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School Education in Post-18th Amendment Balochistan: A Political Economy Perspective

RAFIULLAH KAKAR

In the wake of devolution of education to provinces through the 18th Constitutional Amendment, there has been a noticeable increase in public spending on school education. Moreover, certain reforms have been introduced in education planning, management and monitoring. These measures have enhanced availability of physical infrastructure and reading and writing material for schools and improved education monitoring. There is also evidence of marginal improvements in overall literacy rate and reading and arithmetic skills.

Notwithstanding the limited gains, the reforms and increased public spending have not translated into commensurate improvements in schooling and learning outcomes. Analysis of proximate causes indicates that learning outcomes are not improving because the various elements of education system are not aligned around the goal of learning. In contrast, expansion of schooling appears to have remained a strategic objective of education delivery but it hasn't experienced significant improvement either because of the existence of serious policy incoherence among various elements of education system. Prevalence of centralised, politically-influenced, discretionary and outdated planning and management practices combined with ineffectiveness of accountability mechanisms across the education delivery chain have undermined the effectiveness of well-intended reforms.

A deeper exploration of these issues through the "political settlement" lens reveals that education outcomes aren't recording major improvements because elite interest is aligned neither with the goal of learning nor access. Instead, elite interest is aligned more around patronage politics. Short-term, clientelist, political objectives govern education provision, owing to the highly fragile, exclusive, fragmented and personalised nature of political settlement. The predatory nature of political settlement has adversely affected both the design and implementation of reform initiatives.

Keywords: School Education, Devolution, Education Outcomes, Political Settlement, Politics of Education, Balochistan

1. INTRODUCTION

The adoption of the 18th Amendment to the Constitution of Pakistan in 2010 represents the most pivotal development in the country's recent constitutional history. This amendment, among others, re-defined the federal governance framework by

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devolving authority over social subjects to the provinces. The most significant governance outcome of the Amendment was that the health and school education subjects fell under the exclusive legislative and executive jurisdiction of the provinces (Institute of Social & Policy Sciences, 2012).

In the wake of the adoption of the 18th amendment, nearly all provincial governments have introduced reforms in education management and enhanced financing for education but these have produced partial results at best (Andrabi & Macdonald, 2019; Naviwala, 2016). The Government of Balochistan too enacted a number of reforms in education management. These reforms encompassed various aspects of education delivery, ranging from strategic planning to the provision of basic inputs and monitoring of education outcomes (Kakar & Naveed, 2018; Secondary Education Department, 2020; Zaka, 2018). Furthermore, the public spending on education also witnessed a significant rise in the post-devolution period. However, despite these reforms and increased spending, education outcomes have either recorded only marginal improvement or remained largely stagnant.

This study aims to map and review the trends in school education management and financing in post-devolution Balochistan and analyse why enhanced financing and reforms have not led to commensurate improvements in education outcomes. The study has followed a qualitative research methodology with desk research and key informant interviews with relevant stakeholders as the main sources of data.

This paper is structured into four principal sections. The first section offers a comprehensive review of the current literature, exploring the impact of alterations in education governance on educational outcomes. The second section presents an overview of major reforms and trends in education management, financing, and outcomes during the post-devolution era. The third section delves into the immediate factors contributing to the sluggish progression of education outcomes. Finally, the last section employs a political settlement perspective to unveil the underlying determinants and limitations influencing the public provision of education in Balochistan.

2. LITERATURE REVIEW

Decentralisation has been advocated as a means to improve service delivery and manage ethnic diversity in low and middle-income countries (Ahmad, Devarajan, Khemani, & Shah, 2005). Proponents argue that decentralisation enhances allocative and productive efficiency by aligning public services with local preferences and increasing accountability of sub-national governments to citizens (Channa & Faguet, 2016; Faguet & Sanchez, 2008; Garcia & Rajkumar, 2008; Kahkonen & Lanyi, 2001).

However, empirical evidence on the impact of decentralisation on public service delivery is mixed and inconclusive (Ghuman & Singh, 2013; Robinson, 2007; Shah, Thompson, & Zou, 2004). Studies have shown that decentralisation can also hinder service delivery, widen inter-regional disparities, and increase corruption and rent-seeking by local elites (Azfar & Livingston, 2002; Bardhan, 2002; Shen, Zhao, & Zou, 2014). Existing literature further reveals that the effectiveness of decentralisation reforms is contingent upon various factors, including the design, scope, and process of decentralisation, historical legacies, the presence of local structures of accountability, the capacity of sub-national governments, political competition and quality of governance,

and the quality of formal and informal institutions (Ahmad, et al. 2005; Bardhan & Mookherjee, 2006; Faguet, 2014; Kahkonen & Lanyi, 2001; Sow & Razafimahefa, 2015; Sujarwoto, 2017). These factors highlight the interplay between technical and political considerations, as well as the influence of power dynamics and quality of formal and informal institutions on service delivery outcomes.

In the context of education, it is widely recognised that deficits in education provision cannot be solely attributed to technical challenges in policy design and implementation. Recent scholarship acknowledges the role of both technical and political factors in shaping educational outcomes (Bruns, Macdonald, & Schneider, 2019; Bruns, Schneider, & Saavedra, 2023; Corrales, 2006). For instance, the World Bank Development Report (WDR) 2018 reveals that unhealthy politics, characterised by a 'misalignment' between education policies, goals and practices, contributes to the intractability of education reforms and the slow progress in improving educational outcomes (Bank, 2017).

Within the literature concerning the politics of education, there is a growing consensus that differences in political economies are critical to explaining variations in performance of countries in relation to adoption and implementation of education reforms, especially those addressing learning outcomes (Kingdon, et al. 2014; Kosack, 2012; Levy, 2022; Mcloughlin & Batley, 2012). Although limited in number, existing research studies on the political economy of education reforms have investigated the role of formal as well as informal institutional processes and de-facto power relations (Corrales, 2006; Hicken & Simmons, 2008; Mangla, 2022; Pritchett, 2013; Stasavage, 2005), ideas as well as incentives (Corrales, 2006; Mani & Mukand, 2007), and actors operating at multiple levels, including parents and communities, teacher unions, bureaucracy and political parties (Arif, Nihayah, Rarasati, Revina, & Usman, 2022; Bano & Dyonisius, 2022; Corrales, 2006; Eccles, 2005; Keefer, 2013; Mangla, 2022; Wilder, 2014). These studies, however, frequently focus on singular power relationships, unit of analysis, or ideas, failing to offer a comprehensive understanding of the relative power of diverse stakeholders and its consequences for education reforms and delivery. Consequently, there has emerged a need for a conceptual framework that effectively captures and integrates these multifaceted factors (Hickey & Hossain, 2019; Wales, Magee, & Nicolai, 2016).

In response to this identified gap, political settlement analysis has emerged as a valuable approach within political economy research. By offering an integrated framework that considers the role of elites, formal and informal institutions, and de-facto power relations, political settlement helps in understanding and analysing not only the differential performance of states but also the directions reforms in formal governance structures might (or might not) take (Khan, 2010; Khan, 2018). It facilitates comprehension of the conditions under which broad-based pro-reform coalitions may arise, as well as the reasons and circumstances in which elite actors are more likely to commit to the adoption and implementation of educational reforms aimed at expanding access to schooling and improving learning outcomes (Hickey & Hossain, 2019).

Currently, limited number of studies have applied the political settlement lens to analyse performance variations in education delivery across developing countries. Wales, Magee and Nicolai (2016) applied the political settlements analysis to explore how political

context may shape opportunities and barriers for achieving progress on education outcomes and found that the prospects for improving education quality are most favourable in developmental states and poorest in spoils-driven hybrid states. Similarly, Hickey & Hossain (2019) employed the political settlement lens to examine the politics of learning crisis in six developing countries—each representing a particular type of political settlement. Their findings revealed that the commitment and capacity of elites to improve educational outcomes was systemically related to, and shaped by, by the type of political settlement. Levy (2022) adapted the political settlement analysis to group countries into distinct political-institutional contexts and explored the influence of these divergent contexts on education sector governance and outcomes. He found that political and institutional constraints can render ineffective many specialised sectoral interventions.

However, the current research on political settlements and education delivery primarily focuses on cross-country comparisons, overlooking sub-national and regional variations. There is a dearth of studies examining variations in sub-national performance in social service delivery. The latter is rather concerning given that the responsibility for delivering education, health and other social services lies with sub-national governments in most developing countries. Therefore, this research aims to address the aforementioned gap by applying the political settlement approach to sub-national performance in education delivery in Pakistan through a case study of school education in the Balochistan province. By an in-depth examination of a sub-national context, this study seeks to not only enrich the existing evidence on sub-national state capacity but also to advance the political settlement theory by applying it to sub-national contexts. The findings of this research will enhance our understanding of the complex interplay between politics and education sector governance and outcomes, offering valuable insights for policymakers and practitioners on how to design policies that are more likely to succeed in specific sub-national contexts.

3. OVERVIEW OF EDUCATION REFORMS, FINANCING & OUTCOMES IN THE POST-DEVOLUTION PERIOD

In the post-18th amendment period, the Government of Balochistan (GoB) implemented a number of reforms in the legal, institutional, and governance framework of school education. These reforms included the enactment of the Compulsory Education Act 2014, the development of five-year sectoral plans, the devolution of certain financial and administrative powers to the district (District Education Authority and District Education Authority) and sub-district tier (clusters), and the introduction of a data-driven monitoring system (Real-Time School Monitoring System and Complaint Management System) (Kakar & Naveed, 2018; Secondary Education Department, 2021a). Additionally, to promote social accountability and engage parents and communities in school affairs, various stakeholder forums were established, including the Local Education Group (LEG), District Education Group (DEG), Local Education Council (LEC), and Parent Teacher School Management Committee (PTSMC) at the provincial, district, cluster, and school levels, respectively (Secondary Education Department, 2021a). The introduction of mother languages as compulsory additional subjects in schools was another significant step. These reforms aimed to enhance strategic planning, implementation capacity, monitoring, and accountability in the education sector, with an emphasis on improving learning outcomes (Secondary Education Department, 2013).

Policy reforms were complemented by increased budgetary allocations for education. The overall education budget of Balochistan witnessed a nearly seven-fold increase from PKR 13.8 Billion to approximately PKR 90 Billion between 2009-10 and 2021-22 (Finance Department, 2008-2020) (Figure 1). The average share of education in the provincial budget rose from 14.57 percent during 2007-2012 to 18.24 percent in 2013-2021, aligning closely with the global financing benchmarks set for achieving Sustainable Development Goal 04, which recommends allocating 15 percent to 20 percent of total public expenditure to education in low-and-middle income countries (Mundial & UNICEF, 2016). Furthermore, the development budget for education also experienced an eight-fold increase in nominal terms, from PKR 2.3 Billion to PKR 17.93 Billion between 2009-10 and 2021-22 (Planning and Development Department, 2007-2021) (Figure 2). The salaries of education employees also witnessed significant increments during this period (Figure 3).

The increased public spending has led to improvements in a select few schooling inputs such as physical infrastructure and classroom materials (Attaullah, 2021; Izzatullah, 2021; Kaleem, 2021). Similarly, the management reforms have ameliorated the data regime and strategic planning framework governing school education (Secondary Education Department, 2021a).

However, the enhancements in physical inputs and data regime have not translated into notable improvements in access, learning, or equity outcomes. In terms of learning outcomes, Balochistan appears to have recorded modest improvement in reading and arithmetic skills at the primary and middle levels in the post-devolution period (ASER Pakistan, 2022). Nevertheless, it's noteworthy that this progress has been relatively sluggish in comparison to other regions of the country. In terms of accessibility, there has been an unfortunate increase in the proportion of out-of-school children, while the ratio of enrollments in public schools relative to the total school-age population has remained relatively static, increasing from 22 percent in 2014 to 23 percent in 2021 (Figure 4).

The cumulative impact of these developments is the widening interprovincial disparity in education outcomes between Balochistan and rest of the country since the devolution of authority in 2010. Balochistan lags behind the rest of Pakistan on nearly all outcomes of education (Pakistan Bureau of Statistics, 2020).

Fig. 1. Share of Education Budget in Provincial Budget (2007-2021)

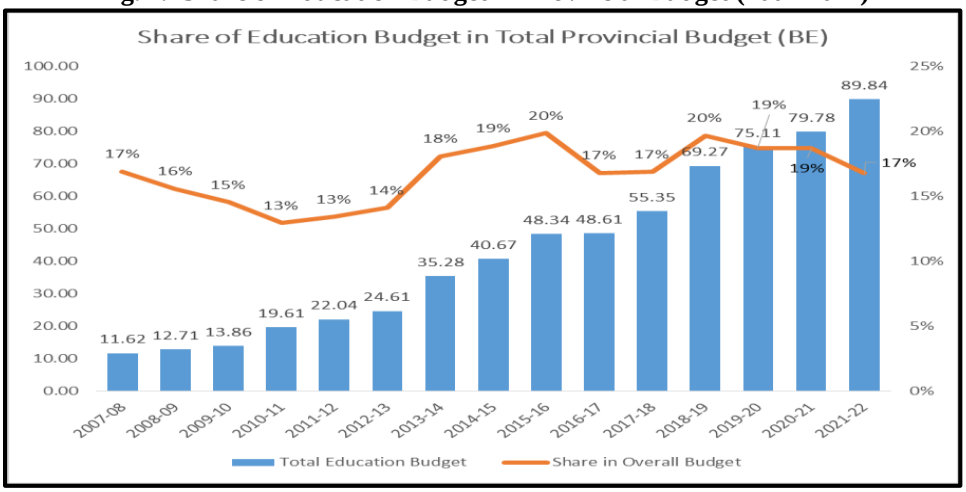


Fig. 2. Share of Education in Balochistan's Development Budget (2001-2020)

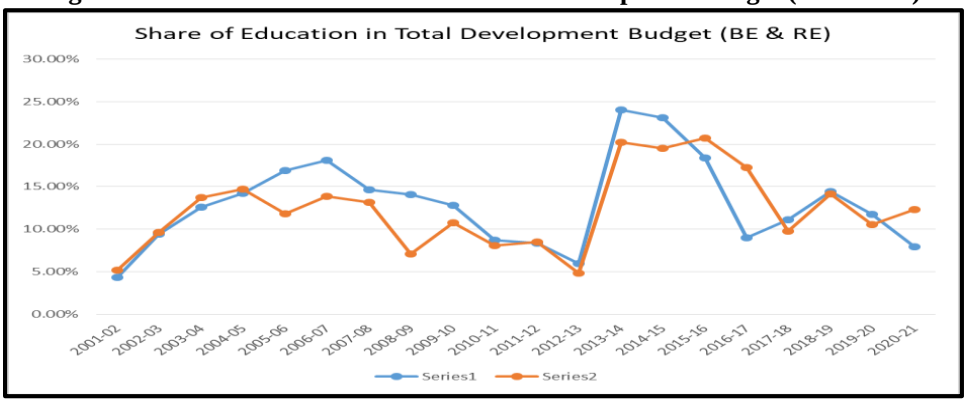


Fig. 3. Trends in Education Salary Budget (2011-2020)

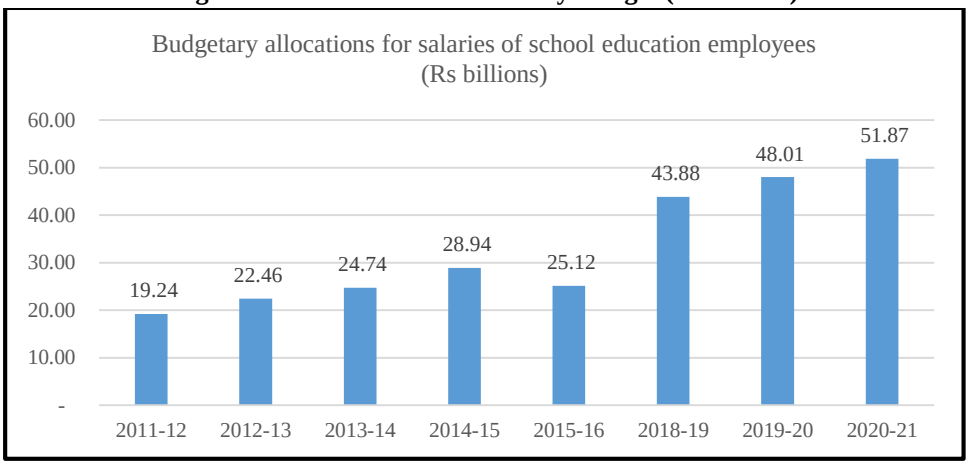
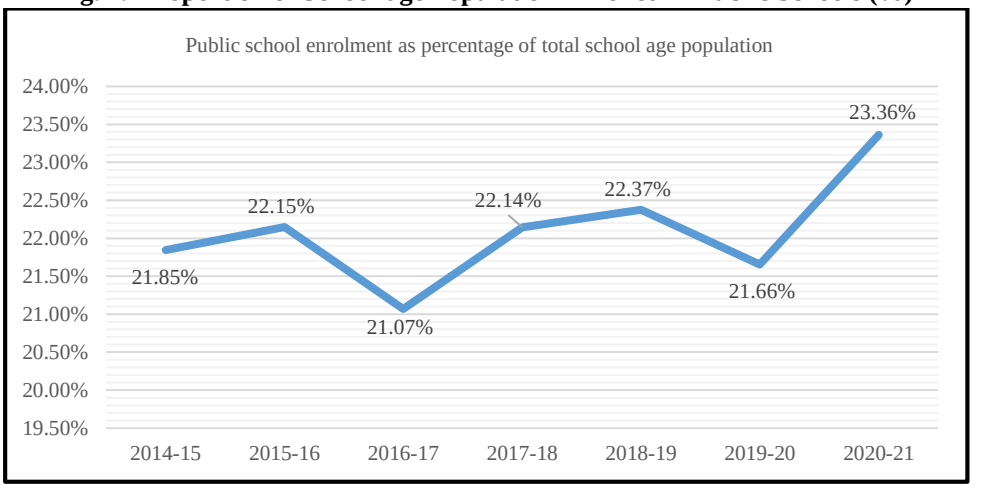


Fig. 4. Proportion of School-age Population Enrolled in Public Schools (%)



4. THE PROXIMATE DRIVERS OF STAGNANT EDUCATION OUTCOMES

At the proximate level, there are two major explanations for the slow progress of education outcomes. Firstly, learning outcomes aren't recording significant improvement because learning has been inadequately prioritised in education policy and practice. Secondly, expansion of schooling appears to have remained a strategic priority of education policy and practice but it hasn't experienced significant improvement either mainly due to the politically-driven, centralised, outdated and discretionary education planning and management practices, and ineffective accountability mechanisms. The latter has resulted in inefficient management of the limited physical, human and financial resources of SED.

4.1. Weak Alignment of Education Policy and Practice with the Goal of Learning

Critical examination of education planning, resource allocation and monitoring framework indicates that improving learning outcomes has not remained a strategic priority. This lack of prioritisation is evident, inter alia, in the budgetary allocation for education, with nearly 99 percent of development expenditures being channeled into physical infrastructure rather than soft aspects of education delivery, such as teacher training, textbook writing, and data and research (Planning and Development Department, 2007-2021) Although official documents and education sector plans acknowledge learning as a key objective (Secondary Education Department, 2013, 2021b), little policy attention and resources are actually directed towards achievement of learning objectives and targets set in sector plans (Baloch, 2021; Secondary Education Department, 2021a). In the absence of a robust commitment from the government towards inputs related to learning, the limited financial support for learning initiatives primarily originates from external donors (Kakar, 2022).

The weak prioritisation of learning can be attributed, in part, to the poor understanding of learning among key stakeholders situated on both the demand and supply-side of the education system. Politicians and bureaucrats often measure education quality in terms of tangible inputs like school infrastructure and teacher attendance (Barech, 2015; Kakar, 2022). School heads and teachers think about quality education in terms of availability of adequate facilities in school and punctuality and disciplined behaviour of students. Parents, including those who are relatively educated, measure education quality in terms of marks in exams and proficiency in English language (Secondary Education Department, 2021a).

Furthermore, the lack of measurement, monitoring, and reporting of learning outcomes in official data contributes to the under-emphasis on learning. Even the recent reforms in education data system fail to track progress in learning outcomes. Lastly, the traditional organisation of the secondary education department does not explicitly assign responsibility for improving and monitoring learning outcomes, leading policy-makers to overlook the severity of the learning crisis and equate poor learning outcomes with resource inadequacy.

As a result, learning remains missing from the agenda of politicians, bureaucrats, and parents alike. The absence of reliable data on learning outcomes implies that parents, civil society organisations, media, and government can overlook the quality of education. This explains why organised public demand for better education quality is almost non-existent.

Within the realm of school education, the only aspects of learning that garner considerable high-level policy attention are language policy and history textbooks. However, this attention too is driven mainly by ideological motives of nation-building rather than a genuine recognition of the importance of language policy in enhancing learning outcomes. In 2014, the Government of Balochistan enacted a legislation to introduce mother languages as compulsory additional subjects at the primary level (Kakar & Naveed, 2018). While the Act itself was adopted swiftly without much due diligence, the policy attention and resources that were subsequently required for effective implementation were not made available. Availability of trained teachers was not ensured and proper mechanism was not developed for teaching mother languages in areas with diverse population (Secondary Education Department, 2021a). Moreover, the political act of introduction of mother languages as additional subject rather than as medium of instruction imposed an additional burden on children by necessitating the learning of a third language alongside Urdu and English.

In conclusion, the weak prioritisation of learning in education policy and practice in Balochistan arises from inadequate understanding and a lack of emphasis on learning outcomes in official data. Without addressing these fundamental issues and transforming the mindset of key stakeholders, achieving meaningful improvements in learning outcomes will remain a challenge.

4.2. Fragmented and Incomplete Legal and Policy Framework

Over a decade has passed since authority over school education was devolved to provinces, the Government of Balochistan still lacks an approved education policy. The current education policy framework comprises of a mix of executive decisions, sector plans, acts, and departmental notices. In absence of a holistic education policy, five-year sector plans have only partially filled the gap.

The legal framework governing education delivery also exhibits significant gaps. Firstly, the Compulsory Education Act of 2014 is deemed overly idealistic in scope and fails to consider the resource constraints faced by the Secondary Education Department (SED) (Baloch, 2021). Secondly, although curriculum and standards were devolved to provinces, there is still a lack of provincial legislation to govern them. Notably, the adoption of the Single National Curriculum by the provincial government lacked proper due diligence and faced strong objections from the Bureau of Curriculum (D. G. Khan, 2021). Thirdly, in various instances, provincial legislation has been adopted, but the corresponding rules have not been formulated. For instance, the rules of the Compulsory Education Act of 2014 and other legislative acts related to the Balochistan Assessment and Examination Commission (BAEC), Mother Languages as Compulsory Additional Subject, and the Compulsory Education Act have yet to be approved (Secondary Education Department, 2021a). Consequently, this situation has created confusion surrounding roles and responsibilities and has impeded progress in their implementation.

Furthermore, the regulatory framework for private schools is deemed weak and underdeveloped. The existing framework purportedly aims to ensure the availability of essential facilities and maintain a minimum standard of quality in non-state schools. However, the lack of well-defined performance standards makes it challenging to monitor the performance of private schools and enforce compliance. Furthermore, this framework

primarily focuses on monitoring and penalising non-governmental actors rather than fostering them as partners in education delivery (Secondary Education Department, 2021a).

4.3. Centralised and Politically-driven Systemic Planning

The provision of education in Balochistan is characterised by a highly centralised, politically-influenced, and ad hoc planning process. Education planning lacks the foundation of both short-term and long-term plans. While the development of five-year education sector plans has partially improved strategic planning by ensuring the availability of a need-based medium-term plan, the efficacy of these sector plans has been eroded by poor implementation. Joint Education Sector Reviews conducted by SED revealed that merely 25 percent of the targets outlined in the Balochistan Education Sector Plan 2013-18 were successfully achieved (Secondary Education Department, 2021a).

In the absence of evidence-based need-assessment studies and annual plans, operational and budgetary planning is conducted in an ad hoc manner, heavily influenced by the preferences of those in positions of authority, particularly the political leadership. Consequently, the process of providing essential education inputs, such as physical infrastructure, textbooks, teachers, trainings, and learning resources, is fragmented and poorly aligned with genuine needs of the education system. In order to elaborate this argument further, a comprehensive review and analysis of public investment planning and teacher recruitment is as follows:

Critical Review of Public Investment Planning for School Education: Available data indicates that the province possesses sufficient school infrastructure at the primary level when compared to the national average. A school is available for every 185 children of primary age in Balochistan compared to 253 children in Pakistan. The findings derived from empirical data are corroborated by the perspectives of community representatives and officials within the provincial education department. Consultations with these stakeholders highlight that the most substantial supply-side factor contributing to dropouts at the primary level is the insufficient availability and poor attendance of teachers (Attaullah, 2021; Izzatullah, 2021; Kaleem, 2021; Mengal, 2021; Secondary Education Department, 2021a). The limited availability of teachers, caused mainly by delays in hiring, is one reason why nearly one in every five public schools in the province remains non-functional (Secondary Education Department, 2022). Furthermore, these stakeholders have consistently emphasised the need to prioritise teacher availability, the provision of basic utilities such as water and electricity, and the deployment of transportation and mobility support to address the challenges posed by vast distances. Lastly these stakeholders advocate for well-designed enrollment campaigns and the provision of incentives to address demand-side issues related to poverty and cultural barriers (Baloch, 2021; Kakar, 2022; Mengal, 2021; Secondary Education Department, 2021a).

It is worth noting that both empirical data and qualitative research converge on the conclusion that the traditional approach of horizontally expanding the school infrastructure is not economically viable in Balochistan, given the province's scattered population. Innovative approaches, including the utilisation of digital technology tools

and the provision of transportation support to students and teachers, are recommended to meet the educational needs of the population effectively. Furthermore, research also supports demand-side interventions to address socio-economic drivers of out of school children crisis.

However, despite substantial evidence supporting the consolidation and efficient utilisation of existing schools and exploring innovative solutions, as well as demand-side interventions to address poverty, a critical examination of the development budget for education reveals a predominant allocation toward the construction of physical infrastructure. This singular emphasis on "brick and mortar" investments raises several concerns. Firstly, it indicates a weak alignment of public investment planning with genuine needs of education as highlighted by research, particularly the provision of missing facilities such as water, electricity, and mobility support at post-primary levels and demand-side interventions. While development funds have been allocated for the provision of missing facilities in schools, there is a strong bias toward "infrastructure," with most of the funds being spent on classrooms and boundary walls. For example, although the number of schools with toilet facilities increased from 2,886 in 2014 to 5,867 in 2019 (Secondary Education Department, 2018, 2021c), most of these newly-built toilets remain without water and sewerage systems (Attaullah, 2021; Izzatullah, 2021; Kaleem, 2021; Secondary Education Department, 2021c).

Furthermore, a large chunk of the education development budget is allocated to expensive large infrastructure projects for boarding schools and university campuses, often neglecting other genuine needs related to schooling and learning. These projects typically take 5-10 years to complete and enroll only a fraction of the total school-age population. While most of these institutions provide better education than regular public schools, their per capita cost is significantly higher compared to regular public schools. In 2022, Balochistan was home to 15 Cadet Colleges and Residential Colleges, serving a student population of approximately 5,000. It is noteworthy that the operational expenditure per student per annum for these institutions amounted to PKR 450,000. This figure stands in stark contrast to the significantly lower per student per annum operational cost observed in conventional public schools, being only one-eighth of the aforementioned cost in FY 2022.

Secondly, the more concerning aspect is that even the "brick and mortar" investments are not directed to geographic areas where they are needed the most. Instead, decisions regarding the location of new schools and the upgrading and strengthening of existing ones are primarily influenced by political considerations (Attaullah, 2021; Baloch, 2021; Kazmi & Khan, 2018; Mengal, 2021; Yahya, 2022). Members of the provincial assembly identify development budget schemes without proper need assessment, then approve them as Members of Cabinet or provincial Assembly (Izzatullah, 2021; Secondary Education Department, 2021a). Usually, members of the treasury and opposition benches are allocated a fixed share within PSDP. These MPAs have significant latitude in identifying projects within their allotted share without adequate due diligence, socio-economic and technical appraisal. The role of relevant technical sections and departments has been reduced to a mere formality. The Secondary Education Department, which is

responsible for developing project proposals based on the genuine needs of the education sector, often submits development project proposals at the behest of the incumbent Minister and MPAs, without a proper assessment of the actual needs of the education system. For example, in financial year (FY) 2018-19, around 395 development schemes were sanctioned in the budget. According to the Secondary Education Department, only 16 of these schemes were proposed by the department based on identified needs, whereas 380 schemes were identified by MPAs (Kazmi & Khan, 2018). Similarly, the Planning and Development Department, tasked with reviewing, scrutinising, appraising, and prioritising public investment proposals competing for scarce resources, endorses and approves the proposals received from SED without proper technical, financial, and socio-economic appraisal. Usually, projects lacking political backing and ownership get dropped, regardless of their technical soundness.

In addition to politically-driven planning, the fragmented and piecemeal approach to the construction and operationalisation of new schools and the upgrading of existing ones is also a significant reason for the growing ineffectiveness of development expenditures. The process of constructing new schools is not synchronised with the process of hiring the necessary human resources to make these newly-built schools functional. Consequently, the process of approving posts for new schools (Schedule of New Expenditures) and hiring against the approved posts often commences after the construction work is completed (Secondary Education Department, 2021b). Both approval and hiring processes are complex and frequently experience long delays. As a result, most new school buildings either remain idle for a number of years after construction (Kakar, 2022).

Critical Review of Teacher Recruitment: Another critical issue is the inadequate responsiveness of the education planning system to the issue of teacher shortage in public schools. Despite a substantial deficit in availability of teachers, the education system has not addressed this challenge effectively (Izzatullah, 2021; Wardag, 2021). Approximately 9,000 teaching positions remained vacant in 2022. The most recent large-scale teacher recruitment occurred in 2014-15 when 5,000 teachers were hired through a merit-based system (Kakar & Naveed, 2018). Since then, very few new teacher appointments have taken place, even as the construction and upgradation of schools has continued alongside teacher retirements during the same period. Consultations with stakeholders indicate that the introduction of a relatively merit-based and rules-based policy for hiring teachers in 2014, which reduces room for discretion and manoeuvring, explains why there is lesser high-level push for the recruitment of new teachers (Kakar, 2022).

The absence of qualified teaching staff not only contributes to the proliferation of non-operational schools within the province but also correlates with suboptimal learning outcomes in a substantial number of primary schools where a single teacher shoulders the entire pedagogical responsibility. According to EMIS data, the number of non-functional schools rose from 955 schools in 2014 to 3152 schools in 2021-22 (Secondary Education Department, 2018, 2022). Most of these non-functional schools were built in recent years but remained non-functional due to non-hiring of the necessary teaching and non-teaching staff (Izzatullah, 2021; Kakar, 2022).

The cumulative outcome of the politically-driven, fragmented and centralised education planning processes is that the effectiveness of growing public expenditures has become increasingly limited, resulting in stagnancy in access as well as learning outcomes. For example: the GoB spent nearly PkR 63 Billion from its development budget between 2014 and 2020 for improving education access outcomes (Planning and Development Department, 2007-2021). These expenditures indeed resulted in construction of at least 3000 new public schools, construction of buildings for nearly 3500 shelter less schools, construction of large number of additional classrooms, and establishment of four cadet colleges and BRCs.[1] However, the proportion of enrollments in public schools as a percentage of the total school-age children increased by mere 1 percentage point during the same period i.e. from 22 percent in 2014 to 23 percent in 2020.[2] These statistics imply that increased public spending on education might not achieve the desired results within the ambit of existing planning and monitoring processes.

4.4. Outdated and Discretionary Workforce Management Framework

The SED operates without a structured, data-driven workforce management framework and specialised institutional arrangements to oversee the extensive workforce and assets within the sphere of school education. The absence of a structured framework necessitates the issuance of notifications as needs arise, leading to a lack of consistency in human resource management (Secondary Education Department, 2021a). For example: the department notably lacks a well-defined transfer posting policy, rendering decisions in human resource management largely discretionary (Izzatullah, 2021; Kakar, 2022; Wardag, 2021). This discretionary approach has left the education system susceptible to individual influences and external pressures.

Secondly, the secondary education department lacks a dedicated unit responsible for the management and development of the workforce. This deficiency leads to unnecessary delays, policy inconsistencies, and discretionary management practices. Furthermore, the management of the approximately 74,173 employees, dispersed throughout every village and union council within the province, relies on an outdated and inefficient manual system. Routine tasks necessitate coordination among multiple segments of the system, resulting in unnecessary delays, heightened transaction costs, and difficulties in performance monitoring. While the Education Management Information System (EMIS) attempts to gather and consolidate data on teachers, this data remains incomplete. The absence of an automated human resource management information system has introduced significant inefficiencies into the system.

Thirdly, an additional challenge arises from the insufficiently specialised skills of personnel responsible for educational delivery. The education system notably lacks specialists in crucial domains, including teacher training, curriculum development, textbook authorship, assessments, data analysis, and education management (Baloch, 2021; Secondary Education Department, 2021a). Consequently, essential technical institutions charged with tasks related to curriculum, textbooks, and assessments are

[1]Author's calculations based on detailed review of Balochistan's development budget of education from 2014 to 2021.

[2] Author's calculations based on EMIS data 2014-2020.

primarily staffed with personnel possessing a generic skill set. Similarly, individuals responsible for overseeing the entire education system often lack specialised management skills, especially at the district and sub-district levels. The management of the education system is chiefly entrusted to two categories of personnel: generalist managers from federal and provincial civil services cadres, and education managers, primarily stemming from teaching backgrounds. Generalist managers have a supervisory role over educational provisions and wield the greatest authority. Although they lack an educational background but possess broad management skills.

On the other hand, district education managers receive no formal management training, either during their initial education or upon assuming managerial roles (SED, 2021). Furthermore, district education managers typically originate from the teaching cadre. After spending 15-20 years as educators, these managers often encounter challenges when attempting to assert authority and monitor the performance of their former colleagues. This situation presents a potential conflict of interest, as the managers are often highly susceptible to the influence and pressure exerted by teacher unions. Consequently, they struggle to address issues such as teacher absenteeism and related concerns at the district level.

In the absence of a structured, rules-based management framework, decisions concerning appointments, deployments, training, postings, and employee tenures are significantly influenced by external actors, including politicians, bureaucrats, teacher unions, and tribal leaders (Secondary Education Department, 2021b). This high degree of politicisation and vulnerability to external pressures has compromised the independence and impartiality of the education workforce, ultimately adversely affecting the quality of education imparted to children. Notable manifestations of the politicised and discretionary human resource management approach include:

- Frequent and abrupt transfer-posting of administrative secretary and heads of attached sections and organisations has become a common practice. For example, from April 2013 to December 2021, Balochistan experienced 13 different individuals serving as Secretary SED, with an average tenure of eight months. A period of relative stability was observed during Dr Malik's two-and-a-half-year tenure, during which the Secretary changed only twice. Similarly, the heads of attached departments are subjected to frequent, often unjustified changes in leadership. At the district level, District Education Officers (DEOs) and teachers also face frequent, abrupt, and often politically-motivated transfer-posting decisions (Attaullah, 2021). Notably, school heads and district education managers have minimal influence over teacher transfer and posting decisions. Consequently, many rural and remote schools remain without teachers as politically-connected educators secure transfers to urban areas (Izzatullah, 2021; Wardag, 2021; Yahya, 2022).
- Additionally, existing vacancies are often filled through ad-hoc appointments or by assigning additional responsibilities to current officers (Wardag, 2021). These ad-hoc practices have proven counterproductive to organisational capacity.

Table 1

Length of Tenures of Secretaries of Secondary Education Department (2013-2021)

S. No.	From	To	Duration (months)
1	22/04/2013	12/05/2013	0.70
2	19/06/2013	24/10/2014	16.17
3	24/10/2014	25/06/2016	18.00
4	27/06/2016	09/01/2017	6.40
5	24/01/2017	12/06/2017	4.63
6	04/07/2017	20/07/2017	0.53
7	21/07/2017	19/01/2018	6.00
8	19/01/2018	25/10/2018	9.20
9	25/10/2018	11/02/2020	15.57
10	12/02/2020	17/08/2020	6.17
11	17/08/2020	05/08/2021	11.63
12	17/08/2021	06/10/2021	1.67
13	06/10/2021	Date	6.00

4.5. Ineffective Monitoring and Accountability Mechanisms

The education system in Balochistan exhibits notable deficiencies in its oversight and accountability mechanisms, both at the systemic and individual levels. Systemic accountability, unfortunately, remains conspicuously absent across all tiers of the education system. At the highest echelons of governance, there exists no structured mechanism for periodic performance reviews of ministers. Similarly, the capacity and inclination of secondary education ministers to scrutinise the performance of the bureaucratic apparatus are constrained. Furthermore, the Secretary SED lacks a data-driven, results-oriented framework to gauge and evaluate the performance of attached units. Consequently, the educational landscape is marked by a conspicuous absence of mechanisms for measuring and reporting the performance of key stakeholders. The one domain within school education that garners significant high-level attention, and is associated with a relatively effective top-down accountability structure, pertains to the approval, execution, and oversight of development projects in school education(Baloch, 2021; Kakar, 2022).

In the absence of a comprehensive systemic accountability framework, limited individual-level accountability mechanisms do exist, albeit with a pronounced focus on teachers alone. The primary instruments of individual-level monitoring and accountability include Real-Time School Monitoring (RTSM) data and Annual Performance Evaluation Reports (PERs). However, both these tools exhibit significant shortcomings, offering, at best, a thin input-centric monitoring framework. Annual evaluations have become largely ineffective. Instances of unfavourable evaluations are exceedingly rare, if not non-existent. Similarly, RTSM primarily concentrates on monitoring teacher attendance, inadvertently burdening primary school teachers, the majority of whom manage all six grades of a primary school (Wardag, 2021). Beyond attendance monitoring, there exists no mechanism for assessing the performance of teachers, school administrators, education managers, affiliated organisation staff, or policymakers. A poignant reflection of the prevailing accountability deficit is encapsulated in the following statement from a middle school headmaster:

"I commenced my tenure at this school as a teacher in 2002. Since then, inquiries regarding attendance and school conditions have been made on only two occasions—2014 and 2021. Apart from these isolated instances, no personnel from the education department has probed into my performance or assessed the achievements of the school. When someone holds me accountable, I have the incentive to demonstrate my commitment to excellence. In the absence of such accountability, what impetus do I possess to strive for excellence?" (Attaullah, 2021)

In addition to the limited array of individual-level accountability mechanisms, various social accountability forums were established as part of the BESP 2013-18 implementation. These forums encompassed bodies such as the Local Education Group (LEG), District Education Group (DEG), Local Education Council (LEC), and Parent Teacher School Management Committee (PTSMC), which were established at the provincial, district, cluster, and school levels, respectively. While the establishment of these platforms did enhance community participation in school affairs to a certain extent, the majority of them have become non-functional due to insufficient community engagement and a lack of sustained government support (Attaullah, 2021; Izzatullah, 2021; Kaleem, 2021).

5. DEEPER DETERMINANTS OF STAGNANT EDUCATION OUTCOMES: A POLITICAL SETTLEMENT APPROACH

This section employs Mushtaq Khan's analytical framework on political settlements to interpret the findings of the preceding sections (Khan, 2018). The political settlement framework offers insightful perspectives for comprehending the interplay between formal and informal institutions, as well as the de jure and de facto sources of power influencing education service delivery in Balochistan. It aids in uncovering the potential incentives of various stakeholders within an imperfect equilibrium of the system. The political settlement plays a crucial role in shaping the capacity and commitment of elites to education delivery (Hickey & Hossain, 2019). Furthermore, it influences the feasibility of implementing specific reforms in the short to medium term.

Various typologies exist for political settlements, each providing distinct incentives, opportunities, and constraints for public service delivery (Khan, 2010; Wales et al., 2016). The manner in which formal and informal power structures are organised in Balochistan aligns more closely with a fragile and predatory settlement characterised by a high degree of political exclusion, fragmentation, competitive clientelism, and personalised institutions. The primary features of the existing political settlement are as follows:

5.1. High Degree of Fragility and Exclusivity

The current political settlement exhibits weak legitimacy and a considerable degree of forced exclusion. This exclusion operates on two levels. First, pro-independence Baloch separatists challenge the very legitimacy of the State and employ violence to alter the political settlement. Second, the more prominent Baloch and Pashtun nationalist parties, although accepting the State's legitimacy, find themselves excluded from the political settlement due to their relative reluctance to adhere to the informal

rules dictated by the most powerful player within the ruling coalition—the military (Haq, 2021; Kakar, 2020). The ruling coalition relies on repression and the distribution of political power and development funds to maintain its grip on power.

However, the current political settlement is highly unsustainable for two reasons. Firstly, the cost of sustaining the loosely-bonded ruling coalition within a fragile formal economy is exorbitant. Given that the most powerful actor within the ruling coalition lacks significant legitimacy and social support, there's a constant need to engineer formal political processes (Mengal, 2022). Moreover, as the loyalty of artificial leaders propped up by the military can't be trusted once they build a sufficient independent support base, the military continually produces new, compliant leadership. This mechanism is employed to preserve the coalition through the credible threat of replacing older, now assertive protégés with new ones. Secondly, the excluded groups enjoy more robust and widespread popular support, particularly among the educated middle class and youth. The social networks supporting these excluded groups include an overwhelming majority of the educated middle class, professional groups, and the bureaucracy.

5.2. Political Fragmentation and Low Elite Cohesion

The second defining aspect of the existing political settlement in Balochistan is the obstinately high level of political fragmentation and the corresponding low level of elite cohesion. This fragmentation derives from the prevalence of a tribal mode of social organisation, regionally-segregated ethnic diversity, and the province's limited political influence within Pakistan's majoritarian federal system.

Balochistan features a comprehensive tribal system characterised by clear leadership structures, lineage patterns, strong affiliations, and well-defined dispute resolution mechanisms. Tribal social organisation prevails in most areas of Balochistan, with possible exceptions being Mekran division and urban centres like Quetta. Tribal networks often serve as the default units for political mobilisation and collective action management. The ubiquity of tribal social organisation profoundly affects politics and service delivery. Firstly, tribal social organisation, with its vertically-aligned structure, discourages inclusive and horizontally-oriented class-based political mobilisation, favouring the targeted provision of public goods through patron-client networks (Gazdar, 2007). Secondly, tribal norms of in-group solidarity, reciprocity, and the credible threat of social sanctions often shape individual behaviour in ways that may promote disregard for and poor compliance with formal rules and processes (Lambsdorff, Taube, & Schramm, 2004). This has significant implications for management and accountability processes associated with the provision of public goods, especially at the local level, where tribal norms have eroded formal rules and accountability mechanisms.

Ethnic diversity in Balochistan amplifies the effects of tribalism on development outcomes. While ethnic diversity encourages ethnically-aligned political behaviour, the regional segregation of the two major ethnic groups motivates political competition, negotiation, and accommodation along ethno-regional lines. Moreover, ethnic diversity complicates the task of reaching a consensus on major development priorities or public sector reforms. It also facilitates the 'ethnicisation' of crucial decisions related to the allocation of public resources, goods and services, job distribution, and the creation of new administrative units (Gazdar, 2007).

In addition to tribalism and ethnic diversity, the majoritarian federal design contributes to political fragmentation in the province (Kakar, 2020). To begin with, it renders the province unattractive for nationwide political parties seeking federal-level power, thereby encouraging the growth of smaller regional parties. The combined factors of tribal and ethnic fragmentation, along with the majoritarian federal design, incentivise the growth and proliferation of small ethnic and regional parties, with appeal rarely extending beyond ethnic boundaries.

