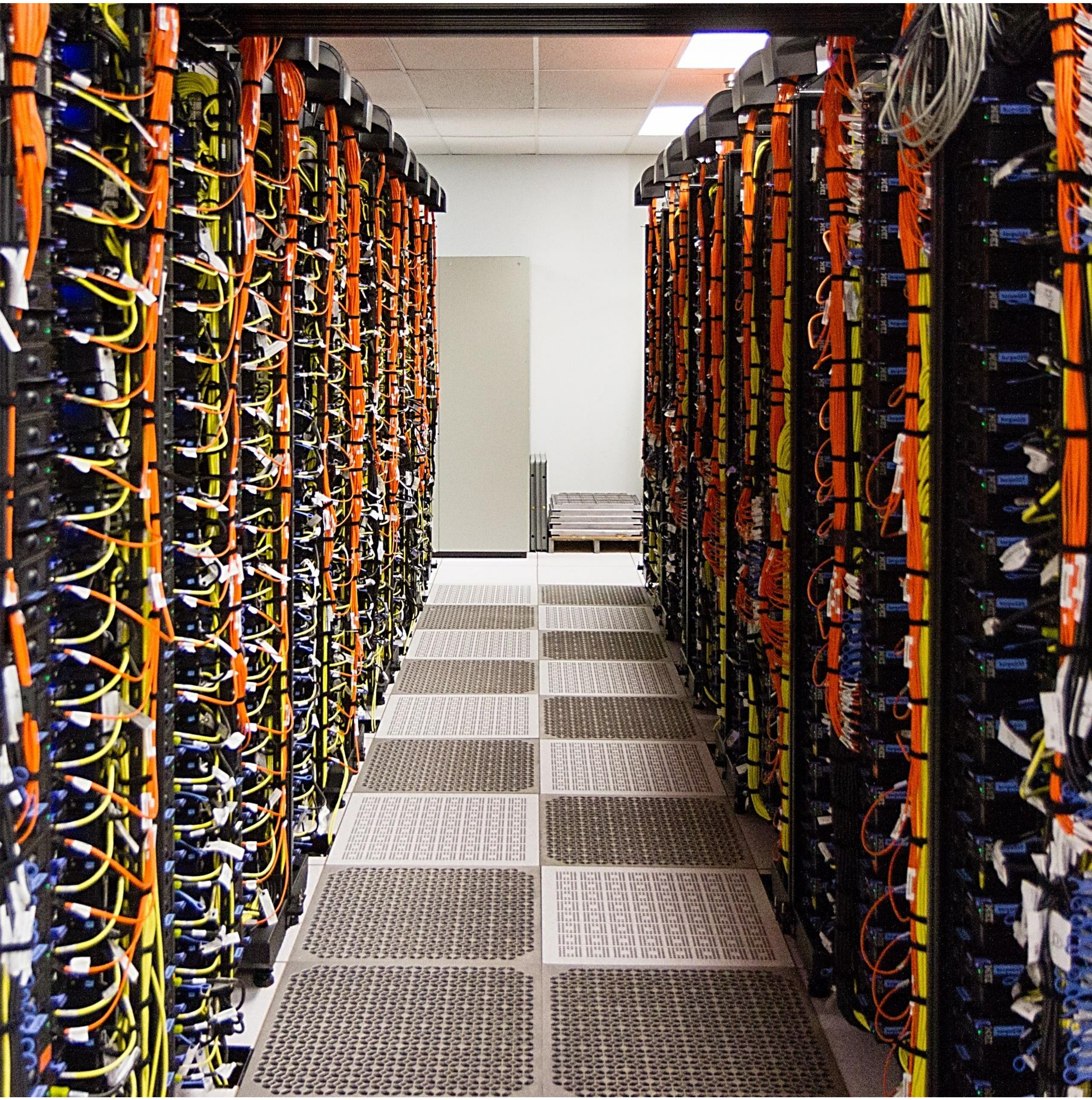
From Reactive to Anticipatory: Scaling AI for Sustainable Development in the Arab Region

By Yusuf E. Younis



Executive Summary

Artificial intelligence is becoming a foundational capability for service delivery, industrial upgrading, and public-sector modernization. For the Arab region, the transition to AI-intensive economies intersects with three structural realities: (i) electricity systems already under pressure from demand growth and high cooling loads; (ii) chronic water scarcity and exposure to heat and drought; and (iii) uneven digital infrastructure and governance capacity across Arab countries. These conditions make the environmental footprint of AI (energy, water, materials, and e-waste) a policy-relevant issue, while also increasing the value of AI as an enabling tool for addressing the region's pressing development challenges and fulfilling international commitments.

