Pakistan Is Not Poor, It Is Poorly Managed: An Empirical Investigation of Energy, Water, and Demographics in Pakistan

Anam Sajjad[1,*] **M Yousaf**[2]

1 Department of Political Science, Bahauddin Zakariya University (BZU), Multan 60800, Pakistan
2 Department of Software Engineering, Emerson University Multan, Multan 60000, Pakistan

*Corresponding Author: anoom994@gmail.com (Alt: anamsajjad171@gmail.com) | Co-Author: mrjosephofficial085@gmail.com

---

Abstract

Context: Developing economies frequently attribute macroeconomic instability and infrastructure deficits to natural resource scarcity. This study evaluates that claim in Pakistan by comparing physical resource endowments with actual developmental outcomes across three core sectors: energy, water, and human capital.

Interdisciplinary Approach: We combine political economy frameworks—specifically institutional quality, contractual lock-in, and common-pool resources—with practical software and data engineering perspectives, including automated metering, telemetry, and open digital infrastructure. This allows us to pinpoint the governance bottlenecks that prevent effective resource utilization.

Empirical Findings: In the energy sector, although the Thar coalfield holds 175.5 billion tonnes of in-situ lignite, commercially proven measured deposits stand at only 2.70 billion tonnes (with 1.57 billion tonnes mineable in Block II). Meanwhile, rigid take-or-pay sovereign contracts have pushed annual capacity payments past Rs 2.18 trillion, driving total energy circular debt to Rs 5.286 trillion (including Rs 1.835 trillion in power liabilities that breached IMF targets by Rs 221 billion). In the water sector, the 16.2 million hectare Indus Basin Irrigation System delivers over 90% of national food production but maintains live reservoir storage of merely 13.168 million acre-feet (MAF). This represents only a 30-day carryover buffer—compared to 120–220 days in India and 1,000 days in Egypt—worsened by 64% canal conveyance losses and widespread groundwater overdraft (affecting 50.2% of irrigated land). Demographically, the 2023 Digital Census records 241.49 million citizens with 67% under age 30 (160.11 million youth). However, sovereign debt servicing absorbs 81% of net federal tax revenues, heavily crowding out education and public health. Simultaneously, promising IT exports ($4.60 billion in FY2026) face serious infrastructure hurdles, including internet throttling, payment gateway barriers, and unstable power grids.

Policy Model: We formulate a practical, quad-pillar governance model: (1) centralized public project execution dashboards, (2) independent forensic audits of sovereign power generation contracts, (3) real-time smart-meter telemetry for power feeders and canal headworks, and (4) regulatory facilitation for digital service

exporters. We conclude that institutional transparency and verifiable data accountability are the essential preconditions for sustainable economic stability in Pakistan.

Keywords: Natural resource curse, circular debt, capacity payments, Indus Basin Irrigation System, water storage deficit, demographic dividend, IT exports, governance transparency, Pakistan economy.

JEL Classification Codes: Q43 (Energy and Macroeconomy), Q25 (Water Resources), J11 (Demographic Trends and Macroeconomic Outlook), H63 (National Debt; Debt Management), O53 (Economywide Country Studies: Asia – Pakistan).

1. Introduction and Problem Statement

A foundational idea in development economics is that countries with abundant natural resources, fertile agricultural land, and a young, growing population have the essential tools needed for sustained economic growth and prosperity [8, 14]. Nations blessed with vast river networks, major fossil fuel basins, and favorable demographic structures are expected to escape poverty through productive investment and industrial growth. In Pakistan, however, public leaders and political discourse frequently blame natural resource scarcity for persistent electricity shortages, agricultural water deficits, chronic budget crises, and sluggish economic growth [20, 39].

When examined against verifiable empirical evidence, this scarcity argument falls apart. Pakistan possesses significant natural and human endowments [2, 9, 30]:

- Energy: The Thar desert contains an estimated 175.5 billion tonnes of in-situ lignite coal, ranking among the world's largest single deposits.
- Water: The Indus Basin Irrigation System (IBIS) covers 16.2 million hectares (Mha) of command area, supporting over 90% of Pakistan's agricultural output.
- Demographics: According to the 2023 Digital Census, 67% of Pakistan's 241.49 million people are under age 30, creating a young workforce of 160.11 million people.
- Technology: Export earnings from information technology and IT-enabled services (ITeS) reached a record $4.60 billion in FY2025-26, showing the high potential of the educated youth.