The low level of elite cohesion is further compounded by the escalating inter-elite competition for access to power, who have strong incentives to use institutions for distributing public goods among their patronage networks. The interaction between formal electoral processes and the informal institutions of tribal social organisation has strengthened and deepened patron-client networks over the years. Fiscal and administrative decentralisation has further intensified political competition among local elites for access to limited public goods.

The cumulative result is that the prospects of a single party securing a majority in the provincial assembly have significantly diminished, and multi-party coalitions have become a structural feature of the polity. Since its establishment as a province in 1970, no party has ever obtained an absolute majority in the provincial assembly (Mehdi, Naqqash, Tariq, & others, 2012a, 2012b). Furthermore, the number of coalition partners has progressively increased over the decades. Coalition politics complicates the agreement on significant policy shifts or reforms. Each faction head and party within a coalition typically wields veto power over key policy decisions and reforms. Similarly, nearly all government coalition members must be rewarded through a share of the Public Sector Development Program (PSDP) and influence over personnel transfers to retain their support for the government. There is no political party that takes ownership of the province as a whole; politicians focus almost entirely on their immediate electoral constituencies. Coalition politics has also hindered and diluted accountability, making it difficult to attribute the performance of public sector institutions to a specific party.

5.3. Personalised Institutions

The third defining aspect of the political settlement in Balochistan is the highly personalised nature of its institutions. Political parties are controlled by individuals and dynasties who also shape and determine party policies and strategies. While nominal democratic mechanisms for decision-making exist, they remain weakly operational. Similarly, the provincial bureaucracy is highly politicised and governed according to personalised norms and informal rules, predominantly influenced by tribal and ethnic identities of the actors involved. The introduction of competitive electoral politics at a time when state capacity was underdeveloped and the provincial bureaucracy was relatively new has helped solidify patronage politics and enabled elite capture of public organisations (Hickey & Hossain, 2019).

5.4. Outsized Importance of Development Funds in Politics

The fourth significant feature of the political settlement in Balochistan is the outsized significance of the Public Sector Development Programme (PSDP). The highly fragmented political landscape, coupled with a negligible private sector

presence and a limited formal productive economy, means that powerful elites have come to utilise budgetary resources acquired through fiscal transfers to accumulate wealth and buy and sustain political loyalties. The development budget holds great political significance in this context. The military employs development funds and associated rent-seeking opportunities such as contracts and procurement opportunities to expand its business empire, reward loyal supporters, and cultivate new leaders. Civilian elites use these funds to maintain otherwise loose and fragile coalitions. The bureaucracy utilises them for corruption and rent-seeking opportunities. Additionally, the limited level of capitalist development means that emerging political entrepreneurs and businesses also focus on the PSDP to accumulate wealth. They build alliances with politicians to secure construction contracts or divert public investments for personal gain. This explains why an increasing number of projects in the PSDP are individual-centric rather than collectively oriented (Mengal, 2021; Shahid, 2018).

Consequently, the share in the PSDP has become a crucial point of contention in inter-elite negotiations and often leads to litigation or coalition break-ups (Buledi, 2022; Shahid, 2020). This behaviour was evident when opposition parties joined forces with dissidents of the Balochistan Awami Party (BAP) to table a vote of no confidence against Chief Minister Jam Kamal (Khan, 2021; Shahid, 2021). The driving force behind the opposition parties and BAP dissidents was the commitment from the new Chief Minister, also a member of BAP, that members of opposition parties would receive a fair share of the current and upcoming PSDP (Buledi, 2022; Notezai, 2023).

The high level of politicisation of the PSDP has not only institutionalised rent-seeking and clientelist distribution of public resources within Balochistan's political economy but also adversely affected service delivery. Nearly all high-level policy attention, time, and effort are dedicated to the PSDP projects, overshadowing the softer aspects of service delivery. Progress on PSDP projects takes precedence in almost all Cabinet, Ministerial, and other senior-level periodic progress review meetings (Baloch, 2021; Kakar, 2022).

5.5. Implications of Political Settlement for School Education

Short-term elite horizons and constituency-centric priorities: The highly fragile, fragmented, and exclusive political settlement in Balochistan carries significant policy ramifications, notably in the realm of school education. The most noteworthy policy consequence emanates from the conspicuously short-term horizons of political elites. These elites grapple with an inherent inability to make credible long-term commitments, thereby adopting a predatory approach to divert public goods toward their patronage networks. Their inclination toward investing in systemic education reforms remains limited due to uncertainties surrounding their capacity to derive long-term benefits from such endeavours.

Moreover, given that no political party possesses a support base that transcends ethnic boundaries, there is a notable absence of provincial ownership as a cohesive entity, discouraging the introduction of province-wide programmatic interventions in education. Instead, education provision gravitates toward constituency-specific and targeted delivery.

Domination of public agenda setting and accountability discourse by issues of conflict & legitimacy: The ethnic conflict prevailing in the region has exerted a considerable influence on public discourse and agenda setting. It has, in fact, overshadowed issues of service delivery, leading to a disproportionate focus on matters of conflict and the legitimacy of the ruling coalition. As a result, service delivery concerns occupy a lower rung on the agenda-setting ladder, receiving minimal attention in accountability debates. The military-led ruling coalition's primary concerns too remain centered on maintaining order, political control, and the semblance of stability, with education delivery relegated to a secondary priority.

Weak alignment of elite interest with access outcomes: Balochistan's lack of a critical mass of capitalist class, capable of advocating for government investment in education to produce skilled labour, has contributed to the misalignment of elite interests with improvement of learning outcomes as well as expansion of schooling. There is almost negligible alignment of elite interest with improving learning outcomes as the latter don't produce visible and rapid returns. In contrast, there is partial alignment with expansion of schooling but only insofar as it enables elites to divert public goods to consolidate and expand their patronage networks. The prime motivation for elites to invest in education lies in the necessity to build, sustain, and enlarge patron-client networks for electoral gains. The latter has resulted in considerable policy incoherence, even concerning access-related objectives. This dynamic underscores the pre-eminence of short-term, constituency-centric patronage politics in shaping education provision.

Significant disparities arise among political parties within the elite spectrum. The relatively ideological and representative political parties exhibit a vested interest in education provision, not only to build and maintain patron-client networks but also to secure legitimacy among their core supporters. This contrastingly explains the unprecedented surge in public financing, merit-based teacher recruitment, and the implementation of essential reforms in management and governance during Dr. Malik Baloch's two-and-a-half-year tenure with the National Party. These reforms predominantly benefited the educated middle class, a core support base. Most of these reforms survived the government change in 2015 but did not receive the same level of support. Conversely, the relatively non-ideological political parties leverage education primarily for patronage politics, showing little interest in systemic reforms. Both categories of elites prioritise education to access international development financing, albeit with variations in the underlying motivations.

The high political fragmentation and fragility of the political settlement contribute to the disjointed and incoherent nature of reform efforts, often yielding "occasional islands of success." These instances predominantly result in "institutional isomorphism and mimicry," where institutions imitate what is considered "good bureaucratic practice" rather than effecting substantial changes in ground realities (Aiyar, Davis, Govindan, & Kapoor, 2021).

Prevalence of politician-teacher nexus: Within Balochistan, the educational workforce operates within a highly politicised framework, heavily influenced by informal institutions and prevailing social norms. Teachers not only actively engage in various election-related responsibilities but also hold significant sway within their respective constituencies. Their involvement in politically significant tasks, such as census-taking

and election duties, coupled with politically-driven processes of teacher transfer and appointment (Attaullah, 2021; Izzatullah, 2021), has given rise to a nexus between teachers and politicians. This nexus has introduced significant inefficiencies in the education delivery system and hindered reform initiatives. On one hand, it has disrupted the management of the education workforce by promoting unwarranted transfer postings and ad-hoc appointments. On the other, it has eroded formal accountability mechanisms for the education workforce, as many individuals seek refuge in their tribal and ethnic identities to evade scrutiny.

Furthermore, this nexus has made education reform initiatives susceptible to resistance from teacher unions. These unions, characterised by their strong organisation and the ability to thwart reforms seen as impinging upon their core interests, wield substantial influence over political parties, prompting them to yield to the pressure exerted by these unions (Baloch, 2021). Political parties often appease teacher unions, as they play crucial roles in election campaigns and on Election Day.

Weak community ownership and engagement: The engagement and ownership of communities in school affairs represent a notable aspect of the education landscape. However, consultations with school heads and government officials reveal a palpable "lack of interest" on the part of parents in school affairs (Baloch, 2021). Several factors account for this disinterest: the relatively educated and well-off classes have opted for private schools, thus reducing their concerns about the state of public schools (Izzatullah, 2021); and the predominantly pessimistic outlook regarding potential returns from enrolling children in public schools, influenced by low literacy levels among relatively poor parents, has discouraged active engagement in school affairs (Secondary Education Department, 2021a). Consequently, a lack of a well-organised and influential constituency to exert pressure on the education system prevails at local and provincial levels. Additionally, hierarchical tribal structures and in-group solidarity norms impede ordinary parents from participating in school affairs or holding teachers and school administrators accountable (Izzatullah, 2021).

Field research yielded intriguing observations regarding community engagement. Schools, especially middle and high schools, function more effectively in areas where community ownership is strong or under the influence of local leaders. Notably, in instances where community leaders proactively engaged in school affairs, these leaders were not traditional tribal elders but, interestingly, ordinary political workers who had risen to leadership positions. Furthermore, the proliferation of madrassahs in rural areas has gained prominence. These madrassahs function autonomously without formal government or non-profit organisation support, largely due to strong community ownership and support. Community members perceive madrassahs not only through a religious lens but also as privately-owned ventures.

Crowding out of "soft" side of education provision: The monopolisation of the public policy space by the PSDP has crowded out softer issues of education provision. The high-level policy attention, time, and resources that should ideally be directed toward the monitoring and enhancement of school education holistically have been significantly absorbed by development projects (Baloch, 2021). Monthly meetings occur at the Cabinet, Chief Minister, Minister, or Chief Secretary Offices to monitor progress on PSDP projects. Conversely, meetings to monitor the softer and less spectacular facets of

education delivery are irregular and infrequent, sometimes not happening for years (Kakar, 2022).

Viewed through the political settlement framework, it becomes evident that elite interests in Balochistan do not align with the objective of enhancing either learning or schooling outcomes. Instead, these interests are primarily focused on providing targeted benefits to patronage networks. Consequently, the substandard quality of education has compelled and incentivised the more educated and affluent segments of society to disengage from the public schooling system. This disengagement, in turn, has resulted in the absence of an organised and influential constituency capable of exerting pressure on the education system at both local and provincial levels

6. CONCLUSION

The devolution of education to provincial governments following the 18th Constitutional Amendment in Pakistan presented an opportunity for significant change in education management and financing. An observable increase in public spending and the introduction of various educational reforms signified the commitment of provincial governments to improve education outcomes. However, the expectations of commensurate improvements in schooling and learning outcomes remain unmet. While improvement of learning outcomes has not remained the strategic priority of education provision, the expansion of schooling appears to have remained a strategic priority of education policy and practice but it has not experienced significant improvement either, mainly due to the politically-driven, centralised, outdated and discretionary education planning and management practices, and ineffective accountability mechanisms. The in-depth case studies of public investment planning, teacher recruitment, and transfer posting framework reveal the prevalence of high degree of politicisation, centralisation and discretionary practices in education management.

A deeper exploration of these issues through the "political settlement" lens reveals a critical point. The alignment of elite interests is neither directed toward the paramount goal of learning nor access. Instead, elite interests are predominantly rooted in patronage politics, thus motivating education delivery for short-term, clientelist, political objectives. This alignment, in turn, is moulded by the intricate, exclusive, fragmented, and personalised nature of the existing political settlement in Balochistan. The fragile and predatory nature of political settlement has adversely affected both the design and implementation of reform efforts. It has not only contributed to the disjointed and incoherent design of reform initiatives but also undermined the effectiveness of well-designed and well-intended reform efforts, especially those pertaining to improved monitoring and accountability. The cumulative outcome is the inefficient management of the limited physical, human and financial resources of SED, thus undermining the system's ability to ensure the timely and reliable provision of necessary inputs for enrolment and student retention.

In the light of the above, the following recommendations are made to ensure better alignment of elite interest with improvement of learning as well as access outcomes of education in Balochistan

- **Enhancing Inclusivity and Stability in the Political Settlement:** It is imperative to pursue strategies aimed at broadening and stabilising the existing political settlement. This entails considering political reconciliation with armed

militant groups and ensuring the conduct of free and fair elections to facilitate the election of authentic representatives of the populace.

- **Reforming Federal Design:** Exploring alterations to the federal design is essential. Options include creating incentives for the emergence of cross-ethnic political parties or enabling ethno-regional parties to secure a simple majority in the provincial assembly. This could be achieved either through augmenting the powers of the Senate or potentially dividing the province into two administrative entities, both of which have the potential to mitigate political fragmentation along ethno-regional lines.
- **Empowering Education Advocates:** Identify, engage with, and officially recognise individuals with a fervent commitment to education, especially within political parties and civil society. These education champions should be incentivised, engaged and supported to advocate for much-needed education reforms in public discourse, agenda-setting and accountability discussions.
- **Strategic Timing for Education Focus:** Recognise key political junctures and leverage them to intensify the emphasis on enhancing education outcomes. These opportune moments can serve as catalysts for meaningful change in the education sector.
- **Reforms in Public Investment Planning:** It is vital to reform the public investment planning processes so that align public investments respond to the actual needs of education system. The unhealthy influence of MPAs may be curtailed and the role of school heads, district tiers and technical sections may be enhanced in identification of public investment needs and development of project proposals.
- **Localising Administrative Affairs:** Decentralise the day-to-day administrative functions of the education system to lower tiers of governance. This approach promotes localised accountability and concurrently alleviates the unnecessary administrative burden at the provincial level.
- **Creating Political Incentives for Access and Quality:** Foster political incentives for prioritising both access to education and the quality of learning. This can be achieved through data-driven information and advocacy campaigns that shed light on issues related to out-of-school children and substandard education quality.
- **Strengthening of Social Accountability Mechanisms:** Steps may be taken to incentivise, support and strengthen community's engagement in the affairs of schools. This can be achieved through provision of direct or indirect support to already notified community engagement and social accountability platforms. Furthermore, advocacy campaigns targeted at community members may be launched. Support campaigns aimed at raising awareness about the detrimental impact of tribal social norms on the education system. These campaigns should also sensitise local communities to the necessity of active engagement in educational affairs.
- **Developing Data-Based Tools:** Construct data-based tools that enable civil society organisations and other stakeholders in the demand side of education to monitor and measure progress in education outcomes. This may include development of district-

wise or constituency-wise composite indices and publication of constituency-wise data on development expenditures. These tools should facilitate the attribution of progress or regression to specific political representatives.

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Revisiting Urban Immovable Property Valuation: An Appraisal of Spatial Heterogeneities in Punjab Using Big Data

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This study employed big data and spatial analysis to assess property values in two cities, Lahore and Faisalabad. Traditional housing price models overlook spatial nuances, focusing solely on structural attributes. To address this, we constructed valuation models using ordinary least square regression and Fast Geographic Weighted Regression (FastGWR), implemented through Python and MPI, based on spatial variables. The models explained up to 75 percent of variance in Faisalabad and around 85 percent in Lahore. Factors like floor area, proximity of health facilities, recreational sites, and marketplaces add a premium to prices, while the nearness of educational institutions, worship places, and solid waste transfer stations or dumping sites lessen the property values in both cities. However, the proximity of industrial units and graveyards affects property values negatively in Lahore but positively in Faisalabad. This study highlights the critical significance of spatial factors in urban immovable property appraisal. As a result, it is recommended to integrate these factors into the process of policy formulation and urban planning.

Keywords: Urban Immovable Property Valuation, Location Specific Parameters, Spatial Heterogeneity, Big Data, Ordinary Least Square Regression (OLS), FastGWR.

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1. INTRODUCTION

Pakistan's real estate market emerges as a potential economic powerhouse, with a substantial portion of the nation's wealth concentrated within its real estate assets, estimated at 60-70 percent. While the sector contributes around 2 percent to the GDP, the combined impact of housing and construction reaches nearly 9 percent. The value of Pakistan's real estate sector, evaluated at approximately $700 billion by the Federal Board of Revenue, signifies its economic significance. Impressively, returns on investment can soar beyond 100 percent (Ouattara et al., 2018). However, this promising market is juxtaposed against a backdrop of challenges and disparities. Pakistan's population, surpassing 225 million, expands annually at a 2.4 percent rate, characterised by an average household size of 6.5 (Pakistan Bureau of Statistics, 2019). With a yearly housing requirement of 700,000 units, merely half of this demand is met, leading to an alarming gap of roughly 10 million units (Rizvi, 2018). This housing shortage necessitates innovative strategies, particularly in the realm of low-cost housing schemes. The intricacies of property valuation further complicate the real estate landscape. Government land acquisitions relying on DC valuation tables often incite public protests due to perceived undervaluation (Sabir et al., 2017). The importance of precise valuation for equitable compensation is underscored by research (Malaitham et al., 2020). Notably, property valuation is not just pivotal for buyers and sellers; it resonates with stakeholders such as investors, banks, agents, and insurers. The geographical location holds substantial influence over a property's price, further emphasising the necessity for accurate valuation (Mankad, 2021).

In dynamically growing cities, the accurate prediction of urban land use evolution plays a pivotal role in fostering sustainable urban planning (Liang et al., 2018) such as Lahore and Faisalabad in Pakistan. Notably, vast untapped potential resides within public properties, including Government Officers Residences (GORs) and railway lands, representing latent avenues for wealth creation. Leveraging these assets effectively can substantially contribute to economic prosperity. The implications of this study extend to policymakers, offering insights to navigate the intricate domains of housing and urban development. A robust housing market stands as a linchpin of a resilient economy; however, Pakistan's housing sector faces an intricate array of challenges. Urbanisation and migration galvanise demand within urban centers, an issue compounded by insufficient supply catalysed by diverse factors. Shortcomings in land usage, planning, and property rights impede progress, while inadequate revenue collection from property taxes curtails infrastructure financing. The labyrinthine regulations further stall land development, exacerbating housing availability discrepancies, particularly pronounced in megacities like Karachi and Lahore. Notably, housing construction trails behind the meteoric pace of population expansion. Skyrocketing market conditions render housing unattainable for many, channeling them towards informal settlements (Dowall & Ellis, 2009; Haque, 2015; Wani et al., 2020; Yuen & Choi, 2012). The challenges are particularly pronounced within Punjab's housing markets, accentuated in cities like Lahore and Faisalabad, grappling with deficits in affordable housing (Malik et al., 2020; Wajahat, 2012). A glaring obstacle lies in the hands of speculative investors who control 75 percent of residential plots, perpetuating this complex issue (Zaman & Baloch, 2011). This practice thrives on secure real estate investments and tax loopholes, compounding the predicament. Although plot prices surge significantly (Gul et al., 2018), official valuations lag behind, generating volatility in Pakistan's property prices. The repercussions of such fluctuations extend to

the public, shouldering the burden of investor gains. Despite intermittent housing policies, the issue remains inadequately addressed, emphasising the urgency of public sector interventions to stabilise spiraling prices (Ahmed et al., 2021).

This investigation delves into the spatial disparities within real estate property values, aiming to underpin a refined and scientific valuation model. A motivation underpinning this study is the inefficiency, non-scientific nature, and inconsistency of the prevailing valuation systems employed by government entities, including DC and FBR rates. Notably, these methods disregard spatial attributes, leading to valuations far below the market values of immovable properties. The absence of mechanisms to record actual market transactions exacerbates the issue, fostering illicit practices and revenue loss for the nation. There arises an imperative to establish a sophisticated valuation system hinged upon spatial variables. Such a framework could not only bridge the gap between official and market rates, but also deter market speculation, which artificially inflates property prices. Annually, the FBR mandates RTOs across Pakistan to constitute committees, including stakeholders such as Chief Commissioners, RTO officers, property dealers, and representatives from the Builders and Developers Association of Pakistan (ABAD). These committees evaluate and adjust valuation tables for tax purposes, a process prone to subjectivity (FBR, 2020). Such a subjective approach underscores the need for scientific calculation methodologies. The persistently lower District Collector's valuation rates (DC rates) in comparison to FBR rates further highlight the shortcomings. Until 2019, DC rates were based on average property transaction prices, often underreported to evade taxes. Although some progress is noted in Lahore's 2020 DC rates, transparency remains questionable. The striking differences highlighted in the

Table 1 & Table 2, underscore the significant gap between market rates and government agency rates.

Table 1

Price per Marla (PKR) of FBR and the Property Portal of Zameen.com

	2016			Feb-19			Jan-20		
DHA Lahore	FBR	Zameen.com	Difference	FBR	Zameen.com	Difference	FBR	Zaineen	Difference
Phase I	672000	1903900	184%	S06400	2140200	165%	360000	2144250	149%
Phase II	552000	1935900	251%	662400	2240325	238%	sooooo	2183400	173%
Phase III	552000	3243600	488%	662400	2909250	339%	300000	3176325	297%
Phase IV	525525	2095S75	299%	630630	2482650	294%	S50000	2478150	192%
Phase V	420000	2733250	563%	504000	3072150	510%	900000	3313350	268%
Phase VI	405000	2184975	440%	486000	2400750	394%	350000	2450025	188%

Source: Zameen.com and FBR.

Table 2

Price per Marla (PKR) of DC Rates and the Property Portal of Zameen.com

	2016			2017			2020		
DHA Lahore	DC Rate	Zameen.com	Difference	DC Rate	Zameen.com	Difference	DC Rate	Zameen.com	Difference
Phase I	560000	1773000	217%	600000	1773400	196%	962500	2144250	123%
Phase EE	460000	1967S50	328%	520000	2026500	2903-4	962500	21S3400	127%
Phase HI	460000	3118975	582%	520000	3GB6550	494%	1100000	3176325	189%
Phase EV	420000	2249325	436%	490000	2255400	360%	825000	2478150	200%
Phase V	250000	2606175	831%	450000	2801250	523%	962500	3313350	244%
Phase VI	270000	2141325	693%	420000	2230875	431%	687500	2450025	256%

Source: Zameen.com and Board of Revenue Punjab.

The objective of this study is to build a valuation model for urban immovable properties based on spatial attributes by utilising big data ($n \geq 1.2$ million) in two big cities of Punjab, i.e., Lahore and Faisalabad.

1.1. Literature Review

The economic value of a commodity is its estimated value based on individual benefits and utility. Quantifying this value is challenging, often relying on market prices and features of both perceptible and imperceptible nature (Fisher et al., 2015; Gabrielli & French, 2020; Lovett, 2019). Hedonic valuation, a prevalent method, uses attributes and past transactions to determine a commodity's utility and market price while the relevant models establish relationships between price and attributes (Baranzini et al., 2008, 2010; Bateman et al., 2001). The hedonic approach identifies factors influencing urban property value, including area, structure, walkability, security, and amenities such as electricity & water supplies, etc. (Boza, 2015; Erickson et al., 2011; Gilderbloom et al., 2015). Models use techniques like ordinary least squares (OLS) or geographically weighted regression (GWR) (Machin, 2011; Pace & Gilley, 1998; Pagourtzi et al., 2003; Shabana et al., 2015). Four sets of variables—structural, locational, environmental, and neighbourhood—are typically used for valuation, with selling prices as the response variable (Freeman, 1981). Mapping urban property values is vital for real estate insights, price monitoring (Brown et al., 2020; Gaffney, 2009), and future city planning (Barreca et al., 2020). Valuation maps benefit buyers, sellers (Goix et al., 2019; Wang et al., 2020), and government agencies for property tax assessments (Chapman et al., 2009; Larson & Shui, 2020). Taxes based on fair market values consider urban services, enhancing tax fairness and benefiting property owners. Urban service provision positively impacts property value, funded by government resources. Hedonic models are essential for estimating real estate property market prices, factoring in various influences. These models provide crucial insights for understanding housing preferences and assume perfect market competition and information symmetry among buyers and sellers (Freeman, 1981; Taylor, 2008). However, housing markets differ due to distinctive features, resulting in product range discontinuities and complexities in assessing price-determining features (Knight, 2008). Residential property value hinges on floor area, structural attributes, and location (Xiao et al., 2017). Spatial hedonic valuation models, accounting for location, prove effective (Helbich et al., 2013; Koschinsky et al., 2012). Proximity to amenities and urban services impacts house prices, with mixed findings – positive correlations for factors like transport access and negative correlations for aspects like waste stations (Seo et al., 2014; Tian et al., 2017). House values are also linked to factors like government policies, infrastructure, water supply, and security (De & Vupru, 2017; Xiao et al., 2017; Yang et al., 2018). Real estate valuation methods encompass spatial dependence and heterogeneity models (Krause & Bitter, 2012).

The utilisation of spatial dependence in property valuation research has a rich history and substantial literature. Spatial dependence refers to the degree of similarity among observation values in geographic space (Crawford, 2009). Positive spatial autocorrelation implies similar values cluster together, while negative autocorrelation indicates dissimilar values cluster (Griffith, 2004; Hubert et al., 1981). Hedonic price theory suggests that utility-bearing features influence the value of commodities, with their impact estimated through hedonic price indices (Lancaster, 1966; Rosen, 1974). A user's willingness to pay

for a commodity feature reflects its hedonic price under consumer utility maximisation. Historical transactions can establish a price function between commodity attributes and price, enabling estimation of implicit hedonic prices for specific features. Notably diverse house attributes warrant separate hedonic models to assess their values. Landscape features significantly affect housing prices, necessitating location-specific valuation (Goodman, 1978). Studies like Can (1990) found spatial attribute inclusion improved urban property appraisal accuracy. Can and Megbolugbe (1997) highlighted that hidden spatial dependence in residential real estate data substantially influenced value estimation accuracy. Liao and Wang (2012) identified a U-shaped spatial dependence pattern in Changsha's house prices, where proximity of high- and low-priced houses positively impacted implicit prices, while medium-priced houses had a comparatively lesser effect. House prices were lower in densely built-up areas, counter to Western city market trends where central properties were usually pricier.

Spatial heterogeneity is a recognised challenge in real estate datasets, often addressed by segmenting the area of interest into functionally homogeneous regions for valuation (Kauko, 2003). Spatial heterogeneity signifies variability in values across space (Dutilleul & Legendre, 1993). In this context, it refers to properties with similar characteristics being valued differently across different areas within the study space. Spatial heterogeneity exploration has historical roots with techniques like Casetti's expansion method (Casetti, 1972), which broadens a mathematical model by redefining parameters through spatial variables (Casetti, 1997). Can (1990) applied the spatial expansion method to construct a hedonic model for residential property valuation, considering neighbourhood attributes. Anselin (1995) used local indicators of spatial association (LISA) to explain spatial heterogeneity and spatial dependence, indicating a potential link between nearby values. Brunsdon et al. (1996) developed geographically weighted regression (GWR) to address spatial non-stationarity by modifying parameters in Kernel Regression. GWR provides localised spatial statistics, offering visual analysis. Fik et al. (2003) used an interactive variable approach for spatial heterogeneity in house prices, highlighting location's interactive effect with other variables. Bitter et al. (2007) compared GWR with spatial expansion methods, concluding GWR's better accuracy in capturing varying attribute effects. Wen et al. (2017) noted GWR's advantages, offering accurate and visually distributive implicit values. Spatial heterogeneity is crucial for accurate house price appraisal due to varying property prices within urban centres influenced by urban facilities (Redfearn, 2009; Yuan et al., 2020). Wu et al. (2020) favoured spatial heterogeneity over spatial dependence in identifying housing submarkets due to urban complexity. (Jiang, 2018) advocated using spatial heterogeneity over spatial dependence for geospatial analysis, especially with large data, suggesting a shift from Euclidean to fractal geometry. Addressing spatial heterogeneity in property valuation is vital as real estate prices vary across locations within urban areas, influenced by varying urban facilities. Techniques like GWR provide accurate insights into such variations and aid in accurate valuation.

Big data refers to vast, intricate datasets accumulating over time on platforms like social media, organisational transactions, and machine-generated sources. When coupled with geographic information, it becomes spatial-big data or geo-big data (Dalton & Thatcher, 2015; Gao et al., 2017; Goodchild, 2013; Guo et al., 2014). C. Wu et al. (2016)

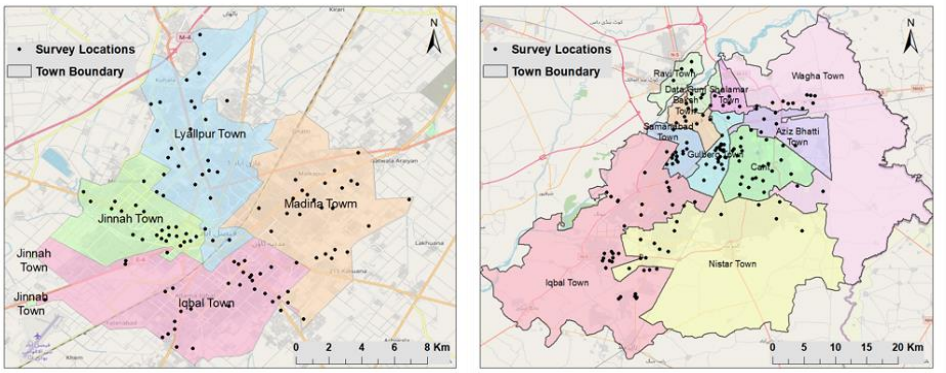
analysed check-in data from Sina Visitor System to gauge urban amenity influence on homebuyer preferences in Shenzhen, China. Yang, et al. (2020) studied the impact of a bus rapid transit system on property values using data from Fang.com. Singh et al. (2020) used software packages including gdata and caret to mine housing sale prices from web sources. Ma et al. (2020) noted big data's advantage in real estate appraisal due to its richness in factors and robustness in analysis compared to traditional methods.

Ordinary least square (OLS), a linear regression type, estimates relationships between dependent and explanatory variables (Dismuke & Lindrooth, 2006; Frost, 2019). It assumes constant relationships across all locations (Wooldridge, 2016). Global techniques like Moran's I and GI* detect spatial patterns and association (Getis, 2008; Getis & Ord, 2010). Local spatial statistic Oi identifies hotspots, considering global spatial structure (Ord & Getis, 1995, 2001). GI* and K-means assess spatial non-stationarity (Peeters et al., 2015). Spatial dependence in real estate is modeled with SLM, SEM (Kim et al., 2003) and GSM which combines both SLM & SEM (Brasington & Hite, 2005; LeSage, 2008). GWR explores spatial heterogeneity, estimating location-specific parameters (Brunsdon et al., 1996; Fotheringham et al., 2015; Scott & Janikas, 2010). Larger datasets challenge traditional GWR (Harris et al., 2010). MGWR relaxes assumptions with unique spatial scales (Fotheringham et al., 2017). MGWR's Python-based mgwr offers efficiency (Z. Li & Fotheringham, 2020; Oshan et al., 2019). FastGWR handles millions of observations, outperforming other packages, it reduces memory constraints and employs parallel diagnostic calculations (Z. Li et al., 2019).

2. MATERIAL AND METHODS

This study covered two major cities of Punjab, Pakistan i.e., Lahore and Faisalabad.

Fig. 1. Study Area



2.1. Data and Sources

Data for the study were gathered from diverse sources including governmental and non-governmental entities and web scraping programs. Property price data, house parcels, road networks, urban land use, and key locations were among the data types used. Property portals in Pakistan such as zameen.com were utilised, with zameen.com being the largest, covering numerous cities. Through web scraping, data on 3,526 houses in Faisalabad were collected from zameen.com and geocoded. These prices serve as

approximations, typically 3-5 percent higher than actual transactions (Wahid et al., 2021). While the property listing data does not provide transactional history, it serves as a proxy for market prices (C. Wu et al., 2016). In Lahore and Faisalabad, property data from zameen.com, encompassing 26,031 properties and 3,526 properties respectively, were employed. As official transaction records tend to understate actual prices, web-based data was used for estimation. Although sellers' asking prices are used, they closely correlate with actual transactional prices in certain markets (Ibeas et al., 2012; Salon et al., 2014). While listed properties might not always be sold, they offer insights into seller perceptions. The study also utilised land use parcels datasets from Urban Units in Lahore and Faisalabad. Deficiencies in the property parcels dataset were resolved through digitisation and geo-referencing.

2.2. Processing Operations

Using ArcGIS 10.8 software, processing operations were performed. Selected properties were displayed using coordinate values, creating price surfaces for entire cities. Raster price surfaces were generated via geo-referenced property points using Inverse Distance Weighted (IDW) interpolation with barriers. IDW computes values of unknown points based on weighted averages of known values, giving more weight to nearby points (Hu et al., 2013; L. Li & Revesz, 2004; S. Li et al., 2017). Raster price surfaces were converted to point layers, shifting price field from point feature layers to property parcels. Resultant parcels were converted to points. Near tables within attribute tables of property point layers were generated for selected spatial amenities, containing Euclidean distances to nearest relevant spatial amenity points.

2.3. The Spatial Hedonic Valuation Model

A hedonic house property valuation model based on various attributes was constructed as follows:

$$\begin{aligned} y = {} & \beta_0 + \beta_1(\mathrm{A}) + \beta_2(\mathrm{d.WP}) + \beta_3(\mathrm{d.HR}) + \beta_4(\mathrm{d.Rec}) + \beta_5(\mathrm{d.Mar}) \\ & + \beta_6(\mathrm{d.Ind}) + \beta_7(\mathrm{d.HF}) + \beta_8(\mathrm{d.Gy}) + \beta_9(d.\mathrm{Edu}) + \beta_{10}(d.\mathrm{Ban}) \\ & + \beta_{11}(d.\mathrm{Com}) + \beta_{12}(d.\mathrm{SCom}) + \beta_{13}(d.SW) + \beta_{14}(d.\mathrm{AF}) + \epsilon \end{aligned} \quad \ldots \quad 2.1$$

In Equation 2.1 the variables are defined as follows:

(1) y is the estimated value of a house;
(2) β_0 is the intercept;
(3) A is the floor area of the house;
(4) d.WP is the proximity distance to the nearest worship place;
(5) d.HR is the proximity distance to the nearest hotel or restaurant;
(6) d.Rec is the proximity distance to the nearest recreational site such as a park, playground or other recreational site;
(7) d.Mar is the proximity distance to the nearest market, a shopping centre, or a supper store;
(8) d.Ind is the proximity distance to the nearest industrial unit;
(9) d.HF is the proximity distance to the nearest health facility such as a hospital or clinic;
(10) d.Gy is the proximity distance to the nearest graveyard;

(11) d.Edu is the proximity distance to the nearest educational institute such as a school, college, university or technical training institute;
(12) d.Ban is the proximity distance to the nearest bank or automated teller machine (ATM);
(13) d.Com is the proximity distance to the nearest commercial building;
(14) d.SCom is the proximity distance to the nearest semi-commercial building;
(15) d.SW is the proximity distance to the nearest solid waste dumping site/collection or transfer station;
(16) d.AF is the proximity distance to the nearest animal farm; and
(17) ϵ represents the error term.

2.4. Variable Selection

After an extensive literature review, we initially selected fourteen covariates for analysis. The prime structural attribute, floor area, a significant determinant of property value (Gluszak & Zygmunt, 2018), was included along with other spatial regressors. Through elimination, multicollinearity was addressed, leading to exclusion of variables like commercial places, semi-commercial buildings, banks and ATMs, restaurants, and animal farms due to multicollinearity. This resulted in a final model with nine explanatory variables.

2.5. Interpolation of Property Values

Before computing the property valuation model, the inverse distance weighting (IDW) interpolation was performed to obtain the predicted surface of property prices. The IDW interpolation with barriers and without barriers was applied to the data to avoid under- or over- prediction. The results of the interpolation with barriers and without barriers for property prices are shown in Figure 2 and Figure 4.

Fig. 2. Interpolation of property prices (A) IDW interpolation (B) IDW interpolation with barriers (Faisalabad)

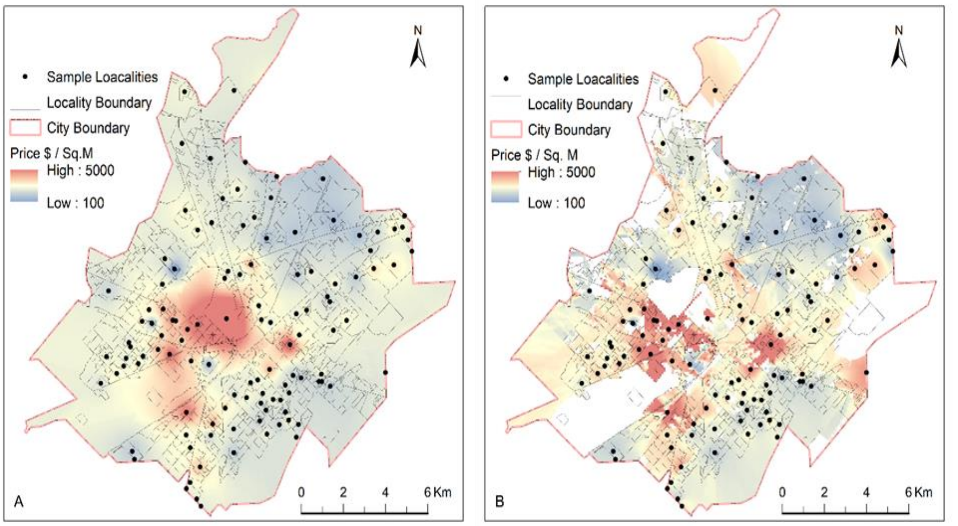


Fig. 3. Transferring Interpolated Values of House Prices to the Locality Boundary and the Individual House Parcel

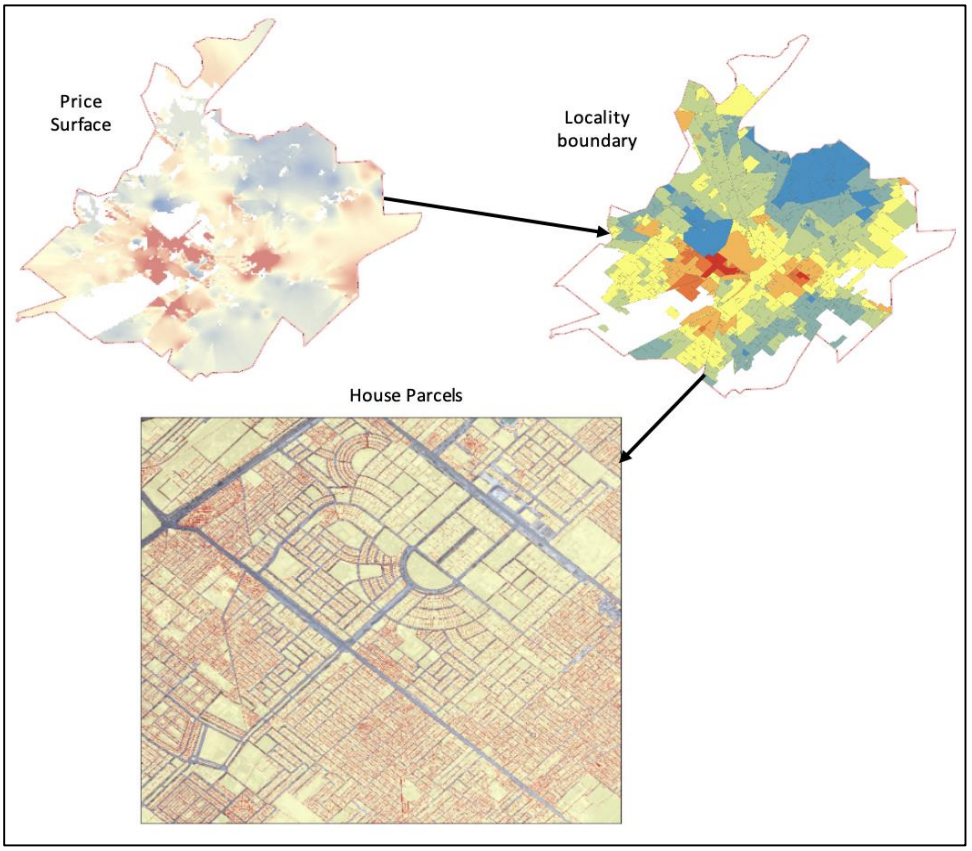
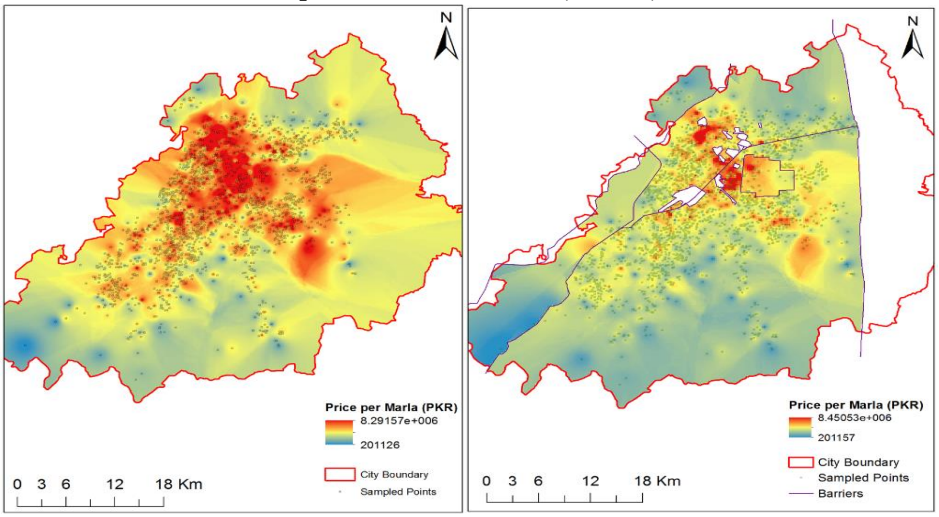


Fig. 4. Interpolation of Property Prices (A) IDW Interpolation (B) IDW Interpolation with Barriers (Lahore)



2.6. Analyses

We first performed the hedonic valuation analysis using the OLS model. The OLS is considered the best technique among all the regression methods and is used as a proper initial procedure before conducting any other regression-based spatial analysis. The OLS in the spatial statistics toolset of ArcGIS desktop can be used to discover, inspect, and model the linear spatial relationship between a dependent and one or more explanatory variables with a global approach. This means that OLS computes the relationship between the variables using a single equation for the whole area under study and assumes that the relationship remains consistent and stationary at all locations (Mitchell, 2005; Scott & Janikas, 2010).

GWR model was then employed to capture the spatial heterogeneity. It is a valuable tool for studying spatial variability. It focuses on estimating site-specific parameters, enhancing calibration. GWR addresses spatial non-stationarity, where traditional linear regression fails in explaining variable relationships across a geographic area. Local GWR analyses residential property values for each area, incorporating regional variation in the model (Getis & Ord, 2010; Mitchel, 2005). Unlike a single model for the entire study area, GWR runs regressions for each location. However, the open-source GWR software is limited, processing around 15,000 data points on a standard computer. This constraint hampers GWR's application, especially in large areas like cities. To overcome this, FastGWR, a Python-based application developed by Li et al. (2019), is utilised. FastGWR employs Message Passing Interface (MPI) for parallel computing, boosting performance and memory usage. This enables processing of millions of observations, surpassing existing GWR software. FastGWR improves memory efficiency through enhanced linear algebra in GWR calibration. Memory requirements are reduced from O(n^2) to O(nk), with k (covariates) typically much smaller than n (observations). FastGWR offers parallel model diagnostics for massive datasets, significantly reducing GWR calibration time. OpenMPI and the "mpi4py" Python wrapper are employed for implementation.