Evidence indicates that the resource trajectory is steep. Data-centre electricity consumption has grown rapidly in recent years, driven by cloud and AI workloads, while corporate operational emissions linked to AI expansion have increased in several leading firms. Water demands are also increasingly remarkable. AI model development and deployment rely on cooling and electricity generation systems that can create direct and indirect water footprints, with emerging estimates suggesting that global AI-related water withdrawals may rise substantially in the near term. These dynamics are especially policy-relevant for the Arab countries where marginal water withdrawals are contested and where peak electricity demand is dominated by cooling.

The core finding is that the Arab region can manage AI's footprint while scaling benefits through technological leapfrogging and a stronger science-policy interface. This entails (1) standardized sustainability metrics and reporting for AI and data centres; (2) embedding Integrated Water Resources Management (IWRM) principles in cooling water governance; (3) circular-economy approaches to ICT equipment and e-waste; and (4) narrowing the "AI divide" through regional cooperation on compute access, skills, and participation in standards and governance.

And while the Middle East is on a rapid data-centre expansion path, Sub-Saharan Africa remains far lower on a per-capita basis but is attracting renewable-linked data-centre investments in select hubs. Southeast Asia demonstrates how water and power constraints can quickly become licensing issues, prompting sustainability-linked roadmaps and tighter planning requirements. These comparisons reinforce a practical lesson for the Arab region: sustainability criteria must be built into planning and permitting now, before lock-in occurs.

Introduction and scope

AI's environmental footprint is not limited to "model energy use." It deals with the entire life cycle, namely: minerals extraction, hardware manufacturing, data-centre construction and operation, electricity generation, cooling water, and end-of-life management. This lifecycle perspective is central to the concept of Sustainable AI, which distinguishes between AI for sustainability (AI applications supporting environmental objectives) and the sustainability of AI (reducing AI's own impacts and ensuring equitable distribution of benefits and burdens). And fundamentally, sustainability is not a constraint, it is a pathway to resilient, competitive digital infrastructure.

For the Arab region, AI sustainability is not marginal. It sits at the intersection of (1) climate commitments and energy security, especially where additional baseload and peak loads interact with summer cooling demand; (2) Water scarcity, where data-centre cooling and indirect water use can generate trade-offs; and (3) biodiversity and pollution risks, including supply-chain impacts and e-waste handling.

The report adopts a solutions-oriented position. AI infrastructure is treated as essential development infrastructure. The purpose is to identify implementable policy levers—standards, licensing criteria, procurement rules, and cooperative mechanisms—that enable evidence-based policy-making and regional cooperation.

A Measurable Impact

A recurring challenge in sustainable AI is the absence of consistent, comparable measurement (Banipal et al., 2023). Environmental impacts are often estimated with different systems and varying assumptions, which can undermine policy credibility and public trust. Without agreed indicators, the debate risks ever shifting between exaggerated optimism and unfocused concern.

Two principles are particularly policy-critical:

- **System boundaries:** narrow accounting (e.g., training electricity only) misses upstream and downstream impacts (indirect water use, embodied emissions in chips, construction materials, e-waste).
- **Context sensitivity:** impacts vary sharply by location and design—especially grid carbon intensity and cooling choice—meaning "one global number" is rarely decision-useful.

A practical science-policy interface should translate broad sustainability frameworks into a small set of decision-relevant metrics. For the Arab region, high-leverage metrics are: (i) electricity use and associated emissions; (ii) direct and indirect water use; (iii) materials, equipment turnover, and e-waste plans; and (iv) equity indicators relevant to the AI divide (skills, access, and participation).

Measurement should be aligned with planning processes: licensing thresholds, grid impact assessments, water allocations, and procurement. This makes sustainability measurable, enforceable, and compatible with potential investments.

Regional Baseline: Why The Arab Region Is a Distinctive "Energy–Water–AI" Nexus

The Arab region spans high-income and middle-income contexts, as well as fragile and conflict-affected situations. Yet four common structural features shape AI sustainability:

1. **Hot climates:** higher cooling demand raises electricity consumption and, for some designs, cooling water consumption.
2. **Water scarcity:** many countries operate with structural deficits and high sensitivity to drought; marginal industrial water use is politically salient.
3. **Rapid infrastructure build-out:** several Arab economies are expanding data-centre capacity quickly, driven by cloud services, AI adoption, and digital economy strategies.