Despite these substantial endowments, Pakistan faces chronic balance-of-payments crises, severe sovereign debt burdens, and repetitive emergency bailouts under International Monetary Fund (IMF) programs, including the current Extended Fund Facility (EFF) [17, 41]. The energy sector carries an accumulated circular debt of Rs 5.286 trillion (5.1% of national GDP). Major water reservoirs store only roughly 30 days of river flow, while nearly two-thirds of the water diverted into canals is lost before reaching crops. At the same time, federal debt servicing consumes 81% of net federal tax revenues, leaving almost nothing for schools, healthcare, and digital infrastructure.

This sharp contrast between rich physical endowments and poor economic outcomes is a classic resource-governance paradox. The fundamental issue is not physical scarcity, but institutional mismanagement: non-transparent procurement, rigid sovereign contracts, unmonitored network losses, and distorted economic incentives [23, 36, 44]. Furthermore, public discussions are often confused by unrealistic claims—such as assertions that Thar coal is equal to the oil reserves of Saudi Arabia, or that unused river water causes tens of billions in losses annually. Such claims distract from real technical constraints, misdirect public funds, and delay practical reforms.

This paper investigates Pakistan's resource-governance paradox using an empirical approach. By combining political economy insights on institutional incentives with practical data and software engineering concepts—such as real-time telemetry, automated metering, and open data dashboards—we examine why these resources fail to deliver stability and propose realistic, low-cost reforms.

Table 1 summarizes the stark differences between popular claims and empirical reality across energy, water, and demographics.

Table 1. Empirical Summary: Natural Endowments vs. Operational Realities in Pakistan

Domain / Dimension	Natural Endowment / Popular Claim	Operational & Governance Reality
Thar Coal Resource	175.5 billion tonnes total in-situ geological deposit; often compared to Gulf oil.	Only 2.7 billion tonnes measured; 1.57 billion tonnes mineable in Block II; high moisture (40–50%) lignite requiring mine-mouth power generation.
Power Capacity	Installed generation capacity expanded to ~45,000 MW (~42,100 MW dependable).	Winter power demand drops to 12,000–14,000 MW; over 16,000 MW stays idle; idle capacity forces annual capacity payments of Rs 2.18 trillion.
Energy Circular Debt	Public discourse views load-shedding primarily as an energy fuel shortage.	Total circular debt reached Rs 5.286 trillion (~$19B USD, 5.1% of GDP), driven by fixed capacity payment obligations and transmission theft/losses.
Irrigation Water Delivery	Indus Basin canal network services over 16.2 million hectares of arable farmland.	System delivery efficiency is only 36% (64% lost to canal seepage, minor spillage, and poor field application).
Reservoir Storage	Annual surface river inflow averages 140–145 million acre-feet (MAF).	Active live reservoir storage is only 13.168 MAF, giving merely a 30-day carryover buffer compared to 120–220 days in India and 1,000 days in Egypt.
Groundwater Aquifer	Rich alluvial aquifer used for supplemental irrigation via tubewells.	Over 1.2 million tubewells pump groundwater without extraction limits, causing water tables to drop 1–3 meters annually in key basins.
Demographics & Youth	241.49 million citizens; 67% under 30 (160.11 million youth) providing a huge labor pool.	26.2 million out-of-school children; debt servicing consumes 81% of net federal tax revenues, heavily crowding out education and public healthcare.

2. Theoretical Framework and Literature Review

To understand why rich resources do not automatically translate into economic stability, we integrate four established theoretical frameworks from political economy, institutional economics, and growth theory.

2.1 The Resource Curse and Institutional Quality

The natural resource curse hypothesis, pioneered by Auty (1993) and Sachs and Warner (2001), observes that resource-abundant developing nations often grow more slowly, experience higher inequality, and suffer from weaker governance than peers with fewer natural resources [8, 14]. Mehlum, Moene, and Torvik [23] showed that institutional quality is the deciding factor: when institutions are transparent and protect the public interest ('producer-friendly'), resources drive technological innovation and capital formation. But when institutions are weak or opaque ('grabber-friendly'), resource rents lead to unproductive rent-seeking, patronage distribution, and administrative decay [10, 18, 36].