3. RESULTS AND DISCUSSION

3.1. Global Model Implementations

Linear model implementation produced adjusted R^2 values of 0.85 for Lahore and 0.75 for Faisalabad. The values were slightly lower than R^2 values and there were no big differences, which indicates that the models were properly specified. The joint-F test result is not interpretable because the associated p-value of the Koenker BP test was statistically significant. Therefore, the joint-Wald test statistic was used to determine the overall model significance. Since the p-value of the joint Wald statistic was statistically significant and smaller than 0.05 at a 95 percent confidence level, there was enough evidence to reject the null hypothesis and accept the alternative hypothesis that the regressors in the model were effective. The P-value associated with the Koenker BP test was also much lower than 0.05 at a 95 percent confidence level, which points toward the conclusion that the relationship between the response and explanatory variables was not consistent and stationary implying that spatial heterogeneity exists. That result was expected as the relevant literature confirms that

the occurrence of spatial non-stationarity in the housing data is a common real-life phenomenon because the degree of the effect contributed to the house prices by different externalities is always unique at different locations. Spatial heterogeneity can be reported using a global model like OLS but could further be measured using some local models, such as GWR (Bitter et al., 2007; Brunsdon et al., 1996; Fik et al., 2003; Wen, Jin, et al., 2017). A statistically significant p-value of the Jarque-Bera test is the indication of the presence of non-normality in the distribution of the residuals and that the model is not unbiased and could not be trusted fully. However, the relevant literature suggests that a model with a significant p-value of the Jarque-Bera test can be trusted when working with a large dataset because it is a proven fact that the assumption of normality for response as well as explanatory variables is not required in an OLS linear model when the sample size is too large. Since the distribution of regression residuals depends on the distribution of regression variables, the normality assumption can be ignored for residual distribution as well in case of large sample size (Lumley et al., 2002). When a regression model has non-normally distributed residuals, one needs to check robust standard errors and robust p-values to check if the variable coefficients are significant statistically instead of standard errors and probabilities (Mitchell, 2005; Scott & Janikas, 2010). Since Koenker statistics were statistically significant in the model diagnostics, only those robust p-values (probabilities) were checked that were smaller than 0.05 for all explanatory variables. There was sufficient evidence to reject the null hypothesis and accept the alternative hypothesis that all the coefficients were significant. The coefficient values reflect the nature and strength of the relationship of each regressor with the response variable.

The results of the linear model for the entire cities of Faisalabad and Lahore are presented in Table 3. The adjusted R^2 value explained the relationship of explanatory variables to the house prices up to 75 percent for Faisalabad and around 85 percent for Lahore in the linear model. However, the robustness of the model was improbable since residential property prices were less normally distributed. Most of the coefficients for the explanatory variables were as expected and explained the relation between the response variable and explanatory variables.

Total floor area (in Marlas for Lahore and m2 for Faisalabad) showed a positive relationship with the house price, which indicates that every additional Marla in the floor area increased the house price by PKR 2,202,216.09 in Lahore, while every additional m2 in floor area increased the house price by PKR 86,256.45 in Faisalabad. Spatial variables, i.e., distance to the nearest health facility, marketplace, and recreational facility, such as a park, lowered the house price by PKR 2,614.52, 1,149.4, 1,105.2, respectively, with a one-meter increase in the Euclidean distance. It implies that people value these facilities and like to live near them. On the other hand, the results show that as the distance between the house and the nearest industrial unit, educational institution, graveyard, solid waste dumping site/transfer station, and worship place increased, the house price also increased by PKR 1,921.57, PKR 647.83, PKR 563.58, PKR 429.79 and PKR 234.92 per metre, respectively. It indicates that the residents do not prefer to reside near these features in Lahore. In Faisalabad, the dynamics, however, are somewhat different from Lahore.

In Faisalabad, as the Euclidean distance to the nearest health facility, park, marketplace, industrial unit and graveyard decreased by one metre, the house price increased by PKR 1,495.64, PKR 1460.89, PKR 517.08, PKR 130.66, and PKR 45.87, respectively. On the other hand, as the distance to the nearest educational institution, solid waste dumping site/transfer station and worship place decreased by one metre, the house price also decreased by PKR 504.57, PKR 393.37, PKR 355.84, respectively. Unlike Lahore, the proximity to industrial units and graveyards contributed positively to house prices in Faisalabad. A possible reason for this contradiction may be the presence of small industrial units, such as power looms, and graveyards within residential areas, especially in the central parts of Faisalabad. This pattern is not present on such a large scale in Lahore.

Table 3

Description of the Variables for the Spatial Hedonic Valuation Model

Category	Features	Description	Faisalabad	Lahore
Parcel counts	Parcels	Number of total parcels in the study area	416,168	808,710
House counts	House Parcels	Number of residential properties in the study area	268,911	780,178
House Attributes	Area (m^2)	Total area of the residential properties in square metres	30.22	116.04
	Area (Marla)	Total area of the residential properties in Marlas	1.20	5.55
Valuation	Total worth	Total worth of residential properties	PKR 2.97 trillion ($ 17.52 billion)	PKR 11.36 trillion ($ 66.83 billion)
	Average Price	Average price per square meter (per Marla)	PKR 98,279 (PKR 2.47 million)	PKR 97,897 (PKR 2.04 million)
Amenities	Solid Waste	Number of solid waste facilities and transfer stations	70	1,091
	Graveyard	Number of graveyards	72	166
Cultural	Worship Places	Number of worship places (i.e., mosques, churches, and temples)	1,409	2,281
Education and Health Facilities	Institutes	Number of educational institutions (schools, colleges, and universities)	1,705	4,329
	Health Facility	Number of health facilities (hospitals, clinics, and dispensaries)	318	2,902
Recreation	Parks and Recreation	Number of public parks and recreational sites	368	1,381
Industrial and Commercial	Industries	Number of industrial units	9,319	8,901
	Market Places	Number of market places	141	5,439
	Commercial	Number of commercial buildings	66,769	96,685
	Semi-Commercial	Number of semi-commercial buildings	2,679	68,967
	Bank and ATMs	Number of banks and automated teller machines	229	2,153
	Restaurants	Number of restaurants and cafes	612	2,793
	Animal Farms	Number of animal farms (poultry and dairy farms)	1,224	2,015

The results are per our expectations and in line with the findings of relevant previous studies. Some of the supporting references are discussed here. The floor area of a real estate property is the most important factor that determines its price (Ma et al., 2020), while the proximity of shopping facilities adds a premium to house prices (De & Vupru, 2017; Xiao et al., 2017; Yang et al., 2018b; Yang, Chau, et al., 2020; Zhang et al.). The presence of worship places in the vicinity of every religion contributes to house prices positively. However, some housing properties that are near worship places may experience price devaluation because of noise and a higher number of visitors that create disturbances for the residents (Brandt et al., 2014; Thompson et al., 2012). On the other hand, urban green spaces, public parks, playgrounds, and other recreational sites add a premium to the housing properties (Crompton & Nicholls, 2020; Liao & Wang, 2012; Shabana et al., 2015). Residential properties close to graveyards fetch lower values due to superstitions linked to the burial grounds (Hassan et al., 2021). Similarly, an industrial neighbourhood is a negative influence on residential property prices in most of the research findings (Grislain-Letrémy & Katossky, 2014; Munshi, 2020).

3.2. Local Model Implementation

The FastGWR model estimation produced an adjusted R squared of 78 per cent for Faisalabad, which shows a strong relationship between the house value and predictors. Table 4 presents the results of the FastGWR model estimation for the entire city. The coefficients of the FastGWR are positively correlated except for the distance to a solid waste facility, which deceptively indicates that the house values decreased as the distance increased from the solid waste facility. Since these coefficients are the average values that are affected by the high negative values in the results, we also examined the results locally. Figure 4c depicts the significant parameter estimates for the distance to a solid waste facility. The map shows that the house parcels coloured in blue had a converse effect of distance to solid waste facility, meaning that the values of these houses decreased as the distance from solid waste facility increased. One possible reason for this inverse coefficient could be that earlier the solid waste facilities were established away from the settlements but with time, the settlements have grown around these facilities and the land prices near these facilities have also increased. The low variance inflation factor (less than 7.5 for each regressor) indicates that there is no multicollinearity as we had already eliminated the muiltcollinear explanatory variables, while the regression residuals are random and not spatially autocorrelated.

In the OLS results table, we need to understand the t-statistics value that evaluates the statistical significance of the explanatory variables. The higher the t-statistic, the more significant the variable is. This value explains that the area of the house is the most important structural variable for house price in the entire city, while the other significant variables are the distance to a solid waste facility, distance to worship places, and distance to educational institutes, respectively. These accessibility variables have positive coefficients indicating that the house price increased as the distance from these features increased. The other significant variables with negative coefficients are the distance to parks, distance to markets, distance to hospitals, distance to graveyards, and distance to industries respectively. The negative coefficients suggest that residential property prices decreased as the distance from locational features increased. These findings are similar to that of Li et al., (2019), who studied the city of Los Angeles, California.

Table 4

Explanatory Variables

Variables	Faisalabad	Lahore
Mean Area (Marla)	4.46	7.11
Mean Area (m^2)	111.87	148.62
Mean Distance to Worship places (Metres)	127.15	352.23
Mean Distance to Solid Waste Facilities (Metres)	798.70	696.50
Mean Distance to Parks (Metres)	520.96	397.55
Mean Distance to Markets (Metres)	1,769.26	495.77
Mean Distance to Institutions (Metres)	129.66	287.90
Mean Distance to Industrial Units (Metres)	165.34	408.30
Mean Distance to Health Facilities (Metres)	388.75	440.37
Mean Distance to Graveyards (Metres)	860.15	978.85
Mean Distance to Commercial buildings (Metres)	31.18	1,464.49
Mean Distance to Semi Commercial buildings (Metres)	1343.56	1654.77
Mean Distance to Banks & ATMs (Metres)	1,004.45	811.83
Mean Distance to Hotel / Restaurant / Café (Metres)	434.17	443.11
Mean Distance to Animal farms (Metres)	283.94	2332.94

The results of the OLS model for the FD-I rating area are presented in Table 5. The semi-log model explains the relationship up to 77 percent, while the linear model explained it up to 80 percent. The coefficients are as expected but the distances to worship places, parks, markets, educational institutes, and hospitals were negative. This indicates that the house price decreased as the distance from these variables increased. The worship places are key cultural features in the city that appear to impact the prices of residential houses positively (Brandt et al., 2014; De & Vupru, 2017). In the FD-I zone, the average price per square metre was US$875 and the average house price was US$81,320 with an average area of 95 square meters. The t-statistics are suggestive of the order of significance for these negative coefficients, which indicates that the distance from places of worship, distance from parks, distance from health facilities, and distance from the market were the most significant locational features influencing prices, respectively. The coefficient of distance to a solid waste facility is negative in the linear model, while in the semi-log model, this coefficient is positive. However, they are not statistically significant.

3.3. Model Implementation for different rating areas in Faisalabad

These values indicate that in the FD-I rating area, the distance to solid waste facilities did not influence the prices of residential properties, while all other explanatory variables had an impact on the house prices positively or negatively. The results of the FastGWR are presented in Table 8. The R-squared value for FD-I is 0.61, indicating that the model explained a 60 percent variance based on the explanatory variables. As suggested by the coefficients of all the predictive variables, there existed a positive correlation. This zone comprises the central business district (CBD) where most of the properties are commercial and semi-commercial and there are only 28,090 residential properties.

Table 5

Results of the Linear Model

	Lahore Adjusted R^2 =0.85				Faisalabad Adjusted R^2 =0.75			
Variable	Coeff.	t-stat	p-Value	VIF	Coeff.	t-stat	p-Value	VIF
Intercept	356,219.99	20.36	0.000*	-----	3,280,398.6	199.14	0.000*	----
Floor Area	2,202,216.09	2,050.22	0.000*	1.04	86,256.45	881.22	0.000*	1.04
D_Worship Places	234.92	6.95	0.000*	3.14	355.84	5.99	0.000*	1.11
D_SolidWaste Site	429.79	24.80	0.000*	2.82	393.37	34.48	0.000*	1.62
D_Parks	-1105.20	-48.86	0.000*	1.85	-1,460.89	-119.19	0.000*	1.18
D_Market	-1149.40	-46.33	0.000*	4.68	-517.08	-94.11	0.000*	1.55
D_Institutes	647.83	15.85	0.000*	3.39	504.57	8.30	0.000*	1.20
D_Industries	1,921.57	73.14	0.000*	1.54	-130.66	-3.04	0.002*	1.23
D_Hospitals	-2,614.52	-109.91	0.000*	3.10	-1,495.64	-73.75	0.000*	1.30
D_Graveyards	563.58	39.45	0.000*	1.26	-45.87	-4.51	0.000*	1.51

Table 6

Results of the FastGWR Model for Faisalabad

	Faisalabad R^2 = 0.78	
Predictor	Coeff.	SE
Area	0.00480	0.00015
D_Worship Places	0.00052	0.00041
D_Solid Waste Facilities	-0.00038	0.00089
D_Parks	0.00094	0.00064
D_Markets	0.00443	0.00065
D_Institutes	0.00042	0.00043
D_Industry	0.00057	0.00049
D_Hospitals	0.00039	0.00062
D_Graveyards	0.00283	0.00076

The FD-II rating area is characterised by small- and medium-scale industries, timber market, and wholesale businesses. Although the average house area in this zone was smaller, the average price per square metre was 22.6 percent higher than the FD-I rating area and the average house price was also 20.32 percent higher (i.e., US$102,063). The higher prices of small houses in this area are due to the ease of access to workplaces and proximity to the city centre. The results of the valuation model for this region are dissimilar to the results of the FD-I rating area. All the explanatory variables are statistically significant except the distance from worship places. Although the average distance to the places of worship was much smaller (93.4 metres), worship places did not seem to influence the residential property prices in this particular zone. This effect is possibly due to the socio-economic conditions of the area since the average house size and the income level were lower than other residential districts. The worship places give the impression of being less important for the residents possibly due to the degree of adherence to religion and the level of noise from the loudspeakers of mosques. Researchers have found the negative effects of places of worship on adjacent house prices but this effect declines with the increasing distance and diminishes after 300 metres (Brandt et al., 2014; Do et al., 1994).

Table 7

Results of the Linear Model for Different Rating Areas in Faisalabad

	Semi-Log OLS Model R^2 =0.77			Linear Model R^2 =0.80			
Rating Area FD-I	Coeff.	t-stat	p-Value	Coeff.	t-stat	p-value	VIF
Intercept	10.35575	1307.87	0.0000*	14,688.14	25.88	0.0000*	–
House Area	0.00985	301.19	0.0000*	793.34	338.31	0.0000*	1.06
D_Worship Places	-0.00063	-30.30	0.0000*	-47.65	-31.82	0.0000*	1.12
D_SolidWaste Facility	0.000002	0.27	0.7859	-0.24	-0.41	0.6831	1.22
D_Parks	-0.00038	-30.17	0.0000*	-30.39	-33.18	0.0000*	1.13
D_Market	-0.00005	-10.15	0.0000*	-6.38	-17.09	0.0000*	1.18
D_Institutes	-0.00012	-5.19	0.0000*	3.95	2.35	0.0186*	1.12
D_Industries	0.00028	18.32	0.0000*	25.08	22.32	0.0000*	1.14
D_Hospitals	-0.00016	-13.58	0.0000*	-16.28	-18.45	0.0000*	1.10
D_Graveyards	0.00016	30.30	0.0000*	12.22	31.22	0.0000*	1.30
	Semi-Log Model R^2 =0.78			Linear Model R^2 =0.81			
Rating Area FD-II	Coeff.	t-stat	p-value	Coeff.	t-stat	p-value	VIF
Intercept	10.16367	852.36	0.0000*	-10,913.75	-10.54	0.0000*	----
House Area	0.01060	187.93	0.0000*	1,015.18	207.08	0.0000*	1.07
D_Worship Places	-0.00007	-1.82	0.0680	-2.52	-0.72	0.4705	1.11
D_SolidWaste Facility	-0.00023	-27.30	0.0000*	-21.46	-29.28	0.0000*	1.53
D_Parks	0.00015	7.21	0.0000*	9.03	4.98	0.0000*	1.44
D_Market	0.00005	7.27	0.0000*	0.72	1.20	0.2305	1.54
D_Institutes	0.00016	4.77	0.0000*	19.52	6.70	0.0000*	1.31
D_Industries	-0.00032	-11.34	0.0000*	-22.13	-8.90	0.0000*	1.59
D_Hospitals	0.00026	16.44	0.0000*	16.89	12.07	0.0000*	1.32
D_Graveyards	0.00047	49.54	0.0000*	38.72	46.48	0.0000*	1.69
	Semi-Log Model R2 =0.71			Linear Model R2 =0.79			
Rating Area FD-III	Coeff.	t-stat	p-value	Coeff.	t-stat	p-value	VIF
Intercept	10.39261	5,323.04	0.0000*	17,254.89	135.38	0.0000*	----
House Area	0.00761	726.77	0.0000*	612.54	896.17	0.0000*	1.04
D_Worship Places	0.000141	22.37	0.0000*	8.88	21.66	0.0000*	1.12
D_SolidWaste Facility	0.000048	40.00	0.0000*	2.66	34.25	0.0000*	1.60
D_Parks	-0.00012	-98.16	0.0000*	-8.76	-106.34	0.0000*	1.15
D_Market	-0.00002	-32.97	0.0000*	-1.72	-42.69	0.0000*	1.53
D_Institutes	0.000011	1.79	0.0741	1.03	2.47	0.0134*	1.21
D_Industries	-0.00005	-10.94	0.0000*	-1.25	-4.15	0.00003*	1.24
D_Hospitals	-0.00008	-37.37	0.0000*	-7.11	-50.95	0.0000*	1.31
D_Graveyards	-0.000045	-41.54	0.0000*	-1.77	-24.89	0.0000*	1.53

Table 8

Results of the FastGWR Model for Rating Area FD-I, FD-II, and FD-III

	FD-I (R^2=0.61)		FD-II (R^2=0.59)		FD-III (R^2=0.80)	
Predictors	Coeff.	SE	Coeff.	SE	Coeff.	SE
Area	0.00511	0.00020	0.00524	0.00021	0.00475	0.00015
D_Worship Places	0.00072	0.00053	0.00181	0.00056	0.00049	0.00039
D_Solid Waste Facility	0.00516	0.00043	0.00025	0.00065	-0.00101	0.00093
D_Parks	0.00044	0.00062	0.00515	0.00043	0.00078	0.00064
D_Market	0.00498	0.00050	0.00205	0.00057	0.00449	0.00066
D_Institutes	0.00047	0.00054	0.00086	0.00053	0.00038	0.00041
D_Industry	0.00220	0.00061	0.00109	0.00063	0.00038	0.00048
D_Hospitals	0.00165	0.00050	0.00442	0.00048	0.00006	0.00064
D_Graveyards	0.00539	0.00053	0.01000	0.00049	0.00209	0.00079

Fig. 5. Maps of Significant Parameter Estimates for the Predictive Variables: Area of the House (a), Distance To Worship Places (b), Distance to Solid Waste Sites (c) Distance to Parks (d)

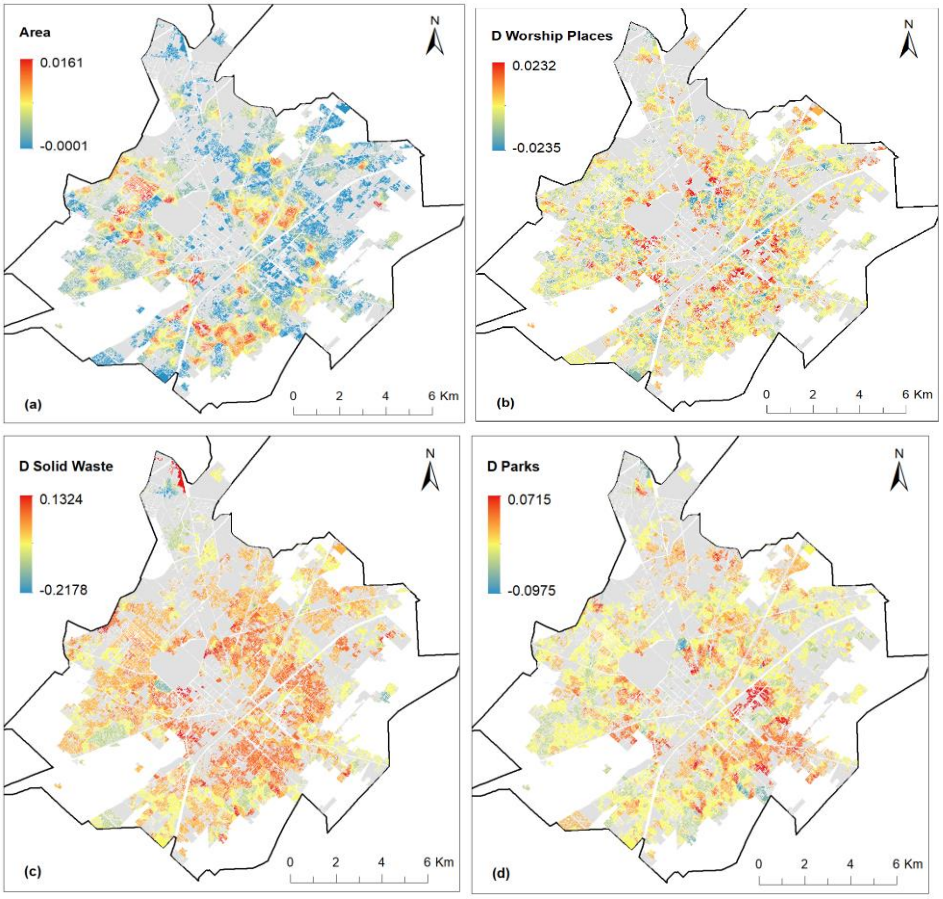
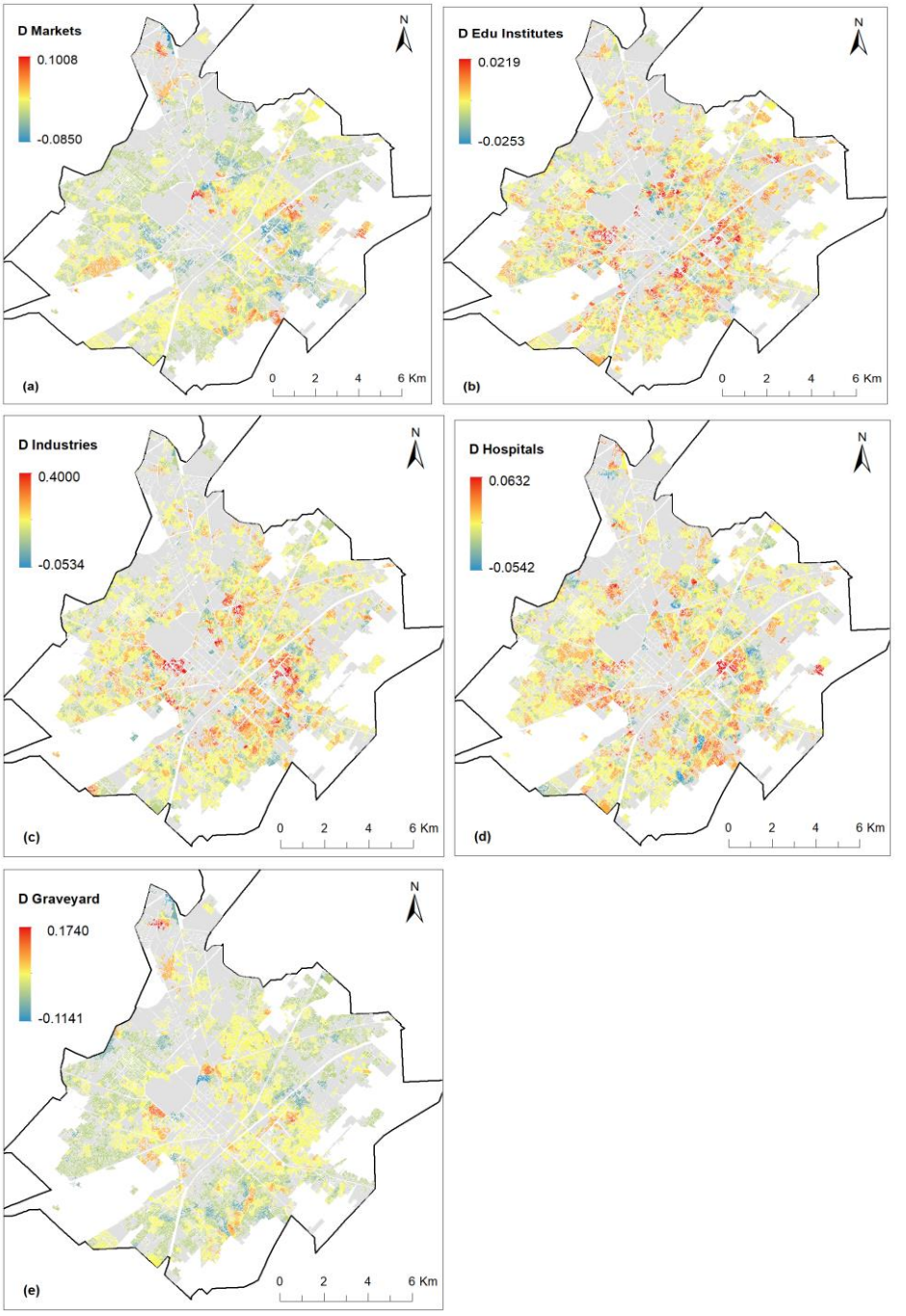


Fig. 6. Maps of Significant Parameter Estimates for Predictive Variables: Distance to Markets (a), Distance to Educational Institutions (c), Distance to Industries (c), Distance to Hospitals (d), Distance to Graveyards (e)



The coefficients for distance to solid waste facilities and distance to industries are negative and statistically significant (99 percent confidence). Solid waste transfer stations provide opportunities for scavengers and scrap dealers to collect recyclable materials to earn their living. Small- and medium-scale industries, like power looms, garment factories, embroidery units, plastic products, leather factories, paper, and chemical factories exist in this area, thus, offering employment opportunities to the residents. Distance to market is statistically significant in the semi-log model but the results of the linear model were not statistically significant. There are only 4.13 percent (n = 11,107) houses present in this zone, whereas 75.7 percent of the houses in the FD-II are exempted from the property tax as per the policy of the revenue department and 24.27 percent of the houses are responsible property tax collection. The results of the semi-log model explain the relationship between house price and explanatory variables by up to 78 percent, while the linear model explained it by up to 80 percent. In this zone, the results of the FastGWR are also positively correlated and the R-squared value is 0.59, which shows an intermediate to high performance by the model. Though the FastGWR model explains a relatively smaller variance as compared to the linear models (59 percent vs. 80 percent), the consideration of spatial aspects in the FastGWR makes it more reliable when applied to analyse geographical disparities. One possible reason for this weak relationship is that there are only 11,107 residential buildings situated in this zone, while most of the buildings are commercial and semi-commercial.

The third zone, the FD-III rating area, is the largest among all other zones in the city, which holds a total number of 339,420 properties of which 229,714 (85.42 percent) are residential. In this zone, only 22 percent of the residential properties are liable to pay the property tax and the rest 78 percent are exempt from any kind of property tax. The results for the FD-III rating area are significant for all the explanatory variables except the distance from educational institutions, which is insignificant under the semi-log model but significant under the linear model. Several studies have demonstrated the effects of schools and educational institutions on property prices (Sah et al., 2016; Wen, Xiao, et al., 2017; Yang et al., 2018a). However, in this zone, the educational institutions did not impact the residential property prices. One explanation for this could be the fact that the schools do not have strict zonal boundaries and the students are willing to travel longer distances to study in educational institutions that offer better quality education. Distances to parks, hospitals, markets, graveyards, and industries have negative coefficients. The results of the FastGWR demonstrate that all the predictive variables have positive coefficients, while the distance to solid waste facilities had a negative effect, suggesting that the residential parcels closer to these facilities have higher values, while the residential properties away from a solid waste facility have lower values. The FastGWR model estimation for Lahore was not possible due to the unavailability of the required high computing power.

4. CONCLUSION

4.1. Summary

This study explored residential property prices in Lahore and Faisalabad using a spatial hedonic approach. It employed spatial hedonic models, OLS, and FastGWR regression to assess the link between explanatory factors and property prices. Nine locational features were considered, revealing significant positive and negative correlations with housing prices. House

size emerged as a key positive influencer, consistently displaying a strong coefficient. Other positively linked variables included proximity to worship places, solid waste facilities, and educational institutions. Conversely, negative associations were observed with distances to public parks, markets, hospitals, graveyards, and industries.

As urban development transforms Punjab's cities into multi-center patterns, property reevaluation is essential for boosting property tax revenues. This study underscores the critical importance of spatial determinants in property valuation. Consequently, integrating these determinants into policy formulation and future urban planning is recommended.

4.2. Limitations

Several limitations are notable in this study. Although it emphasised locational factors, socio-economic determinants could also impact housing prices across various spatial scales. However, their inclusion faced two challenges. Firstly, housing-level socio-economic data is severely limited not only in Pakistan but also in many developing nations, precluding their incorporation. Secondly, the study's primary focus was on analysing locational attributes to underscore their influence on housing prices, a neglected aspect in prior Pakistani research. Lastly, unavailability of the necessary high computing power prevented the application of the FastGWR model to Lahore. These limitations underscore the need for caution when interpreting the findings and highlight avenues for future research.

4.3. Recommendations and Policy Implications

This study's outcomes hold implications for policymakers, investors, real estate developers, and urban planners. Our reliable model explains residential property values, vital for decision-makers seeking insights into local housing markets. This informs refined policies and better comprehension of house price variations. The adaptable approach suits various Pakistani regions. To establish accurate property values, we propose:

(1) Waive property transfer fees to encourage transparent property deal prices, compensating via increased annual property tax.
(2) Institute property valuation desks in revenue departments to assess property values at a nominal fee. These desks would gather property details and values, benefiting both assessment seekers and public funds.
(3) Embrace a uniform valuation method, incorporating structural attributes and real-time spatial amenities updates. Federal and provincial revenue bodies can adopt this approach.
(4) Make residential property data accessible to researchers, enabling comprehensive exploration of real estate dynamics and informed policy formulation.

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An Ecosystem Valuation for Enhanced Transboundary Water Cooperation in the Kabul River Basin

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The ongoing water conflicts between Afghanistan and Pakistan in the transboundary Kabul River Basin are narrowly focused on quantitative water distributions, which lead to win-lose situations. This study proposes a novel idea of using the biodiversity and ecosystem services (BESS) concept to bring together multiple stakeholders across the KRB and transform the water-sharing conflicts. The study redefines the water management problem in the context of a green water economy and evidence of shared environmental benefits. The study found that the BESS provided by the Kabul River are vital for the livelihood of the residents and the natural flow of water is a win-win situation for both Afghanistan and Pakistan. The study recommends designing PES schemes for the sustainability and shared prosperity of the region. A new perspective on transboundary water conflicts in the KRB is needed, one that focuses on shared environmental benefits and the BESS of the river basin. This new perspective could lead to more cooperative and sustainable water management solutions.

Keywords: Kabul River Basin, Biodiversity and Ecosystem Services, Valuation, Market-based Pricing Method

1. INTRODUCTION

Biodiversity and the ESS is a complex but significant area, which influences the well-being of humans in diverse ways. The ESS can provide provisioning services as well as regulate services. The literature shows different approaches to the of provisioning ESS (Häyhä, Tiina, & Franzese, 2014). Placing an economic value on nature can be a powerful tool as it makes the invisible benefits identifiable. ESS represent outcomes of a natural system which benefits the people. The significance of water as a natural resource and ecosystem provides a wide range of services and various functions as the use of water for drinking, irrigation, or livestock (Radoslav, 2018).

River water services provide numerous benefits in terms of social and ecological facilities, which benefit the people and contribute to the well-being of the area. Globally, in 150 countries, there are a total of approximately 310 transboundary rivers. Water-

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related conflicts are not only frequent but are increasing due to the current worsening situation of water globally. Several water treaties are in place between various countries, yet the conflicts emerge frequently (Wang, et al., 2021). The water politics of transboundary rivers are emerging as a compelling research field in social hydrology. Many international basins are governed by multi-level institutions. Besides, the valuation of the benefits of river systems can positively contribute to efficient river-water management and reduce water-related conflicts and problems (Khan & Zhao, 2019). However, this is not the case with managing the Kabul River Basin (KRB).

The KRB between Afghanistan and Pakistan is not governed by an international agreement and boundary problems, that is, the contested Durand Line, affect the relationship (Yousaf, 2017). Water conflicts in the KRB between Afghanistan and Pakistan have intensified since 2000, coupled with security issues due to the ongoing insurgencies in the region. Growing industrialisation, urbanisation, and climate change which affect the continuity of snow-fed rivers, environmental hazards, and the geo-strategic importance of the area further exacerbate these disputes. The existing transboundary water mechanisms are state-centric and bilateral, exclude other relevant actors, and emphasise water quantity as the basis for water sharing (Yousaf, 2017). These agreements disregard the broader biodiversity and ecosystem services (BESS) of the river basin and what these services could imply in terms of enhancing human well-being. The BESS of water includes biodiversity, provisioning (e.g., food production), regulating (e.g., climate & water regulation), supporting (e.g., nutrient cycling), and cultural services (recreational, spiritual) (Pavan, Wittmer, & Miller, 2014). The value of global BESS was estimated at $145 trillion in 2011 at a time when global GDP was $73.3 trillion[1] (Robert, et al. 2014). Extrapolating to the river basin between the two countries, one can argue that understanding the value of the BESS in the region could lead to a different problem framing and enable integrative multi-level bargaining leading to win-win solutions. While the BESS values the interdependence of humans and nature, it also offers conceptual and empirical tools to communicate with a wide-ranging audience (Robert, et al. 2014) and reveals the cost of damage, it may lead to the commoditisation or privatisation of such resources (Sullivan, 2013). Therefore, an analysis is required for a better understanding of the water BESS (it may still avoid such commoditisation) to evaluate if a change in the behaviour of relevant and powerful actors can be pursued while addressing socio-relational (dispute resolution, capacity building, and inter-generational equity) and ecological (pollution prevention, and the protection of BESS) goals and, thereby, contribute towards the Sustainable Development Goals (SDGs). By embracing economic, ecological, and social-relational mechanisms, the BESS concept connects the environmental system with politics and decision-making as well as fosters interdisciplinary science (Schröter, et al). It enables integrated trans-disciplinary approaches to solve such complex issues by building bridges between science and practice (Robert, 2011). The water conflict arising due to transboundary river basins can be analysed using an ecological valuation. Hence, the focus of this study is on estimating the provisioning ecosystem services on Pakistan's side of the KRB. An objective of the study is to develop an understanding of transforming a win-lose situation into a win-win situation for both parties.

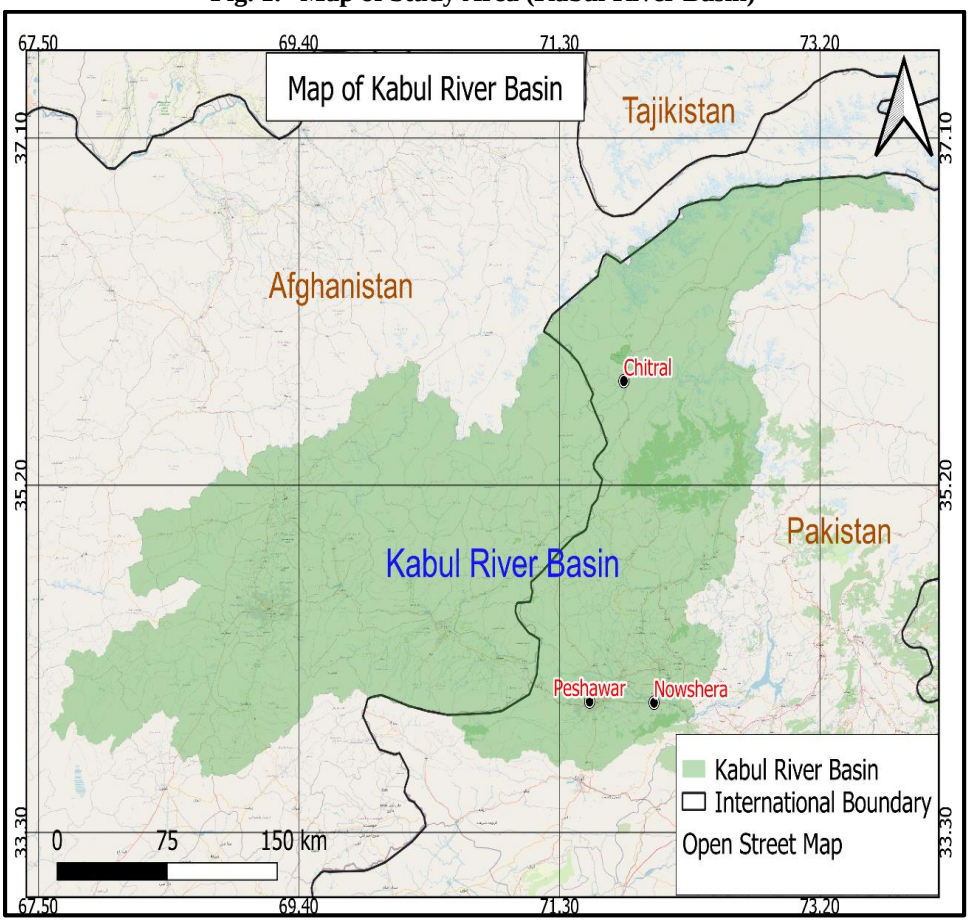
[1]This is because GDP measurement is based on market pricing, whereas BESS considers several market and nonmarket ecosystem services.

2. MATERIALS AND METHODS

2.1. Study Area

The present study carried out an ESS valuation of the KRB in the upstream and downstream areas. The data was collected in two phases. In the first phase, the data was gathered and analysed from district Chitral (upstream). Later, data from Warsak, Charsada, and Nowshera districts (downstream areas) were also combined. Chitral is in northern Khyber Pakhtunkhwa and is considered one of the highest-altitude areas globally. The district has Gilgit-Baltistan in the east, Afghanistan on its northern and western sides, and on the southern side, it is connected with the Swat and Dir districts of Khyber-Pakhtunkhwa (Haidar & Qaiser, 2009). The geographical coordinates of this area are 350 15′ 06" to 360 55′32" North and 710 11′ 32" to 730 51′ 34" East. The size of the area is 14,850 sq. km area and it is inhabited by 447,824 dwellers (Pakistan Census, 2017). The population of the area is heterogeneous and ethnically diverse. There are eleven distinct ethnic groups who speak almost eleven different languages or dialects. More recently, the area has been further divided up into two districts, namely, Upper Chitral and Lower Chitral.

Fig. 1. Map of Study Area (Kabul River Basin)



The Kabul River enters the downstream of Pakistan through the mountains of Mohmand in the Warsak areas of Peshawar.[2] The Kabul River goes through Nowshera and converges into the Indus River at Attock (Khattak, et al. 2016).

For Afghanistan, the Kabul River is also the fourth largest basin which is mainly utilised for irrigation purposes on both sides. The river is fed by the Chitral River, which has its origin in Chitral—the northernmost part of Pakistan. Out of the total 700 km length of the Kabul River, 560 km flows in Afghanistan and remaining in Pakistan (Yousaf, 2017).

The downstream of the Kabul River Basin on the Pakistani side is a lifeline for the people of Peshawar Valley and the Nowshera district. These areas grow fruits, vegetables, and other cash crops. These areas also have different industries which provide livelihood to the local community. The Peshawar Valley is 7,176 km^2 (2,771 sq. mi) in area and is traversed by the Kabul River (Yousaf, 2017). The people of this area constitute Pashtuns and Non-Pashtuns who live along the Kabul River. The Kabul River irrigates areas of Khalsa, Douaba, Daudzai, and other regions of the Peshawar Valley. Some of these areas have fruit orchards in which locals earn millions of rupees annually. In its lower reaches in Pakistan, the Kabul River crosses a region with a desert climate where maximum daily temperatures in early summer often exceed 104 °F (40 °C) and mean monthly temperatures in winter remain above 50 °F (10 °C).

With the increase in the population residing along the Kabul River Basin, the need for drinking and non-drinking water has also increased. Both Pakistan and Afghanistan are heavily dependent on the Kabul River Basin (Yousaf, 2017). For most people, the mainstay of the local economy is agriculture, while other sources of income include fuel woods, medicinal plants, livestock, fishery, mines, minerals, etc.

2.2. Conceptual Framework

There are various techniques available for estimating Biodiversity and Ecosystem Services of rivers and other types of ecosystems. Three main approaches are cost-based, revealed preference approach, and stated preference approach. The cost-based approach considers the cost of provisioning of these services (Grizzetti, et al. 2016). The revealed preference approach is based on actual behaviour, but it only considers the use-values of the resources. Moreover, this can be measured either using direct benefits (such as timber, fruits, water, or other uses) or indirect methods (such as travel cost methods, housing prices, and allied methods).[3] Stated preferences are based on hypothetical scenarios and are usually based on choice experiments or contingent valuation (CV) methods. Additionally, in case of non-availability of site-specific BESS values, the benefit transfer approach is also utilised. The following table summarises BESS valuation methods.

[2] There is also a historic hydroelectricity dam in this area-Warsak Dam.

[3] For a full exposition of the types of valuation methods, see, Freeman (1993) and Reynaud and Lanzanova (2015).