4. **Institutional heterogeneity:** e-waste governance, environmental licensing, and data governance vary widely, underscoring the need for minimum common standards and interoperable reporting.

The policy implication is clear: sustainability cannot be treated as an add-on. It must be embedded into datacentre permitting, public procurement, and energy-water planning, with clear institutional roles for utilities, water authorities, environment protection agencies, and IT ministries.

Energy & Carbon Footprint: Grids & Cooling Demand

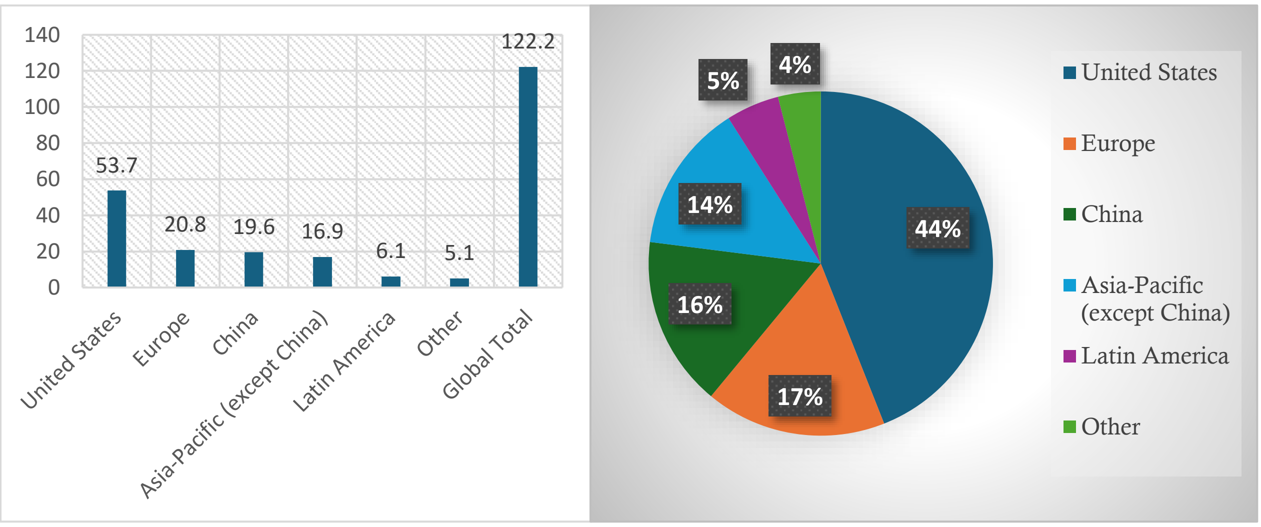
Data centres are on a rising electricity trajectory globally, with AI workloads a leading driver. In hot climates, the "AI load" is amplified by cooling needs. For Arab utilities, the system-level issue is not only annual energy but peak management: clustering of large facilities can add both baseload and peak demand, reinforcing the case for integrated planning, demand response, and grid flexibility.

The carbon impact of AI is strongly shaped by the electricity mix and by siting decisions (Dhar, 2020). Locating compute in lower-carbon electricity systems and procuring clean power is key to reduce emissions. In practice, data-centre siting and design become climate policy decisions, not just ICT decisions—directly aligning with the mitigation pathways.

Comparative node (Sub-Saharan Africa): the African experience underscores a different risk profile—limited capacity and power reliability can increase dependence on backup generation and external hosting, raising both cost and emissions intensity. The lesson for the Arab region is to avoid resilience models anchored in high-emission backup systems and instead prioritize grid upgrades, storage, and low-carbon resilience options.

Implementable policy options include grid impact assessments for large facilities; carbon-aware procurement and power purchase agreements; performance thresholds for energy efficiency adapted to hot climates; and transparent reporting aligned with international sustainability guidance.

Global Data Centre IT Power Capacity by Region (Q1 2025)



Compiled by author using data from The Global E-waste Monitor (2014, 2017, 2020, and 2024 editions) by UNU, UNITAR, ITU, and ISWA.

Water Footprint: Cooling In Arid Climates & IWRM-Aligned Governance

Currently, water is the Arab region's binding constraint. AI's water footprint arises through direct cooling water and indirect water embedded in electricity generation and supply chains. These impacts are frequently under-reported in public discourse, and measurement practices remain uneven.