In Pakistan, this vulnerability appears as a structural 'quasi-resource curse' [25, 43, 44]. Although Pakistan is not an oil exporter, the government distributes discretionary sovereign guarantees, non-cost-reflective power contracts, subsidized gas, and unmetered canal water to politically influential groups. As Adams et al. [1] and Sharma and Paramati [38] observed in other emerging markets, these rents distort market incentives, encouraging companies to lobby for subsidies rather than improve technical productivity. The state absorbs commercial risks through sovereign guarantees and passes the resulting debt onto captive tariff-paying citizens.

2.2 Contract Inflexibility and Monopsony Risks in Infrastructure

Transaction Cost Economics (Williamson, 1985; Joskow, 1987) examines the risks of bilateral monopolies and contract lock-in in large infrastructure projects. Power plants require massive upfront capital and take decades to pay off. To encourage private investment, developing nations often sign long-term Power Purchase Agreements (PPAs) that offer sovereign guarantees, US dollar-indexed returns on equity (ROE), and Take-or-Pay capacity payments [7, 35].

However, as Joskow (1987) and Bacon [7] warned, long-term Take-or-Pay contracts that lack flexible risk-sharing shift all market, demand, and foreign exchange risks onto the government buyer (monopsony). In Pakistan, the Central Power Purchasing Agency-Guaranteed (CPPA-G) is contractually bound to pay fixed capacity charges whether electricity is used or not [26, 34, 37]. When generation capacity outgrew transmission limits and winter demand dropped, capacity payments surged, creating severe financial insolvency [3, 31].

2.3 Common-Pool Resources and Collective Action in Water

Large river basins and underground aquifers are classic Common-Pool Resources (CPRs), characterized by high subtractability and difficulty of exclusion (Ostrom, 1990). In gravity-fed canal networks, asymmetric geography creates a head-to-tail dilemma: upstream farmers draw excessive water, leaving downstream farmers with shortages and salty soil [1, 19, 40].

Ostrom established that managing CPRs sustainably requires clear boundaries, shared costs, transparent monitoring, and graduated penalties. In the Indus Basin, manual water measurements at canal gates rely on paper logbooks, which are prone to tampering and political pressure. This has

fueled inter-provincial mistrust under the 1991 Water Apportionment Accord [4, 16]. Because canal supplies are unreliable, farmers have installed over 1.2 million private tubewells, creating an unmonitored groundwater race that depletes aquifers at 1–3 meters each year [9, 11, 24, 33, 46].

2.4 Demographic Dividend and Public Capital Complementarity

Demographic transition theory (Bloom, Canning, and Sevilla, 2003) explains that when birth rates decline, a country temporarily enters a window where working-age people outnumber dependents—a demographic dividend that can boost per capita economic growth [5, 13]. Modern growth theory (Lucas, 1988; Lam, 2011 [22]), however, emphasizes that this dividend does not happen automatically. It requires public investments in education, technical skills, and reliable physical and digital infrastructure [12, 15].

When debt servicing consumes 81% of net tax revenues, public spending on schools and skills is heavily squeezed [28, 29]. As 3.5 million young people enter the job market each year, the economy struggles to create formal jobs. The digital services and IT export sector offers an essential escape valve for this educated youth, enabling them to earn foreign currency globally without requiring capital-heavy domestic manufacturing [28, 42].

3. Research Methodology and Formal Specifications

This study uses an empirical, interdisciplinary approach combining quantitative policy analysis with institutional evaluation. By bringing together perspectives from Political Science and Software Engineering, we evaluate both the legal and governance structures of public contracts and the technical data systems needed to track real performance.

3.1 Verified Data Sources

- Energy Data: Annual State of the Industry Reports from NEPRA, statistical bulletins from the Power Division, and mining reports from the Geological Survey of Pakistan (GSP) and SECMC [6, 26, 27].
- Water Data: Hydrological records and reservoir live storage numbers from WAPDA, conveyance studies from the FAO, and groundwater research from PCRWR [33, 45].
- Macroeconomics & Demographics: Official 2023 Digital Census results from the Pakistan Bureau of Statistics (PBS), monthly reports from the State Bank of Pakistan (SBP), and IMF Country Reports [17, 30, 41].
- Digital Economy: IT export receipts from the State Bank of Pakistan and freelance market share data from the Oxford Online Labour Index [42].