Table 1

BESS Valuation Methods

Ecosystem Services	Category	Value Type	Valuation method	Examples of Economic Goods Provided
(1) Fisheries and aquaculture	Provisioning	Direct	MP, RC	fish catch
(2) Water for drinking	Provisioning	Direct	MP, CV	water for domestic uses
(3) Raw (biotic) materials	Provisioning	Direct	MP, RC	algae as fertilisers
(4) Water for non-drinking purposes	Provisioning	Direct	MP, PF	water for industrial or agricultural uses
(5) Raw materials for energy	Provisioning	Direct	RC	wood from riparian zones
(6) Water purification	Regulation	Indirect	RC, CV	excess nitrogen removal by microorganisms
(7) Air quality regulation	Regulation	Indirect	RC	deposition of NOx on vegetal leaves
(8) Erosion prevention	Regulation	Indirect	RC	vegetation controlling soil erosion
(9) Flood protection	Regulation	Indirect	RC, CV	vegetation acting as a barrier to the water flow
(10) Maintaining populations and habitats	Regulation	Indirect	RC	habitats use as a nursery
(11) Pest and disease control	Regulation	Indirect	RC, CV	natural predation of diseases and parasites
(12) Soil formation and composition	Regulation	Indirect	RC	rich soil formation in flood plains
(13) Carbon sequestration	Regulation	Indirect	RC, MP	carbon accumulation in sediments
(14) Local climate regulation	Regulation	Indirect	RC, MP	maintenance of humidity patterns
(15) Recreation	Cultural	Direct	CV, TC, DC, HP	swimming, recreational fishing, sightseeing
(16) Intellectual and aesthetic appreciation	Cultural	Non-use	CV, DC	matter for research, artistic representations
(17) Spiritual and symbolic appreciation	Cultural	Non-use	CV, TC, DC	existence of emblematic species
(18) Raw abiotic materials	Extra abiotic	Direct	PF, MP	extraction of sand gravel
(19) Abiotic energy sources	Extra abiotic	Direct	PF, MP	hydropower generation

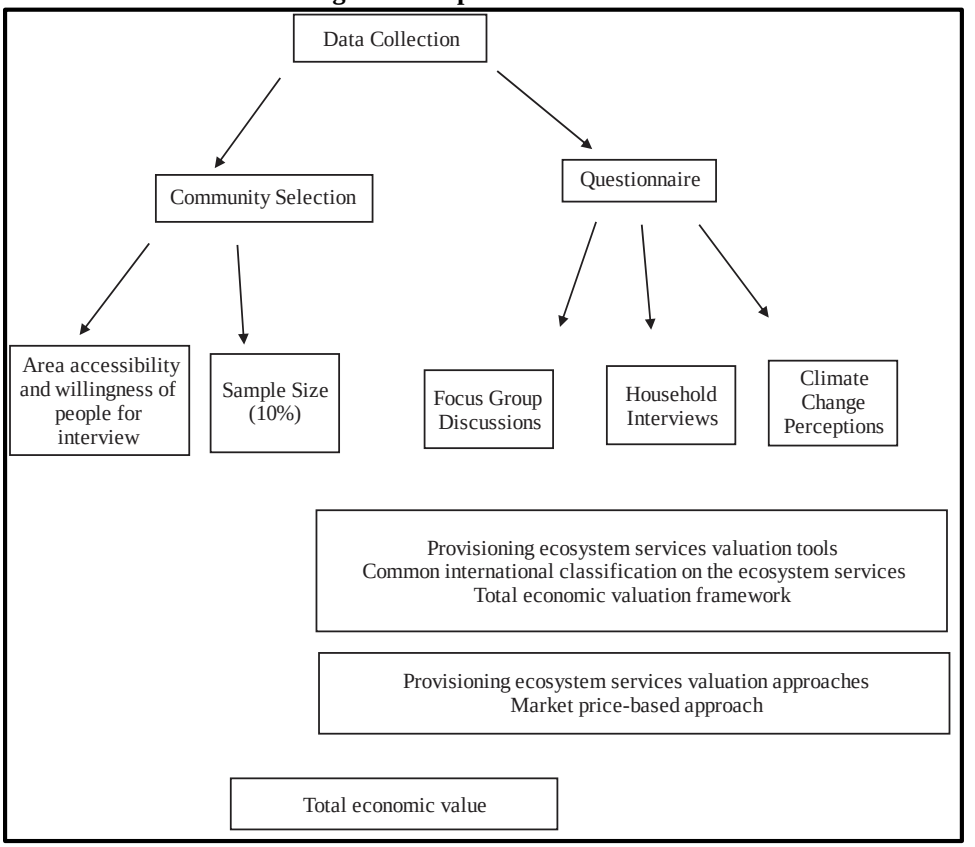
Source: (Reynaud and Lanzanova, 2015). Contingent valuation (CV), Hedonic price (HP), Market price (MP), Production function (PF), Replacement cost (RC), travel costs (TC).

Given the enormous scale of the KRB, the present study relied on the market price-based approach[4] for the valuation of the ESS of the KRB and employed the total economic valuation (TEV) framework suggested by The Economics of Ecosystems & Biodiversity (TEEB, 2010)[5] to value the ESS. However, our estimates of the ESS only include the provisioning and cultural services of KRB. Figure 1 summarises the complete methodology adopted for this study.

[4]This is based on the revealed preference approach and only measures the direct values of BESS.

[5] It is a global initiative to make visible the values provided by the nature.

Fig. 1. Conceptual Framework



2.3. ESS Identification and Economic Valuation

For the economic valuation, the interview responses were collected and compared to each provisioning and cultural ESS typology. These were assigned codes based on the Common International Classification of Ecosystem Services (CICES) (Haines-Young, et al. 2018). The TEV framework is a well-known instrument for economic appraisals of the ESS (Emerton, 2016). The framework is a well-organised way of outlining all the benefits provided by an ecosystem. It reflects the value in economic or other market-based units that can be compared across ESS types. The provisioning ESS is evaluated using this paradigm by applying direct and indirect use values. We used the market pricing method to calculate ESS values. This approach has also been used in previous investigations, such as Murali, et al. (2020), Thapa, et al. (2020), and Grizzetti, et al. (2016). Besides, the variables used in this study are in total conformity with the framework. Therefore, this study used the same framework to measure the ecosystem services provided by the Kabul River in its basin.

2.4. Total Economic Value (TEV)

The overall economic benefit was calculated by allocating the economic value for each provisioning ESS to each home and adding the means and standard errors for each

household service (Sköld, et al. 2018). Household earning values were computed from all sources of income, including employment, agricultural production, animals and medicinal herbs sold. These values were then summed up to determine the Gurez Valley's average income (Saeed, et al. 2022). The total economic value of the ecosystem services can be included as a separate section in the GDP as earnings from the ecosystem because the data generated shows that rivers contribute significantly to the economy in different ways, and if there is proper planning and thought process, the income generation from the ecosystem can be increased.

2.5. ESS Valuation Based on Market Price

To determine the value of ESS, the market price-based technique was employed. Because provisioning ESS is frequently sold, market pricing is thought to provide meaningful information on value (Richard, 2019). The same technique was also employed to calculate ESS of the Gurez Valley (Saeed, et al. 2022).

The economic values of the ESS were calculated for the following CICES classes: (i) agriculture crops (e.g., beans and potatoes tomatoes, pulses, onion, barley, wheat, maize, and perennial crops), (ii) livestock, (iii) fuel wood (iv) medicinal plants, and (v) water (drinking and non-drinking uses).

Crop economic values were calculated by taking all the crops harvested each year and multiplying them by their market values. To calculate the ESS value of the agricultural yield, the value of all external inputs, such as chemical fertilisers, labour utilised, and tractor charges were subtracted from the value of the products produced. The economic value of milk was calculated by multiplying the per-litre market value of milk by the number of litres consumed per family per day multiplied by the number of days in a year. The cost of animal husbandry was calculated as the cost of their annual feed. The economic worth of meat was calculated by multiplying the market price of an animal per family by the number of animals sold annually. The annual collection of medicinal plants per family was multiplied by local market prices to evaluate the economic value of medicinal plants. The economic worth of the fuel wood was calculated by multiplying the per-household annual consumption by the local price of the fuel wood.

2.6. Data Collection

2.6.1. *Community Description and Selection*

The entire area of the KRB comprises upstream (Upper and Lower Chitral) and downstream areas from Warsak to Nowshera areas. Therefore, for the present study, 400[6] in-person household interviews were conducted using a pretested questionnaire.[7] The entire sample was then proportionally prearranged as 200 random[8] interviews in the upstream areas and the same number of interviews in the downstream areas.

[6] S=(Z)2*(p)(q)/(e)2

[7] Questionnaire is discussed in detail in the next section.

[8] Even for random selection, local referencing was mandatory. We held key informant interviews to get to know local clans, production types, hamlets, small groups, etc. This is a cultural thing, but still, the randomness element was maintained.

In the upstream areas, further stratification includes the Upper and Lower Chitral area. Upper areas include Boni, Mustuj, Yarkun, and Bragoal Pass, while the Lower Chitral areas consist of Aram Chasma, Darosh, and Ayun-Kalash areas. These specific locations were identified during key informant sessions.[9] The data collection scheme was grounded on the provisioning and cultural ecosystem services of the KBR. Subsequently, a pilot study[10] was completed in the lower Chitral area. The results of the pilot study were utilised to strategise the data collection in the upstream and downstream regions.

In the downstream areas, 200 in-person interviews were conducted based on the same data collection tool. The data were randomly collected in Warsak, the Sardaryab area of the Kabul Riverbank in the district Peshawar, the Jahangira district, and other adjoining areas.[11]

To have a complete sense of the ecosystem services corresponding to cultivated crops, animal feed, vegetables, and the kind and quantity of natural resource harvesting, like wild animal feed, medicinal plants, fuel wood, and wild vegetables, focus group discussions were held with the local representatives.

Data were collected from households and communities based on a structured questionnaire.[12] The details of the collected data in the upstream are given in the following table:

Table 2

Data Collection in the Upstream Region

Area	Number of Questionnaires
Upper Chitral-Garam Chashma	33
Darosh	33
Ayun-Kalash	34
Lower Chitral-Boni	25
Mastuj	25
Yarkun	25
Barogal Pass	25

The number of questionnaires filled in the downstream areas is summarised in the Table 3.

[9] KIIs or key informant interviews were unstructured interviews with the well know local inhabitants. They provided useful information about the local production, household, clans,etc.

[10] We sent our trained enumerators to selected sites in the lower Chitral areas to assess the viability of the data collection method and the initial response to assess the validity and reliability of the questionnaire. Although no major revision of the questionnaire was required, still the feedback from the team was important for us to start the full survey.

[11] These specific locations included Shaghala Payan, Wazir Kalay, Jahangir Pura, Mehmood Abad, Shaghala Bala, Sardaryab, Khan Aala, Sheikh, Jahangira, Mian Issa, Nandrak, Ali Muhammad Kale, Mishak, Akbar Pura, Kheshko Bala, Kheshko Payan, Nizam Pura, Hussain Abad, and Pir Payan.

[12] For this reason, a one-day training session was held for the enumerators to train them about how to approach the respondents, technical aspects of data, moral and cultural issues, and other important protocols of primary data collection.

Table 3

Data Collection in the Downstream Region

Area	Number of Questionnaires
Shaghala Payan, Wazir Kalay, Jahangir Pura, Mehmood Abad, Shaghala Bala	45
Sardaryab, Khan Qala, Sheikh, and other villages	55
Jahangira, Mian Issa, Nandrak, Ali Muhammad Kale, Mishak	50
Akbar Pura, Kheshko Bala, Kheshko Payan, Nizam Pura, Hussain Abad, Piry Payan	50

The respondents were randomly selected depending on the population of the village/area. Separate male and female enumeration teams were dispatched to these areas owing to cultural sensitivity and local norms. The respondents were adults, above the age of 18 years, including males and females. The number of questionnaires in each sub-strata was based on the proportion of the population of each sub-strata.

2.6.2. *Questionnaire*

To complement the data collection process, we also analysed secondary data. The analysis revealed that the most common agricultural products in these areas include wheat, tomatoes, potatoes, beans, maize, barely pulses, onion, rice, and different other vegetables. The inhabitants of the area collect medicinal plants, wild grass, and fuel wood from the non-agricultural land and nearby forests. Some amount of the agricultural product is used for household use, while the rest is sold in the market for income generation. Those households who deal in livestock, mostly use wild grass from the forest, and the non-agricultural land is used as pastures. Nevertheless, to further acquire the information at the household level, a questionnaire was prepared based on the toolkit for ecosystem service assessment (Murata, N., 2016).[13] The questionnaire consisted of four different aspects of ecosystem services, i.e., cultivated goods, the extraction of natural goods, water use, and recreation. The details are discussed in the following section.

Data on the perceived implications of climate change on the ESS, such as the cultivation of crops, animal rearing, the availability of water, etc. were also collected.

2.6.3. *Types of Ecosystem Services*

For the present study, we only considered the cultural and provisioning ecosystem services, which have been further classified into four subcategories, i.e., cultivated/agricultural goods, natural goods, water provision, and recreation services. Each of these is discussed below.

2.6.3.1. Cultivated Goods

Cultivated goods include agricultural goods and perennial crops that are cultivated by farmers on river basins. Cultivated goods in this study include fruits, vegetables, pulses,

[13] Toolkit for Ecosystem Service Assessment (TESSA).

wheat, sugarcane, maize, and other perennial crops in the KRB. The values were obtained by multiplying market prices with the unit minus the cost.[14,15]

2.6.3.2. Natural Goods

Natural goods include all those goods which are not cultivated by farmers or local residents. In this study, natural goods include gym stones, wood for domestic use and sale, fish from the river, medicinal plants, and other important products.

2.6.3.3. Water

Ecosystem provisioning services include water for agriculture and domestic use of the households in the river basin. However, we have only considered water for drinking and other domestic uses. The skirting of the irrigation part (directly) is deliberate to evade the double counting problem as this value is already captured in the market prices of the products. The per-capita household water consumption is based on World Health Organisation (WHO) standards.[16] The values have been calculated as under:

> (The gross annual amount of water used from the site, e.g., tonnes/year) x (the unit price of water from an alternative source) – (the unit cost for current water use).

2.6.3.4. Recreation

Recreation services along rivers include tourism and other activities that people undertake during their leisure time. Recreation activities include tourism, boating, water skiing, swimming, fishing, and canoeing. However, we could not access the number of tourists that visit the KRB area.

3. RESULTS AND DISCUSSION

3.1. Identified Ecosystem Services in Upstream and Downstream Areas

The study identified a range of ecosystem services that are provided in the district of Chitral, Pakistan. During the survey, the communities provided information about a list of the ESSES that they use for household use and monetary benefits. The forests of Chitral are a source of fuel wood for local communities, safe habitat for many medicinal plants, wild animals, and fodder for the livestock of nearby villages (Zeb, et al., 2019). All the respondents of the survey were using one or more of the ESS for household purposes and also as a source of finance. The cultivation of different crops, medicinal plants, fodder for livestock, getting fuel wood for household use and selling in markets, the use of surface water for drinking and non-drinking purposes, and fishing were identified as the major ESS used by local communities. The ESS provided by the Kabul River is the main source of livelihood for the local communities in the district of Chitral. The importance of the ESS provided by the Kabul River for the localities of the district of Chitral can be identified by the monetary benefits obtained by the local communities (Saeed, et al. 2022).

[14] These prices were obtained from the growers.

[15] See Appendix 1.

[16] According to WHO, a normal individual consumes 15 litre of water per day.

River Kabul is an important source of various kinds of ecosystem services for the communities living nearby it. Some of the ESS are of more importance in terms of monetary benefits and some are of less importance to the localities (Najmuddin, Omaid, Deng, & Siqi, 2017). This study's results show a high monetary contribution in provisioning ESS to the communities living nearby the Kabul River.

The study identified a list of ESS along the downstream of the River Kabul Basin, i.e., the main services include agriculture, animal fodder, and water.

3.2. Provisioning ESS in Upstream Areas

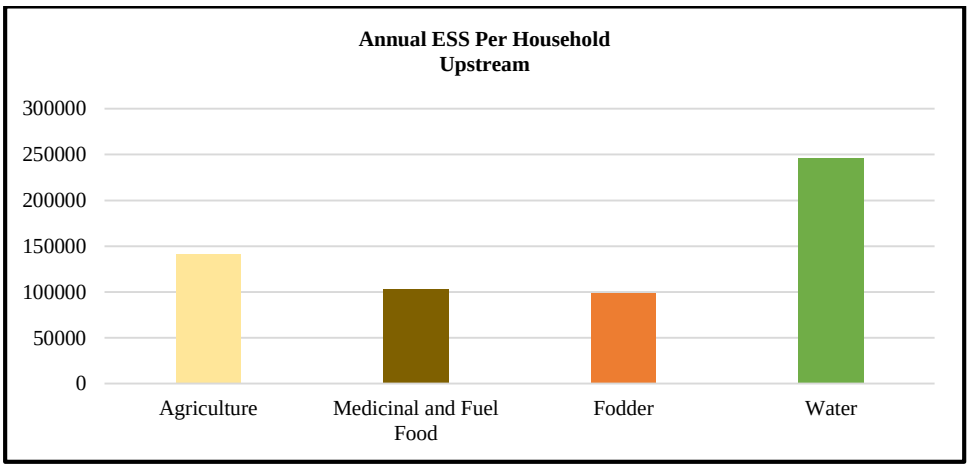
The ESS IS a boon for the inhabitants of the district of Chitral. The most common use of ESS is in agriculture and livestock, i.e., the cultivation of different crops, surface water for drinking and non-drinking purposes, medicinal plants, minerals, fuel wood, animal fodder, fishing, and surface water for non-drinking uses.

Table 4

Population Benefiting from ESS of KRB (Percent)

	% of Population Benefiting				
Region	Agriculture	Fuel Wood for Business	Medicinal Plants	Fodder for Animals	Water
Upper Chitral	100%	94%	64%	100%	100%
Lower Chitral	100%	95%	62%	100%	100%
Overall	100%	94.50%	63%	100%	100%

The table shows the percentage of the population benefiting from the ESS provision in the upper stream (Chitral). In the upper Chitral areas, one hundred per cent of the sampled population were the beneficiaries of agriculture, whereas 94 percent benefited from the fuel wood business, another 64 percent profited from medicinal plants, 100 percent received some portion or all of the fodder needed for their livestock, and 100 percent of the respondents used water provided by the Kabul River for drinking and non-drinking purposes. The trend was similar for Lower Chitral.



3.3. Economic Values

3.3.1. *Upstream Areas of Chitral*

The best ESS in terms of monetary value was drinking and non-drinking water use, which had a value of 246,118[17] ± 753 PKR/household/year ($1,231)[18] based on the sample data collected from respondents. The second-best ESS in terms of monetary value was crop yield, which had a value of 141,979 ± 4,132 PKR/household/year ($710). The third-best income-generating ESS was medicinal plant cultivation and fuel wood. The data shows that the average income generated from medicinal plants and fuel wood was 103,433 ± 1,679 PKR/household/year ($517). Animal fodder was the fourth leading ESS in terms of monetary value. This ESS generate a value of 98,976 ± 2,330 PKR/household/year ($1,012).

Table 5
ESS Valuation of KRB Upstream Areas

ESS Types in Upstream Area (Values)	Agriculture	Medicinal Plants and Fuel Food	Fodder	Water
Per Household	141,979.0094± 753	103,433.35 ± 1679	98,475.05± 2,330	246,117.5± 753

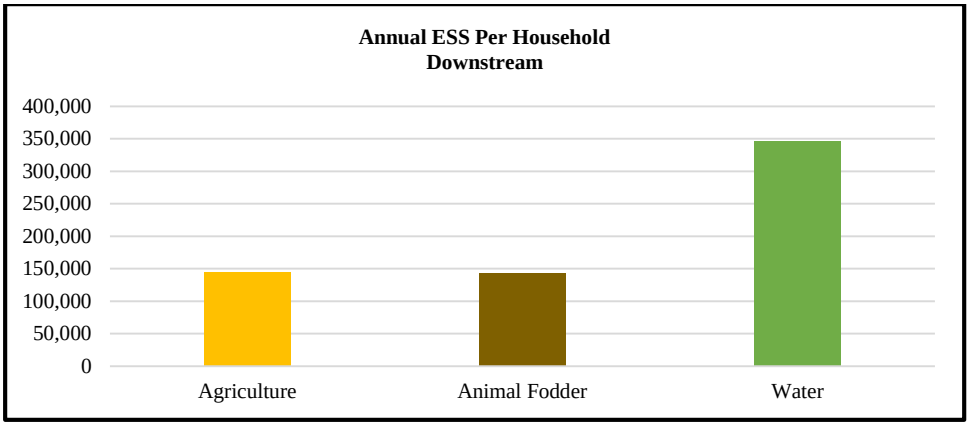
3.3.2. *Downstream Areas—Peshawar & Nowshera*

Table 6
ESS Valuation of KRB in Downstream Area

ESS Types in Downstream Areas (Values)	Agriculture	Animal Fodder	Water
Per Household	143,061.85±3057	143,176.91±1,277	346,030.8±1,120

The survey data reveals the economic value of the ESS from the Kabul River in the lower stream was 641,753 ± 407 PKR/household/year ($3,209). Water was a major part of the provisioning services, followed by animal fodder and agriculture proceeds. The provisioning services of the KRB in the downstream areas were found to be higher than in the upstream area. This is because the income level in the lower stream of the KRB is higher than the income level of the upper stream of the KRB (based on economic activities used by Hassan & Beyer, 2021). The higher income level in the downstream area is due to business spread over a wider area, more employment and income generation opportunities because of easy access to a relatively bigger market in comparison to Chitral, and the more developed industrial sector.

[17] (15 litres per person) x (times the number of of household/day) x (365 days) x (6.5 PKR/litre).
[18] 1 USD = 200 PKR.



The following section delineates information about a particular type of ESS in the upstream and downstream areas.

3.4. Ecosystem Services Categories and Values

3.4.1. *Medicinal Plants*

Medicinal plants obtained from Chitral are more important because of their contribution to curing major diseases. Some of the major medicinal plants cultivated or gathered from the forests of Chitral are *Artemisia maritima*, *Artemisia*, *Brevifolia*, and *Rosa webbiana* are the dominant species, while *Ephedragerardiana* and *Ferula narthex* are also important medicinal plants found in Chitral. The average monetary benefit obtained from the cultivation/harvesting from forests of medicinal plants was 10,136 PKR/household/year. Some of the medicinal plants harvested are used by households, while the rest are sold in the local markets. Some of the medicinal plants are of extremely high value and are sold to bigger herbal markets in other cities.

3.4.2. *Fuel Wood*

Fuel wood is another important ESS provisioning of the Kabul River to the communities living nearby. The total monetary value of fuel wood recorded amounted to 91,228 PKR/household/year ($456). The value of ESS provisioning of the Kabul River exceeded the economic value of fuel wood estimated by Murali, et al. (2020) for the arid regions of the Indian Trans-Himalayan Spiti valley. The estimated economic values for fuel wood were 432 USD/household/year with 11.7 percent of the total economic value produced by the Qurumber National Park. In the KRB, the fuel wood collection varies from valley to valley.

3.4.3. *Agricultural Crops*

Agricultural production is the most important ESS of the Kabul River. The survey shows that the river supports the agriculture sector in its basin. The study shows that Kabul River provided providing ESS worth 141,979.0094±753 PKR/household/year along the upstream, while along the downstream, the river provided ESS worth

143,061.85±3,057 PKR/household/year, amounting to a total agriculture ESS of 56,869,441 PKR/year. River Kabul plays a vital role in providing food security to the localities in its basin by providing irrigation water for agricultural production (Nafees et al., 2018). The availability of water for irrigation purposes is, therefore, pertinent for food security and the sustainable agriculture sector in South Asia. Climate change brings a new dimension to agriculture and food safety in South Asia. Studies suggest that the relationship of climate change with crop production in South Asia could be inverse and may be as high as 18.2–22.1 percent/year (Najmuddin, Omaid, Deng, & Siqi, 2017).

3.4.4. *Animal Fodder*

River Kabul is also a major source of provision of fodder for livestock. The survey shows that the provisioning of fodder ESS was worth 98,475.05± 2,330 PKR/household/year in the upstream area and 143,176.91±1,277 PKR/household/year in the downstream area. The average of these values is $604. The monetary amount of the ESS in the dry area of the Trans-Himalayan Spiti Valley was 523 46.2 USD/household/year, with a total economic share of 13.2 percent, 3,881±360 USD/household/year and 2.6 percent of the total economic value in Tost Nature Reserve, Mongolia, 929±67 USD/household/year and 6.2 percent of the total economic value for nomadic communities in Changtang area, India, and 1,182 ± 177 USD/household and 4.6 percent of the total economic value in Sarychat region, Kyrgyzstan.

3.4.5. *Water Consumption*

Water was found to be the most important and highest valued ESS provided by the Kabul River in the district of Chitral with a monetary value of 246,117.5±753 PKR/household. In the downstream areas, it was 346,030.8±1,120 PKR/household. The average value of the ESS provided in both upstream and downstream areas was $1,480. Water consumption includes both drinking and non-drinking consumption use.

These results are in line with past studies. Begenas watershed in Nepal contributes a major portion of the water used for irrigation and household (drinking and non-drinking) used by the localities (Thapa, Mainali, Schwank, & Acharya, 2020). The study shows that the Indian Trans-Himalaya is a vital source of the existing as well as prospective livestock in Central Asia and South Asia as it contributes 100 percent of water used for livestock purposes.

3.5. Per-Capita Total Economics Value (TEV)

The River Kabul makes a significant contribution in terms of the ESS in its upstream and downstream basins as the results indicate. The total economic value of the provision of ESS of the Kabul River upstream and downstream is significantly high, with an average economic benefit per household of 590,000±340 PKR/household/year ($2,950) in the upstream areas and 641,753.61±407 PKR/household ($3,209) in the downstream areas, averaging $3,080/household/year in both the areas. Our results are comparable to other regional estimates, for example, Din, et al. 2020 & Saeed, et al. 2022. However, our estimates do not include estimates of other services such as hydroelectricity generation, minerals, and tourism. We could not obtain these values due to various issues, such as accessing tourists during survey time and secondary data.

4. CONCLUSIONS

This study was undertaken to assess the idea of the BESS concept to contribute to understanding water-sharing conflict and present an economic valuation of the ESS provisioning of the KRB to redefine the water management problem in the context of green water economy and evidence of shared environmental benefits. The results of this study suggest that the ecosystem services provided by the Kabul River to the localities living nearby are vital and serve as a source of economic protection for the residents of the districts Chitral and Nowshera. The majority of the residents of the KRB are engaged in agriculture and livestock, which are the direct ESS provided by the Kabul River. The river also plays a key role in maintaining the greenery of the forests in the district of Chitral, which are safe habitats for wild animals, some medicinal plants, fuel wood, and fodder for livestock. The study shows that ESS provided by the Kabul River are vital for the livelihood of the residents as the ESS provided are the main source of income for the local population. The ESS values on the Pakistani side of the KRB suggest that merely the provisioning ESS related to the natural flow of water are enormously advantageous for the people living in the KRB area. This study covered only THE Pakistan side of the KRB due to limitations.

5. RECOMMENDATIONS AND POLICY IMPLICATIONS

This study has contributed to evidence of a broad range of shared ESS services and other benefits that the population on both sides of the boundary use. However, the conventional understanding of water sharing is based on water quantities which can obscure a wide range of ESS of the KRB that people depend on. This evidence and knowledge can also bring into discussion other international environmental agreements that both Afghanistan and Pakistan have signed such, as the SDGs 6, 13, and 15 on water, climate change, and biodiversity, respectively as well as other conventions on climate change and biodiversity. Looking at the benefits and environmental degradation from this lens can also create avenues for dialogue and cooperation for fulfilling the environmental commitments of both riparian countries.

In terms of policy implications based on the results, it suggests that the natural flow of water is a solution from which where both Afghanistan and Pakistan can benefit. Based on the evidence of shared benefits of ESS as a result of water flows, dialogue and cooperation between different stakeholders and beneficiaries in both countries can be initiated. These results can be converted into a policy brief by consulting a wide range of stakeholders, especially government officials involved in water management and related sectors. The Kabul River facilitates Pakistan and Afghanistan and the ESS provided by the river are of significant importance to each country as it is the basis for agriculture production and livestock rearing as well as related value chain by creating jobs indirectly. Therefore, both countries need to use the available water sustainably so that both can benefit from it sustainably. We recommend that a Payment for Ecosystem Services (PES) scheme may be designed for the sustainable use of these resources. Since the KRB is also a natural sink of Carbon, we highly recommend that the relevant stakeholder from both sides should also design a mechanism by upholding the natural flow of the river rather than non-cooperation (construction of dams on both sides). The sustainable use of water can enhance the ESS provided by the Kabul River in both countries in all aspects. There

is a need for joint research collaboration on these aspects from both sides of the KRB to generate more evidence on shared benefits due to the natural flow of water.

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Policy Impacts on Comparative Advantage and Production Protection to Cotton and Its Competing Crops in Pakistan

IRFAN AHMED BAIG, SAMI ULLAH, and SHOAIB NASIR

Agriculture, particularly cotton cultivation, holds paramount significance for the economy of Pakistan. The cotton crop shares 0.6 percent of the gross domestic product and contributes 70 percent to the country's export earnings. Nonetheless, during the last two decades, cotton area and production in the country have declined. Therefore, this study aims to evaluate the economic benefits and competitiveness of cotton and its competitive crops under the current set of relevant policies. We have employed a Policy Analysis Matrix to assess the impact of agricultural policies on cotton and its competing crops. The results show that cotton producers across Pakistan are implicitly taxed, while sugarcane and rice producers are protected under the current policy measures. It has also become evident that large cotton growers are more likely to get a comparative advantage of prevailing policy incentives than medium and small growers. Thus, crop-specific and scale-specific policy interventions are suggested to enhance cotton production. Similarly, exploring and converging on new potential areas for cotton production, especially in Balochistan, can improve the country's overall cotton production.

Keywords: Cotton, Policy Analysis Matrix, Comparative Advantage, DRC, Pakistan

1. INTRODUCTION

State institutions worldwide protect and support the agricultural sector through various policy measures. This support keeps the agriculture sector productive and competitive to ensure food security for the masses, livelihoods for farming entities, and to meet the requirements of agro-based industries (GOP, 2019). These policies broadly deal with farm inputs and outputs, trade facilitation/restrictions, mechanisation of cropping systems, and investment in rural and agricultural infrastructure, including R&D and irrigation. Government interventions have resulted in various advantages for specific crops while creating social and economic externalities for others. Pakistan has also

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adopted several policy measures to cater to the needs of farming communities in the changing global scenario. These policies are sometimes crop-specific but, most of the time, are designed to increase total crop productivity (MPDS, 2013).

Agriculture contributes around 22.9 percent of the GDP and almost 34.7 percent of employment in Pakistan (GOP, 2023a). The share of major crops in GDP is nearly 4.32 percent, of which cotton accounts for 0.6 percent of GDP and 3.1 percent of total value addition in agriculture. In the case of cotton, Pakistan is the fifth largest producer globally. Its share is around 0.6 percent of GDP and contributes 2.4 percent of the value added in agriculture (GOP, 2023a). Similarly, cotton has the longest value chain among all crops, contributing significantly to Pakistan's foreign exchange earnings. Pakistan exports $836 million (4.7 percent) of raw cotton and yarn, while cotton-based exports account for $9.5 billion, comprising more than half of the country's total exports (GOP, 2021b). Though cotton is considered the main cash crop in the country with its strong backward and forward linkages, the past couple of decades have observed a dismal cotton performance in many instances. At the same time, the last five years can be considered devastating in terms of cotton area, production, and profitability. Table 1 below reflects the reduction in the cotton area in Punjab (which contributes around 70 percent of the total cotton acreage) and the decline in cotton production and yield. It has been observed that since 2000, cotton has lost 12 percent of its area, while its competing crops have gained the area under cultivation, mainly sugarcane, which followed a 17 percent increase in its area.

The area replacement of cotton crop with its competitive Kharif crops, i.e., sugarcane, maize, and rice, has many interesting insights from a policy perspective. There are diverging opinions at the policy level, whether the downfall of the cotton crop is due to adverse climatic conditions, the development of pest pressure in cotton growing areas, or the frequent distortions in output and input markets. It has been observed that output prices, among all other factors, remain the primary cause of reducing the profitability of the cotton crop.

Table 1

Major Crops Area in the Cotton-Wheat Zone of Punjab

(000 hectares)

Year	Rice	Sugarcane	Cotton	Maize	Cotton Yield (40kg/acre)
2014-15	2891.89	1141.01	2962.72	1143.01	8.11
2015-16	2740.72	1132.11	2903.19	1192.03	5.88
2016-17	2725.21	1218.14	2490.01	1349.00	7.38
2017-18	2901.89	1342.40	2701.50	1251.96	7.61
2018-19	2811.25	1102.50	2374.06	1374.61	7.15
2019-20	3041.91	985.91	2517.72	1405.02	6.26
2020-21	3337.07	1165.55	2079.83	1418.43	7.08
2021-22	3538.94	1260.85	1937.83	1653.24	7.12

Source: (AMIS.PK, 2023).

Several causes of low cotton production have been reported in the literature, including the higher cost of production, climatic changes, pest attacks, poor seed quality,

adulterated inputs, and conventional farming practices (Aslam, 2016; Khan & Damalas, 2015; Zulfiqar & Thapa, 2018). There are several other factors, like policy divergences, which significantly impact the farmers' decision to grow a specific summer (Kharif) crop in the context of Pakistan. These policies include specific incentives for competitive crops, such as ensuring a consistent supply chain with the support of the private business firms to procure from the farmers, indicative/support price, subsidising the input(s), etc. (GOP, 2019).

A significant number of stakeholders do believe that there is a gradual drift of policy initiatives away from cotton. At the same time, an inclination of support towards competitive crops has resulted in developing a less conducive environment for cotton. When comparing the agricultural policies in the world's major cotton-producing countries (Table 2), Pakistan's cotton sector is least protected by policy support and technological advancements. Major cotton-producing countries like China, India, and the USA provide subsidies on production, while India has a minimum support price system for cotton. Similarly, very little investment in cottonseed technologies has resulted in poor crop performance.

Keeping in view the importance of the cotton crop and the challenges being faced, a holistic analysis of the impact of a set of policies on the competitiveness and efficiency of cotton (w.r.t its competitive crops) and factors affecting the reduction of area under the cotton crop. There is a need for time to explore possibilities to enhance cotton production to strengthen rural communities and ensure raw materials for Pakistan's largest export-oriented sector (textile).

Table 2

Support to the Cotton Sector among Major Cotton-Producing Countries

Country	Cotton Subsidies* (% of Value of Prod.)	Assistance to Growers	MSP	Seed Technology
China	33%	$4.7 billion	No MSP	Fusedg, Cry1Ab, Cry1Ac, Stacked
India	About 10%	$600 million**	Up to 150 % of CoP	Bollgard-II (2006)
USA	Nearly 9 %	$2 billion	No MSP	Bollgard-III (2017)
Pakistan	1% **	–	No MSP	Bollgard-I (2010)

Source: (ICAC, 2020).

** No direct assistance; most subsidies are provided regarding Minimum Support Price.

The economic practicality, competitiveness of production systems, technology adaptation, cost of farm inputs, the productivity of cropping practices, degree of product differentiation, share in the market, market distortions, and government interventions in economic activity are various factors reported in the literature (Kennedy, et al. 1998; Pahle, et al. 2016; Williams, 2010). Several studies have been conducted in Pakistan to evaluate the economic efficiency and profitability of cotton (Abdul & Sadia, 2016; Abro & Awan, 2020; Kannapiran & Fleming, 1999a; Quddus & Mustafa, 2011; Wei, et al. 2020). However, none of the studies have adopted a holistic approach to investigate the impact of agricultural policies on cotton production in Pakistan. The objectives of the study are:

- To evaluate the impact of significant public policies on financial economic benefits and costs associated with cotton production and its competitive crops in the cotton-wheat zone.
- To estimate the financial and economic benefits and costs associated with producing major crops under three different scales of farms.
- Moreover, it will assist policymakers in addressing the challenges to cotton production by designing policies based on empirical findings.

2. REVIEW OF LITERATURE

Dwindling cotton sector performance for years brought unrest among the farming community and relevant governmental organisations, especially in Punjab, to work out any doable recipes to cure the situation. A couple of good policy reports have also been worked over (GOP, 2021b) where national and international experts compiled the review of the prevailing condition in cotton, gauged the institutional strengths and weaknesses, evaluated the policies related to the cotton, and framed a set of recommendations for the policymakers to bring about a structural change on cotton production canvas. Some recent international studies, like ICAC's Cotton Vision 2030 (ICAC, 2020), have employed various econometric tools to evaluate the impact of policy measures in shaping the decisions of cotton growers in Pakistan and different other cotton-growing countries.

Policy Analysis Matrix (PAM) is a computational framework Monke & Scott (1989) developed for measuring the input use efficiency in production, the degree of government interventions, and comparative advantage. Many studies in the past have utilised PAM to evaluate the policy effects and investigated the efficiency of agricultural pricing policies and public interventions that substantially impact consumer satisfaction and domestic prices (Anwar, et al. 2015; Kannapiran & Fleming, 1999b; Mohanty, et al. 2003; Najafi, 2005; Nelson & Panggabean, 2011).

Salam (2012) and Salam & Tufail (2016) reviewed the effect of policies on cotton and rice production in Pakistan by employing secondary data from 2010-12. They found that the competitiveness of cotton production is sensitive to fluctuations in cotton prices and those of farm inputs. (Gürer, et al. 2017a) studied the impact of agricultural policies on cotton production in Turkey by employing PAM. They found that the current set of policies doesn't provide satisfactory support to increase the competitiveness of the cotton sector. A rich body of literature highlights discrete choice modelling for evaluating the farmer's decisions in the specific context of socio-economic conditions, access to information, the available set of policy incentives/disincentives, and political support arguments (Caviglia & Kahn, 2001).

Fang & Babcoc (2003) have quantified the impact of China's agricultural and accession to WTO on cotton production and area in the country. China's cotton policy focuses on the supply and demand of cotton, prices, and textile output. The results suggest that WTO accession would increase cotton imports by 670 thousand metric tons. Quddus & Mustafa (2011) reported that the nominal protection coefficient ranges from 1.33 to 1.99 under an export price parity situation. It shows that the prices received by farmers are more significant than the export parity/economic prices. This leads to the conclusion that sugarcane cultivation for export purposes is not economical.

Suresh, et al. (2014) have studied the impact of technology and policy on cotton sector performance in India. They have concluded that better agricultural policies and modern technologies resulted in a decrease in input use. Sadiq (2015) investigated the impact of India's economic policies on cotton production before and after liberalisation. He concluded that better performance witnessed during liberalisation is mainly attributed to adopting modern technologies and sound political and economic policies. MacDonald, et al. (2015) have concluded that support prices to Chinese cotton farmers resulted in lower cotton production, which resulted in a policy shift: direct subsidies to cotton producers. They have concluded that lower Chinese import quotas would reduce world cotton prices. Gürer, et al. (2017b) have investigated the impact of Turkish agricultural policies on cotton production in the country. Using Policy Analysis Matrix, this study has measured policy transfers, resource utilisation, and costs, private and social profits and concluded that ongoing agricultural policies have turned cotton production into a profitable enterprise, giving Turkey a comparative advantage.

ELsamie, et al. (2020) evaluated the impact of agricultural policies on Egyptian cotton production using Policy Analysis Matrix. They concluded that financial performance was less than the economic performance of cotton growers. However, Egyptian cotton producers have a comparative advantage and earn foreign exchange for the country. Abro & Awan (2020) reported that the profitability of minor crops has been increasing since 2011 compared to major crops. Wei, et al. (2020) estimated the economic cotton viability of growing cotton in Pakistan and reported that smallholders were more prone to economic shocks and had low technical efficiency. They also noted that financial constraints and lack of extension services were the main factors for lower productivity.

Wang, et al. (2021) have analysed the impact of the targeted price policy on cotton production in China. The studies show that implementing targeted price subsidies has stimulated cotton production by increasing the area, but the yield has decreased over time. They suggested that policies should focus on comparative advantages between different crops. The body of literature also has a considerable set of evidence that reflects that various cotton diseases and pests flourish in humid environments. At the same time, the application of excessive water to the crop may also lead to excessive vegetative growth, thus hindering crop protection operations and the rotting of lower fruit. Based on the above studies, it can be inferred that agricultural policies play a major role in crop competitiveness, profitability, and efficiency. This study aims to investigate the impact of major agricultural policies on cotton and its competitive crops and assess the impact of the production of these crops on the overall economy.

3. DATA AND METHODOLOGY

To execute the study, we collected primary data from various districts of three provinces of Pakistan. Details of the data collection and methodology are provided below.

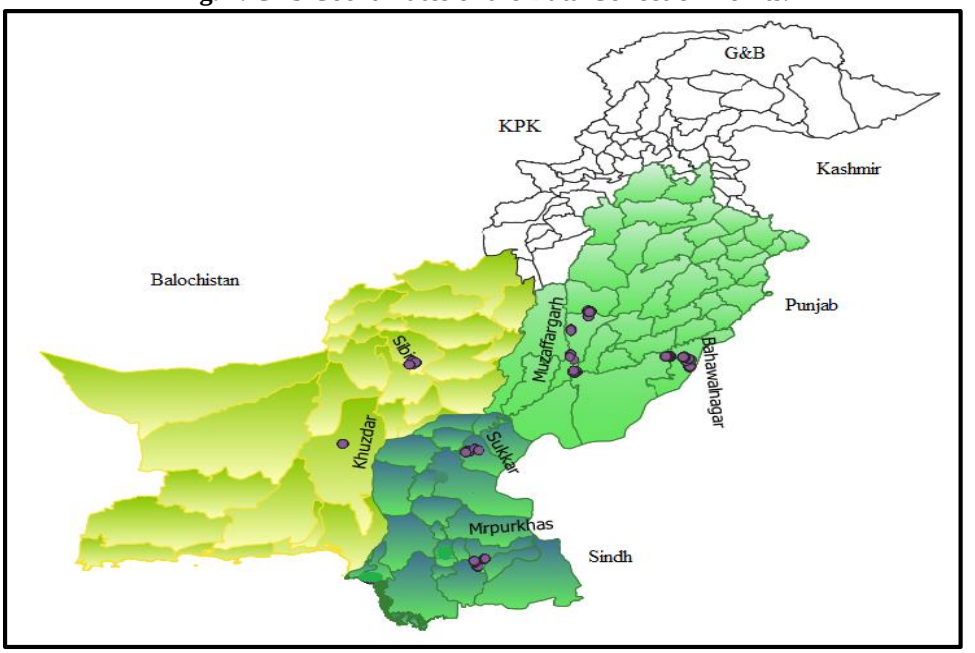
3.1. Data Collection

The primary data was collected through a multistage cluster sampling technique from 881 farmers through well-structured digital questionnaires on cotton and its competing crops from farmers in Punjab, Sindh, and Balochistan provinces. In Punjab,

data was collected from four tehsils, two from each district, Bahawalnagar and Muzaffargarh. From Sindh province—data was collected from two tehsils of Mirpur Khas district and one tehsil of Sukkar district. Similarly, data from Balochistan was collected from one tehsil of each Sibi and Khuzdar district (Figure 1). Though the sample size is generally distributed based on the share of provinces/ areas in the total production, in this study, respondents from Balochistan are included to investigate the policy impacts in new areas (and the potential regions) of cotton production. Secondary data was collected from various published sources.

A detailed questionnaire was developed considering the research objectives, and pre-testing was carried out in Kot Addu Tehsil of District Muzaffargarh. After corrections and modifications, a questionnaire was digitised on the Kobocollect (https://www.kobotoolboxorg/) Android application. To collect data, we selected three teams to serve in each province. Data collection teams were selected from respective provinces to ensure the smooth collection of data by reducing linguistic and cultural barriers. Similarly, teams were trained on survey techniques and data collection methods to ensure data quality.

Fig. 1. GPS Coordinates of the Data Collection Points.



3.2. Econometric Techniques

We have employed various econometric and mathematical techniques to explore the research objectives. Policy Analysis Matrix is crucial to evaluating crops' competitiveness and economic and social profitability. It also reports the comparative advantage of crop production by comparing international prices of the products. We have employed it to analyse the competitiveness of cotton and its competitor crops using a mix of primary and secondary data.

The Policy Analysis Matrix developed by Monke & Pearson (1989) provides an essential insight into analysing the economic systems' competitiveness and efficiency, which describes the degree of protection or (implicit) taxation resulting from the country's overall policies towards the agriculture sector (Table 3). These policies affect the input and output markets and trade of the sector. Some selected indicators are measured in this research.

Table 3

Policy Analysis Matrix

		Costs		
Item	Revenue	Tradeable Inputs	Domestic Factors	Profit
Private Prices	A	B	C	D
Social Prices	E	F	G	H
Divergence	I	J	K	L

Private Profit calculates a given crop's private profitability and competitiveness at market prices. It is calculated as D = A – (B+C), and its positive values show that the crop under consideration is financially viable. Social Profit for a given crop is calculated as H = (E-F-G), and it describes the profit at social/economic prices of inputs and outputs. Its positive sign indicates the viability of the crop.