From an IWRM perspective, data-centre water demand is not merely a technology issue but an allocation issue across sectors and basins. An IWRM-aligned approach for AI infrastructure should prioritize:

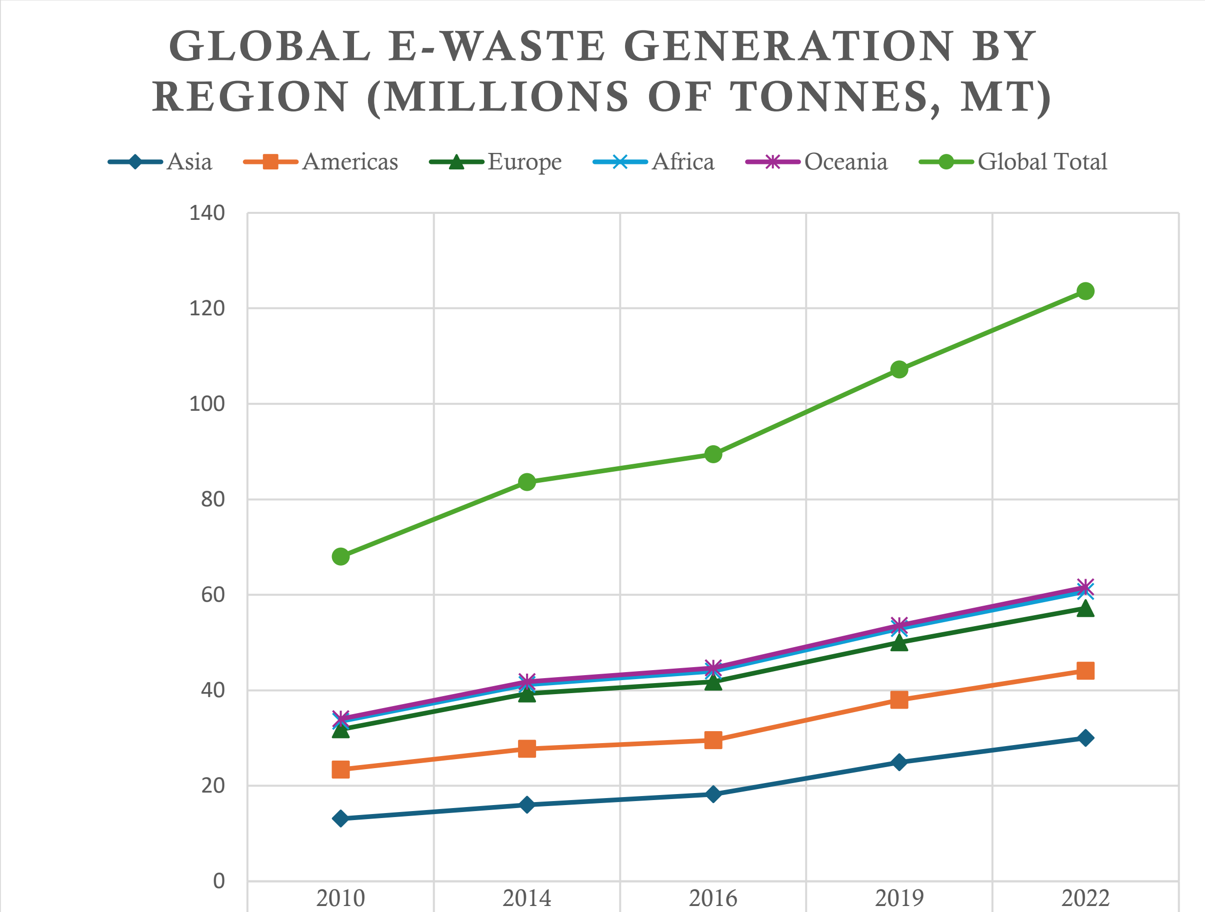
1. **Mandatory water accounting** (direct and, where possible, indirect).
2. **Preferential use of non-potable sources**, including treated wastewater and reclaimed water.
3. **Cooling design guidance** for hot-arid contexts to minimize water stress and manage trade-offs with energy efficiency.
4. **Transparent stakeholder engagement** for major projects to strengthen social licence and reduce conflict risks.

Comparative node (Southeast Asia): Southeast Asia illustrates how water governance can become a licensing constraint. In several markets, water stress concerns, tariff reforms, and sustainability-linked planning have become central to approvals and investment attractiveness. The policy takeaway for the Arab region is to mainstream water criteria early, rather than retrofitting governance after scarcity conflicts emerge.