3.2 Analytical Formulations

We specify four formal analytical equations to model performance across energy, water, and contract finance:

- 1. Circular Debt Accumulation: $\Delta CD_t = (CP_t + F_t - R_t) + L^{(T\&D)}_t \cdot P_t + \Delta TDS_t + \beta \cdot \Delta e_t + i_t \cdot CD_{(t-1)}$, where CP_t represents fixed capacity charges, F_t is fuel expense, R_t is revenue collected, $L^{(T\&D)}$ is excess transmission losses, ΔTDS_t is delayed tariff subsidies, $\beta \cdot \Delta e_t$ is foreign exchange debt adjustment, and $i_t \cdot CD_{(t-1)}$ is commercial interest.
- 2. Multi-Stage Irrigation Conveyance Loss: $E_{sys} = e_{main} \cdot e_{dist} \cdot e_{wc} \cdot e_{field} \approx 0.84 \times 0.88 \times 0.75 \times 0.89 \approx 0.36$ (36%), showing that 64% of diverted surface water is lost before reaching plant roots.
- 3. Capacity Charge Formula: $CP_t = \Sigma [K_j \cdot (CPP_{base_j} + \alpha_j \cdot \Delta FX_t + \gamma_j \cdot \Delta KIBOR_t)]$, capturing the compounding impact of idle capacity K_j indexed to US dollars and local interest rates.
- 4. Groundwater Balance: $\Delta S_{gw} = R_{seep} + R_{rain} - (Q_{pump} + ET_{gw} + Q_{base})$, where persistent overdraft occurs when pumping Q_{pump} exceeds recharge, causing water tables to fall 1–3 meters annually.

4. Empirical Findings: Energy, Water, and Demographics

4.1 Energy: Resource Realities vs. Circular Debt

4.1.1 Geological Assessment of Thar Coal

In public speeches, Thar coal is frequently described as an endless reserve capable of powering Pakistan for centuries. A careful technical review reveals a crucial difference between total geological occurrences and commercially mineable coal:

- Total Geological Occurrence: GSP estimates 175.5 billion tonnes of lignite over 9,000 km², but 98.46% of this is only indicated or inferred, requiring significant exploration before mining.
- Measured Reserves: Proven deposits with high geological certainty total only 2.70 billion tonnes (1.54% of the total).
- Block II Commercial Mine: Confirmed mineable reserves in Thar Block II stand at 1.57 billion tonnes. While enough to support 5,000 MW of power for 50 years, this is 111 times smaller than the popular 175 billion tonne claim.
- Fuel Quality: Thar coal is low-rank lignite with high moisture (40–50%), making long-distance transport unviable and requiring mine-mouth power generation.

Table 2. Classification of Thar Coalfield Deposits (GSP / SECMC Baseline)

Deposit Category	Tonnage (Billion Tonnes)	Share (%)	Economic Description
Total In-Situ Resource	175.50	100.0%	Total regional geological occurrence across 9,000 km².
Measured Reserves	2.70	1.54%	High-assurance proven deposits confirmed through core drilling.
Block II Mineable Reserve	1.57	0.89%	Commercially mineable reserve currently supporting power plants.

Indicated / Inferred	172.80	98.46%	Unproven deposits requiring extensive exploratory drilling.

4.1.2 The Circular Debt Crisis and Capacity Payments

As of June 2026, Pakistan's combined energy circular debt reached Rs 5.286 trillion (5.1% of GDP). This includes Rs 3.50 trillion in the gas sector (driven by subsidized imported LNG and 10–14% gas theft/leakage) and Rs 1.835 trillion in the power sector under Ministry of Finance/IMF accounting, exceeding the IMF benchmark ceiling by Rs 221 billion.

The primary cause is rigid Take-or-Pay contracts. Installed generation capacity grew to ~45,000 MW (~42,100 MW dependable), but the transmission network can only evacuate ~25,500 MW. In winter, demand drops to 12,000–14,000 MW, leaving over 16,000 MW completely idle. Because contracts guarantee capacity charges regardless of use, annual capacity payments skyrocketed from Rs 465 billion in FY2018 to Rs 2.18 trillion in FY2026, making up 71.2% of total wholesale electricity tariffs.

4.2 Water Resources: The 30-Day Storage Deficit and Conveyance Losses

Agriculture uses over 90% of diverted surface water and contributes over 22% of national GDP. However, Pakistan's active live reservoir storage across Tarbela (5.580 MAF post-sedimentation), Mangla (7.277 MAF), and Chashma (0.311 MAF) totals only 13.168 MAF. This provides merely 30 days of carryover storage. As shown in Table 3, India maintains 120–220 days, Australia holds 500 days, the US Colorado River holds 900 days, and Egypt's Aswan High Dam stores 1,000 days.