The Nominal Protection Coefficient (NPC) measures the protection provided to the crop under consideration. It is calculated by getting the ratio between A and E, i.e., dividing the total revenue calculated at actual market prices by the total revenue measured at social prices. When NPC > 1, it means domestic production has protection, and a value of NPC < 1 suggests implicit taxation to domestic producers. The Effective Protection Coefficient (EPC) evaluates the net effect of policy interventions in the inputs and output markets. It is measured by taking a ratio between the values added by a crop at private prices and social prices, i.e., (A – B) / (E-F). EPC is interpreted similarly to that of the NPC.

Domestic Resource Cost (DRC) describes the ratio between the cost of domestic factors and value added at social prices of a crop, i.e., G / (E-F). If the value of DRC > 1, it shows that the country does not have a comparative advantage in the domestic production of that crop, while DRC < 1 shows that the country has a comparative advantage.

3.3. Descriptive Analysis

We collected data from 881 farmers from three provinces and six districts of Pakistan. Details are given in Table 4 below.

Table 4

Province/ District/Tehsil-wise Data Collection (n=881)

Punjab				Sindh			Balochistan	
Muzaffargarh		Bahawalnagar		Mirpur Khas		Sukkar	Sibi	Khuzdar
Kot Addu	Ali Pur	Chishtian	Haroonabad	Kot Ghulam Mohammad	Digri	Rohri	Kurak	Khuzdar
122	125	103	101	115	115	95	55	50

Table 5 describes the socioeconomic characteristics of farmers. It shows that the average education, age, farming experience, and cotton cultivation experience are 5.59, 41.9, 22.6, and 20 years respectively, in the study area. At the same time, the average distance from the metaled road is 2.6 kilometres.

Table 5

Socioeconomic Indicators of Cotton Producers

Variables	Mean	St. Dev.	Min.	Max.
Education (Years)	5.59	5.07	0	18
Age (Years)	41.91	12.85	17	78
Farming Experience (Years)	22.66	12.85	1	60
Cotton Cultivation Experience (Years)	19.98	13.42	1	60
Distance to Agricultural Market (km)	11.66	7.49	0	35
Distance to City (km)	11.33	7.54	1	35
Distance to the Metaled Road (km)	2.62	3.04	0	27

We have observed that 22 percent of the farmers are registered with the agriculture department, and 35 percent of the farmers receive a message from the agriculture department through SMS. Only 15 percent of farmers have received training regarding agricultural practices, and 30 percent of farmers have access to loans (Table 6).

Table 6

Access to Services

Services / Access	Yes	No
Registered with Agriculture Dept.*	22%	78%
Farmer Card*	10%	90%
Avail Subsidy on Fertilisers and Seed	11%	89%
Subsidy on Machinery	2%	98%
Receive SMS Regarding Farming Services	35%	65%
Access to Weather Information	46%	54%
Training on Cultivation Practices	15%	85%
Training on Cotton Cultivation	12%	88%
Access to Loan Facilities	30%	70%

*Only in Punjab.

The average area, production, and yield of the cotton, sugarcane, rice, and maize farmers are reported in Table 7. It shows that the average area of cotton and sugarcane in the study area is almost the same. After that, the acreage (3.22) of rice and maize (2.66) is reported.

Table 7

Area, Yield, and Revenue of Crops

Variables	Cotton	Sugarcane	Rice	Maize
Avg. Area (acres)	6.89	6.76	3.22	2.66
Avg. Yield (Mounds)	19.0	896	53	81
Avg. Price of Output (Rs. /40kg)	6372	260	1583	1500
Avg. Cost of Production (Without Land Rent)	41393	108579	52563.58	65673
Avg. Revenue	119364	234432	115751.5	117000
Avg. Profit	77970	125852	63187.96	51326

4. RESULTS AND DISCUSSION

The nominal protection coefficient (NPC) represents the unit domestic price (DP) and the foreign price ratio (PP), with both prices expressed in national currency. Table 8 illustrates the NPC of 1.02, 1.44, and 1.06 for cotton, sugarcane, and rice, respectively. It shows that the cotton crop is least protected under the existing policies, while sugarcane is highly protected. At the same time, the cotton protection level among provinces is almost the same. However, sugarcane is more protected in Sindh as compared to Punjab. While rice is almost equally protected in Punjab and Sindh. The maize NPC is 1.06. These results coincide with the estimates of Abdul & Sadia (2016). However, the protection of sugarcane has increased over time compared to previous studies (Quddus & Mustafa, 2011).

The effective protection coefficient (EPC) measures the private value added (PVA) compared to the social or economic value added. If the value of EPC is more than one, it shows that the producers generate a value-added higher than under the optimal situation. Due to protection, farmers are economically efficient, while the value of less than one shows that producers are implicitly taxed. It provides a better measure of protection as compared to NPC. Table 8 shows that cotton producers across Pakistan are implicitly taxed in Punjab (10 percent) and Sindh (2 percent), while sugarcane producers are implicitly subsidised (protected) to 63 percent; however, maize producers have mild protection under the current set of policies (2 percent implicit subsidies). The rice growers were found to be neither implicitly taxed nor subsidised in the research area. In the case of sugarcane, it is pretty evident from the EPC value of greater than one that the domestic growers enjoy huge protection as the prices they receive are much higher than the corresponding economic prices as worked back from export prices. Though for cotton, rice, and sugarcane, the results coincide with the previous studies (Abdul & Sadia, 2016; Quddus & Mustafa, 2011), however, the EPC for maize has increased over time as compared to previously reported results, this being the reason, maize area has drastically increased over the time (Hasnain, et al., 2014).

Table 8

Estimates of Policy Analysis Matrix (Based on Export Price Parity)

Economic Efficiency	Region	Cotton	Sugarcane	Rice	Maize
NPC	Pakistan	1.02	1.44	1.06	–
	Punjab	1.00	1.40	1.06	1.08
	Sindh	1.00	1.49	1.05	–
	Balochistan	1.04	–	–	–
EPC	Pakistan	0.98	1.63	1.00	–
	Punjab	0.90	1.60	1.18	1.02
	Sindh	0.97	1.66	1.08	–
	Balochistan	1.00	–	–	–
DRC	Pakistan	0.44	1.05	0.49	–
	Punjab	0.66	1.33	0.71	0.49
	Sindh	0.28	0.80	0.37	–
	Balochistan	0.34	–	–	–

The domestic resource cost (DRC) indicates the opportunity cost of the domestic resources and the social value added per crop unit. The country has a comparative advantage in the product under consideration if the value of DRC is lower than one, and vice versa. The results show that DRC for cotton, sugarcane, rice, and maize are 0.44, 1.05, 0.49, and 0.34, respectively. Pakistan has a comparative advantage in producing all the crops except sugarcane production in Punjab. In this scenario, sugarcane has more DRC, which means it consumes PKR 1.05 units of domestic resources to produce output worth about PKR 1. In other words, we use our foreign exchange earnings to grow sugarcane. We have observed DRC of cotton 0.44, 0.66, 0.28, and 0.34 for Pakistan, Punjab, Sindh, and Balochistan, respectively. It shows that by consuming PKR 0.44, farmers produce cotton worth PKR 1. It further indicates that Sindh has a more comparative advantage in growing cotton crops while Punjab has a less comparative advantage in cotton production. On the other hand, maize has the least DRC, which means it has more comparative advantages than other crops in Punjab. These results coincide with the study of Hasnain, et al. (2014).

To estimate the PAM for three different scales of farmers, we have divided the farmers into small farmers (area ≤ 5 acres), medium farmers (5< acres < area ≥ 25 acres), and larger farmers (area < 25 acres). Table 9 describes the estimates of PAM for major crops under three different scales of farm sizes in Pakistan. The value of NPC is greater than one for cotton, sugarcane, and rice, which shows that small, medium, and large farmers have protection in Pakistan. In the case of cotton, medium farmers are more protected than small farmers, while in the case of sugarcane, small farmers are more protected than medium and large farmers. This may be because small growers are provided with input subsidies. When it comes to EPC, sugarcane farmers are most protected, then comes rice farmers, while cotton farmers have the least or no protection.

Table 9

Estimates of Policy Analysis Matrix (Based on Export Price Parity) for Different Farm Sizes

Economic Efficiency	Farm Size	Cotton	Sugarcane	Rice
NPC	Small	1.04	1.49	1.06
	Medium	1.11	1.39	1.05
	Large	1.04	1.38	1.07
EPC	Small	0.99	1.68	1.14
	Medium	1.08	1.55	1.11
	Large	1.00	1.61	1.27
DRC	Small	0.51	0.92	0.60
	Medium	0.43	1.03	0.45
	Large	0.32	1.26	0.83

Domestic resource cost shows the comparative advantage of a crop. Cotton and rice have a comparative advantage, while sugarcane has a comparative disadvantage. Regarding farm farm-level comparative advantages, large cotton growers have a comparative advantage compared to small growers. It shows that large farmers use PKR 0.32 of domestic resources to produce an output worth PKR 1.00, while medium and

small farmers use more domestic resources to produce output worth PKR 1.00 of cotton. In the case of rice, medium farmers use the least domestic resources (PKR 0.45) to produce an output worth PKR 1.00. While small and large farmers use more domestic resources. The production of sugarcane costs more domestic resources as compared to values of output. Medium and large sugarcane growers use the country's foreign exchange earnings to produce sugarcane. However, small sugarcane growers use PKR 0.92 of domestic resources to produce output worth PKR 1.00.

5. CONCLUSION AND RECOMMENDATIONS

Cotton plays an essential role in the national economy by providing raw materials to export-oriented industries and employment to the rural communities by delivering 100 billion rupees in terms of payments to labour. However, during the last two decades, the area under cotton has declined to nearly 12 percent. It has threatened the provision of raw materials for industry and resulted in reduced employment opportunities for rural labour, especially women. Similarly, Pakistan may lose well-experienced cotton growers if the trend continues. Considering the challenges, the current study has adopted a holistic approach to evaluating the economic importance of cotton and its competing crops for rural communities and their competitiveness and profitability under the current policies.

The estimates of the Policy Analysis Matrix showed that cotton is the least protected major crop in terms of Nominal Protection Coefficient under the current scenario. In addition, the Effective Protection Coefficient (EPC) showed that cotton growers were implicitly taxed by 2 percent while maize and sugarcane growers were implicitly subsidised by 2 percent and 63 percent, respectively. However, rice growers in the research were neither protected nor taxed. Results showed that cotton growers received a maximum protection of 4 percent in Balochistan. However, they were implicitly taxed to 10 percent in Punjab but received no protection in this central cotton sone. The Domestic Resource Cost showed that cotton has a comparative advantage over sugarcane and rice despite all this. The growers produced one unit of cotton by consuming PKR 0.44, while sugarcane growers produced one unit by consuming PKR 1.05. When it comes to protection provided to crops by farm size, small cotton and rice growers are less protected compared to medium and large growers. In the case of sugarcane, small growers are more protected as compared to medium and large growers. Regarding the domestic resource cost (comparative advantage) of cotton, large farmers have a comparative advantage over small and medium farmers. When it comes to sugarcane and rice, small and medium farmers have comparative advantage, respectively.

Based on these empirical findings, we suggest providing crop-specific and farm-scale-specific incentives to farmers so that farmers could be inclined towards producing those crops that use fewer domestic resources to produce output. Similarly, there should be efforts to reduce price fluctuations in input and output markets, especially in the case of cotton prices to encourage farmers to produce cotton in cotton-wheat zone. Balochistan has a comparative advantage in producing cotton production so efforts should be made to strengthen the market structure to expand cotton production.

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The Ongoing Crisis in the Sugar Industry: The Implications of Legislation and a Need for Deregulation

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The proposed research project is based on a multidisciplinary approach in order to analyse the law governing the sugar industry and the implications thereof. The proposed research project focuses on the current market operation within Pakistan, critically contrasting it with the model implemented within different jurisdictions for effective market operation of the sugar industry. It highlights the inefficaciousness and longstanding practices of the market players, how these are supported by existing legal structures, and how these undermine competition. While the sugar industry is highly significant towards the economy of Pakistan and regardless of the so-called stringent legislative control, which have without a doubt failed, this study shall focus on unveiling the adverse implications of these rules and regulations and analyse a more viable model for an effective market operation.

INTRODUCTION

The sugar industry plays a crucial role in Pakistan's economy, but government regulations have made it highly regulated, inefficient, and anti-competitive. This article explores the historical development of the sugar industry in Pakistan, focusing on the legislative framework that has shaped it up to 2021. It considers relevant laws, case law, and findings from the Sugar Inquiry Report (Sugar Inquiry Commission, 2020).

To gain a comprehensive understanding, the study includes key informant interviews with stakeholders along the sugar supply chain and experts. These interviews assess the proposed reforms' prudency, efficiency, and adequacy, aiming to determine their effectiveness and viability. Ultimately, the article will propose reforms tailored to Pakistan based on this research.

PRE-PARTITION

From the late 1800s to the early 1930s, the sugar industry in the Dutch East Indies, particularly on the island of Java, went through significant developments. Initially, sugar was a crucial export commodity for the colony, primarily directed towards European

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markets. However, in the 1880s, the Java-based sugar factories lost contact with these markets. Around the turn of the 20th century, the United States became a major recipient of Java's sugar exports due to disruptions in Caribbean sugar supplies caused by the Cuban revolution and the Spanish-American war. However, by the early 1910s, Java shifted its focus to Asian markets, particularly the Indian Subcontinent, China, and Japan (Knight, 2010).

The development and maintenance of the sugar industry became crucial for the Indian subcontinent, and historical records indicate that India had a well-established sugar industry dating back centuries. Around the same time, with the decline of indigo cultivation in North Bihar and increased emphasis on cane production, modern sugar factories began to emerge.

Table 1

Mean and Coefficient of Variation of Decadal Values of Sugar Area, Production, Yield, and Recovery: 1930-31/1939-40 to 1940-41/1949-50

	Area (Million Hectare)		Production (Million Tons)		Yield (Tons/Hectare)		Recovery	
Decades (% Cane)	Mean	% CV	Mean	% CV	Mean	% CV	Mean	% CV
1930–31/1939–40	1.443	15.29602	51.2889	19.75914	35.36246	7.76582	9.079	3.426276
1940–41/1949–50	1.4308	10.33157	49.2878	10.27937	34.49068	5.411209	9.95	2.024515

Sir James MacKenna, in 1928, highlighted India's substantial sugarcane consumption. By 1930, India was on the path to self-sufficiency in sugar production, with a significant increase in the number of modern sugar factories (Burt, 1935).

In 1932, the Indian Legislature passed the Sugar Industry Protection Act, which protected the local sugar sector and imposed tariffs on sugar imports, ensuring India’s self-sufficiency in sugar production by 1935 (Kansal, 1997).

To regulate the sugarcane sector, the government passed the Sugar Excise Act and the Sugarcane Act in 1934. The Sugar Excise Act aimed to offset revenue losses due to decreased sugar imports, and the Sugarcane Act allowed provincial governments to set minimum cane prices and established a “Zoning System” to regulate cane purchasing.

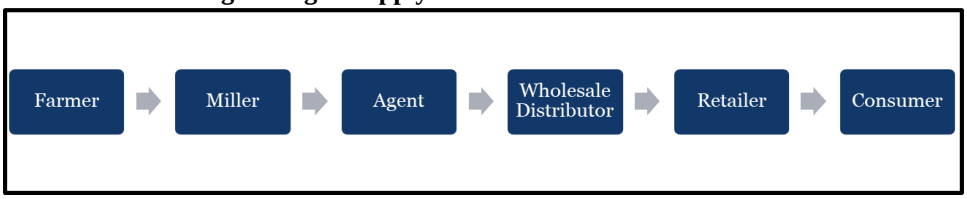
The “Zoning System” required every farmer in a specified “command area” to sell to an associated mill, and these areas were clearly delineated. The system aimed to enhance the collaboration between farmers and mills, increase cane production per acre, and benefit both parties.

However, the implementation of the Zoning System led to variations in farmer outcomes, depending on the ownership structure of the mills (cooperative, private, or public). The efficiency and coordination of mills played a crucial role in determining how much sugar was extracted from each ton of cane (Mullainathan & Sukhtankar, 2014).

Overall, these developments in the sugar industry transformed India into a self-sufficient sugar producer by the mid-1930s, with a significant increase in the number of sugar mills and the implementation of regulatory acts to ensure fair pricing and protect the local industry.

POST PARTITION OVERVIEW

Fig. 1. Sugar Supply Chain/Relevant Stakeholders



Note: Federal, Provincial, and Local Governments are also key stakeholders.

Prior to partition, non-Muslims owned over 80 percent of the industrial enterprises in West Pakistan for example, they owned 167 of the 215 indigenously held firms in Lahore and dominated the whole finance market (Ali & Malik, 2009).[1] Hence, Pakistan had only two sugar mills at the time of partition. However, as a result of the Indian subcontinent's perfervid commitment towards the sugar industry and its reform prior to partition, the sugar industry in Pakistan grew to become a major processing sector, second only to textiles in terms of sales volume.

The Government laid the groundwork for the business in the 1950s with the establishment of four sugar mills (Lodhi, et al. 1988). Industrial growth became a major policy goal. The large-scale manufacturing sector in West Pakistan increased at a rate of 34 percent per year from 1949 to 1950 and 1954 to 1955, resulting in a significant increase in industrial growth thereby facilitating a significant increase in the rate of capital influx into the country, which rose from around 2.5 percent of GNP in the mid-fifties to around 7 percent in the mid-sixties. Hence, the industrial sector saw a relatively high pace of expansion in the early 1950s (Ali & Malik, 2009).

Moreover, with the enactment of The Sugar Factories Control Act 1950 regulated cane was marketed to mills, and each mill was assigned a zone or area from which it was compelled to purchase a certain amount of cane supplies. However, the percentage varied amongst provinces, for instance, in Punjab, it was 80 percent, in the NWFP, it was 65 percent, and in Sindh, it was 100 percent. Mill zone growers were required to sell a similar amount of their cane production to the mill and the Government determined the minimum price at which mills may purchase cane each year. The Act made it illegal for middlemen to be involved in the sale of sugar cane to mills. Mills were expected to keep a grower register, estimate the amount of cane produced by each grower in their respective zones before the start of each crushing season, guarantee regulated supply to the sugar factories, declaration of areas to be reserved for the supply of cane to a particular factory. To ensure the execution of the Act, the Provincial Cane Commissioner was appointed (Lodhi, et al. 1988).

However, the success or failure of any venture was dependent on businessman's access to official channels as there was almost no financial infrastructure in place. To fill this funding shortfall, public institutions, such as the Pakistan Industrial Development Corporation ("PIDC"), were established. These agencies, however, tended to favour larger,

[1] Until the end of 1955 it is estimated that about 7 million refugees entered West Pakistan, and 1.25 million refugees entered East Pakistan, while 5.6 million Hindu and Sikh refugees left Pakistan for India

more established businesses with a proven track record of profitability and security. Hence, jeopardising the entire purpose for which they were established (Lodhi. et al. 1988).

Notwithstanding, by the 1960s, with eight (08) sugar mills, direct economic controls on imports, new investments, the prices of domestically produced manufactured goods were implemented in the 1950s (Safdar, et al. 2016). These controls were seen as not only ineffective economically, but also as a source of corruption. In the 1960s, the Ayub Khan's government removed these price limits, liberalised commerce, and welcomed new investment. The main source of export encouragement was a 1959 export-bonus plan, which effectively provided a subsidy for exporters and a limited free market for imports (Safdar, et al. 2016).

In the 1970s, sugar manufacturing capacity continued to expand as different tariff and non-tariff constraints on sugar imports made domestic sugar production profitable and twelve additional mills were built. The majority of these were in the public sector, but government policy switched again in the late 1970s, this time in favour of the private sector (Lodhi, et al. 1988).

By 1981, Pakistan had 31 sugar mills which eventually grew to 45 mills in 1988, with a total refining capacity of 1.26 million tonnes (Safdar, et al. 2016). During this period of deregulation in the sugar industry, government intervention decreased significantly. Price and distribution controls on refined sugar were lifted, and rationing was abolished. The government replaced imports with a regulatory duty on sugar imports, ending its import monopoly. The mill zoning system was phased out, and the sugar sector was no longer classified as a Specified Industry, eliminating the need for government approval for new investments or capacity expansions (Lodhi, et al. 1988).

The Government further launched a new sugar policy for the country in May 1987 and the decision to officially remove the zoning system, beginning with the 1987 and 1988 crop year, was a crucial component of this policy. Farmers were now free to supply cane to any mill that offered the best price under the new arrangement and they were also empowered to convert any amount of cane into gur. At the same time, the said policy also entailed that the cane support price must be maintained at a minimum and the mills were also allowed to buy cane from outside the designated zones; after de-zoning (Lodhi, et al. 1988).

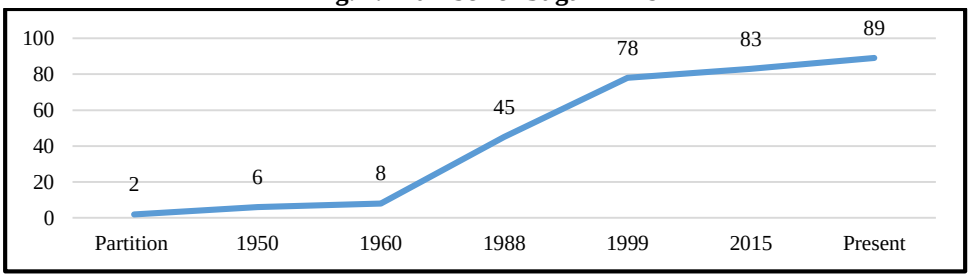
Pakistan has been on a "liberalisation" path since 1990 (Ali & Malik, 2009). The sugar industry became a crucial area of state patronage, and politically influenced decision-making resulted in a plethora of underutilised sugar mills (Ali & Malik, 2009). Despite this, sugarcane production had greater protection rates in the 1990s than wheat, rice, or cotton, and was thus, disproportionately grown by farmers. Pakistan was the world's fourth largest sugarcane grower in terms of area under production in 1999, however, the same ranked fifteenth in terms of yield per hectare (Rizvi, 2000).

More recently, Pakistan has become a major sugarcane producer, ranking fifth in terms of sugarcane cultivated area, 60th in yield, and 15th in sugar production. The industry employs more than 100,000 labour force while more than 9 million people of rural population are involved in the production of sugarcane. There were 78 sugar mills from 2003-2004, with one in Azad Kashmir, while the number of mills increased drastically, reaching an overall of 83 Sugar Mills in 2015; 45 in Punjab, 08 in Khyber Pakhtunkhwa and 30 in Sindh, in accordance with the Pakistan Sugar Mills Association (Safdar, et al.

2016). Currently, there are 89 operating sugar mills in Pakistan (Sugar Inquiry Commission, 2020). Pakistan has the ability to develop an area of 13,224 hectares along the main feeder canal from the Indus river in Sindh, utilising 34 percent idle capacity of Pakistani mills capable of exporting 50,000 tonnes of sugar to the Arab World in exchange for half a million barrels of crude oil (Rizvi, 2000). However, due to greater production costs, increased imports, and deteriorating competitiveness of the native sugar sector and the future of this business in Pakistan mostly linked to production efficiency, adoption and development of new production technology can boost productivity and efficiency; however, it is a challenging due to restricted income and loan to growers.

The following graph depicts the gradual increase in the number of sugar mills throughout the decades:

Fig. 2. Number of Sugar Mills



Moreover, agriculture has been devolved to provinces since the 18th amendment to the Constitution of the Islamic Republic of Pakistan, 1973, was implemented in 2011, and sugarcane prices are now controlled by provincial administrations. Sugarcane price in Pakistan has always been a sensitive issue and it is critical to link sugarcane pricing to its sucrose concentration to improve efficiency in the sugar industry. However, the current pricing system is weight-based, with little respect for the quality of the produce. The sugar sector will continue to be inefficient and uncompetitive, wasting resources, unless provincial governments acquire the competence to solve the myriad difficulties, concerns, and challenges in this setting and balance the conflicting interests of all stakeholders (Salam, 2019).

There have been numerous issues influencing the sugar sector through the decades. In Pakistan, lower productivity is owing to a shortage of irrigation water, inadequate fertiliser input, and improper insecticide and pesticide spraying et al (Rizvi, 2000). The sucrose content of sugarcane plays an important role in boosting sugar output and the government may take steps to ensure that cane growers adopt better sugarcane types with high sucrose content and are disease and insect resistance. Moreover, our research institutes should develop high sucrose content sugarcane varieties, and each mill should have a diligent cane department that ensures that fresh cane supplies from the fields are delivered to the mills on the day of harvest so as to ensure minimum weight and sugar content losses during transit (Rizvi, 2000).

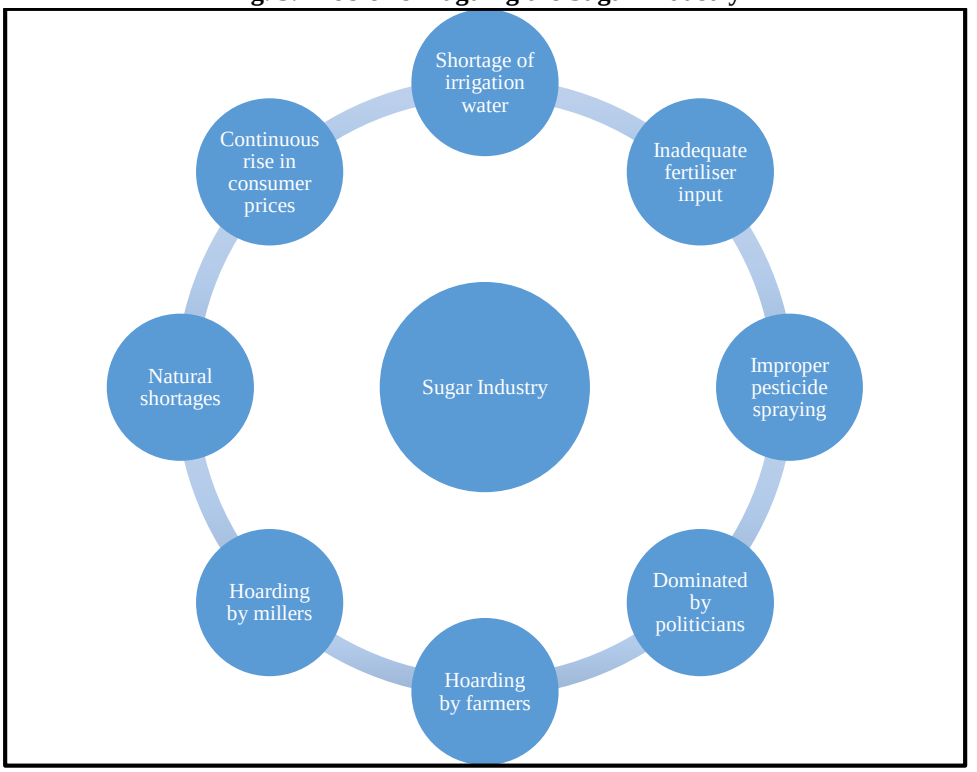
Rising consumer prices worldwide, especially in emerging nations like Pakistan, have led to economic challenges and reduced the purchasing power of the average citizen, resulting in a food crisis in the country. Sugar shortages in Pakistan have occurred due to

various issues, driving up food costs and severely limiting consumer purchasing power. The political influence in Pakistan's sugar industry is significant, with many mills established with the help of Developmental Financial Institutions ("DFIs"), which often face working capital problems. This has led to the closure of some mills, further contributing to the loss of national assets, reduced sales tax revenue, and increased unemployment.

Cultivators argue that the sugar crisis is not a natural disaster but the result of mill owners' failure to purchase available sugarcane stocks from the market. They contend that the sugar industry is not uncompetitive and point to two primary causes: keeping sugarcane prices below the support price and sugar mill owners reaping excessive profits (Chhapra, et al. 2010). Chhapra, et al. (2010) make similar claims, highlighting the monopolisation of governmental institutions by large farmers and the use of corrupt practices by landlords and sugar mill owners to access more lucrative marketing channels, leading to artificial shortages driven by hoarding for disproportionate profits.

However, the shortage could be natural as well. Unfavourable weather conditions, a market structure that reduces supply over time, and changes in government policy that may affect production are all examples of natural shortages. In a report published in 1988, the National Commission on Agriculture acknowledged that the area under sugarcane cultivation was suffering from water stress, and that it would be unrealistic to expect further production growth based solely on area expansion, especially since future irrigation supplies were expected to be limited (Dawn, 2006).

Fig. 3. Problems Plaguing the Sugar Industry

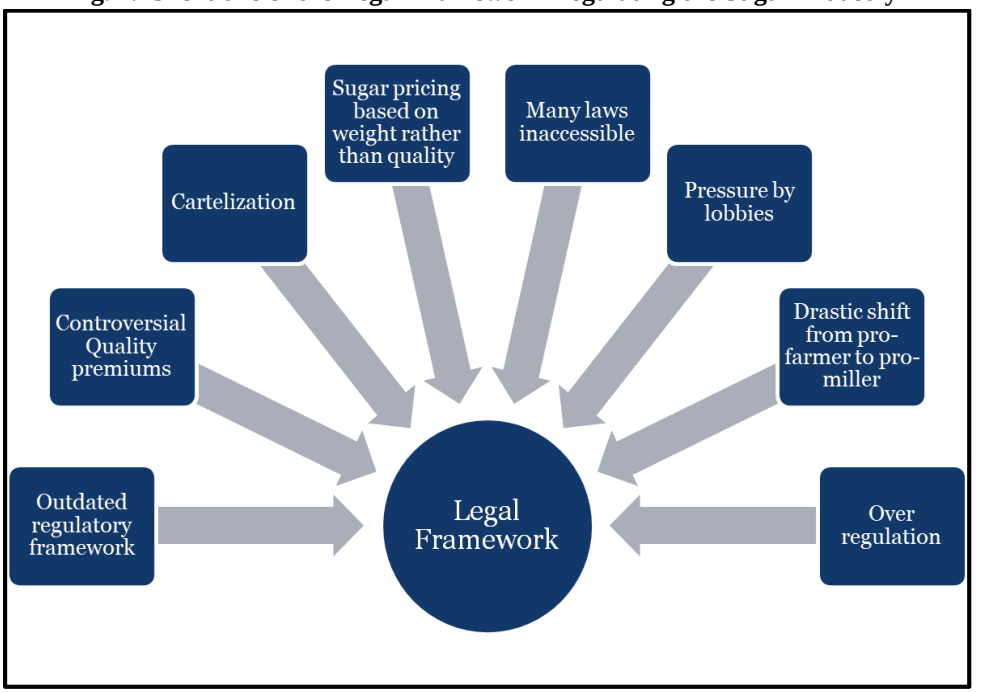


Also, the depreciation of the local currency is another factor that affects sugar pricing, as Salam (2009) observed in his study that distortions in incentives of major crops in Pakistan from 1991 to 2008, were due to large fluctuations in domestic and world market prices, as well as an upward trend in domestic prices triggered by the depreciation of the local currency (Dawn, 2006). It is noteworthy that, unfortunately, pricing systems that produce the right incentives necessitate a level of sophistication that is difficult to legislate and is more likely to emerge through cooperative ways (Larson & Borrell, 2001).

LEGAL REVIEW

To understand the regulatory framework governing the industry, relevant laws (total 34) were compiled and analysed. In particular, enabling provisions, the legislative intent behind its drafting, which key stakeholders it affects or regulates, any SROs drafted under it, the enforcement mechanisms, penalties, and the law's relevance were taken into account in drawing conclusions.

Fig. 4. Shortfalls of the Legal Framework Regulating the Sugar Industry



Attention is drawn to the following laws:

Sugar Factories Control Act 1950

Pakistan inherited a total of 2 sugar mills from the sub-continent, which attracted imports to meet the demand. The main policy concern at the time was promoting the industry and attracting all involved stakeholders towards a safe investment, foremostly, the agriculturalists. To accommodate the fact that the sugar industry is functional only through a limited period and the consumption needs to be met throughout the year and to ensure

timely payments to the growers, the government was buying entire stocks of sugar and making it available to consumers at subsided rates (Rizvi, 2020).

The main purpose of this Act was to ensure a regulated supply to the sugar factories, at a price at which it may be purchased. This objective is met through establishing a Sugarcane Control Board and a Cane Commissioner who may: require the occupier of any factory to submit to him an estimate of the quantity of cane required during the crushing season, declare areas to be reserved or assigned area for the supply of cane to a particular factory, and binding cane growers to particular factories etc.

Markedly, under s. 13 and 14, the Cane Commissioner is to allocate specific growing areas to specific sugar manufacturers to ensure a constant supply for the mills. S. 13 delegates reserved areas; these areas are completely reserved for the sole manufacturer and other purchasing units are forbidden from purchasing the cane from that area. Assigned areas under s. 14 provide for more flexibility; in the event of failure to supply the requisite amount of cane to the factory, the factory may purchase the balance from an outside assigned area.

Concerning price regulation, the Act grants the Provincial Government the power to determine a minimum price to procure sugar cane, to protect growers from manipulation.

To guarantee cane price fairness by ensuring that the growers get paid price based on the sucrose content, and not just the sole ornamental factor of weight, a quality premium[2] was introduced in the early 1980s[3] to encourage farmers to use better quality cane varieties to increase the sucrose content of their crops. Sugar mills of Sindh and south Punjab are recovering up to 11.5-12 pc sucrose against the base level content of 8.7pc (Jamal, 2020).

This requirement, arguably, still goes against the profit interests of millers who have consistently fought against having to pay such premiums. From their perspective, they are having to pay for the same stock twice[4] when in reality, the premiums provide an incentive for growers to invest in growing varieties with higher sucrose content allowing these millers to make a lot more sugar than competitors who are recovering base level content (Jamal, 2020). Perhaps instead, the better argument to be made is of the absurdity that Pakistan remains the only country to have sugarcane pricing that is not based on recovery and the inefficiency of this model is demonstrated by Pakistan's low sugarcane productivity of 54.6 tonnes per acre compared to Egypt's 120 tonnes per acre (Ahmad, 2020). After all, if the intention is to encourage farmers to cultivate better sugarcane, then the pricing model should allow for proportionate compensation and more regular reviews of the minimum support price ought to be undertaken to this end.

Other accusations leveled against the provisions of this Act by millers include that this allows the Provincial Governments to 'arbitrarily' or 'unilaterally' set the minimum procurement price for cane (Bokhari, 2014). However, the process for determining the minimum support price has always been fairly comprehensive and inclusive; it starts with the Agricultural Policy Institute (API) sending the Provincial governments non-binding recommendations regarding the support price after using an elaborate system of calculation

[2]A quality premium is the additional price given to the farmers for higher sucrose content.

[3]N.W.F.P Sugar Factories Control (Amendment) Act, 1988, s 2; Sugar Factories Control (Amendment) Ordinance, 1985, s 2;

[4]Fauji Sugar Mills vs. The Province of Punjab 1996 CLC 592 LAHORE-HIGH-COURT-LAHORE

for its determination. Then, the Sugarcane Control Board is established in each province (under the 1950 Act) which includes representatives of all stakeholders to determine the final support price (Sugar Inquiry Commission, 2020). Furthermore, mill owners point out that in the regulation of this minimum support price, the Government tends to increase it while the price of sugar, largely unregulated, remains the same (Bokhari, 2014). In contrast, according to the Commission of Inquiry's report, the support price has remained constant from 2015 to 2019 despite outcry from farmers associations that this did not take into account the substantial increase, since 2015, in the cost of real inputs such as fertiliser, labour etc. (Sugar Inquiry Commission, 2020). Admittedly however, it appears that in recent times millers themselves conceded that there should be a 10 pc increase in the minimum price for 2021-22 and apparently, both growers and millers seemed to finally be coming onto the same page as opposed to locking horns as usual (Khan, 2021).

Nevertheless, it should not also be forgotten that despite all these restrictions, the Sindh Abadgar Board notes that millers appear to consistently make profits and sugar mills remain a lucrative business—something that cannot be said of cane farming (Bokhari, 2014). In fact, a sugar commission report shed light on the grave reality of how the sugar lobby has not only continuously coerced governments—past and present—to line its own pockets but also violated the Sugar Factories Control Act with impunity. It was shown, through a forensic analysis of the sugar mills, that the actual sugar output had been largely under-reported and consequently, there have been accounts of massive income tax evasion that go entirely unchecked by the Central Board of Revenue (Jaferii, 2020 & Ahmad, 2020).

Price Control and Prevention of Profiteering and Hoarding Act 1977

This Act came into force on 25 May 1977 for the purpose of controlling the prices and preventing the profiteering and hoarding of specific 'essential commodities'. An exhaustive list of these has been provided in the Schedule to this Act. Crucially, 'white sugar' and 'gur' have also been listed here (though a number of other commodities have also been listed) so the provisions of this Act, and any legal principles that flow from it, are relevant for present purposes. Provisions of note include; s.3, which empowers the Federal Government (or any authority delegated by it[5]) to control/regulate, through notification, prices, production, movement, supply etc. of any essential commodity for the purpose of ensuring equitable distribution and fair prices. Under s. 6, no person shall dispose of an essential commodity at a price higher than the maximum price as fixed by the Controller-General of Prices and Supplies (as appointed by the Federal Government) and s. 7 makes it a criminal offence to contravene any order made under ss. 3 and 6.

To date, this Act has remained extremely relevant for legal purposes; as recently as this year, the Price Control and Prevention of Profiteering and Hoarding Order 2021 (under the 1977 Act) came into force. This has been subject to much public criticism for simply being an attempt to put a band-aid over the pervasive issue of surging prices due to inflation and shortages (Jamal, 2021). It has been argued that such knee-jerk measures unnaturally disrupt the supply-demand equilibrium causing shortages and other widespread adverse effects for the consumers – the very group such provisions are enacted to protect. Furthermore, according to experts, price controls provide incentives for hoarding, black

[5] Price Control and Prevention of Profiteering and Hoarding Act 1977, s 4.

marketing, production cuts etc., causing consumers to eventually pay a lot more than they would have otherwise (Jamal, 2021).

Price Control and Prevention of Profiteering and Hoarding Order 2021

This Order was promulgated on 24 August 2021 under the Price Control and Prevention of Profiteering and Hoarding Act 1977. It outlines the powers and functions the Controller-General possesses for the exercise of the provisions of the 1977 Act and this Order. E.g., the authority to; seek the record of timely reports from producers/dealers/importers, search the premises of a registered trade associations etc.[6]

Of special note is the power to fix the price of an essential commodity *suo moto* in case of a "national emergency" i.e., a 'situation of uncontrolled price hike with average increase of not less than thirty-three per cent in price from the immediately preceding year and also includes a situation of war, famine or natural calamity'. This equation of a price hike with situations of war, famine or a natural calamity has been criticised as an attempt to justify sudden price curbs when and if imposed (Jamal, 2021).

The idea behind giving the executive such powers to flexibly impose price caps is to provide immediate subsidies for consumers but is perhaps the economic equivalent of brushing the dust under the rug. It not only removes incentives for farmers but adversely impacts them, leading to suppressed supplies, inferior quality product, artificial shortages etc., culminating in higher prices eventually.

Despite this, producers of sugar are expected to thrive as the vague policies and the employment of a 'cost-plus' method of determining the prices to be fixed means that the higher costs of doing business can simply be passed on to the consumer. There is now incentive to inflate costs unnecessarily as producers can simply demand higher prices while their margins stay constant.

Essentially, free market prices are indicators of scarcity which can only be resolved once it is identified however, such artificial distortions can confuse market forces precipitating more serious problems in the long-term (Mahmood, 2021).

Sugar Supply Chain Management Order 2021

The Order requires those involved in the sugar industry, such as factory occupiers, brokers, dealers, and wholesalers, to register their go downs with the Deputy Commissioner. An appeal can be made to the Cane Commissioner if registration is rejected. The Order limits sugar storage to two and a half metric tonnes, with notification required for excess storage. Millers can only sell sugar to registered wholesalers or brokers.

The Order also grants powers to Cane Commissioners and Deputy Cane Commissioners. They can issue directives to ensure the proper management of sugar stocks, including storage, sale, and movement between provinces. In cases of sugar shortages, they can direct the sale of specified quantities at ex-mill prices or take possession of stored sugar and sell it as needed. They have the authority to inspect documents and sugar stocks held by various industry stakeholders.

Khan, (2021) suggests that the Sugar Supply-Chain Management Order 2021 aims to prevent sugar hoarding and create a more competitive market. This would benefit sugarcane

[6] Price Control and Prevention of Profiteering and Hoarding Order 2021, s 4.

growers, who could explore other options in a deregulated market, and incentivise sugar producers to enhance their efficiency in production and pricing (Khan, 2021).

The Punjab Sugar Supply Chain Management Order 2021 and the Prevention of Speculation in Essential Commodities Ordinance 2021, according to Chief Minister Usman Buzdar, are key initiatives made by the government to provide assistance to the people. Furthermore, he stated that the regulation will prohibit price increases in edibles (Fareedi, 2021).

Moreover, after manufacturers refused to reduce the price of sugar, the Punjab Government, acting on the said Order, seized stock from sugar mills to sell in the market at notified rates. The seized stock will be sold through dealers at a maximum of Rs 85 per kg, down from the previous high rate of Rs115 per kg (Geo News, 2021).

Sugar Factories Control (Amendment) Act 2021

Originally, when the sugar crisis hit Punjab in the preceding year, the Sugar Factories Control (Amendment) Ordinance 2020 was promulgated in September 2020 to quickly respond to the situation because bringing a whole Act into force would be a time-consuming task (Khan, 2021). This Ordinance was largely pro-farmer and included provisions such as; giving the Government the authority to decide the date for crushing, making the delay of payment of dues to growers or any illegal deduction punishable upto 3 years imprisonment and a fine of Rs. 5 million, delay in the start of crushing was made similarly punishable, mill owners were required to present formal receipts and if dues to farmers were not paid then the mill owner could be arrested and the mill could be forfeited (Baig, 2021). This was a welcome change as it allowed the Punjab Government to get the crushing started by early November, force the compliance of millers and ensure payments to farmers (Khan, 2021).

Later, following the expiry of the Ordinance, the Sugar Factories Control (Amendment) Act 2021 was brought into force however, unusually took a complete U-turn by reversing all the pro-farmer provisions of the preceding year. This Act took away the power of the Government to decide the date of commencement for the crushing season, resuming the relaxation of commencing it at any time before November 30[7]. Critically, the millers were previously receiving cane on a 15-day credit but this Act extends this to an 8-month credit cycle by fixing the deadline for payment as June 30, following the crushing season.

This immediately drew the condemnation of nearly all stakeholders involved except, of course, the millers. The Act has been described as "a black law which legalises exploitation and is designed to hurt farmers" and all farmers' bodies are now threatening protests and sit-ins (Khan, 2021).

With the help of the resources provided to us by the Office of the Cane Commissioner, we gained insight into some of the unreported cases such as JS Bank vs. Brother Sugar Mills and M/s Tandlianwala Sugar Mills Ltd vs. Province of Punjab and others. The former clarified that title to white sugar, where the price for the sugarcane remains unpaid, is with the growers whereas the latter reaffirmed that Cane Commissioners could only proceed against mills for determination of liability under the procedure set out in the Sugar Factories Control Act 1950. Moreover, some of the landmark judgements we covered in our research is the judgement of Fauji Sugar Mills Vs The Province of Punjab, where the Lahore High Court held that the imposition of quality premium through S.16-A

[7] Note how this was criticised for being too rigid and ignoring varietal changes over time.

is unconstitutional. Also, as per the Army Welfare Sugar Mills Vs The Government of Sindh, the courts cannot question the existence of quality premium in itself- the only point that can be brought in question is whether the quality premium is commensurate with the revisions to the minimum price of cane set by the Government.