Materials & E-Waste: Circular Economy Alignment

AI depends on hardware, minerals, and global supply chains. Environmental risks occur upstream (mining impacts, pollution from manufacturing) and downstream (hazardous e-waste handling and informal processing). Globally, e-waste generation continues to rise faster than formal collection and recycling, implying mounting pollution and resource loss risks (Baldé et al., 2024). For the Arab region, the challenge is dual: managing domestic e-waste flows while preventing the region from becoming a destination for informal or illicit flows that exploit regulatory gaps.

A practical circular strategy treats ICT lifecycle management as a competitiveness and public health issue. High-feasibility measures include Extended Producer Responsibility (EPR); certified recycling and refurbishment ecosystems; green procurement requirements (take-back, repairability, lifecycle disclosure); and regional enforcement cooperation to reduce illegal shipments and regulatory arbitrage.



	2010	2014	2016	2019	2022
Global Total	34	41.8	44.7	53.6	62
Oceania	0.5	0.6	0.7	0.7	0.9
Africa	1.7	1.9	2.2	2.9	3.5
Europe	8.4	11.6	12.3	12	13.1
Americas	10.3	11.7	11.3	13.1	14.1
Asia	13.1	16	18.2	24.9	30

The AI Divide: Capability, Equity, & Governance

The "AI divide" is not only about connectivity. It includes access to compute, cloud services, skilled labour, high-quality datasets (including Arabic language resources), and representation in global decision-making. Global South perspectives emphasize that AI governance can reproduce structural inequalities when standards and rules are set without meaningful participation, while material burdens (labour, extraction, and waste) are externalized (M.-T. Png, 2022).

For the Arab region, the risk is a two-speed outcome: a small number of hubs concentrate investment and compute capacity while other countries remain dependent on external infrastructure and services. This becomes an environmental justice issue if burdens—such as e-waste handling or resource-intensive siting—shift toward weaker regulatory environments.

Comparative node: Africa's low per-capita data-centre footprint highlights dependence risks, while Southeast Asia's rapid scale-up highlights governance and social licence risks when infrastructure growth outpaces resource planning.

Policy responses should emphasize cooperation and practicality: regional compute and research partnerships; capacity building for regulators and ministries at the science-policy interface; open public-good datasets; and coordinated participation in standards bodies to shape sustainability reporting and governance norms.

AI For Rio Conventions: Scaling Benefits While Managing Trade-Offs

Artificial Intelligence (AI) is increasingly positioned as a decision-support layer that can help Arab countries move from reactive environmental management to anticipatory, risk-informed governance. The value proposition is strongest where the region faces chronic data gaps, high climate exposure, and tight resource constraints—especially water scarcity, land degradation, urban air pollution, and coastal risks. At the same time, the region's AI strategy must be "two-sided": leveraging AI for sustainability while also managing the sustainability of AI (energy, water, and material footprints) across the full lifecycle of AI systems (van Wynsberghe, 2021).

Air quality, dust storms, and emissions intelligence

Across major Arab metropolitan corridors, AI can improve air quality management by integrating information from satellite observations, low-cost sensors, traffic data, and meteorology to generate high-resolution exposure maps and short-term forecasts. This enables practical targeted interventions delivered through an integrated "urban dashboard" model. In arid subregions, AI-enabled dust-storm early warning is particularly material: machine learning can reduce uncertainty in localized dust lifting and transport, improving preparedness for health systems, transport and aviation, and solar power operations.

The same air-quality analytics can strengthen GHG inventories and mitigation tracking by better attributing emissions to sectors and by quantifying policy impacts. This improves MRV readiness, which is often a bottleneck for scaling climate finance and credible NDC implementation.

Strengthening IWRM and Drought/Flood Forecasting

AI can be operationalized as a core enabler for Integrated Water Resources Management (IWRM), particularly when it comes to demand forecasting, and drought/flood early warning. The strongest near-term payoffs in Arab countries typically come from (a) municipal non-revenue water reduction, (b) irrigation efficiency, and (c) drought impact readiness for agriculture and food security. These applications align with a broader global evidence base on AI supporting drought prediction and flood forecasting through machine/deep learning on hydro-meteorological data (Agrawal, 2024).

Water gains from AI must be balanced against AI's own water footprint. Training large models can consume substantial freshwater for cooling; one estimate notes GPT-3 (an older version released in 2020) training could directly evaporate ~700,000 litres of ultra-pure freshwater, and global AI demand could drive 4.2–6.6 billion m^3 of water withdrawal in 2027 (Li et al., 2025). This is strategically important for the Arab region, where water stress is structural rather than cyclical.