Table 3. International Comparison of Carryover Storage Buffers in Major River Basins

River Basin / Country	Live Storage (MAF)	Buffer (Days)	Strategic Resilience Assessment
Indus Basin (Pakistan)	13.17	30	Extreme vulnerability; cannot bridge even a single delayed monsoon season.
Major River Basins (India)	~200.00	120–220	Substantial carryover storage; can absorb single-season droughts.
Murray-Darling (Australia)	28.50	500	Multi-year buffer designed for extended drought periods.
Colorado River (United States)	50.00	900	Multi-year protection for agricultural and municipal users across dry cycles.
Nile River (Egypt / Aswan)	130.00	1,000	Multi-year security; protects agriculture through several consecutive dry years.

In addition to storage deficits, 64% of water diverted into canals is lost: 16% in main canals, 12% in distributaries, 25% in unlined watercourses, and 11% during field application. As a result, farmers have installed over 1.2 million tubewells, causing underground water tables in Balochistan and Punjab to fall 1–3 meters annually and worsening soil salinity across 50.2% of farmland.

4.3 Demographics and IT Exports: Untapped Potential

The 2023 Digital Census established Pakistan's population at 241.49 million, with an intercensal growth rate of 2.55% per year—the highest in South Asia. Over 67% of citizens (160.11 million) are under 30 years old, with roughly 3.5 million youth entering the workforce annually. However, with 26.2 million children out of school and 81% of net tax revenues spent on debt service, funding for skills and education is severely limited.

In contrast, the digital economy has shown strong momentum. IT export receipts grew from $1.44 billion in FY2020 to $4.60 billion in FY2025-26. On the Oxford Online Labour Index, Pakistani freelancers hold a 12.4% global market share, ranking 3rd worldwide behind India (26.5%) and Bangladesh (14.8%). Yet reaching the official $10.0 billion target by FY2029 requires addressing three infrastructure obstacles: arbitrary internet throttling, lack of direct merchant payment gateways like PayPal and Stripe (which imposes 5–10% middleman fees), and 0% commercial 5G coverage with low fiber backhaul.

5. The Quad-Pillar Institutional Reform Model

Our empirical analysis shows that Pakistan's primary crises stem from institutional and administrative bottlenecks rather than physical shortages. To resolve these challenges without demanding massive foreign loans, we propose four pragmatic, low-cost interventions focused on transparency and telemetry:

5.1 Pillar 1: Open Public Project Execution Dashboards

Major public infrastructure projects frequently suffer from massive delays and cost overruns (for instance, the Neelum-Jhelum project expanded from Rs 84B to over Rs 500B). We propose an open online dashboard for all public energy and water projects valued above Rs 5 billion, publishing approved PC-I budgets, contractor payments, and physical completion milestones via open public APIs.

5.2 Pillar 2: Forensic Audits of Sovereign Power Contracts

Annual capacity payments of Rs 2.18 trillion cannot be solved simply by raising consumer electricity rates. We propose an independent technical audit of generation plants to test actual thermal efficiency against NEPRA allowances, recalculate equity returns for fully paid-off plants, and accelerate the transition toward competitive bilateral trading (CTBCM) where power plants sell directly to industrial buyers.

5.3 Pillar 3: Real-Time Grid and Canal Loss Telemetry

Aggregated billing hides where physical theft and water seepage actually occur. We propose installing smart AMI meters at all 11 kV electricity feeders to publish feeder-level losses on public GIS maps, and installing automated acoustic Doppler gauges at major canal junctions to establish transparent water data and rebuild inter-provincial trust under the 1991 Water Accord.

5.4 Pillar 4: Digital Exporter Facilitation and Fintech Integration

To help the youth cohort scale IT exports toward the $10 billion target, the state must remove digital friction: provide legal protections against internet throttling for registered co-working hubs, allow 100% foreign currency retention in exporter bank accounts, and create a State Bank regulatory sandbox to support direct international payment processing.