Additionally, there was also a recent judgment by the Competition Commission of Pakistan ("CCP") whereby sugar mills, under the Pakistan Sugar Mills Association ("PSMA") were found to be engaged in anti-competitive practices (cartelisation) following an investigation. This judgment resulted in one of the highest penalties levied to date by the CCP i.e. Rs. 44 billion or $265 million. Notably, the National Accountability Bureau ("NAB") also conducted a number of inquiries into the sugar business, however findings from these are not publicly available. Additionally, the Sugar Inquiry Report that was delivered to the Prime Minister in 2020 also pointed out that contrary to popular belief at the time, the infamous sugar price hike in December 2018 to June 2019 was the result of mala fide practices by the sugar mills rather than low production of sugarcane.

KEY INFORMANT INTERVIEW

Interviewees:

(1) Seerat Asghar, Former Secretary, Ministry of National Food Security and Research.
(2) Mian Muhammad Umair Masood, President, Pakistan Kissan Ittehad.
(3) Mohammad Amin, Chief of Sugar Cane, Agriculture Policy Institute.
(4) Masood Ajmal Dullu, Cane Grower.
(5) Mohammad Zaman Wattoo, Cane Commissioner, Food Department of Punjab.
(6) Dr. Hassan Iqbal, Secretary General, Pakistan Sugar Mills Association.
(7) Syed Mahmood ul Haque Bukhari, President, All Pakistan Farmer's Association.
(8) Maqsood Malhi, Legal Head, JDW Sugar Mills.

The following themes were discussed:

- The current status of zoning systems
- The preferred regulatory model
- The reality and impact of quality premium and minimum price
- Government intervention in the sugar industry
- The influence of mills in the sugar industry
- The trainings/awareness campaigns by the government
- The issues affecting the farmer community
- Sugar a preferred commodity over Gur
- The lack of implementation of governing laws
- The existence of legal loopholes in the sugar industry

Findings and Discussion

Two contrasting narratives exist within the sugar industry: that of the farmers and the millers. Farmers generally perceive a significant power imbalance in the industry, leading to numerous injustices and limited recourse. They feel excluded from a system heavily influenced by a powerful sugar lobby with direct government connections. While

recent improvements in payment delays are acknowledged, they attribute these changes to reduced cane production. Farmers believe that mills exploit their dominant position by making unwarranted deductions, delaying payments, and benefiting from regulatory loopholes. They also feel there is insufficient research and development (R&D) and almost no on-ground extension programs. The current legal and regulatory framework is seen as favouring mills, and this is attributed to the political ownership of several major mills.

In contrast, millers argue that the farmers' claims are exaggerated and that no widespread malicious intent exists in their business practices. They view the industry as overly regulated without adequate justification and advocate for sugar to be traded like any other commodity. Millers assert that government regulations place them in a tight spot, with minimum prices set for cane and maximum prices for sugar. They claim that malpractices like delayed payments and deductions are exceptions, not the norm. Millers suggest that the industry needs deregulation, as the existing system is outdated and hampers progress.

From this discussion, it is apparent that there are two diverging perspectives prevailing in the industry with little common ground beyond the fact that the current system needs to change. While there are obvious biases on either end, any effective change that is to be undertaken must endeavour to address these concerns so far as it is possible. Overall, our findings through these Key Informant Interviews are also concurrent with the literature that reviewed such as the fact that there has been severely deficient Research, Development and Extension work (Raza & Amir, 2021), and the unsustainable price control mechanisms (Jamal, 2021). Other points raised that we also found reflected in pre-existing literature include the existence of challenges such as scarcity of water and improper irrigation and the dominance of political figures as millers (Rizvi, 2000; Chhapra, et al. 2010; Rizvi, 2000).

PROPOSED RECOMMENDATIONS

Phased-Out Plan for Implementation of Reforms

The challenges faced by the sugar industry, including water security, politicisation, and a lack of innovation, have limited its potential. However, the industry's success or failure is primarily determined by its governing institutions, policies, incentives, and effective management of challenges.

There is a consensus among stakeholders that reform is needed in the governing framework of the sugar industry. However, vested interests and short-term solutions often hinder the establishment of a sustainable solution. This is particularly problematic given the industry's importance in Pakistan and its entanglement with political interests. Implementing change, whether favouring millers or growers, is politically challenging due to entrenched industry practices and associated costs. Nonetheless, the recurring sugar crisis highlights the need for systemic change. To address this, three industry models have been considered: Partial Deregulation (as seen in India), the Single Regulatory Model (as in the Philippines), and Complete Deregulation (as implemented in Australia).

The Indian Model—Partial Deregulation

Prior to deregulation, the defining feature of the Indian Sugar Industry was the concept of 'Levy Sugar' and a monthly release mechanism (Randhawa & Gupta, 2017). Levy sugar represented the proportion of sugar produced that mills were obligated to

supply to the Government at a cheaper rate for sale through the Public Distribution System ("PDS"), the remainder of which could then be sold in the open market (subject to controls by the government in case of excessive fluctuation). The idea was that this would allow the Government to ensure that sugar could be made available at a grassroots level at an affordable price (Priyanka, et al., 2016). Furthermore, the monthly release mechanism was established to guarantee a consistent and uninterrupted supply of sugar in the market by controlling the quantities sold in the market on a monthly basis (Randhawa & Gupta, 2017).

Parallels between the Indian and Pakistani sugar industries can be drawn in that the industry is highly politicised with the Government extending its control over a multitude of aspects concerning sugar such as licensing, capacity, cane area, procurement, sugar pricing, distribution, imports and exports (Randhawa & Gupta, 2017). Generally, since 1967-68, the Indian government adopted a policy of 'partial decontrol', interspaced with two short periods of 'complete decontrol' in the 1970s (Priyanka, et al. 2016). Over the years, various committees like the Mahajan, Tuteja, Thorat, and Nanda Kumar Committees repeatedly recommended partial decontrol of the sugar industry, but their suggestions were not implemented. However, in 2012, the Rangarajan Committee's report prompted the government to partially decontrol the industry in April 2013. This partial decontrol eliminated restrictions related to levy sugar and the monthly release system but retained some production controls imposed by state governments, such as licensing, cane procurement areas, and cane pricing (Priyanka, et al., 2016).

Despite this progress, it was generally regarded as unsatisfactory with some suggesting that the Government needs to further and implement complete deregulation instead (Lavanya, 2019; Kalra, 2012). Others remain unconvinced arguing that complete deregulation would leave stakeholders vulnerable. For example, the argument against abolishing the Cane Area Reservation system includes concerns about uncertainty in cane supply, leading to uneconomical mill operation. Deregulation might expose sugar pricing to market fluctuations, both domestically and internationally, without consumer protection. Additionally, farmers, dealing with highly perishable cane, could face restricted negotiation capabilities, impacting their deals (KPMG, 2017).

The Filipino Model—Single Regulator

Philippine's Sugar Regulatory Administration ("SRA") was established on 28 May 1986 via Executive Order No. 18. This was the focal regulatory body for the sugar industry responsible for establishing an orderly system for sugarcane cultivation for the purpose of ensuring a stable, sufficient and balanced sugar production and carrying out relevant research as may be necessary for the formulation of policies and the planning and implementation of programs (Tobias, 2020). It consists of a Sugar Board which is tasked with the formulation of policies rules and regulations for the promotion of growth and development of the industry. The Administrative wings of the SRA are then charged with overseeing and enforcing the governing laws, policies, procedures, systems rules and regulations. The SRA also consists of an internal auditing department to determine the degree of compliance to the SRA's mandate (Sugar Regulatory Administration, 2019).

The Australian Model—Complete Deregulation

Australia is a leading global sugar producer due to its adoption of a free-market approach in the sugar industry. Despite its current success, the industry was previously heavily regulated. However, subsequent reviews led to complete deregulation in 2006. Regulation provided stability but limited the industry's ability to adapt to market conditions, and deregulation ultimately enhanced its competitiveness (Craigie, 2014).

Consequently, when deregulation was effective, it allowed growers and mills to set their own cane prices and abolish 'assigned areas' so that growers could have more freedom to contract (ASMC, 2020). The result of this was that there was increased innovation and a significant improvement in the trade prospectus across all industry processes i.e. growing, milling marketing, etc. (Kumar, 2019).

There was, eventually, a step back to regulation in 2015 due to farmers' fears that their interests would not be sufficiently protected however, this move was heavily critcised as there was no market failure to justify reregulation (Queensland Productivity Commission, 2015).

The proposed recommendations aim to pave the way for Pakistan's sugar industry to transition towards a free and competitive market by advocating complete deregulation. Recognising the present industry landscape, a five-stage plan is suggested to gradually reduce government intervention and establish a coherent framework, allowing the industry to realise its full potential over time.

PHASE I – Consolidation & Accessibility of Laws

During research, there were significant hurdles in accessing relevant legislative instruments due to limitations of major legal databases and the fact that experts and key players in the industry did not seem to agree on the present regulatory framework. This fragmented understanding of the mechanics of the industry increases compliance costs and opens the door for exploitation of more vulnerable stakeholders. For example, the provisions of the Gur Control Order 1948 were reportedly used to restrict farmers from producing Gur even though there was never any legal force behind the Order since the promulgation of the Sugar Factories Control Act 1950. This fact was not made apparent until 2021 when a Lahore High Court judgment declared the Order ultra vires.

Either one of the following actions is recommended:

- Formulate a working manual (to be made available in local languages) for stakeholders elucidating the processes, rights, roles and responsibilities of those involved in the industry.
- Initiate comprehensive education and awareness campaigns with improved availability and access to relevant laws, rules and regulations so that all stakeholders can be brought onto the same page regarding their rights, roles and responsibilities alongside generating an understanding of threats and opportunities within the industry.
- Redraft and consolidate all relevant governing provisions into a single enactment. This should then be made readily accessible in local languages.

PHASE II—Implementation and Enforcement

The lack of sincere implementation and enforcement of the protectionist measures already in place is a major problem in the sugar industry. This is mainly due to the dominant influence of mills and the lack of political will to challenge the status quo. However, no progress can be made without genuine enforcement of laws, rules, and regulations.

One way to encourage cooperative enforcement is for enforcement agents to identify key problem areas and distinguish between violations by hardened offenders and the compliance irregularities of well-meaning individuals. For the latter, a more cooperative and less intrusive approach can be adopted, while the former may need to be pursued more rigorously and be faced with harsher enforcement. This would allow for better allocation of resources and reduced enforcement costs, and it may also serve as an incentive for voluntary compliance (Scholz, 1984).

PHASE III—Review

Industry reviews are a key driving force behind the deregulation of the sugar industry in both India and Australia. In India, a series of committees culminated in the partial deregulation of the industry in 2013. Similarly, in Australia, it took several federal government and government/industry task force reviews to convince the Queensland government to deregulate the sugar industry in 2006 (Craigie, 2014).

Industry reviews are important for effecting radical change within an industry. Even though recommendations are often disregarded, they contribute materially in driving impetus for change. Additionally, they develop a sense of surveillance among producers, encouraging better commercial practices overall.

As such, the setting up of a collaborative task force or committee consisting of both government officials and industry representatives to conduct comprehensive reviews of the sugar industry from time to time to objectively identify impediments to progression and advocate for appropriate reform is recommended.

PHASE IV—Amendments to Laws and Other Initiatives to Promote Competition

As evidenced by the results of the Inquiry Commission Report 2020 and the recent CCP judgment, cartelisation and political influence of mills has been an enduring problem for the industry. Furthermore, there have been repeated calls among the academia pushing the importance Research and Development initiatives by the Government to combat productivity and yield inefficiencies in order to boost the competitiveness of the industry (Khan & Jamil, 2004; Qureshi & Afghan, 2020).

The existing regulatory framework for the sugar industry in Pakistan has several shortcomings, including:

- The unsatisfactory definition of the "Occupier of the Factory" per s 2(k) of the Sugar Factories Control Act 1950, which allows the actual owners of sugar mills to evade responsibility for violations by pinning the liability on to 'managing agents' which often tend not much more than simple employees at the factory.
- Cane Purchase Receipts, which are not directly legally enforceable.
- Price fixation provisions that cause more problems than they solve in the long term.

- Criminal violations under the 1950 Act that are non-cognizable and bailable allowing opportunities to escape proceedings among others.

Additionally, the management of various aspects of the sugar industry is spread out across several departments and ministries, which leads to a lack of coherence and inefficiencies. For example, there is the Office of the Cane Commissioner under the provincial Food Departments, separate Extension Departments responsible for agricultural R&D and training programs, the Agricultural Policy Institute under the Ministry of National Food Security and Research, the Sugar Advisory Board and Controller-General under the Ministry of Industries & Production and the CCP dealing with competition laws and accountability. Consolidation of the regulatory network and amendment of the shortcomings in the existing framework could potentially make a significant difference for the Pakistani sugar sector.

Finally, there is the problem of outdated agricultural practises which have prevented sugarcane farmers from overcoming production constraints. This is largely due to the fact that most farmers tend to be illiterate and lack the knowledge and funds necessary to adopt more scientific cultivation practices. This is reflected in a disappointing yield of 50-57 tonnes per hectare and recovery of 9-10 percent compared to the potential for 150-250 tonnes per hectare yield along with 10-12 percent recovery (Raza & Amir, 2021). To counter this, Pakistan does have several research institutions, including some mills dedicated to R&D for cane however, these have been unable to produce results due to poor management and insufficient funding. Reportedly, the Federal Government, via the ECC decided that 15 percent of the Provincial sugarcane development funds was to be allocated for R&D but failed to follow through with implementation (Khan & Jamil, 2004). Even the performance of Provincial Extension departments has been considered lacklustre with the under-utilisation of the Cess fund which was originally envisioned to, among other objectives, generate funds for sugarcane research (Qureshi & Afghan, 2020). As a result, there has been a great deal of emphasis in literature on the need for quality R&D and Extension programs dedicated solely to sugarcane research and designed to help farmers adopt modern agronomic practices (Iqbal & Iqbal, 2014).

The following recommendations are made:

- Amendments to the law with view to overcoming the gaps in the legal framework.
- Create a Single Regulator with a dedicated focus on supporting sugarcane cultivation and overseeing all aspects of sugar production, marketing, and import/export. This regulator would formulate and implement strategic development plans to benefit all industry stakeholders and ensure long-term sustainability. Its main role should be providing proactive support, including farmer training and timely law enforcement, rather than being solely a vehicle for government intervention during crises.
- Remove unnecessary barriers to entry into the industry such as regulatory prerequisites for the setting up and running of sugar mills. Further study may be required for this.
- Increased focus on the robust enforcement of competition and antitrust laws.
- Revitalisation of and increased funding for R&D and Extension programs.

PHASE V—Deregulation

The Australian experience with deregulation offers valuable lessons. The sugar industry in Australia was heavily regulated, with price controls, marketing restrictions, and assigned areas. Despite calls for deregulation, concerns about farmer vulnerability to mill monopolies kept the government cautious. However, eventually embracing deregulation transformed Australia into a major sugar producer. This success didn't happen overnight or in isolation.

Deregulation involves removing or simplifying government rules that limit market forces. Not all regulations need to be abolished, especially those related to essential services or rural community support, like food safety standards and natural resource protection. When considering significant deregulation, it's crucial to identify vulnerable stakeholders and provide support and risk management tools.

The Australian example demonstrates that, with the right support, farmers and stakeholders can adapt and become more resilient. Agriculture should be viewed as a regular industry, with farm operations as typical businesses. Regulations can hinder efficiency and innovation in agriculture, discouraging risk-taking, and preventing the industry from reaching its full potential. Ultimately, excessive regulations result in a loss of national welfare.

To ensure successful deregulation, the following considerations must be taken into account:

- Significant power imbalances between stakeholders must have been correct e.g. farmers must have a unified representative association, with a functioning and reliable mode of recourse in case of abuses of power.
- Eradication of monopolistic abuses of mills and effective mechanisms to prevent future cartelisation/collusion.
- The process of deregulation must be transparent, and stakeholders must be made aware of what to expect in a deregulated market.
- Availability of appropriate adjustment programs to ameliorate the negative impact of change to those most vulnerable to it.

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Policy

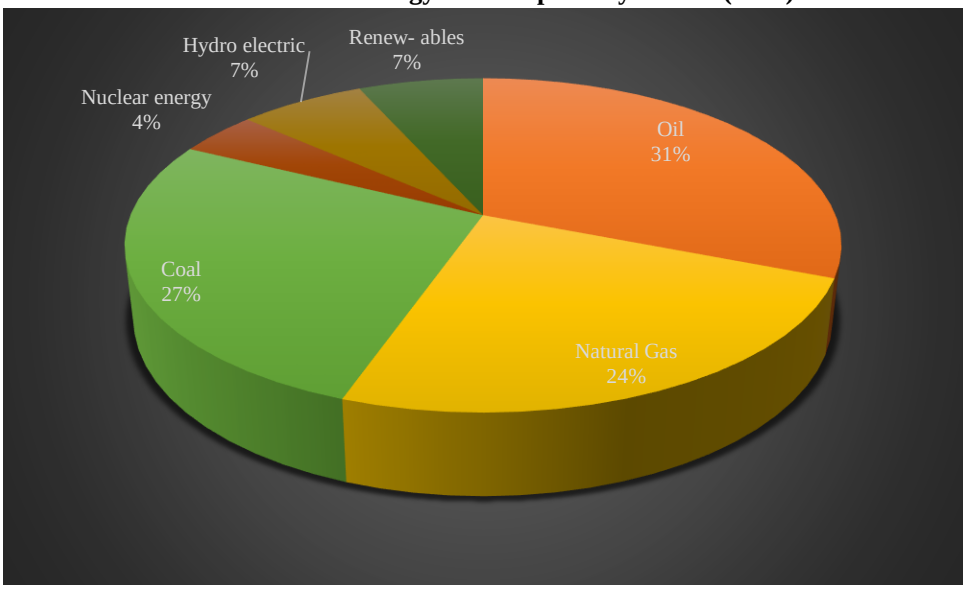
Local Coal for Power Generation in Pakistan

AFIA MALIK

PREFACE

Coal contributes significantly to global energy supplies. In 2021, coal was the second-largest energy source consumed globally (Chart 1). Over the years, coal demand has increased substantially from 2.6 billion tons in 1980 to 5.5 billion tons in 2021 (Chart 2). Because of environmental concerns and the increasing trend towards renewables, its share declined in the United States and many European countries, decreasing global consumption in 2014 and onwards. But the trend reversed in 2020. It is because of the Russia-Ukraine war leading to the worldwide energy crisis that the demand for coal has increased.[1]

Chart 1. World Energy Consumption by Source (2021)



Source: BP Statistical Review 2022.

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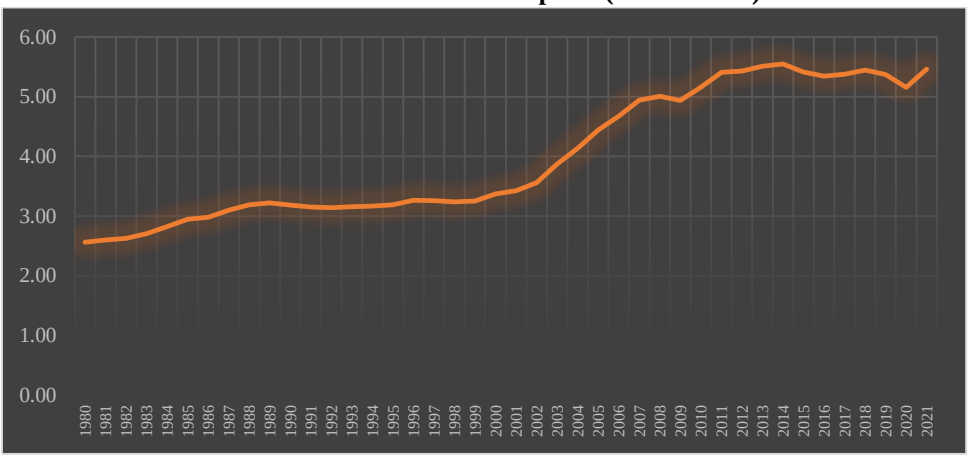
[1]https://www.iea.org/news/the-world-s-coal-consumption-is-set-to-reach-a-new-high-in-2022-as-the-energy-crisis-shakes-markets

According to the International Energy Agency (IEA) forecast, coal demand is expected to exceed the previous coal demand record of 2014 in the next few years. The United States and many European countries are shifting back to coal as it is still one of the cheapest energy sources.

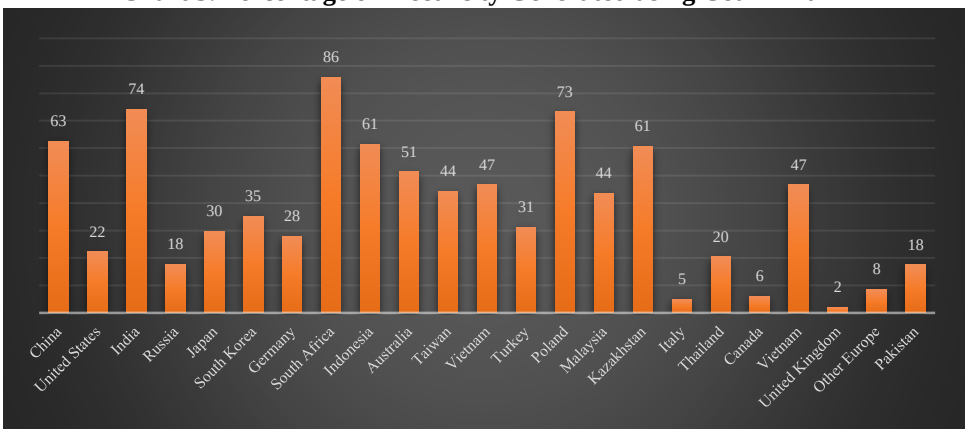
Chart 2. World Coal Consumption (Billion Tons)



Source: BP Statistical Review 2022.

The primary coal-consuming sector is electricity generation. High natural gas prices have increased reliance on coal for generating power. Coal consumption in electricity generation is expected to grow by more than 2%.[2] If the gas prices continue to increase in 2023 or onwards, dependence on coal will remain, and demand will surge further.[3] Besides gas prices, coal prospects will depend on the transition speed towards renewable energy sources.[4]

Chart 3. Percentage of Electricity Generated using Coal in 2021



Source: BP Statistical Review, 2022.

[2] In 2022, coal was the primary source of electricity generation, accounting for 36% of the share compared to 22% of natural gas share (Statista, 2023). These shares were 35% for coal and 24% for gas in 2020 (BP Statistical Review, 2022).

[3] Fossil fuels are deemed suitable for meeting baseload demands.

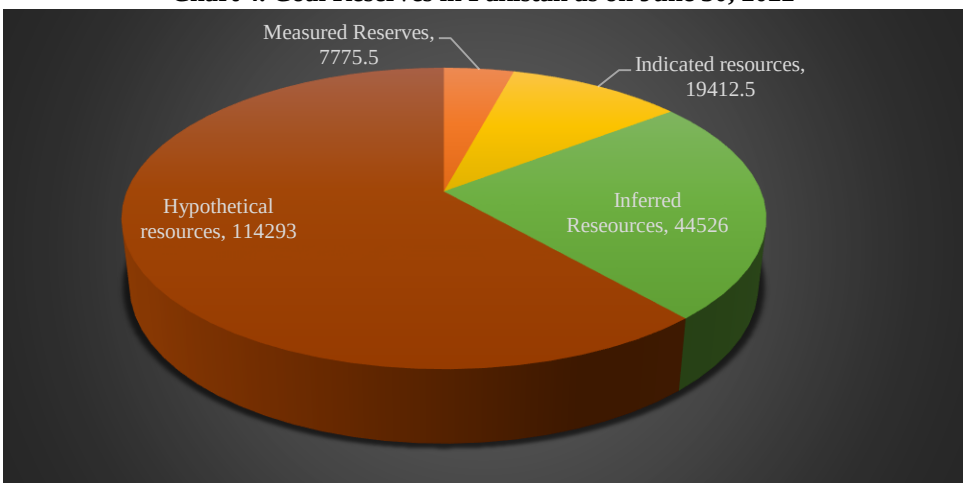
[4] https://www.barrons.com/articles/coal-use-hits-new-record-the-stocks-are-soaring-51671473657

PAKISTAN COAL POTENTIAL

Pakistan has 186 billion tons of coal reserves, primarily located in the province of Sindh (Chart 4). Only Thar desert (10,000 sq. km) contains the world's 7th largest coal reserves of about 175 billion tons (Chart 5), equivalent to 50 billion tons of oil equivalent (more than Saudi Arabia and Iran's oil reserves) and 2000 trillion cubic feet of gas (68 times more than Pakistan's total gas reserves).

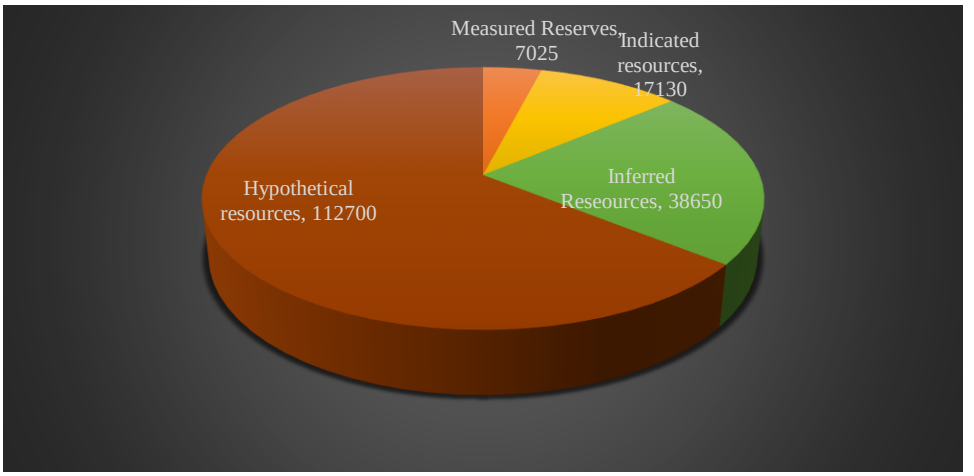
Thar Block-II alone contains 2 billion tons of lignite reserves, of which 1.57 billion tons are exploitable. This Thar Block-II can produce 5,000MW of electricity for 50 years, while the total Thar reserves can sustain 100,000MW for over two centuries[5]. Most of the coal in Pakistan is lignite (with more moisture content, up to 50%).

Chart 4. Coal Reserves in Pakistan as on June 30, 2022



Source: Pakistan Energy Yearbook, 2022.

Chart 5. Thar Coal Reserves as on June 30, 2022



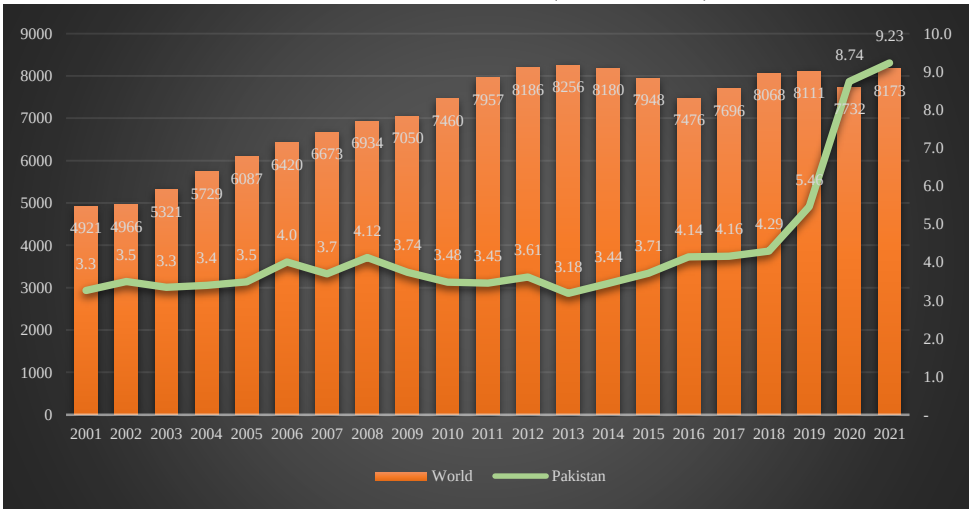
Source: Pakistan Energy Yearbook, 2022.

[5] https://www.secmc.com.pk/

PAKISTAN COAL CONSUMPTION, PRODUCTION, AND QUALITY

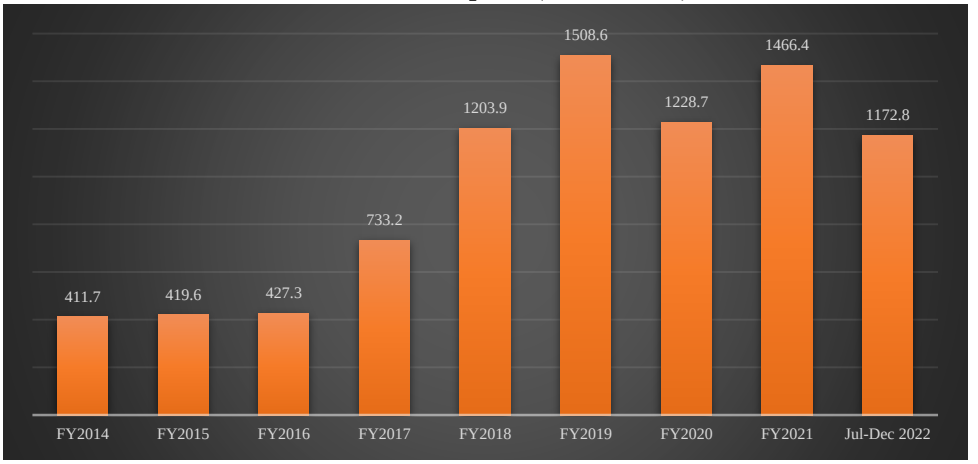
Globally, 8,172.6 million tons (Mt) of coal was produced in 2021. The top five coal producers were China,[6] India, Indonesia, the USA, and Australia, with a share of 50%, 10%, 8%, 7%, and 6%, respectively. Coal mining is critical to many economies[7], enabling them to grow stronger and tackle the dual challenges of poverty and development (PACRA, 2020).

Chart 6. Coal Production (Million Tons)



Source: BP Statistical Review 2022 and Pakistan Energy Yearbook 2022.

Chart 7. Coal Imports (Million US$)



Source: State Bank of Pakistan, 2023.

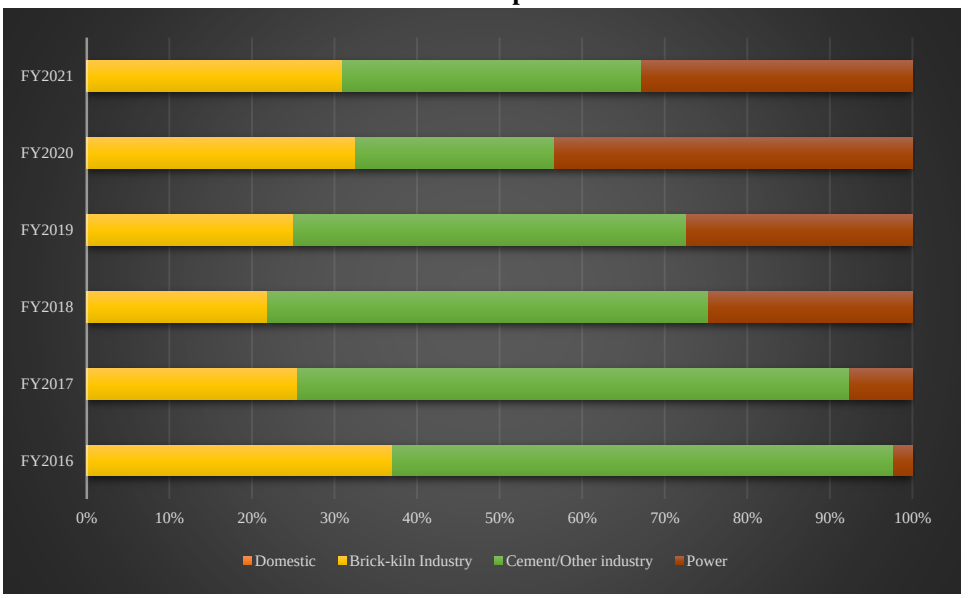
[6] China's energy output doubled from 1990 to 2005, and its electrification rate surpassed 99% due to the abundant coal reserves (World Coal Association Report 2012)

[7] Coal mining provided more than seven million jobs worldwide in 2010 (World Coal Association Report 2012).

Despite having colossal coal potential, coal production in 2021 was only 0.1% of the coal produced globally. About 67% of the country's total coal consumed (28.1 million tons) in 2021 was imported. Pakistan spent about US$ 1.5 billion on coal imports in FY2021 (Chart 7)[8]. An import-dependent energy policy is unsustainable for Pakistan, especially given its limited foreign exchange reserves and in the global context. The global economy has been experiencing a commodity super-cycle due to many factors, including the Russia-Ukraine conflict and COVID-related logistical issues leading to rising prices and disruptions in global supply chains due to the Ukraine-Russia War (Sheikh, 2022).

Even after an 8% growth in Pakistan's coal consumption in the four decades, its share in world consumption is 0.4%. Power generation, the cement industry, and brick kilns are major coal consumers in the country (Chart 8). Imported coal is used in coal fire power plants and the cement industry, about 50% each (Ali, 2022). The main argument for not using local coal is its quality, mostly lignite with more moisture content (Table 1 and Table 2). However, it is also a fact that lignite quality produced in Pakistani fields is better than coal produced and used for electricity generation in India (Table 3). The second primary concern is the expense of transporting Thar coal to the power plants, e.g., Sahiwal and Port Qasim due to the absence of a railway connection with the Thar coal site.

Chart 8. Coal Consumption in Pakistan



Source: Pakistan Energy Yearbook, 2022.

Out of total reserves at Thar amounting to 175,506 million tons, 16% are divided into twelve blocks with an area covering 1,121 sq km. Blocking of the remaining 84% of reserves still needs to be done. Phase I of Block II was commissioned in July 2019.

[8] With the dollar hike and increase in global coal prices, the trend of the first two-quarters of FY2022 is doubling coal imports. The exact figure from the source is not available.

Table 1

Thar Coal Qualities for Blocks I to XII

Block	Area (km^2)	Total Reserves (billion ton)	Moisture (%)	Ash (%)	Vol. Matter (%)	Sulphur (%)	Heating Value (As Received) (Btu/lb)	Fixed Carbon (%)
I	122.0	3.56	43.13	6.53	30.11	0.92	6,398	20.11
II	79.6	2.24	47.89	7.37	25.15	1.12	5,008	19.68
III-A	99.5	2.00	45.41	6.14	28.51	1.12	6,268	19.56
III-B	76.8	1.45	47.72	9.30	25.49	1.15	4,808	16.79
IV	82.0	2.47	43.24	6.56	29.04	1.20	5,971	21.13
V	63.5	1.39	46.82	8.92	30.24	1.20	5,682	13.26
VI	66.1	1.65	46.80	5.89	29.34	0.90	5,727	16.6
VII	100.0	2.17	48.27	8.03	25.30	1.16	5,440	25.30
VIII	100.0	3.03	49.57	7.78	24.32	1.44	5,302	18.10
IX	100.0	2.86	48.60	5.92	29.03	0.96	5,561	15.73
X	100.0	2.87	48.99	6.35	30.79	1.17	4,840	13.54
XI	101.0	1.61	49.97	8.07	24.16	1.61	5,228	17.26
XII	100.0	2.34	50.82	5.71	25.00	1.11	5,459	17.26

Source: JICA (2013).

Table 2

Coal Quality of Coalfields in Pakistan

Province/ Coal Field	Coal Quality Proximate Analysis (in percent)					Rank ASTM Classification	Heating Value (mmmf) Btu/lb	Heating Value (mmmf) Kcal/kg	Average Annual Production 2000-2001 (tonnes)
	Moisture	Volatile Matter	Fixed Carbon	Ash	Total Sulphur				
Sindh									
Lakhra		9.7 = 38.1	18.3 = 38.6	43.49	1.2 = 14.8	LigB to SubC	5,503 = 9,158	3,057 = 5,088	1,112,406
Sonda-Thatta		22.6 = 48.0	16.1 = 36.9	2.7 = 52.0	0.2 = 15.0	SubC to hvBb	8,878 = 13,555	4,932 = 7,531	–
Jherruk						SubC to hvCb	8,800 = 12,846	4,889 = 7,137	–
Ongar	9.0 = 39.5	20.0 = 44.2	15.0 = 58.8	5.0 = 39.0	0.4 = 7.7	LigA to SubA	5,219 = 11,172	2,899 = 6,207	–
Indus East						LigA to SubC	7,782 = 8,660	4,323 = 4,811	–
Meting-Jhumpir	26.6 = 36.6	25.2 = 34.0	24.1 = 32.2	8.2 = 16.8	2.9 = 5.1	LigA to SubC	7,734 = 8,612	4,297 = 4,784	–
Badin*	15.4 = 29.8	29.8 = 39.8	31.0 = 36.3	8.2 = 14.6	3.4 = 7.4		6,740 = 11,100	3,744 = 6,167	–
Thar Coal	29.6 = 55.5	23.1 = 36.6	14.2 = 34.0	2.9 = 11.5	0.4 = 2.9	LigB to SubA	6,244 = 11,045	3,469 = 6,136	–
Balochistan									
Barkhan-Chamalang	1.1 = 2.9	24.9 = 43.5	19.4 = 47.1	9.1 = 36.5	3.0 = 8.5	hvCb to hvAB	12,500 = 14,357	6,944 = 7,976	NA
Duki	3.5 = 11.5	32.2 = 50.0	28.0 = 42.0	5.0 = 38.0	4.0 = 6.0	SubB to hvAB	1,131 = 14,164	5,628 = 7,869	278,518
Mach Abegum	7.1 = 12.0	34.2 = 43.0	32.4 = 41.5	9.6 = 20.3	3.2 = 7.4	SubA to hvCb	11,110 = 12,937	6,172 = 7,187	317,004
Sor Range – Deghari	3.9 = 18.9	20.7 = 37.5	41.0 = 50.8	4.9 = 17.2	0.6 = 5.5	SubA to hvBb	11,245 = 13,900	6,247 = 7,722	279,564
Pir Ismail Ziarat	6.3 = 13.2	34.6 = 41.0	19.3 = 42.5	10.3 = 37.5	3.2 = 7.4	SubA to hvCb	10,786 = 11,996	5,992 = 6,664	384,108
Khost-Shahrig-Harnai	1.7 = 11.2	9.3 = 45.3	25.5 = 43.8	9.3 = 34.0	3.5 = 9.55	SubB to hvAb	9,637 = 15,499	5,354 = 8,611	227,784
Punjab									
Makarwal	2.8 = 6.0	31.5 = 48.1	34.9 = 44.9	6.4 = 30.8	2.8 = 6.3	SubA to hvAb	10,688 = 14,029	5,938 = 7,794	47,928
Salt Range	3.2 = 10.8	21.5 = 38.8	25.7 = 44.8	12.3 = 44.2	2.6 = 10.7	SubC to hvAb	9,471 = 15,801	5,262 = 8,778	221,964
NWFP									
Hangu/Orakzai	0.2 = 2.5	16.2 = 33.4	21.8 = 49.8	5.3 = 43.3	1.5 = 9.5	SubA to hvAb	10,500 = 14,149	5,833 = 7,861	77,000
Cherat/Gulla Khel	0.1 = 7.1	14.0 = 31.2	37.0 = 76.9	6.1 = 39.0	1.1 = 3.5	SubC to hvAb	9,388 = 14,171	5,216 = 7,873	36,006
Azad Kashmir									
Kotli	0.2 = 6.0	5.1 = 32.0	26.3 = 69.5	3.3 = 50.0	0.3 = 4.8	LigA to hvCB	7,336 = 12,338	4,076 = 6,854	

hvAB = high volatile A bituminous coal
hvBb = high volatile B bituminous coal
hvCv = high volatile C bituminous coal
ASTM = American Society for Testing and Materials
To convert Btu to Kcal/Kg multiply by 0.556.
To convert Kcal/Kg to Btu/lb multiply by 1.798

Source: Geological Survey of Pakistan (June 30, 2011), Badin*: Sindh Coal & Energy Department, GoS 2010.
Note: Table in cited from JICA (2013).

Table 3

Thar Coal Comparison with Other Mines

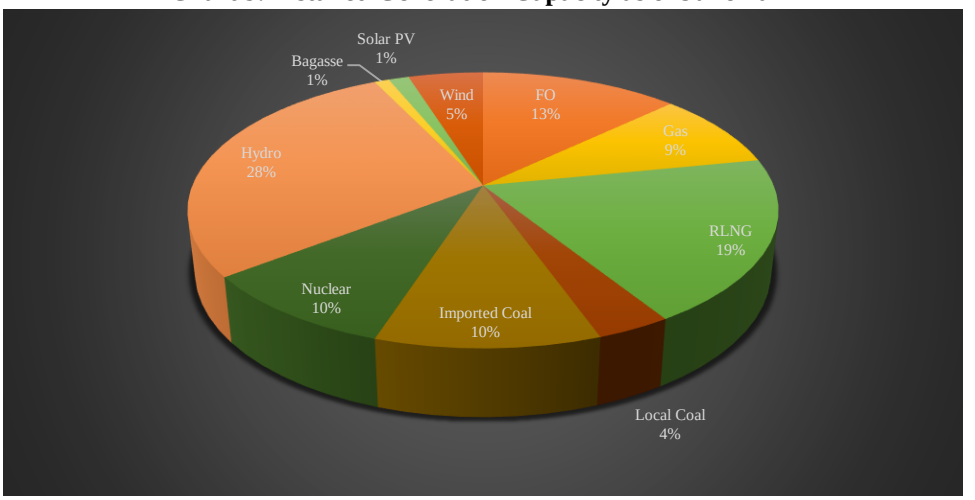
	Heating Value (Net) (Kcal/ kg) Higher is better	Sulfur (%) Lower is better	Ash Lower is better	Moisture Lower is better	Stripping Ratio (m^3/t) Lower is better
Thar Block II	2770	1.07	7.8	47.46	6.12
Gujarat, India	2600 - 3000	3.4 - 5.9	9 – 12	38.40	9 – 14
Hambach, Germany	1911- 2747	0.2 – 0.4	2 – 5	48.52	6.3
Maritza East – Bulgaria	1550	4.5	19-35	54	1.7

Source: PPIB.

COAL-BASED POWER GENERATION IN PAKISTAN

In the electricity fuel mix of Pakistan in FY2021, coal share (both local and imported) was 18%. Much lower than many developed and developing countries (Chart 3). This share was reduced to 14% in FY 2022 (Chart 9). Because of the global coal price surge and shortage of foreign reserves, companies could not import coal.

Chart 9. Installed Generation Capacity as of June 2022



Source: IGCEP 2023-31.

Pakistan is seeking to expand the share of domestic coal in the electricity fuel mix. The objective is to save foreign exchange on import-base electricity generation, which stands at about 30% as of June 30, 2022. The government has developed policies and frameworks to enhance the local share. The share of local coal in the fuel mix for FY2024 is projected to be over 16%.[9] Unfortunately, due to the long-term agreements with commissioned and committed energy projects, the share of imported coal and RLNG would remain at 7% and 12% by FY2031 (Chart 10). It is challenging to convince power projects already commissioned on imported coal to switch to local coal.[10]

[9] NEPRA Tariff Determination for FY2024.