Addressing Desertification & Drought Resilience

AI is well-suited to land monitoring at scale—particularly for drylands where field data is limited and changes are spatially heterogeneous. Using remote sensing plus machine learning, Arab countries can strengthen Land Degradation Neutrality (LDN) pathways by tracking vegetation cover, soil moisture proxies, rangeland condition, erosion hotspots, and post-disturbance recovery (e.g., fire or conflict impacts). AI can also optimize sustainable agriculture by improving decisions on irrigation, pest management, and soil management practices (Pachot & Patissier, 2023), providing an actionable bridge between national monitoring and local extension services.

Marine Protection and Coastal Resilience

Coastal and marine systems are economically and culturally strategic for many Arab states (Mediterranean, Red Sea, Gulf, Atlantic). AI can improve marine spatial planning and biodiversity conservation by automating habitat mapping, species detection, and anomaly identification (e.g., coral bleaching signals, harmful algal blooms). Recent peer-reviewed work has demonstrated machine learning approaches for monitoring coral reef cover in the Red Sea using long time-series data, illustrating how AI can strengthen evidence-based conservation in regional reef systems.

For climate adaptation, AI can enhance coastal risk analytics: shoreline change detection, storm surge impact estimation, and prioritization of nature-based solutions (mangroves, seagrass) versus hard infrastructure. This supports investment-grade coastal adaptation planning—especially when linked to tourism assets, ports, and critical infrastructure.

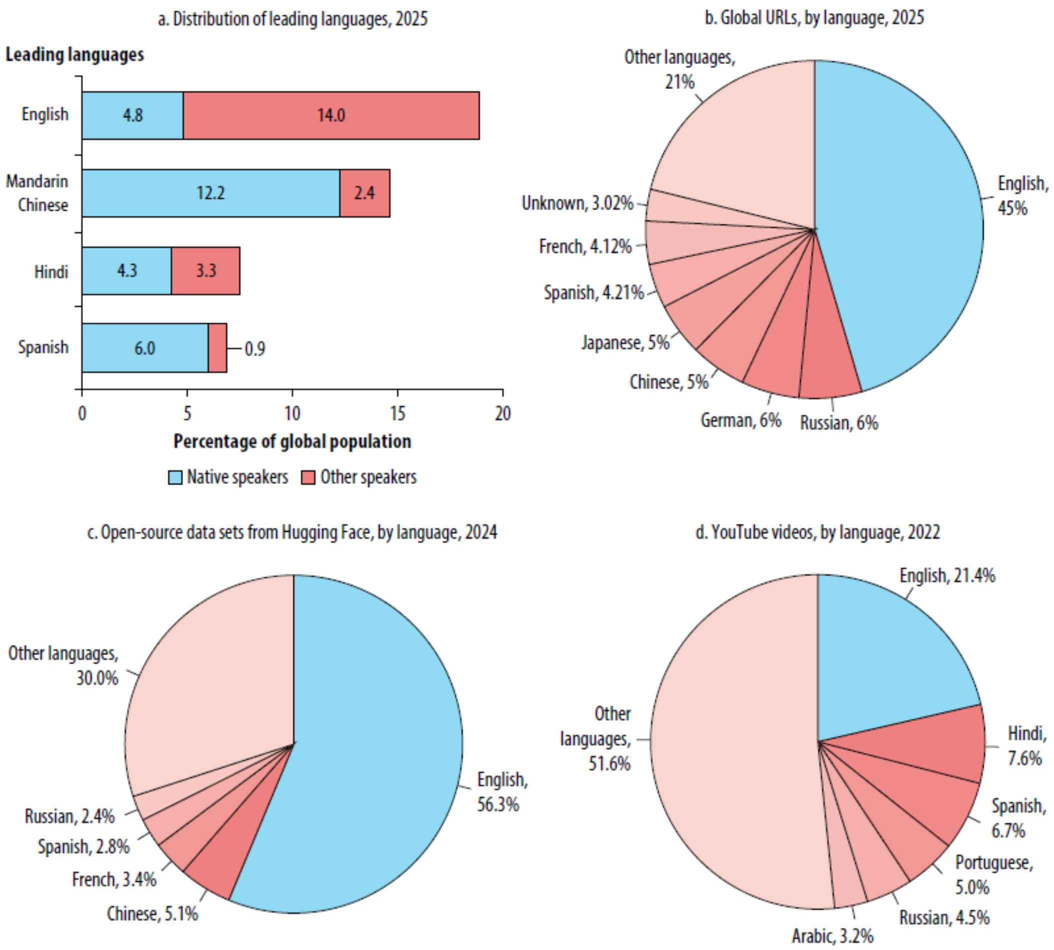
Critical Considerations Regarding Governance, Equity, And "Fit-For-Context" Deployment

Across all domains, Arab-region success depends less on model sophistication and more on governance quality: data access, institutional interoperability, and accountability. Two risks are particularly material:

1. **Bias and weak data governance**
   Environmental AI systems inherit biases from how data is collected, represented, and curated; governance frameworks increasingly emphasize rights-based and trustworthy approaches, while acknowledging that "bias-free" data is often unrealistic and definitions of fairness differ across contexts (Leavy et al., 2020).