Table 4. Operational Implementation Matrix of Proposed Interventions

Pillar	Regulatory Mechanism	Implementing Agency	Measurable Target
1. Project Dashboards	Centralized public portal tracking PC-I budgets, contractor payments, and physical milestones.	Planning Commission, Auditor General of Pakistan.	Cap cost overruns below 15%; enforce contractor penalties.
2. Contract Audits	Independent thermal heat-rate audits; shift Take-or-Pay contracts toward competitive bilateral power trading (CTBCM).	NEPRA, CPPA-G, Independent Engineering Panel.	Reduce annual capacity payment overhead by over Rs 250 billion.
3. Real-Time Telemetry	Install AMI smart meters on 11 kV feeders; automated Doppler discharge sensors at canal headworks.	DISCOs, NEPRA, IRSA, Provincial Irrigation Departments.	Reduce grid losses below 12%; improve canal delivery efficiency toward 45%.
4. Digital Facilitation	Unthrottled internet guarantees for tech parks; 100% foreign exchange retention; fintech regulatory sandbox.	Ministry of IT, State Bank of Pakistan, PTA.	Support 28% annual growth to reach $10B IT export target by FY2029.

6. Discussion and Phased Implementation Sequencing

To prevent political gridlock, these governance reforms should follow a clear three-phase sequence:

- Phase 1: Transparency and Loss Disclosure (Months 1–12): Mandate open reporting of 11 kV feeder losses and canal headwork telemetry. Public data creates immediate accountability. Simultaneously, protect internet stability for freelancers and software exporters.
- Phase 2: Contract Renegotiation and Market Opening (Months 12–36): Implement forensic PPA audit recommendations to transition from single-buyer Take-or-Pay terms to competitive bilateral trading (CTBCM). Reinvest water recovery revenues into lining canals in salty soil areas.

- Phase 3: Structural Reform and Human Capital (Months 36–60): In parallel with new dams coming online (Diamer-Bhasha and Mohmand), introduce private management concessions in loss-making DISCOs. Reallocate savings from energy subsidies into primary education, technical training, and rural broadband.

7. Methodological Limitations

- Geological Data: Thar coalfield estimates rely mainly on exploratory drilling in Block II; basin-wide 3D seismic data for other blocks remain incomplete.
- Circular Debt Discrepancies: A gap exists between operational cash flows (Rs 1.675 trillion) and Ministry of Finance/IMF figures (Rs 1.835 trillion), reflecting different treatments of holding company debt.
- Informal Digital Receipts: State Bank figures ($4.60 billion) capture formal banking inflows, while some freelance income remains in overseas digital accounts due to local banking restrictions.

8. Conclusion

Pakistan's economic problems are often described as the unavoidable result of natural resource poverty. However, empirical evidence proves that the country possesses substantial natural and human endowments: one of the world's largest coal basins, the world's largest contiguous irrigation network, and a young population of over 160 million people under 30.

The real bottleneck is extractive and inefficient governance: rigid take-or-pay contracts that produce unpayable debt, canal networks that lose two-thirds of diverted water, and budget allocations that spend 81% of net revenues on debt while starving education and throttling digital exports. Solving this paradox does not require speculative megaprojects or endless foreign bailouts. It requires pragmatic institutional governance: open project dashboards, contract audits, real-time telemetry, and regulatory support for digital creators. By choosing verifiable data transparency over opacity, Pakistan can transform its rich endowments into durable economic prosperity.

References

[1] Dawda Adams, Subhan Ullah, Pervaiz Akhtar, Kweku Adams, and Samir Saidi. The role of country-level institutional factors in escaping the natural resource curse: Insights from Ghana. Resources Policy, 61:433–440, 2019.

[2] Tauseef Aized, Muhammad Shahid, Amanat Ali Bhatti, Muhammad Saleem, and Gabrial Anandarajah. Energy security and renewable energy policy analysis of Pakistan. Renewable and Sustainable Energy Reviews, 84:155–169, 2018.

[3] Hina Amber and Bezawit Beyene Chichaibelu. Narrowing the gender digital divide in Pakistan: Mobile phone ownership and female labor force participation. Review of Development Economics, 27(3):1354–1382, 2023.

[4] D. R. Archer, N. Forsythe, H. J. Fowler, and S. M. Shah. Sustainability of water resources management in the Indus Basin under changing climatic and socio economic conditions. Hydrology and Earth System Sciences, 14(8):1669–1680, 2010.