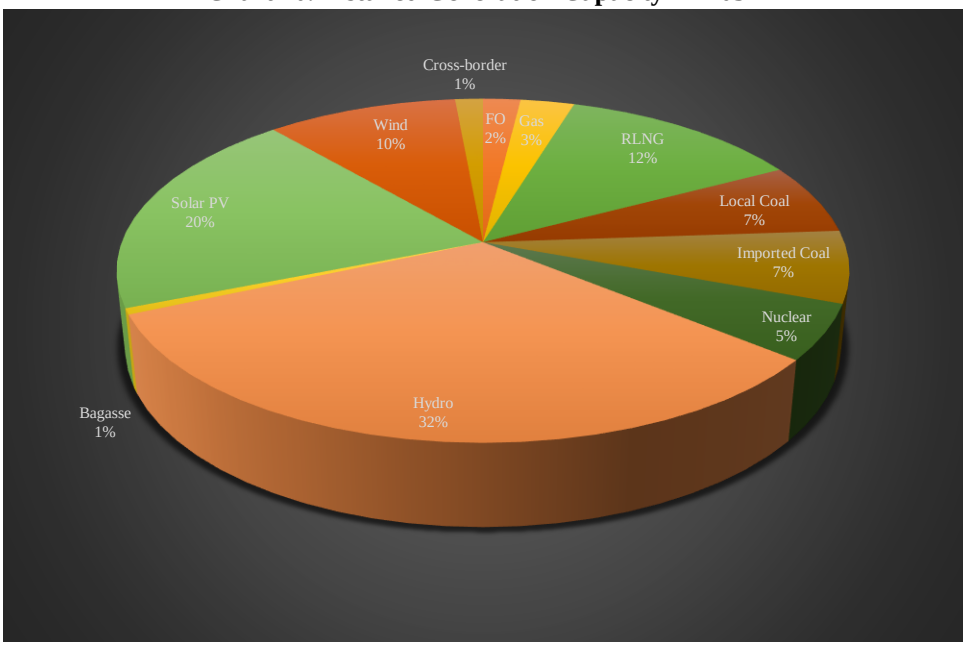
[10] The Government of Pakistan (GOP) had finalized a plan to shift CHIC Pak Power Company (Pvt.) in Gwadar from imported coal to Thar coal, but the Chinese government has refused this plan. During the PM's visit

Under the Power Generation Policy 2015, preference was given to RLNG and coal and not to reducing reliance on imported fuels. As a result, the new projects under this policy are becoming increasingly dependent on imported fuels. Utilizing local resources has always been a priority in our planning strategies. Regrettably, we have not seen the desired level of effective implementation.

As of June 30, 2022, the installed capacity based on imported coal was 4620MW, higher than the capacity based on domestic coal (3600MW). Domestic coal-based power generation capacity has been delayed for more than three decades due to a lack of infrastructure, insufficient financing, and the absence of modern coal mining technical expertise (cited from Sheikh, 2022).

Thar coal reserves were discovered in 1992 by the Geological Survey of Pakistan. Nevertheless, this cheap potential was not realized given our lack of long-term vision and planning capacity for two decades. The focus remained on imported fuels. The environment was not the reason for not realizing this vast potential, but financing the mega project was. It was in 2012 when Sindh Engro Coal Mining Company (SECMC) launched coal mining as a joint venture between the Government of Sindh and Engro[11].

Chart 10. Installed Generation Capacity FY2031



Source: IGCEP 2023-31.

to China, he was required to modify the plan; the Chinese Foreign Ministry has sought written confirmation from the GOP (Ghumman, 2023).

[11] Investing in coal-based projects in Pakistan was challenging as no Western bank was willing to finance the USD3 billion mega project. The Government of Sindh (GOS) recognized that developing Thar coal required a partnership between the Public and Private sectors and launched an International Competitive Bidding process for Thar Block II in 2008 to address this. As a result, a joint venture was formed between GOS and Engro, which led to the creation of SECMC in 2009. However, the joint venture came at the cost of a Sovereign Guarantee worth USD 700 Million (issued in 2012), which made the Thar coal project possible but also became a source of dollar capacity payment burden (details at https://www.brecorder.com/news/4392709).

Under the 2015 generation policy, several coal-fired power plants entered the system. Though high returns on equity were offered to locally sourced power plants (Table 4), low global coal prices at that time and slow progress in Thar mining failed to attract much investment in plants using Thar coal. High moisture content in the local coal was regarded as not suitable for the technology to be used. Plus, given the great distance of the coal reserves from load centers, the government also promoted importing coal. At that time, policymakers assumed coal-based generation was the best option to scale up power generation in the country (Bhandary & Gallagher, 2022).

Despite the importance of the power plant's proximity to the mine, it was not given much consideration in Pakistan. Instead, the preference was given to imported coal without realizing it would increase the burden on foreign exchange reserves.

The unit cost of imported coal-fired power plants is much higher than local coal-fired power plants (Table 4). Coal for power generation is mainly imported from South Africa and Indonesia. Coal prices have inflated tremendously. The global coal price index reached 483.84 index points in October 2022[12]. It was 119.18 index points in January 2020. Although figures decreased compared to the previous month, net coal prices have significantly increased over the past two years. For instance, the South African coal export price increased from US$ 90.63 per metric ton in December 2020 to US$ 332.84 per ton in August 2022 (Chart 11). Consequently, the per unit cost of electricity generated from imported coal increased from Rs. 10.17/kWh to Rs. 29.12/kWh last year. As a result, these plants became lower on the Economic Merit Order (EMO), putting pressure on the capacity payment part of the tariff. In comparison, the per unit cost of electricity generated from Thar Coal during FY 2022 was around Rs. 7 / kWh to Rs. 9/kWh (NEPRA, 2022).

Table 4

Coal-based Installed Capacity as of June 30, 2022

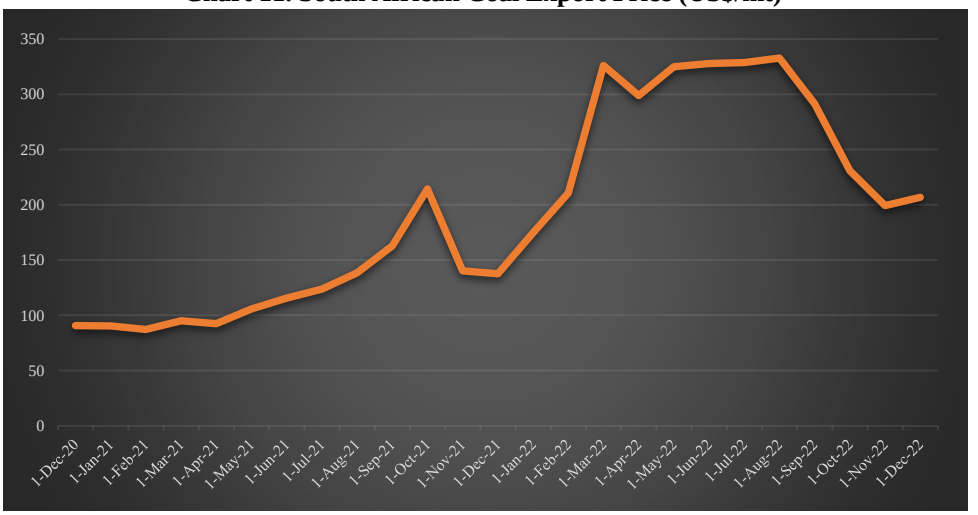
Plants_ Commissioned	Coal Type	Capacity MW	RoE %	Fixed O&M $/KW/Year	Variable O&M $/MWh	Fuel Cost $/GJ	Heat Rate GJ/MWh	Unit Cost $/MWh	Unit Cost Rs/KWh
Lucky*	Imported	660	27.2	25.39	2.94	0.95	9.23	11.71	2.08
Engro Thar	Local	660	30.65	338.96	6.21	1.47	9.66	20.37	3.62
Port Qasim	Imported	1320	27.2	28.07	1.24	14.15	9.01	128.71	22.90
Sahiwal	Imported	1320	27.2	24.87	1.22	17.50	8.51	150.09	26.71
China HUBCO	Imported	1320	27.2	26.64	3.02	17.39	8.95	158.73	28.25
Plants_ Committed	Coal Type	Capacity MW		Fixed O&M $/KW/Year	Variable O&M $/MWh	Fuel Cost $/GJ	Heat Rate GJ/MWh	Unit Cost $/MWh	Unit Cost Rs/KWh
Thar I	Local	1320	34.49	97.21	6.20	1.47	9.23	19.72	3.51
Thal Nova	Local	330	30.65	98.97	6.20	1.47	9.73	20.45	3.64
Thar Tel	Local	330	30.65	98.97	6.20	1.47	9.73	20.45	3.64
Gwadar	Imported	300	17	33.77	1.15	2.80	9.66	28.21	5.02
Jamshoro Coal U1	Imported	660	–	5.06	2.85	6.17	8.71	56.59	10.07

Source: IGCEP 2022-31 and NEPRA.

* Lucky Electric Power's 660MW is ultra-supercritical coal-fired plant started commercial operations on 21 March 2022. It is designed to burn a wide range of coal from diverse sources, including domestic coal.

[12] *Source:* www.tradingeconomics.com

Chart 11. South African Coal Export Price (US$/mt)



Source: https://ycharts.com/indicators/south_african_coal_export_price#:~:text=Basic%20Info,50.50%25%20from%20one%20year%20ago.

Pakistan is still in the initial stages of developing Thar coal resources. The costs will be reduced even more with expansion and reaching the optimum level. As Rizvi (2021) mentioned, coal mining, like other mineral resources, is a 'game of economies of scale' globally.

Compared to other fuels, coal-based generation costs in Pakistan remained low compared to RLNG and RFO (Chart 12) because of cheap domestic coal share. Coal-fired electricity tariff is lower than other fuels even though the upfront tariff determined by NEPRA was more than the average tariff levied in most South Asian Countries at that time (Abbasi, 2014). If the upfront tariff had been determined per the international rates, coal-based generation costs would have been lower.

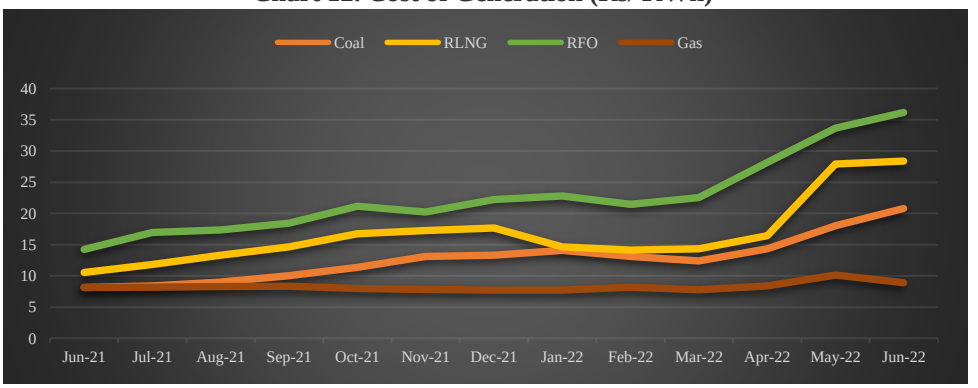
Natural gas-based cost of generation is the lowest among fossil fuels. Nevertheless, its resources are depleting rapidly. Therefore, it is not dependable. Increasing the share of Thar coal via replacing/ substituting it with a portion or all of the imported coal can reduce the average cost of electricity generation and save foreign exchange reserves.

Despite being the cheapest, renewables in Pakistan cannot be adopted on a large scale. Pakistan is not ready yet. First, for solar PV, Pakistan heavily relies on imports from China for its equipment, and its domestic industry has yet to develop. Secondly, other costs, e.g., seasonality and lack of storage and transmission infrastructure, have made this a relatively expensive choice for Pakistan[13].

Local coal is Pakistan's reliable and inexpensive fossil fuel option for sustaining energy supply, especially given the country's growing population, increasing energy demand, and volatile global oil and LNG prices; *however, up to a specific acceptable limit* (Cheema et al., 2022).

[13] In FY2021, a verified amount of Rs. 3.94 billion was payable to the Wind Power Plants because of Non-Project Missed Volume (NPMV). The intermittent nature power plants (wind) enjoy the priority dispatch condition. Non-evacuation of available power due to transmission constraints from these plants makes them eligible for this payment.

Chart 12. Cost of Generation (Rs/ KWh)



Source: NEPRA State of Industry Reports (2021 & 2022).

BLENDING IMPORTED COAL WITH LOCAL COAL

Due to the rise in imported coal prices, the power plants have been exploring alternate cheaper coal sources on the advice of the GOP. Imports from Afghanistan are allowed provided its MMBTU price is lower than the international coal prices, and payments are permitted in Pakistan Rupees. As stated in the NEPRA State of Industry Report (2022), the existing capacity of Afghanistan coal is insufficient, and there is no published price index for Afghanistan coal, which is liquid, transparent, and reflective of the market. Therefore, the best would be to convert the existing capacity of imported coal power plants under long-term agreements of 30 years to Thar coal.

In Pakistan's coal power plants (Table 4), the Pulverized Coal Combustion (PCC) [14] System is used: subcritical (SUBC) and supercritical (SC) types. The SC boiler is used in the Sahiwal, Port Qasim, and China HUBCO power plants. According to the third modification in its license, Lucky Power Plant has upgraded its technology to ultra-supercritical (USC). These plants are designed to burn different coal types. The SUBC boilers are used in the remaining power plants. The Gwadar power plant has yet to start its operations. However, under the pressure of the Chinese government, the government is forced to allow imported coal. All other SUBC plants under operation in the country are using Thar coal.

Since the 3960 MW installed capacity is based on imported coal, a certain percentage of the blend can reduce the import burden significantly. Literature suggests that it is possible to replace a certain percentage of bituminous coal (imported in the case of Pakistan) with lignite coal (Thar coal) without any plant modification.

Box 1. Appropriate Blending Ratio

SC coal-fired power plants are designed to burn 100% sub-bituminous coal with vertical and roller-type pulverizers. Based on global experiences in boilers firing sub-bituminous coals, a moisture content of 30% is the maximum limit for such boilers to avoid any damage to the boiler.
In SC plants in Pakistan, Thar coal can be mixed up to 20%. Mixing 20% Thar coal and 80% sub-bituminous coal in weight, the moisture content of uniformly mixed coals is calculated as follows:
Moisture in normal design basis: (22.4 x 80+ 47.6 x 20)/100= 27.44%
Taking account of a deviation of 10% on moisture contents, 20% would be an upper limit for the mixing lignite produced in Thar with the imported sub-bituminous.

Source: (JICA, 2016).

[14] PCC power technology with a stable operation record was developed long ago.

By replacing 20% of the imported coal used (Box 1) in power plants, Pakistan can save over US$ 147 million of the amount used for coal imports in 2021 (i.e., US$ 1466.4 million).

It is enormous, given the pressures on our foreign reserves. Jamshoro Coal Power Plant is planning to employ SC new boiler(s) to use imported sub-bituminous coal blended with local coal in a ratio of 80:20 as its fuel (ADB, 2022).

Coal blending is practiced worldwide to avoid disruption due to transportation problems or fuel costs. Globally, coal of various types is blended at different points, including the mine, preparation plant, trans-shipment point, plant site, or even at the boiler[15]. The method selected depends upon the site conditions, the level of blending required, the quantity to be stored and mixed, the accuracy required, and the end use of the blended coal. Large power plants treating coal in bulk prefer a mechanized stacking method (Sloss, 2014).

In PCC plants, the sub-bituminous (imported) coal is pulverized to a powder form, which is later fired from sideways. It does not require pre-drying as the coal used (sub-bituminous) is usually dry. With technology, it is possible to pulverize lignite coal. Thar coal's pre-drying process can be done through solar energy; Thar has plenty of sunshine. It can be dried at both mines and power plants. Exhaust steam is generally used in a reverse cycle for extra drying. This has already been done in Germany. Lucky Power reportedly uses almost the same approach in burning imported lignite and eventually plans to use local lignite (Ali, 2022).

COAL AND ENVIRONMENT

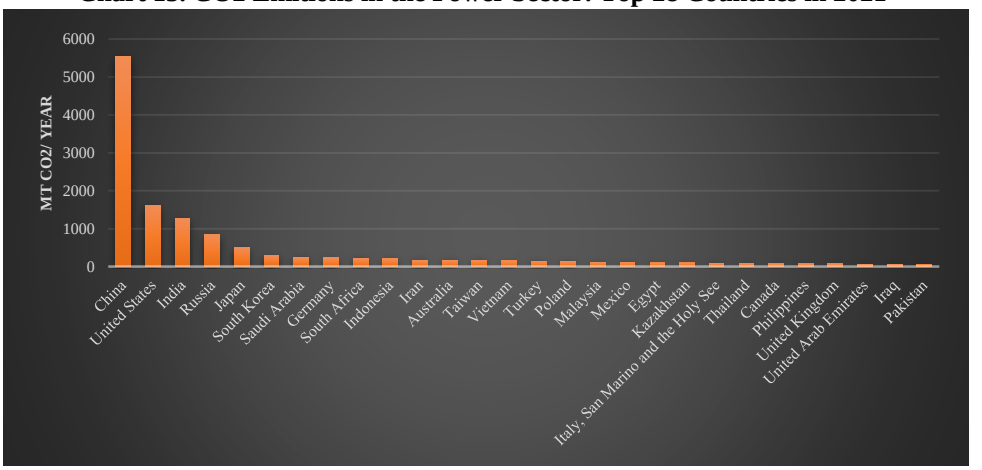
Despite being the cheapest fossil fuel, coal is the most environmentally detrimental energy source and is considered a significant contributor to climate change. The Paris Agreement calls for eliminating coal use in the power sector by 2050 (Sheikh, 2022). Nevertheless, its use is increasing globally.

Pakistan's power sector contribution to global power sector emissions is hardly 0.4% compared to over 38% by China, 11% by the US, 9% by India, and 6% by Russia in 2021. Still, as per the Global Climate Index 2021, Pakistan is the 8th most vulnerable country to climate change. *The technology used in coal-fired power plants is vital from an environmental perspective.*

Subcritical power plants (SUBC) achieve thermal efficiency in the range between 34% and 40% (based on coal heating value), with a global average efficiency of around 36%, whereas supercritical power plants (SC) reach efficiencies between 42% and 45%. Ultra-supercritical power plants (USC) employ advanced metal alloys to withstand extreme steam conditions and achieve even higher efficiencies. This is due to the elevated steam conditions: superheat and reheat steam temperatures of 600/620°C and steam pressures of up to 275 bar. Advanced ultra-supercritical power plants (A-USC) are expected to enter operation in the next decade, which will approach 50% net electricity generation efficiency with advanced metal alloys capable of withstanding steam temperatures and pressures over 700°C and 350 bar (Tramošljika et al., 2021).

[15] https://www.powermag.com/types-of-coal-and-fuel-blending-tips-for-coal-power-plants/

Chart 13. CO2 Emitions in the Power Sector: Top 28 Countries in 2021



Source: https://edgar.jrc.ec.europa.eu/report_2022

In Pakistan, SC boilers are used in more than half of coal-fired capacity (4680 MW: commissioned and committed), with a minimum net thermal efficiency of 39% and a maximum of 40.5%[16]. SUBC boilers are used in the remaining power plants of Engro, Thar I, Thal Nova, Thar Tel and Gwadar with a minimum net thermal efficiency of 37% and a maximum of 38.5% (as per the license issued by NEPRA).

SUBCs are less efficient, and countries are dumping these to reduce carbon footprints. Several countries across the world have moved towards USC (Box 2). Besides granting high upfront tariffs on coal-fired power plants, NEPRA failed to regulate heat rate, measuring the efficiency of power plants to convert a fuel (coal) into heat and electricity (Abbasi, 2014).

Higher efficiency translates into less coal consumption to generate a single unit of electricity while reducing CO2 emissions, mercury, and local air pollutants, releasing less local air pollutants, and leaving a smaller environmental footprint. Above all, it means lower consumer tariffs (Abbasi, 2014). Additionally, SC and USC require less water to generate electricity (per MW) than non-SC power stations (Alkon et al., 2019; Abbasi, 2014). However, generation capacity is the most crucial driver of cooling water demand magnitude.

Under efficiency-linked improvements in coal-power technology, SC and USC coal power generation technologies operate at higher temperatures and pressures than conventional (SUBC) pulverized coal combustion (PCC) plants, achieving high efficiencies. SC technology is considered clean coal technology as CO2 emissions are less than for older plants. Therefore, the environmental impact of such technologies would be less.[17]

Replacing an old SUBC power plant with SC parallels a 10% efficiency gain and a CO2 emission reduction of more than 20%. For example, a conventional SUBC generates

[16] Although the technology used in the Lucky power plant is now USC, the reported efficiency is 39%.

[17] A 1% gain in efficiency for a typical 700MW plant reduces 30-year lifetime emissions by 2,000t NOx, 2,000t SO_2, 500t particulates and 2.5 million tons of CO_2 (https://www.power-technology.com/projects/yuhuancoal/)

electricity at 36% thermal efficiency with around 1000 kgCO2/MWh emissions. In comparison, a USC unit with 46% thermal efficiency generates 28% (0.46/0.36 = 1.28) more electricity per unit of fuel heat input with emissions of 781 kgCO2/MWh (1000/1.28 = 781), about 22% reduction. USC plants could achieve up to 700 kg/MWh with post-combustion carbon capture (Tramošljika et al., 2021).

Box 2. Technology Modernization for Efficiency_ Global Practices

- In Japan and Korea, supercritical technology was adopted before 2000. These countries now have high-performance coal plants with average efficiencies above 40%. These countries have now adopted USC technology. Yokosuka (Japan) is one of the 22 new coal-fired power plants planned to be built in Japan by 2025, equipped with two USC coal-fired units of 650MW capacity each.
- Germany's RWE power, a lignite-fired power plant, uses USC technology with an efficiency of 43.2%. A record-high net efficiency of 47.5% was achieved by the RDK Block 8 USC unit in Germany.
- NTPC, India's leading power generator, has commissioned the country's first USC unit having a capacity of 660 MW at Khargone in Madhya Pradesh, with operational efficiency of 41.5%, 3.3% higher than the conventional SC ones. The high efficiency will result in less coal consumption for generating the same amount of electricity vis-à-vis SC plants and will reduce 3.3 % CO2 emissions.
- Bangladesh commissioned a 1,320 MW USC coal-fired power plant in a joint venture with China in 2022.
- China's share of SC and USC is increasing rapidly. For instance, China's Huaneng Yuhuan power plant (recently commissioned) is equipped with four USC coal-fired power generating units of 1,000MW capacity each. New units also incorporate high-efficiency dust removal and desulphurization.

Sources: (Tramošljika et al., 2021), IEA (2012), and
https://www.nsenergybusiness.com/projects/yokosuka-coal-fired-power-plant/
https://www.rwe.com/en/the-group/countries-and-locations/neurath-power-plant/#:~:text=Most%20modern%20power%20plant%20of%20its%20type&text=Like%20the%20BoA%20unit%20K,to%20cleaning%20the%20flue%20gas.
https://www.ntpc.co.in/en/media/press-releases/details/ntpc-commissions-india%E2%80%99s-first-ultra-super-critical-plant-0
https://www.aa.com.tr/en/asia-pacific/bangladesh-launches-its-largest-thermal-power-plant/2541508
https://www.power-technology.com/projects/yuhuancoal/

Indeed, the environment is of concern for Pakistan, as it is already among the world's most vulnerable countries. The only thing that needs to be done is to focus on the most efficient technologies. In Pakistan, it is expected that even after developing Thar coal at full scale, carbon emissions will be twenty times lower than the fast-growing and developed economies on an absolute basis and five times lower than the global average per capita basis (Rizvi, 2022). With high-efficiency and low-emission technologies, the emissions from coal-fired power generation would be reduced even more.

The technology used in coal plants is one part of the equation. Transporting Thar coal to a power plant is also significant. Although, there is no railway link with the Thar coal site. The coal plant in Sahiwal should have been avoided due to the high cost of electricity generation and the negative environmental impact caused by the 1200 km rail

journey required to transfer imported coal from the port to the plant site (Cheema et al., 2022). It has been determined that the Sahiwal coal power plant has caused damage to fertile agricultural land, contaminated canal water, and polluted the air[18]. The plant's location is significant not only in terms of cost-effectiveness but also for its environmental implications.

Box 3. Mitigating the Environmental Impact of Coal Power Plants

- Efficient technology that conserves energy and resources is crucial. When constructing a new coal-fired power plant, it is essential to prioritize high efficiency and ensure that it can be easily retrofitted for CO2 capture and storage.
- Dry handling methods for coal combustion wastes, such as fly ash, eliminate the ecological risks associated with surface impoundments, such as metal contamination of wildlife.
- Recycling of coal combustion waste for use in cement, concrete products, and construction fills.
- Reusing wastewater in coal-fired plants through recycling.
- Ensuring that ash disposal and reclamation are managed in accordance with internationally recognized standards.
- Construction of plants near coal mines to avoid transport-related environmental impact.
- Relocating nearby communities.
- To establish stronger operational and maintenance protocols and better-coordinated land use planning.

Source: Coutinho, M. and Butt, H. K. (2014).

KEY TAKEAWAYS

Pakistan faces a significant challenge with its energy imports, which strains its energy security. Tapping into the country's energy resources is essential to address this issue. However, it is also crucial to consider the environmental impact of using local coal. When deciding on the best fuel mix for generating electricity in the future, it is critical to strike a balance between energy and capacity costs while prioritizing environmental protection.

- Due to long-term agreements, immediately decommissioning the existing plants with outdated technology is impossible. Commissioned SUBC power plants or pipeline technology must be upgraded or retrofitted to more efficient USC.

Additionally,

- A 20% blending of Thar coal in commissioned SC plants can be done to save foreign exchange reserves.
- Future commissioning of the power plants based on Thar Coal must not ignore power plant technology, its efficiency, and its location. *All new power plants must be USC or even A-USC with higher efficiency to reduce future carbon and other pollutant emissions.*

[18] https://dailytimes.com.pk/300805/environmental-impact-of-the-sahiwal-coal-power-plant/

- It is crucial to adhere to all environmental safety protocols when operating a power plant that runs on coal.

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Situation of Brain Drain in Pakistan, with a Focus on the Healthcare Sector

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In this brief, we draw attention to Pakistan with the purpose of diversifying research on brain drain of individuals who migrate from the country primarily in search of a better quality of life and institutions, particularly focusing on the healthcare sector. Brain drain in Pakistan has become a perpetually rising phenomenon with more and more highly skilled workers leaving the country, yet there is relatively less research on this group. Pakistan offers a unique insight into migration of skilled workers from developing states due to the recent economic turmoil, as well as the consequent effects on the country, the repercussions for those who remain behind, and policy instruments used to maximise benefits for all stakeholders. Brain drain in the country has led to a shortage of highly qualified medical professionals, and poor returns on investment by the government.

Keywords: Brain drain, Migration, Healthcare Sector, Pakistan, Developing Country

INTRODUCTION

In discussions about the flow of human capital, there is a common belief that developing countries are increasingly becoming a source of talented individuals who eventually end up in developed countries due to a lack of adequate institutions or environments in their home countries to support them. International migration benefits immigrants by allowing them to achieve a higher income and better quality of life.

While origin countries experience an influx of remittances, increased trade and technological transfers, they also incur losses in human capital and subsequent brain drain. Despite increasing trends in brain drain, most studies on migrants' demographics and sociology tend to neglect it.

In this brief, we draw attention to Pakistan as a significant region to add to research and theory on studies of migration patterns in developing countries. Pakistan, we argue, exemplifies the global trend of brain drain as approximately 832,339 Pakistanis went abroad for employment in 2022, which is the highest number since 2016 and the third-highest ever recorded according to the Bureau of Emigration and Overseas Employment (BEOE). Additionally, official records indicate that among those who traveled overseas in 2022, over 92,000 were graduates and more than 350,000 were trained workers and labourers (BEOE, 2022). Therefore, Pakistan -a low income country- presents a distinctive prospect to analyse a rapidly growing and diverse brain drain

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phenomenon as it offers important insights for migration scholars in comprehending the various factors associated with high-skilled worker migration, its effects on the country, the repercussions for those who remain behind, and policy instruments used to maximise benefits for all stakeholders.

BRAIN DRAIN TRENDS

Pakistan is listed as the second largest country in South Asia with high emigration rates. Pakistanis living abroad primarily reside in the Middle East, Europe, and the United States, with smaller populations in other regions world- wide (World Population Review, 2023). There is a widespread consensus that emigration of highly skilled workers may worsen the economic situation for Pakistan. A large number in the form of health professionals and engineers migrate to countries that offer higher incomes, a better standard of living and increased political stability (Kousar et al., 2020). Nearly 8771567 skilled and educated workers have migrated globally from 1971-2015 (Afridi et al., 2020) Amongst these emigrants, most migrated to Gulf countries, especially Saudi Arabia (736,000 in 2022) and the United Arab Emirates (UAE), while around 40,000 individuals migrated to Europe (particularly Romania) as well as other Asian countries (BEOE, 2023). In recent years, there has been a significant increase in the number of Pakistani emigrants choosing to go to China, primarily due to China's allocation of over 20,000 scholarships to Pakistani students (Hippler and Ahmed, 2022). In Thailand, Pakistani emigrants are primarily involved in business activities. Female migrants from Pakistan exist in lower numbers (Shah et al., 2020). This can be attributed to the fact that large number of migrants are occupied in less-skilled jobs (which exclude women) such as construction.

Since 1947, and particularly after the year 1971, Pakistan has seen a worrisome trend of professionals leaving the country, including highly-skilled engineers, doctors, computer programmers, teachers and accountants (Doghri, et al. 2006). High skilled workers may face an easier migration process due to a possession of greater resources to relocate along with more favourable conditions in host countries. Figure 1 below shows the occupational group-wise emigration.

Fig. 1. Number of Universities in Pakistan (by Year)

Sources: Authors, using data from Pakistan's BEOE (2023).

Common drivers of brain drain in Pakistan are long term governance issues, quality of living, financial instability and worsening infrastructure (Kousar et al., 2020). Further, insecurity and the dwindling law and order conditions in the country encourage individuals to move overseas for a more stable life (Afzal et al., 2012). Clemens et al., (2019) while looking at the wage gap amongst immigrants in the host country and natives in the home country found a significant monetary gain as a result of migration. Thus migrant mobility with the intention of moving up the economic ladder is increasing as this income inequality between countries persists.

Due to the recent economic turmoil in Pakistan, a large part of the population has had little choice than to move overseas in search of economic and political stability. With a fall in foreign reserves and per capita income along with rising inflation and unemployment, the country offers little incentive for individuals to stay back. Worsening economic times has contributed largely to the recent brain as even highly skilled workers and younger citizens face bleak prospects. As per the Pakistan's National Human Development Report, around 64 percent of migrants in 2017 were below 30, whereas around 29 percent were between 15-29 (UNDP, 2018).

Since more than half of the migrants in Pakistan can be characterised as less skilled workers, a vast majority of studies on migration in Pakistan tend to focus more on them, paralleling global trends in the study of migration. Previous research investigating economic migration from Pakistan mainly examines the impact of the incoming remittances and policies regarding them (Najimdeen et al., 2014). The handful of studies explicitly examining brain drain in Pakistan use only time-series data (Ali et al., 2015) , and tend to focus on certain sectors only. For instance, it remains unclear whether brain drain is conducive to the country in the long run, what determines whether migrants stay and return or the link between recent economic downturns and consequent brain drain in the country. Furthermore, the policy framework in Pakistan related to migration is somewhat weak, mainly due to a lack of reliable data on migration from Pakistan (Hippler and Ahmed, 2022). Individuals registered with the BEOE are recognised as emigrants, whereas those who do not register remain untracked (Zeeshan and Sultana, 2020).

THE HEALTHCARE SECTOR

The healthcare sector is no exception to the worsening and ever-rising global phenomenon of brain drain. The rising demand for healthcare workers in more developed countries is driven by demographic shifts, such as the aging of the baby-boomer generation (Dodani and LaPorte, 2005). According to the BEOE (2023), around 1000-1500 doctors emigrate from the country annually. A survey conducted by Gallup-Pakistan found that over two-thirds of Pakistan's population including doctors, expressed a desire to seek opportunities overseas and that over half of these individuals had no intention of returning (Gallup Survey, 2011). The negative consequences of this brain drain include a severe shortage of skilled professionals in the public service, resulting in poor healthcare outcomes for the nation and hindered progress.

Talati and Pappas (2006) predicted a shortage of doctors in Pakistan ranging from 58,000- 451,000 in 2020. Where- as a survey of 366 immigrants in Ireland found that the highest number of migrant doctors belonged to Pakistan, where most did not want to

return (Brugha et al., 2016). Similarly, there exists a shortage of nurses in Pakistan due to low production rates, and those who do qualify often leave the country to seek employment opportunities abroad. Nurse educators are drawn to developed countries due to the higher salaries, which results in a shortage of qualified nursing faculty in Pakistan (Asghar et al., 2020).

CAUSES OF BRAIN DRAIN

In Pakistan, large numbers of Bachelors of Medicine and Bachelors of Surgery students graduate annually from various medical colleges and universities, however 50-60 percent of these graduates migrate in search of better professional careers overseas. Most graduates in Pakistan complain of inadequate salaries despite high accountability and long hours at work (Nadir et al., 2023). This, combined with an absence of compensation for overtime duties encourages a large part of the doctor community to shift overseas. Similarly, the lack of merit in a system which is heavily influenced by politics creates insecurity amongst workers (Tahir et al., 2011). Finally, it can be argued that the primary reason for the emigration of doctors from the country is the current inadequate infrastructure of the health sector. The lack of poor career progression and growth opportunities for young doctors in Pakistan, including limited specialisation options and complicated procedures for obtaining paid or unpaid study leave, has resulted in a shortage of skilled medical professionals in the country. Thus, inefficient government policies along with political and social conflicts are major contributors to the exodus of doctors from Pakistan. Askari (2008) discussed how migration of skilled workers exacerbates the issues of an already weak and struggling health sector in developing countries like Pakistan. In contrast, workers migrating to developed countries have access to stable working environments, higher salaries, opportunities for continued education, better housing, and the ability to send remittances back to their home country.

Medical professionals and doctors require rigorous training, with doctors often having to work more than 80 hours per week which becomes tedious if not matched with respect, salary, and recognition. Female doctors in particular may be motivated to establish their careers abroad due to push factors such as workplace harassment, political conflicts, and inadequate salaries, as well as pull factors such as improved training and higher salaries (Talati and Pappas, 2006). Most skilled professionals express that they face a lack of sufficient opportunities to sustain themselves within the country due to an unstable labour market as well as migration prompted by issues like temporary displacements and climate change (Salik et al., 2017)

Furthermore, post COVID-19, travel restrictions have eased and the demand for human resources around the world has risen. Thus, a significant number of Pakistani emigrants were motivated to either return to the destinations from where they had come to Pakistan during COVID-19 restrictions or to seek new employment opportunities elsewhere.

CONSEQUENCES OF BRAIN DRAIN

The impact of brain drain may be particularly significant in terms of the country's development, as the demand for highly qualified professionals may end up far exceeding the available supply.

Thus, developed countries harvest the effort due for the country which invests into highly skilled workers. While origin countries lose precious human capital, they also end up wasting the funds invested into the formation of the capital. Brain drain lowers skilled human capital in the origin country, ultimately leading to a decrease in productivity (IMF, 2016). Further, a fall in labour supply may result in an increase in wages, thereby lowering economic growth. Moreover, brain drain may have significant long term implications for the institutional quality in home countries. Lastly, rapid emigration of labour force may result in a demographic transition in the working age population. Due to emigration of younger population, there is a shift of working age population to older ones (IMF, 2016).

Stilwell et al. (2004) examined the negative outcomes associated with doctor migration and concluded that the exodus of doctors is a major contributing factor to the inadequate healthcare services and insufficient coverage of certain diseases in origin countries. With the emigration of skilled medical professionals and doctors out of the country, there begins a dearth of capable individuals to implement and carry out medical services properly in rural and urban areas alike.

Brain drain may create a 'migration current', which may be ultimately filled with semi-skilled 'dispensers, physicians using traditional remedies (hakims) and spiritual healers'. Therefore, the primary consequences of brain drain on Pakistan's health sector are inadequate patient care and a fall in quality of medical services (Nadir et al., 2023).

Emigration may also provide benefits or 'brain gain' as argued by researchers to some extent. Due to large scale emigration, origin countries including Pakistan experience a reduction in workforce which in the short term potentially addresses unemployment in the country and improves the availability of jobs (Grogger and Hanson 2011). Moreover, investment activity by immigrants develop capital markets driving funding into the country (Burchardi et al., 2019). In terms of support in education, innovation and research, emigrants who are physicians can play a huge role in improving the underdeveloped healthcare systems in the country. Around 10-15 percent of physician migrants return to Pakistan. Further, remittances contribute to a large part of the gross domestic product (GDP) in many countries. The World Bank estimates officially recorded remittances at $29.87 billion in 2022 in Pakistan (World Bank Open Data, 2023). Remittances provides households in the lower income bracket some economic freedom, especially in instances of sudden shocks and allow consumption smoothing as recipients gain access to credit and are free to save for shocks (Mohapatra et al., 2009). In the past, remittances have significantly worked at bringing down poverty levels in the home country along with improving educational outcomes (Binci and Giannelli, 2018).

POLICIES FOR POSSIBILITIES OF REVERSAL OF BRAIN DRAIN

University enrollments and higher income have a positive influence on reversing brain drain, so it would be beneficial for authorities to establish job banks to assist fresh university graduates in finding better job opportunities across the country. However, as trivial increases in wages in the healthcare sector are not expected to have a substantial impact on brain drain reversal due to the large and ever-rising wage gap between origin and destination countries, it is necessary to examine the social, political, and economic

factors contributing to the brain drain and create a secure environment. Lowering standards cannot be an option, on the other hand, local conditions should be evaluated and improved. Policy makers should prioritise making productive investment opportunities more attractive for immigrants so countries experience positive returns so as to channel resources away from less productive investments such as real estate.

Similarly, citizens should also show responsibility in terms of reducing the consequences posed by brain drain by contributing their experience to origin countries with no significant costs with the help of technological advancements like telemedicine.

China converted Taiwan's brain drain into brain gain by offering good education and research opportunities to entice and retain talent in the country. By participating in the Human Genome Project, China became the only developing country to lead in scientific research (Cyranoski, 2001). By implementing specific educational programs, developing countries can create strong networks of skilled and experienced expatriates and ultimately redirect brain drain.

Finally, improvement of work standards for women in their respective professions, particularly in the healthcare sector can go a long way, including flexible hours, safe transportation, and day-care facilities, along with family-friendly policies in place. Policy makers should also focus on increasing the migration pie for female migrants by providing training in skills that are in high demand in host countries such as nursing (Shah et al., 2020).

CONCLUSION

The issue of highly skilled professionals leaving developing countries is a challenging problem that poses a significant dilemma for the global community. However, brain drain in Pakistan, particularly in the healthcare sector, should be looked at closely since Pakistan has lost a significant portion of its trained workforce in proportion to its needs. Although remittances can aid in development, it is crucial to acknowledge that countries require skilled individuals to drive innovation and establish strong institutions, which are the foundation of sustainable development. Highly skilled and talented workers in Pakistan opt for migration due to factors including a lack of opportunities, weak institutions and limited research facilities. Further, a lack of a merit system, a productive working environment and lower salaries have led to emigration of medical professionals and doctors out of the country. This phenomenon of brain drain has had significant and far-reaching effects on society, including a shortage of highly qualified medical professionals, a decrease in concern for the public good, and poor returns of investment by the government into the youth of the country.

Therefore, developing country governments like in Pakistan should focus on policies for ensuring availability of job opportunities, provide appropriate research facilities and ensure secure working environments and merit systems to limit brain drain out of the country. Conclusively, it is important to note that the development and successful implementation of policies relating to migration in Pakistan face significant challenges due to a lack of a significant database containing international migration statistics. Hence, for successful policy implementation maintaining such a database is crucial amongst other factors.

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Situation of Brain Drain in Pakistan, with a Focus on the Healthcare Sector

SAMEEN ZAFAR

In this brief, we draw attention to Pakistan with the purpose of diversifying research on brain drain of individuals who migrate from the country primarily in search of a better quality of life and institutions, particularly focusing on the healthcare sector. Brain drain in Pakistan has become a perpetually rising phenomenon with more and more highly skilled workers leaving the country, yet there is relatively less research on this group. Pakistan offers a unique insight into migration of skilled workers from developing states due to the recent economic turmoil, as well as the consequent effects on the country, the repercussions for those who remain behind, and policy instruments used to maximise benefits for all stakeholders. Brain drain in the country has led to a shortage of highly qualified medical professionals, and poor returns on investment by the government.

Keywords: Brain drain, Migration, Healthcare Sector, Pakistan, Developing Country

INTRODUCTION

In discussions about the flow of human capital, there is a common belief that developing countries are increasingly becoming a source of talented individuals who eventually end up in developed countries due to a lack of adequate institutions or environments in their home countries to support them. International migration benefits immigrants by allowing them to achieve a higher income and better quality of life.

While origin countries experience an influx of remittances, increased trade and technological transfers, they also incur losses in human capital and subsequent brain drain. Despite increasing trends in brain drain, most studies on migrants' demographics and sociology tend to neglect it.

In this brief, we draw attention to Pakistan as a significant region to add to research and theory on studies of migration patterns in developing countries. Pakistan, we argue, exemplifies the global trend of brain drain as approximately 832,339 Pakistanis went abroad for employment in 2022, which is the highest number since 2016 and the third-highest ever recorded according to the Bureau of Emigration and Overseas Employment (BEOE). Additionally, official records indicate that among those who traveled overseas in 2022, over 92,000 were graduates and more than 350,000 were trained workers and labourers (BEOE, 2022). Therefore, Pakistan -a low income country- presents a distinctive prospect to analyse a rapidly growing and diverse brain drain

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phenomenon as it offers important insights for migration scholars in comprehending the various factors associated with high-skilled worker migration, its effects on the country, the repercussions for those who remain behind, and policy instruments used to maximise benefits for all stakeholders.

BRAIN DRAIN TRENDS

Pakistan is listed as the second largest country in South Asia with high emigration rates. Pakistanis living abroad primarily reside in the Middle East, Europe, and the United States, with smaller populations in other regions world- wide (World Population Review, 2023). There is a widespread consensus that emigration of highly skilled workers may worsen the economic situation for Pakistan. A large number in the form of health professionals and engineers migrate to countries that offer higher incomes, a better standard of living and increased political stability (Kousar et al., 2020). Nearly 8771567 skilled and educated workers have migrated globally from 1971-2015 (Afridi et al., 2020) Amongst these emigrants, most migrated to Gulf countries, especially Saudi Arabia (736,000 in 2022) and the United Arab Emirates (UAE), while around 40,000 individuals migrated to Europe (particularly Romania) as well as other Asian countries (BEOE, 2023). In recent years, there has been a significant increase in the number of Pakistani emigrants choosing to go to China, primarily due to China's allocation of over 20,000 scholarships to Pakistani students (Hippler and Ahmed, 2022). In Thailand, Pakistani emigrants are primarily involved in business activities. Female migrants from Pakistan exist in lower numbers (Shah et al., 2020). This can be attributed to the fact that large number of migrants are occupied in less-skilled jobs (which exclude women) such as construction.