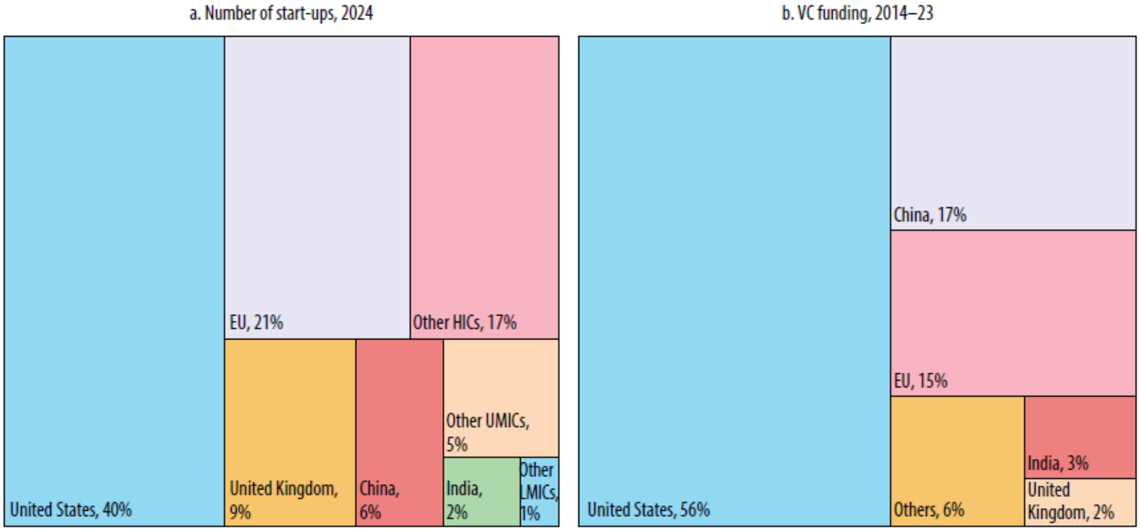
2. **Digital colonialism / context mismatch**
   Imported AI systems trained on other regions' datasets may misfire in Arab socio-ecological realities (aridity, informal settlements, conflict constraints). Research stresses that AI in the Global South is often marginalized due to the dominance of Global North narratives, resulting in limited inclusion of local perspectives and culturally contextual approaches, which requires informed governance frameworks that foster local stakeholder participation and capacity-building (Ghozali, n.d.). It also highlights the risk of contextual incompatibilities when country-specific training datasets are missing (M. T. Png, 2022).

FIGURE 4.3 Predominance of English in online content



Sources: Original figures for this publication based on calculations using Ethonologue 2025 data (https://www.ethnologue.com/); CommonCrawl data accessed in July 2025 (https://commoncrawl.org/); OECD.AI data updated on April 22, 2024 (https://oecd.ai/en/); and Figure 18 in McGrady et al. 2023.
Note: AI = artificial intelligence.

FIGURE 4.2 Training AI in a data desert: VC investments in training data, by country and region



Sources: Original figures for this publication using calculations from OECD.AI (https://oecd.ai/en/data?selectedArea=investments-in-ai-and-data&selectedVisualization=vc-investments-in-data-start-ups-by-country) and CB Insights (https://www.cbinsights.com/); data extracted in September 2024.
Note: Start-ups in the training data sector were selected because the keywords *data management, data collection,* or *data tracking* were present in their company descriptions. EU = European Union; HICs = high-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries; VC = venture capital.

equity, and regional resilience. Recognizing the differentiated responsibilities of developing nations in the Global South, policy approaches should reflect varying capacities while advancing shared regional standards.