[5] G. M. Arif and Nusrat Chaudhry. Demographic Transition and Youth Employment in Pakistan. The Pakistan Development Review, pages 27–70, 2008.

[6] Hina Aslam, Jian Liu, Abeer Mazher, Dagne Mojo, Imran Muhammad, and Chao Fu. Willingness to Pay for Improved Water Services in Mining Regions of Developing Economies: Case Study of a Coal Mining Project in Thar Coalfield, Pakistan. Water, 10(4):481, 2018.

[7] Robert Bacon. Learning from Power Sector Reform: The Case of Pakistan. World Bank, Washington, DC, 2019.

[8] Ramez Abubakr Badeeb, Hooi Hooi Lean, and Jeremy Clark. The evolution of the natural resource curse thesis: A critical literature survey. Resources Policy, 51:123–134, 2017.

[9] John Briscoe and Usman Qamar. Pakistan's Water Economy: Running Dry. World Bank, Washington, DC, 2008.

[10] Matthias Busse and Steffen Gröning. The resource curse revisited: governance and natural resources. Public Choice, 154(1-2):1–20, 2011.

[11] M.J.M. Cheema, W.W. Immerzeel, and W.G.M. Bastiaanssen. Spatial Quantification of Groundwater Abstraction in the Irrigated Indus Basin. Groundwater, 52(1):25–36, 2013.

[12] International Monetary Fund. Statistics Dept. Measuring the Digital Economy. Policy Papers, 2018(016):1, 2018.

[13] Durr e Nayab. Demographic Dividend or Demographic Threat in Pakistan? The Pakistan Development Review, pages 1–26, 2022.

[14] Jeffrey Frankel. The Natural Resource Curse: A Survey. Technical report, National Bureau of Economic Research, 2010.

[15] Ibrar Hussain, Jawad Hussain, and Hazrat Bilal. An analysis of the success of fiscal adjustment in reducing public debt: Evidence from Pakistan. PLOS ONE, 17(6):e0269536, 2022.

[16] Indus River System Authority. Apportionment of the Waters of the Indus River System Between the Provinces of Pakistan (Indus Water Accord 1991). Government of Pakistan, Islamabad, 1991.

[17] International Monetary Fund. Pakistan: Request for an Extended Arrangement Under the Extended Fund Facility-Staff Report. Technical report, IMF Country Report No. 24/298, Washington, DC, 2024.

[18] J. Isham. The Varieties of Resource Experience: Natural Resource Export Structures and the Political Economy of Economic Growth. The World Bank Economic Review, 19(2):141–174, 2005.

[19] P. Karimi, W. G. M. Bastiaanssen, D. Molden, and M. J. M. Cheema. Basin-wide water accounting based on remote sensing data: an application for the Indus Basin. Hydrology and Earth System Sciences, 17(7):2473–2486, 2013.

[20] Hussain Kazmi, Fahad Mehmood, Zhenmin Tao, Zainab Riaz, and Johan Driesen. Electricity load-shedding in Pakistan: Unintended consequences, opportunities and policy recommendations. Energy Policy, 128:411–417, 2019.

[21] A. N. Laghari, D. Vanham, and W. Rauch. The Indus basin in the framework of current and future water resources management. Hydrology and Earth System Sciences, 16(4):1063–1083, 2012.

[22] David Lam. How the World Survived the Population Bomb: Lessons From 50 Years of Extraordinary Demographic History. Demography, 48(4):1231–1262, 2011.

[23] Halvor Mehlum, Karl Moene, and Ragnar Torvik. Institutions and the Resource Curse. The Economic Journal, 116(508):1–20, 2006.

[24] Muhammad Muzammil, Azlan Zahid, and Lutz Breuer. Water Resources Management Strategies for Irrigated Agriculture in the Indus Basin of Pakistan. Water, 12(5):1429, 2020.

[25] Ijlal Naqvi, Ate Poorthuis, and Anirudh Govind. Urban governance and electricity losses: An exploration of spatial unevenness in Karachi, Pakistan. Energy Research & Social Science, 79:102166, 2021.

[26] National Electric Power Regulatory Authority. State of Industry Report 2023: Power Sector Performance and Financial Review. Technical report, NEPRA, Government of Pakistan, Islamabad, Pakistan, 2023.

[27] National Electric Power Regulatory Authority. State of Industry Report 2024: Power Sector Capacity Payments and Dispatch Dynamics. Technical report, NEPRA, Government of Pakistan, Islamabad, Pakistan, 2024.

[28] Edward Oughton, David Amaglobeli, and Mariano Moszoro. Estimating Digital Infrastructure Investment Needs to Achieve Universal Broadband. IMF Working Papers, 2023(027):1, 2023.

[29] Edward Oughton, Zoraida Frias, Tom Russell, Douglas Sicker, and David D. Cleevely. Towards 5G: Scenario-based assessment of the future supply and demand for mobile telecommunications infrastructure. Technological Forecasting and Social Change, 133:141–155, 2018.

[30] Pakistan Bureau of Statistics. Announcement of Results of the 7th Population and Housing Census 2023 (Digital Census). Technical report, Ministry of Planning, Development and Special Initiatives, Government of Pakistan, Islamabad, Pakistan, 2023.

[31] Usama Qazi and Mirza Jahanzaib. An integrated sectoral framework for the development of sustainable power sector in Pakistan. Energy Reports, 4:376–392, 2018.

[32] A.S. Qureshi, P.G. McCornick, M. Qadir, and Z. Aslam. Managing salinity and waterlogging in the Indus Basin of Pakistan. Agricultural Water Management, 95(1):1–10, 2008.

[33] Asad Sarwar Qureshi. Groundwater Governance in Pakistan: From Colossal Development to Neglected Management. Water, 12(11):3017, 2020.

[34] Muhammad Rehman and Shahid Habib. Power Generation Policies, Governance Mechanism and Utilization of Indigenous Resources: A Case of Pakistan. Journal of Policy Research, 9(3):253–262, 2023.

[35] Obaid ur Rehman, Yousaf Ali, and Muhammad Sabir. Risk assessment and mitigation for electric power sectors: A developing country's perspective. International Journal of Critical Infrastructure Protection, 36:100507, 2022.

[36] James A. Robinson, Ragnar Torvik, and Thierry Verdier. Political foundations of the resource curse. Journal of Development Economics, 79(2):447–468, 2006.

[37] Syed Sajid Ali and Sadia Badar. Dynamics of Circular Debt in Pakistan and Its Resolution. The Lahore Journal of Economics, 15(Special Edition):61–74, 2010.

[38] Chandan Sharma and Sudharshan Reddy Paramati. Resource curse versus resource blessing: New evidence from resource capital data. Energy Economics, 115:106350, 2022.

[39] Rehana Siddiqui. Energy and Economic Growth in Pakistan. The Pakistan Development Review, pages 175–200, 2004.

[40] G.W.H. Simons, W.G.M. Bastiaanssen, M.J.M. Cheema, B. Ahmad, and W.W. Immerzeel. A novel method to quantify consumed fractions and non-consumptive use of irrigation water: Application to the Indus Basin Irrigation System of Pakistan. Agricultural Water Management, 236:106174, 2020.

[41] State Bank of Pakistan. The State of Pakistan's Economy: Annual Report 2023–2024. Technical report, State Bank of Pakistan, Karachi, Pakistan, 2024.

[42] Fabian Stephany, Otto Kässi, Uma Rani, and Vili Lehdonvirta. Online Labour Index 2020: New ways to measure the world's remote freelancing market. Big Data & Society, 8(2), 2021.

[43] Sundus, Samina Naveed, and Tanweer Ul Islam. An empirical investigation of determinants & sustainability of public debt in Pakistan. PLOS ONE, 17(9):e0275266, 2022.

[44] Kafait Ullah, Maarten J. Arentsen, and Jon C. Lovett. Institutional determinants of power sector reform in Pakistan. Energy Policy, 102:332–339, 2017.

[45] Water and Power Development Authority. WAPDA Annual Report 2022–2023: Water Storage and Hydropower Operations. Technical report, WAPDA, Government of Pakistan, Lahore, Pakistan, 2023.

[46] Yi-Chen E. Yang, Casey Brown, Winston Yu, James Wescoat, and Claudia Ringler. Water governance and adaptation to climate change in the Indus River Basin. Journal of Hydrology, 519:2527–2537, 2014.

[47] William J. Young, Arif Anwar, Tousif Bhatti, Edoardo Borgomeo, Stephen Davies, William R. Garthwaite III, E. Michael Gilmont, Christina Leb, Lucy Lytton, Ian Makin, and Basharat Saeed. Pakistan. World Bank, Washington, DC, 2019.