Regional Framework for Sustainable AI Governance	**Embed Integrated Water Resources Management (IWRM) in Digital Infrastructure Planning**
A regionally coordinated framework would reduce regulatory fragmentation and strengthen collective power in global digital markets. The key elements of such a framework are: • Standardized Regional Sustainability Reporting for AI Infrastructure for: energy use and carbon intensity, direct and indirect water consumption, e-waste and lifecycle management plans, and social inclusion and capacity-building indicators.	Given the structural water constraints in many Arab states, AI infrastructure must be aligned with basin-level water planning. Recommended actions: • Prioritize non-potable and treated wastewater sources for cooling. • Incorporate digital infrastructure projections into national water allocation models. • Develop regional technical guidelines for cooling in hot-arid climates. • Facilitate cross-ministerial coordination between digital, water, energy, and environment authorities.

• AI infrastructure planning should be incorporated into climate mitigation and adaptation pathways, ensuring that digital growth supports energy transition strategies.	This approach reframes water governance as a strategic enabler rather than a persistent constraint.

Public-Private Partnerships (PPPs) for Sustainable Infrastructure	**Advance Regional Data Sovereignty with Cooperative Architecture**
AI infrastructure development is largely private sector driven and shall remain so in the near future. Governments should create enabling environments that incentivize sustainability while maintaining investment attractiveness. Public-Private Partnerships can: • Co-finance renewable-powered data centres. • Support wastewater reuse systems linked to industrial zones. • Develop certified regional e-waste recycling and refurbishment hubs. • Facilitate innovation initiatives for low-energy and low-water AI solutions.	Regional Data Sovereignty does not imply isolationism. Rather, it involves: • Strengthening domestic and regional hosting capacity. • Ensuring compliance with national regulatory frameworks. • Protecting public-interest datasets. • Enabling cross-border interoperability under mutually agreed standards. A cooperative regional cloud or federated data ecosystem could reduce dependence on external infrastructure while maintaining openness to global markets. Such arrangements should recognize differentiated capacities—allowing smaller economies to participate through shared platforms rather than standalone infrastructure; so, no one is left behind.

Accelerate Circular ICT and E-Waste Formalization	**Bridge the AI Divide through Shared Capacity Platforms**
A coordinated regional approach to e-waste can: • Harmonize Extended Producer Responsibility (EPR) frameworks. • Develop regional certification systems. • Reduce illegal shipments and informal disposal. • Create green jobs in refurbishment and materials recovery.	To avoid fragmentation within the region: • Establish regional AI research clusters. • Share computational infrastructure through pooled funding mechanisms. • Support Arabic-language datasets and open public-interest data. • Strengthen participation in international AI governance forums. This ensures that AI growth does not concentrate benefits unevenly and reinforces

Rather than focusing on enforcement gaps, the policy emphasis should be on capacity-building and investment mobilization.	the principle of equitable technological development.

Support Technological Leapfrogging	**Strengthen the Science-Policy Interface**
The Arab region has the opportunity to embed sustainability criteria into AI expansion from the outset. Technological leapfrogging may include: • Direct integration of renewable energy in data-centre development. • Adoption of water-efficient cooling technologies tailored to arid climates. • Early implementation of circular economy requirements. • Deployment of AI tools for climate adaptation, biodiversity monitoring, and land restoration. Rather than retrofitting environmental safeguards later, proactive integration reduces long-term costs and strengthens global competitiveness.	Finally, evidence-based decision making requires institutionalized knowledge exchange. Recommendations: • Establish an Arab Sustainable AI Observatory under a regional platform. • Develop joint research programs linking universities, practitioners, and regulators. • Facilitate regular policy dialogues on the Digital–Water–Energy nexus. • Promote shared data repositories for sustainability metrics. This enhances transparency, builds trust, and supports iterative, evidence-based policy refinement.

Conclusion

The environmental footprint of AI in the Arab region is not a peripheral issue; it is structurally intertwined with energy systems, water governance, material flows, and equity considerations. Yet these same systems provide an opportunity for coordinated, forward-looking policy design. AI's sustainable potential will be realized through well-designed applications for climate action, biodiversity protection, and land degradation management. The strategic opportunity is technological leapfrogging: embedding low-carbon electricity, IWRM-aligned water governance, and circular economy principles into AI infrastructure from the outset.

By emphasizing Public-Private Partnerships, regional data sovereignty, IWRM alignment, circular economy principles, and differentiated responsibilities across the Global South, the Arab region can position itself not merely as a technology adopter, but as a contributor to sustainable AI governance frameworks.

The path forward is cooperative rather than competitive, systemic rather than fragmented, and evidence-driven rather than reactive. Through regional coordination and pragmatic implementation, AI can reinforce—not undermine—the environmental and development objectives shared across the Arab region and its Global South partners.

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