Since 1947, and particularly after the year 1971, Pakistan has seen a worrisome trend of professionals leaving the country, including highly-skilled engineers, doctors, computer programmers, teachers and accountants (Doghri, et al. 2006). High skilled workers may face an easier migration process due to a possession of greater resources to relocate along with more favourable conditions in host countries. Figure 1 below shows the occupational group-wise emigration.

Fig. 1. Number of Universities in Pakistan (by Year)

Sources: Authors, using data from Pakistan's BEOE (2023).

Common drivers of brain drain in Pakistan are long term governance issues, quality of living, financial instability and worsening infrastructure (Kousar et al., 2020). Further, insecurity and the dwindling law and order conditions in the country encourage individuals to move overseas for a more stable life (Afzal et al., 2012). Clemens et al., (2019) while looking at the wage gap amongst immigrants in the host country and natives in the home country found a significant monetary gain as a result of migration. Thus migrant mobility with the intention of moving up the economic ladder is increasing as this income inequality between countries persists.

Due to the recent economic turmoil in Pakistan, a large part of the population has had little choice than to move overseas in search of economic and political stability. With a fall in foreign reserves and per capita income along with rising inflation and unemployment, the country offers little incentive for individuals to stay back. Worsening economic times has contributed largely to the recent brain as even highly skilled workers and younger citizens face bleak prospects. As per the Pakistan's National Human Development Report, around 64 percent of migrants in 2017 were below 30, whereas around 29 percent were between 15-29 (UNDP, 2018).

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The healthcare sector is no exception to the worsening and ever-rising global phenomenon of brain drain. The rising demand for healthcare workers in more developed countries is driven by demographic shifts, such as the aging of the baby-boomer generation (Dodani and LaPorte, 2005). According to the BEOE (2023), around 1000-1500 doctors emigrate from the country annually. A survey conducted by Gallup-Pakistan found that over two-thirds of Pakistan's population including doctors, expressed a desire to seek opportunities overseas and that over half of these individuals had no intention of returning (Gallup Survey, 2011). The negative consequences of this brain drain include a severe shortage of skilled professionals in the public service, resulting in poor healthcare outcomes for the nation and hindered progress.

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CAUSES OF BRAIN DRAIN

In Pakistan, large numbers of Bachelors of Medicine and Bachelors of Surgery students graduate annually from various medical colleges and universities, however 50-60 percent of these graduates migrate in search of better professional careers overseas. Most graduates in Pakistan complain of inadequate salaries despite high accountability and long hours at work (Nadir et al., 2023). This, combined with an absence of compensation for overtime duties encourages a large part of the doctor community to shift overseas. Similarly, the lack of merit in a system which is heavily influenced by politics creates insecurity amongst workers (Tahir et al., 2011). Finally, it can be argued that the primary reason for the emigration of doctors from the country is the current inadequate infrastructure of the health sector. The lack of poor career progression and growth opportunities for young doctors in Pakistan, including limited specialisation options and complicated procedures for obtaining paid or unpaid study leave, has resulted in a shortage of skilled medical professionals in the country. Thus, inefficient government policies along with political and social conflicts are major contributors to the exodus of doctors from Pakistan. Askari (2008) discussed how migration of skilled workers exacerbates the issues of an already weak and struggling health sector in developing countries like Pakistan. In contrast, workers migrating to developed countries have access to stable working environments, higher salaries, opportunities for continued education, better housing, and the ability to send remittances back to their home country.

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Thus, developed countries harvest the effort due for the country which invests into highly skilled workers. While origin countries lose precious human capital, they also end up wasting the funds invested into the formation of the capital. Brain drain lowers skilled human capital in the origin country, ultimately leading to a decrease in productivity (IMF, 2016). Further, a fall in labour supply may result in an increase in wages, thereby lowering economic growth. Moreover, brain drain may have significant long term implications for the institutional quality in home countries. Lastly, rapid emigration of labour force may result in a demographic transition in the working age population. Due to emigration of younger population, there is a shift of working age population to older ones (IMF, 2016).

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CONCLUSION

The issue of highly skilled professionals leaving developing countries is a challenging problem that poses a significant dilemma for the global community. However, brain drain in Pakistan, particularly in the healthcare sector, should be looked at closely since Pakistan has lost a significant portion of its trained workforce in proportion to its needs. Although remittances can aid in development, it is crucial to acknowledge that countries require skilled individuals to drive innovation and establish strong institutions, which are the foundation of sustainable development. Highly skilled and talented workers in Pakistan opt for migration due to factors including a lack of opportunities, weak institutions and limited research facilities. Further, a lack of a merit system, a productive working environment and lower salaries have led to emigration of medical professionals and doctors out of the country. This phenomenon of brain drain has had significant and far-reaching effects on society, including a shortage of highly qualified medical professionals, a decrease in concern for the public good, and poor returns of investment by the government into the youth of the country.

Therefore, developing country governments like in Pakistan should focus on policies for ensuring availability of job opportunities, provide appropriate research facilities and ensure secure working environments and merit systems to limit brain drain out of the country. Conclusively, it is important to note that the development and successful implementation of policies relating to migration in Pakistan face significant challenges due to a lack of a significant database containing international migration statistics. Hence, for successful policy implementation maintaining such a database is crucial amongst other factors.

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Invest in Future: Prioritising Youth Family Planning

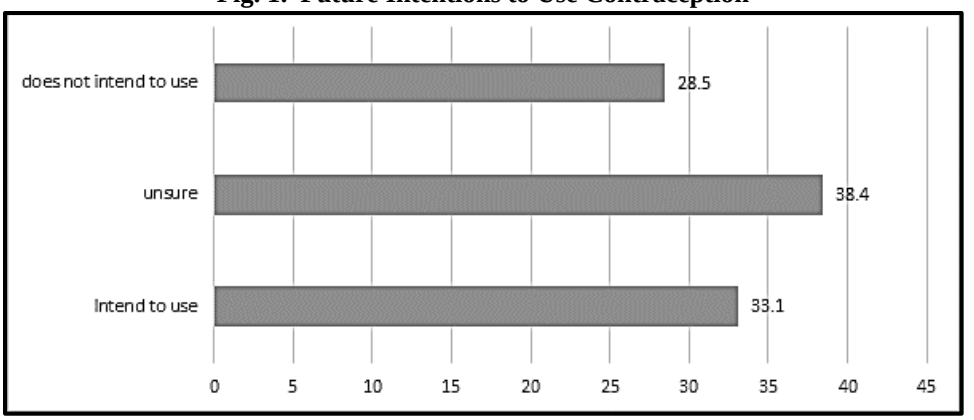
SAIMA BASHIR

Dividend of our much-touted youth bulge will remain a pipedream unless our policy makers realise the need for investing in the health, education, and general wellbeing of the young. Our young population is at a greater risk than adults when using contraceptive services. This risk results from a lack of early education in human reproductive system as well as the cultural taboos surrounding the subject. Affordability, accessibility, and knowledge of contraception are inadequate for young women and couples who would want to space pregnancies. Individuals' reproductive intentions remain uninformed by critical awareness that swells the number of unintended pregnancies, further aggravated by hazardous unprofessionally administered abortions.

ONE-THIRD OF YOUNG MARRIED WOMEN HAVE A DESIRE TO USE CONTRACEPTION

There are misconceptions that family planning is for older or married women, despite the fact that many adolescent girls are sexually active. Nearly one third of the young married women, aged 15-19, have a desire to use contraception but are not currently using any contraceptive methods in Pakistan.

Fig. 1. Future Intentions to Use Contraception



EARLY INITIATION OF CHILDBEARING IS LINKED TO EDUCATION, OR LACK OF IT

Universally, early childbearing before age 18 is associated with many socio-demographic and economic risk factors for young women. For instance, having a child

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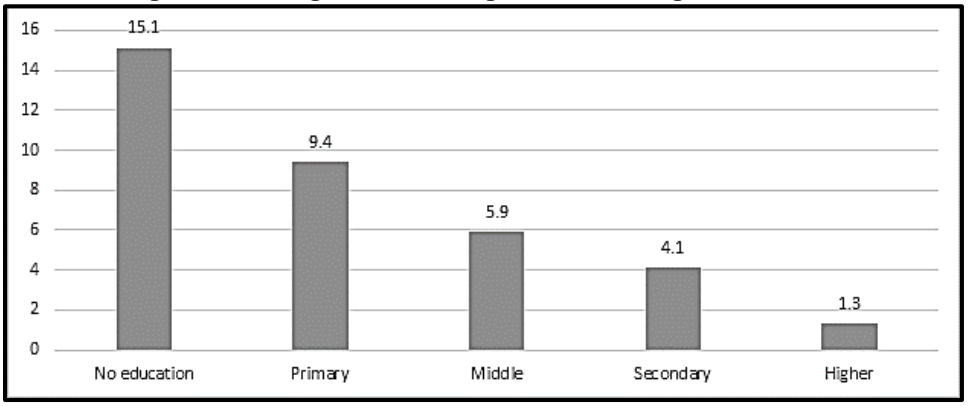
during teenage has adverse consequences for both mother and child's health. Similarly, women who marry before they are 18 are more likely to drop out of school and are less likely to work.

In Pakistan, eight percent of teenage women between 15-19 have begun child bearing and it has remained unchanged since 2012-13 (NIPS 2018). Young women, aged 15-19, with no formal education are at a higher risk of teenage childbearing. Around 15 percent of the teenage ever-married girls with no formal education had already begun childbearing.

Fig. 2. Percentage who have Begun Childbearing: 15–19 Years



Source: PDHS 2017-18.

DISCONNECT BETWEEN KNOWLEDGE AND USE OF CONTRACEPTION AMONG MARRIED WOMEN AGED 15-19

Around 93 percent of currently married teenage women (15-19 years) are not using any contraceptive methods. However, when it comes to knowledge about contraceptive use, only 9 percent of the teenage women did not know any family planning method. A vast majority of women (90.5 percent) know about modern contraceptive methods (Figure 3a & 3b).

Fig. 3a. Current Contraceptive Use by Type

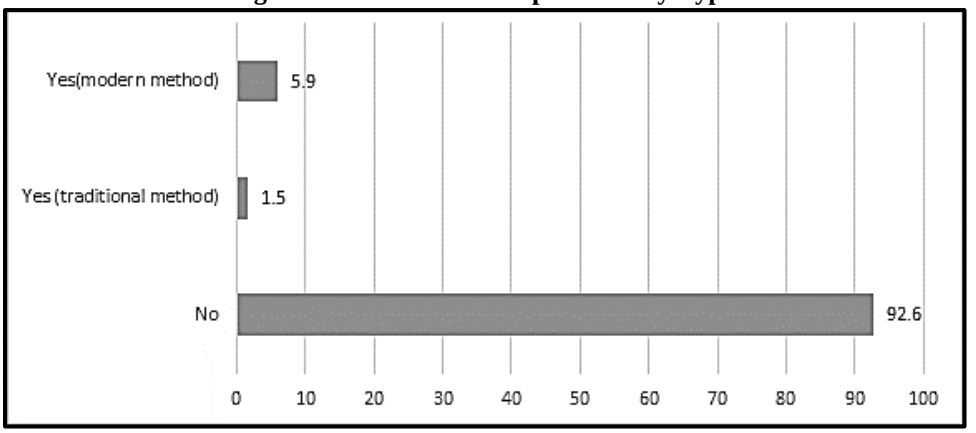
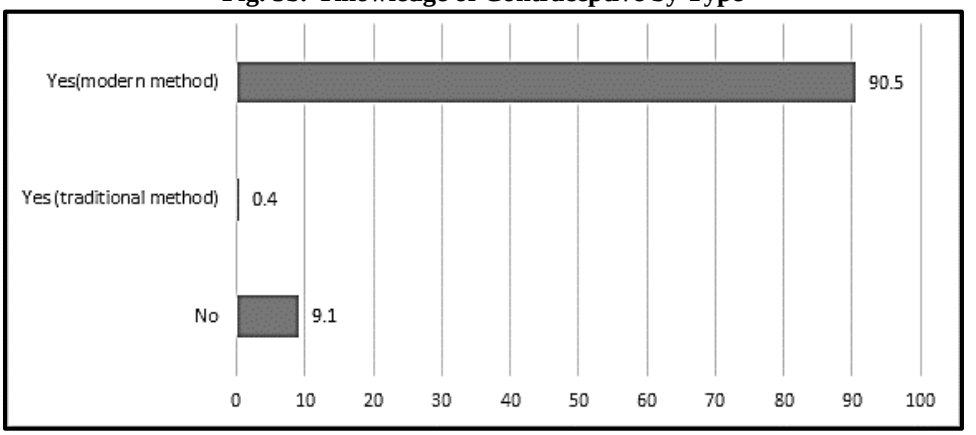


Fig. 3b. Knowledge of Contraceptive by Type



UNINTENDED FERTILITY AND UNMET NEED FOR FAMILY PLANNING AMONG YOUNG WOMEN

Despite the universal knowledge of family planning methods, particularly modern methods, the lack of use of contraception results in unintended fertility. According to PDHS 2017-18, around 4 percent of the births among mothers less than 20 years old are mistimed. Unmet need for family planning is higher among women aged 15-19. Nearly 18 percent of the young currently married women have an unmet need for family planning in Pakistan (NIPS 2018).

WHAT CAN POLICY MAKER DO?

Experiential evidence abounds on the benefits of family planning programs. In most developing countries, family planning programs have proven to be cost-effective and high-impact. They have been shown to invariably improve maternal, neonatal, and child health outcomes. Our policy makers need to recognise the importance of investing in the family planning needs of young couples as almost half of Pakistan's population is below age 20. Investment on the youth will potentially bring about socio-economic development within a short time frame.

Support Youth's Access to Contraception

Our public health system does not recognise young unmarried men and women as key targets of family planning programs so they remain underserved by sexual and reproductive health information and services. Most youngsters enter adolescence with little to no information and without any preparation of puberty. Much of the learning comes from peers and social media. Similarly, young couples start their family life without any proper planning. Therefore, it is not surprising to see that couples generally begin childbearing immediately after marriage and contraceptives are scarcely used before the first birth in Pakistan (NIPS, 2019).

Counseling of young married couples before marriage, therefore, is imperative and hence, reproductive health and family planning strategy must focus on younger men and women and adolescent boys and girls. Given the large youth cohort entering the

reproductive life span, policies that assist in preventing, spacing, or delaying pregnancies should be encouraged. Counselling services, facilitation centers, follow up mechanisms, and easy and affordable access to contraceptive methods encourage young couples to use contraceptives (Streifel, 2021).

Ensure Youth-friendly Services for Family Planning

Counselling services and distribution of contraceptives are the responsibility of family planning units. However, access to these services is different or somewhat limited for unmarried youth, which may be caused by the service providers' reluctance and culturally induced inhibition in discussing sexuality with the young unmarried boys and girls, and their lack of training.

Similarly, the inadequate number of community health workers needs urgent attention of the policy makers. Another often overlooked missing link is the very scant involvement of young males in family planning activities. Any family program has to have the involvement of males of the family in order for it to be fully successful. In addition, lack of transportation, financial constraints, and confidentiality are other barriers/concerns which need to be addressed.

Research has shown that providing youth-friendly services significantly reduced teen pregnancy (Brindis et al, 2005). Therefore, to reduce unintended fertility, family planning services and facilities must be made accessible to both young married and unmarried people.

Revision of Legal Age of Marriage

Pakistan has committed to end underage marriages by 2030 under the UN's SDGs. Pakistan's legal age of marriage, set at 16 for girls and 18 for boys, besides being discriminatory in gender terms except in the province of Sindh where it is 18. The age at marriage is the main determinant of the number of children each woman will have (Bongaarts, 1982).

Underage marriage has serious consequences for both the mother and child's health. Besides, women who marry before the age of 18 drop out of school more often and are less likely to work. They are at higher risk of physical and sexual violence. In order to protect young girls' rights to health and education, and to prevent underage pregnancies, government must immediately revise the legal age of marriage upwards without waiting till 2030.

Collaborate with Community and Traditional Leaders to Address Sociocultural Barriers

Kinship structures and community norms drive human behaviour. These traditional institutions are ensconced within and inside an outer circle of national socio-political institutions, ideologies and power dynamics (Kanein et al., 2016). Gender norms of the society make certain behaviours of men and women socially acceptable. That in turn impacts the sexual and reproductive health of a woman. These gender norms make sexual ignorance for women acceptable and even desirable, and give sexual power to men thereby making men decide matters of reproductive health including contraceptive usage.

This very gender discrimination is the driver behind child marriage. Lack of education and child marriage contribute to lower empowerment for women (Lee-Rife, 2010). This is how patriarchal gender system becomes part of a society's value system and is perpetuated. As Stith (2015) pointed out "Patriarchal religious traditions celebrate girls as young wives and mothers, not as the girls they are. This appropriation is a key component of patriarchal power and girls' disempowerment."

The shackle of patriarchal power can be broken only by interventions designed to break the socio-cultural barriers that come in the way of family planning. That entails sensitising the community elders and traditional leaders, including religious clerics, on the benefits of gender equality and involving them in public debate and policy formulation and implementation process about underage marriage. This would help in prevention of the continuing cycle of reproduction of discriminatory norms and may ultimately lead to the legislation required for raising the legal age of marriage.

Creation of Demand for Family Planning

Pakistan's family planning program is mostly focused on the supply side of contraceptives. However, recent PDHS 2017-18 shows a percentage decline in contraceptive use which may signify lack of demand. Therefore, instead of solely focusing on the supply side, the creation of demand for family planning and for contraceptives is necessary. This can be achieved by focusing on socio-economic development particularly on the women education as well as economic participation. This will, in turn, increase the opportunity for having children even for young couples.

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Impact of Climate Change on Water in Pakistan

NAZAM MAQBOOL

"The water issue is critically related to climate change. People say that carbon is the currency of climate change. Water is the teeth." Jim Yong Kim, Former President, World Bank

1. INTRODUCTION

Water is the prime channel through which the impacts of climate change on the world's ecosystems and livelihoods will be felt. Pakistan is already a water-stressed country, ranking 14 among the 17 'extremely high water risk' countries.[1] Climate change in the form of rising temperatures and extreme and less predictable weather patterns are projected to affect patterns of rainfall, snowmelt, river flows, groundwater and water quality in Pakistan. This can lead to an increase in both inter- and intra-country disputes over water sharing arrangements.

Over the last two decades, Pakistan has been ranked among the top 10 most vulnerable countries of the world to climate change, with 10,000 fatalities due to climate-related disasters and financial losses amounting to about $4 billion from 173 extreme weather events.[2] The country is already facing climate-related threats to water resources as is evident from the change in monsoon patterns, receding glaciers, rising temperatures and recurrence of floods and droughts. The floods of 2010, 2011 and 2012 not only incurred human cost but also economic costs, resulting in economic growth on average at a rate of 2.9 percent instead of its potential rate of 6.5 percent.[3] Prolonged droughts in Tharparkar in Sindh and Balochistan also caused loss to human life and livelihoods. Since mid of June 2022, Pakistan has been affected by worst floods caused by record monsoon rains and melting glaciers, costing the economy over US$30 billion. Over 33 million people have been affected out of total population of 222 million, and around 1,400 people have been killed. One-third of the country is under water, with over 80 districts (out of 160 districts) in the country having been officially notified as 'calamity hit' – 31 in Balochistan, 23 in Sindh, 17 in KP, 06 in GB and 03 in Punjab.[4] The paper aims to address the impact of climate change on water systems and people.

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[1]WRI 2022.

[2]Eckstein *et al.* 2021.

[3]Saeed 2013.

[4]WFP, Pakisan 2022.

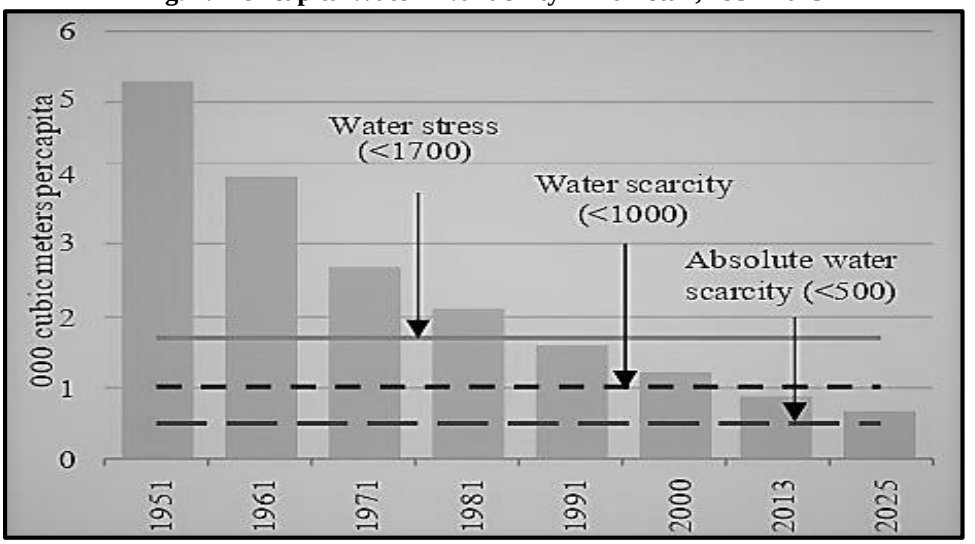
2. MAIN SOURCES OF WATER IN PAKISTAN

With 2.8 percent of the global population, Pakistan accounts for 0.5 percent of global renewable water resources.[5] In other words, with the fifth largest population in the world, Pakistan ranked 36 out of 184 countries in total renewable water resources compared to India's rank at 8th and Bangladesh's at 12th in 2017.[6]

Pakistan is a 'water scarce' country with a per capita water availability of less than 1,000 cubic metres. In 1951, Pakistan had an abundance of water with 5,260 cubic metres per capita, however, the country became 'water vulnerable' in 1981 with less than 2,500 cubic metres of water availability per capita to 'water stress' in 1991 with less than 1,700 cubic metres of water (see figure 1). By 2025, Pakistan could face droughts as its per capita water availability is going to become 'absolutely scarce' with less than 500 cubic metres.[7]

Indus Basin accounts for 96 percent of total available freshwater resources in Pakistan and around 80 percent of the country's freshwater originates from outside the country, making it extremely risky and vulnerable (see Table 1).[8] ***Glacier melt***, ***snow melt*** and ***rainfall runoff*** account for 10 percent, 55 percent and 35 percent of total water in the upper Indus respectively. Over 85 percent of total water in the Indus originates from the Upper Indus and is shared between Pakistan (53 percent of the total area of Indus), India (33.5 percent), China (6.7 percent) and Afghanistan (6.3 percent).[9] Stream flow in the upper Indus basin is highly seasonal: approximately 80 percent of the volume of annual stream flow in the tributaries of the upper Indus basin occurs during the summer months of mid-June to mid-September.[10]

Fig. 1. Per capita Water Availability in Pakistan, 1951-2025



Source: GOP 2017.

[5]FAO, 2022.
[6]FAO, 2022.
[7]Roberts, 2017.
[8]Young, *et al.* 2019.
[9]Biemans, *et al.* 2019.
[10]Mani, 2021.

Table 1

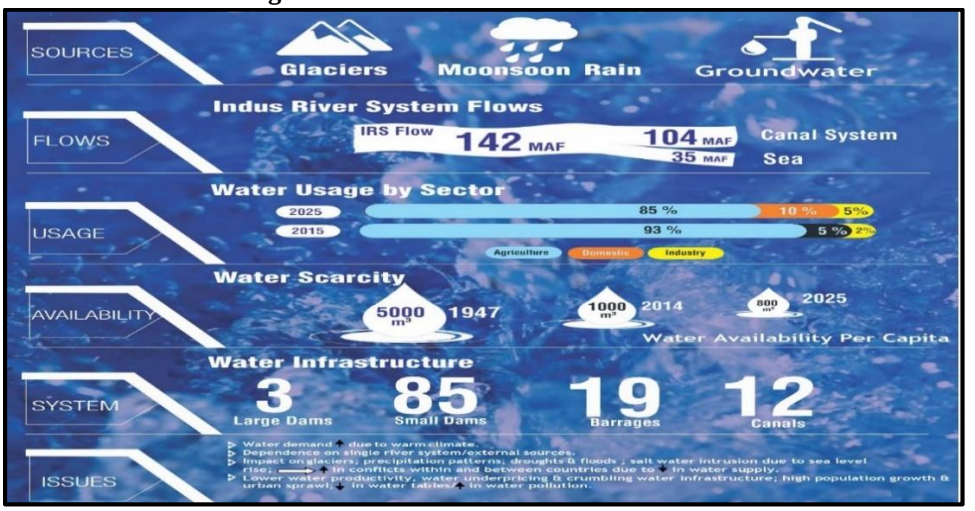
Water Resources in Pakistan vis-à-vis South Asia, 2018

	Pakistan	India	Bangladesh	Afghanistan	Nepal	Sri Lanka	China
Long-term average annual precipitation in depth (mm/year)	494	1,083	2,666	327	1,500	1,712	645
Total internal renewable water resources (IRWR) (10^9 m3/yr)	55	1,446	105	47	198	53	2,813
Total external renewable water resources (10^9 m3/yr)	192	465	1,122	18	12	0	27
Groundwater as a percentage of total renewable water resources	19%	19%	2%	16%	9%	13%	…
Total renewable water resources (10^9 m3/yr)	247	1,911	1,227	65	210	53	2,840
Total renewable water resources per capita (m3/inhab/yr)	1,163	1,413	7,604	1,758	7,482	2,487	1,946

Source: FAO, 2022.

Pakistan ranks 160th in the ratio of water withdrawals to water resources (in 2017), performing better than 18 countries only.[11] Agriculture is the largest water consumer, followed by households and industry (see Figure). More worrying is that Pakistan's groundwater supplies, the last resort of water security, are also being rapidly depleting. NASA's satellite data (released in 2015) of global underground water aquifers reveals that the underwater aquifer in the Indus Basin, whose rivers and tributaries constitute Pakistan's key water resource, is the second-most stressed in the world.[12] Demand for water is on the rise, projected to reach 274 million acre-feet (MAF) by 2025 mainly due to increasing population, expanding cities and rising incomes, while supply is expected to remain stagnant at 193 MAF (143 MAF from river inflows plus 50 MAF from groundwater), resulting in a demand-supply gap of approximately 81 MAF.[13]

Fig. 2. Pakistan's Water Sector Overview



Sources: PIDE Staff computations, FAO, 2022 and LEAD, Pakistan, 2016.

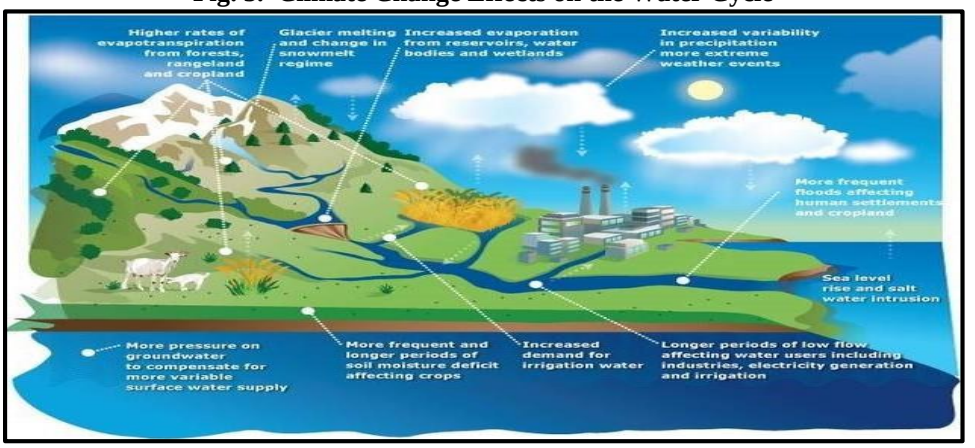
[11] WRI, 2022.
[12] NASA, Global Climate Change. 2015.
[13] IMF, 2015.

3. IMPACT OF CLIMATE CHANGE ON WATER CYCLE

Climate change is not the sole factor for water crisis in Pakistan, however, it further exacerbates existing conditions, making the management of water availability and quality more difficult, and demanding new strategies for managing water resource.

Climate change manifests itself primarily through changes in water cycle – the delicate balance between evaporation and precipitation. As climate changes, it alters the water cycle through an increase in temperature and increased evaporative demand, changes in the amount of rainfall and monsoon patterns, rapid melting of Himalayan glaciers, a rise in sea level, and variations in river runoff and groundwater recharge with severe consequences (see Figure 3).

Fig. 3. Climate Change Effects on the Water Cycle



Source: FAO 2017.

3.1. Melting of Glaciers

As mentioned above, about two-thirds of the flow to the Indus River is ensured by the glacial and snowmelt in the upper Indus basin. With Himalayan glaciers having lost more mass since 2000 than in the entire 20th Century, the water scarcity in the country is projected to worsen with climate change. The Indus Basin, with an expected GDP loss of US$ 5,000 billion by 2100, is among the world's five basins where water scarcity-led GDP losses are projected to be the highest.[14]

The Northern areas of the country are home to over 7,000 glaciers. An increasing temperature can cause faster melting of glaciers, resulting in glacial lake outburst floods. Over 3,000 glacial lakes have formed in Gilgit-Baltistan (GB) and Khyber Pakhtunkhwa (KP), with 33 glacial of them identified as being vulnerable to dangerous glacial lake outburst floods (GLOF). Around 7 million people in GB and KP are exposed to the risk of glacial lake-outburst floods, which typically occur in July and August, the warmest months.[15] The record-high temperature during April in the country has resulted in the melting of glaciers faster than normal; a key highway bridge in the Gilgit-Baltistan region has been swept away in flash flooding caused by glacier melt. In Pakistan, river flows are

[14] ANI, 2022.

[15] Abubakar, 2020.

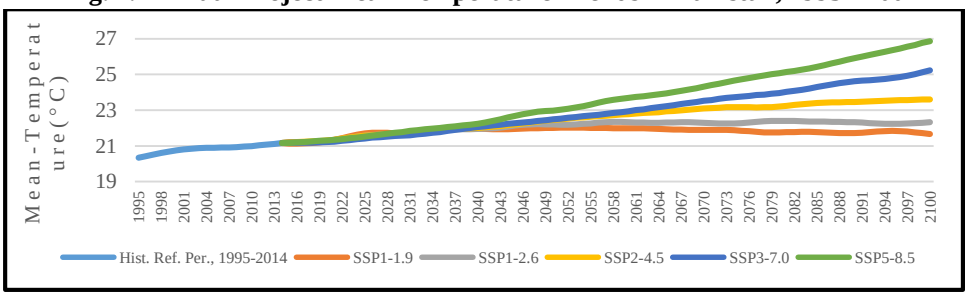
expected to increase during the first 50 years and decrease by 30-40 percent during the next 50 years. The Indus River could likely become a seasonal river in soon.

3.2. Rising Temperature and Erratic Precipitation

Climate change will change the temperature and increase the variability in the magnitude and timing of rainfall especially during the monsoon season, resulting in lesser water storage and increased water stress.

The average annual mean temperature in Pakistan increased by 0.74°C between 1961 and 2018.[16] The future projected annual temperature rise in Pakistan is significantly higher than in the world. The IPCC projects a global average temperature increase of 3.7°C (between 1986–2005 and 2081–2100) under the highest emissions pathway (RCP8.5) compared to of 5.3°C increase for Pakistan in the same scenario. The difference in the average estimate under RCP2.6 and RCP8.5 is over 3.0°C, reflecting the huge potential benefits of enhanced global emissions reductions (Figure 4).

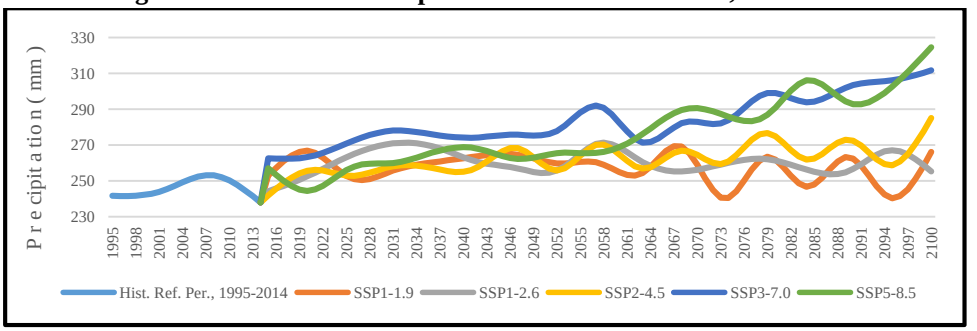
Fig. 4. Annual Project Mean Temperature Trends in Pakistan, 1995-2100



Sources: PIDE Staff computations and World Bank 2022.

In Pakistan, both increasing and decreasing trends in rainfall have been observed over the last century. In the future, the annual mean precipitation is projected to increase in Pakistan under all emission scenarios (low to high) (see Figure 5). The country has observed a shift in the summer monsoon trend that has shifted from north-east to north-west by a range of 80-100 kilometres, making an additional 25 districts of KPK and Punjab vulnerable.

Fig. 5. Annual Mean Precipitation Trends in Pakistan, 1995-2100



Sources: PIDE Staff computations and World Bank, 2022.

[16] Sathar and Khan, 2019.

3.3. Extreme Weather Events (Floods and Droughts)

Climate change is already making extreme weather events such as droughts and floods more intense and more frequent, and will continue to do so in the future, negatively affecting water resources and water security.

In 2010, the country experienced one of the worst cases of flooding in its history as a result of exceptionally heavy monsoon rains. The event caused some 2,000 casualties and affected more than 20 million people. Other years in which the country faced severe flooding include (in decreasing order of severity) 2015, 1983, 2011, 1976, 1997, 1994, and 1992.[17] In Punjab, 48 million of Punjab's 120 million people live in high-risk flood zones, corresponding to 38 percent of the province's total population.[18]

Similarly, Pakistan has experienced three major dry periods over the last 58 years, including 1962–66, 1968–72, and 1999–2002. At the national level, 2018 was the eighth driest year in Pakistan since 1961; the annual average rainfall was 207.2 mm, 34 percent below the normal (1981–2010) annual average value of 312.2 mm.[19] This was also the fifth consecutive year in which dry conditions prevailed in the southwest of the country (Balochistan province), with rainfall less than 62 percent of the normal amount.

The frequency and intensity of *droughts* have also increased in Pakistan due to rising temperatures, resulting in a decrease in water tables. Drought frequency is increasing in already arid and semi-arid areas.[20]

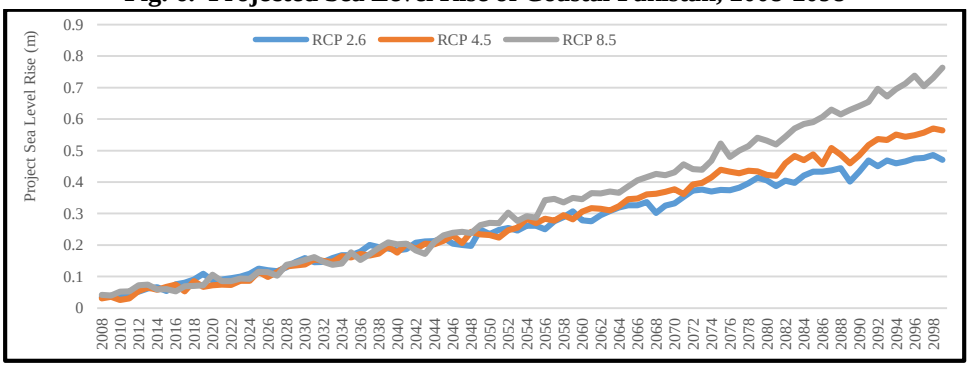
In future, the intensity of floods and droughts will increase, with a negative impact on water resources. According to the World Resource Institute, between 2010 and 2030, the number of people exposed to riverine flood risk in Pakistan is expected to increase from 1.9 million to 5.2 million, GDP loss to increase from $4.6b to $22b and the amount of urban property damaged by riverine floods is expected to increase from $1.6 billion to $9.3 billion by 2030.[21] The probability of meteorological drought is projected to increase under all emissions pathways, and with very strong increases.

3.4. Sea Level Rise

The global sea level is rising at an increasing rate with a similar trend in Pakistan, partly due to massive loss from glaciers and ice melt. The country is vulnerable due to its long and densely populated coastal areas, especially Karachi, facing the threat of inundation, and the threat of saltwater intrusion for its agricultural plains and freshwater resources. The average temperature in Pakistan has increased by 0.6^0C between 1901-2000, and the annual rise in sea level is estimated at 1.1 mm.[22] The seawater intrusion has already reduced Sindh's farmland significantly. Figure 6 shows a projected increase in the sea level in the range of 0.3 to 0.8 metres under all emission scenarios (low to high) in coastal areas of Pakistan during the 21st Century (Figure 6).

[17] Sathar and Khan, 2019.
[18] Rentschler, *et al.* 2022.
[19] Sathar and Khan, 2019.
[20] Ahmed, *et al.* 2018.
[21] WRI, 2020.
[22] GOP, 2015.

Fig. 6. Projected Sea Level Rise of Coastal Pakistan, 2008-2098



Sources: PIDE Staff computations and World Bank, 2022.

4. THE IMPACT OF CLIMATE CHANGE ON WATER: IMPLICATIONS FOR PEOPLE

4.1. Implications for Agriculture and Food Security

Climate change affects the country's agriculture and food security through increased temperature (resulting in an increase in crop water requirements) and changing water availability. In Pakistan, the 2010 floods destroyed 2.1 million hectares of farmland, decreasing food production and increasing wheat prices 50 percent higher than the pre-flood prices.[23] The impact will be higher on the urban poor who will pay more for food. Furthermore, global warming will increase net crop water requirements, putting stress on already scarce water resources, which will further be exacerbated by climate change. According to a study, in Pakistan, a 6 percent decline in rainfall will increase net irrigation water requirement by 29 percent.[24] According to the Global Change Impact Study Centre's (GCISC) projections, wheat crop yield will be reduced by 3.4 to 12.5 percent in semi-arid irrigated areas including Faisalabad and Sheikhupura, and 3.8 to 14.5 percent in arid areas including Hyderabad, Badin, Bahawalpur and Multan towards the end of the current century. Additionally, rice crop yields are likely to register a fall of 12 to 22 percent in almost all rice-growing areas of the country by the end of this century because of the rising global temperatures.[25]

4.2. Implications for Human Displacement

Climate-induced human migration is already happening in Pakistan due to rising sea levels, floods, droughts and glacial melt.

Low-lying coastal cities in Pakistan could be affected by coastal impacts of climate variability which can result in massive displacement of the population. In Pakistan, a rising number of people have fled the country's coastal region in recent years to escape rising sea levels and saltwater contamination. The coastal belt of Pakistan, especially in Thatta and Badin, has seen more than 40,000 people migrating to Karachi due to extreme events like the cyclones of 1999 and 2005, seawater intrusion which has rendered up to 1.2 million

[23] Cheema, *et al*. 2015.
[24] Spijkers, 2012.
[25] APP, 2017.

acres of land infertile, and water shortages since the 1970s.[26] Entire communities from Badin, Sajiwal and Thatta districts have migrated to Karachi permanently after the cyclones and floods of 2010 and 2011.[27]

A similar trend is evident in the case of floods. For instance, in the 2010 floods, 14 million people were temporarily relocated while 200,000 took shelter in aid camps. Moreover, heatwave and hot weather are expected to have much larger impacts than the cold weather in Pakistan. According to a study, between 1991 and 2012, flooding had modest to insignificant impacts, while heat stress increased the long-term migration of men to look for work elsewhere, mainly because it reduced income from farming and other sources. High temperatures affect people's livelihoods by harming farm yield thus; when heat stress caused wheat to mature early in Pakistan in 2010, yields dropped by 13 percent.[28]

In Pakistan, a study has found a strong correlation between extreme high temperatures in the summer and human migration.[29] Climate shocks impact ecological conditions in rural areas that trigger shifts in farm productivity, thus eroding the incomes of poor and marginalized cultivators. Rural households may take migratory decisions to escape the losses in rural incomes that may be aggravated by climatic stress. It has been projected that such changes are likely to be magnified by 2030 in the arid and semi-arid areas of Pakistan that are important in terms of wheat production and are home to a majority of the country's rural population. Given the sensitivity of the wheat crop to heat stress, it is anticipated that a decline in wheat production will affect the rural poor and marginalized households across Pakistan.[30]

4.3. Implications for Health

Water-borne diseases (diarrhoea, cholera, malaria and dengue fever), deaths and injuries due to disasters and malnutrition may be the most devastating consequences. In Pakistan, the incidence of infectious disease and diarrhoea increased after the 2010 floods.[31] The World Health Organization (WHO) projects that, under a high emissions scenario (RCP8.5), 46 million people in Pakistan will be at risk of contracting malaria by 2070. However, under a significant reduction in global emissions (RCP2.6), this number is projected to be around 12 million by 2070. Similarly, diarrhoeal-related deaths in Pakistan are projected to decrease significantly by 2050, but, under a high emissions scenario, the proportion of those attributable to climate change is expected to rise from 11.7 percent in 2030 to 17 percent by 2050.[32]

5. CLIMATE CHANGE PLANS, INITIATIVES AND POLICIES IN PAKISTAN

The Government of Pakistan has ratified all the major global conventions on climate change with the aim of climate change mitigation and adaptation. The country ratified the '1992 United Nations Framework Convention on Climate Change (UNFCCC)' in 1994,

[26] Sattar, 2013.
[27] Oxfam, Pakistan, 2019.
[28] Rowling, 2014.
[29] Mueller, *et al.* 2014.
[30] Saeed, *et al.* 2015.
[31] Hallegatte, *et al.* 2016.
[32] WHO, 2015.

the '1997 Kyoto Protocol to the UNFCCC' in 2005, the '2015 Paris Climate Agreement to the UNFCCC' in 2016, the '1985 Vienna Convention for the Protection of the Ozone Layer' in 1992, and the '1987 Montreal Protocol on Substances that deplete the Ozone Layer' in 1992.

The country developed both the National Policy on Climate Change and the National Disaster Risk Reduction Policy in 2012 to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the country. This was followed by a Framework for Implementation of the Climate Change Policy (2014-2030) in 2013 which listed priority, short-term, medium-term and long-term adaptation and mitigation actions required to be taken in various sectors. However, the climate change policy and its implementation framework need to be reviewed based on the Paris Climate Agreement and the SDGs framework.

The existing water sector initiatives include National Water Policy 2018 and the Indus Water Treaty. The National Water Policy 2018 does talk about climate change, however, does not mention any guidelines to offset the effects of climate change. The Indus Water Treaty is the only treaty that governs water sharing in the Indus Basin. However, it does not address the effects of climate change on water availability. Article VII of the Treaty does provide a clause for 'future cooperation'. There is a need to strengthen the role of institutions like the Permanent Indus Water Commission to work on the resolution of issues such as monitoring water quality, the impact of climate change and better watershed management.

In 2017, Pakistan approved the Climate Change Act, which brought it among the small group of countries with climate change legislation building on the commitment made in Paris in 2015. The Act suggested the formation of three institutions: the establishment of the high-level Pakistan Climate Change Council, the full-fledged Pakistan Climate Change Authority, and the Pakistan Climate Change Fund. The establishment of these institutions is instrumental to the implementation of the Climate Change Policy, in fulfilling the country's international climate change (mitigation) commitments, and in building the country's resilience capacity to adapt to climate change. Effective implementation of all these initiatives requires strong linkages between the federal Ministry of Climate Change and the related ministries of food security, energy, finance, planning, industry, housing, maritime affairs and water which have not been fully institutionalized yet. Moreover, after the initiation of all the policy initiatives, the delivery of outcomes in the policy documents depends on the efficiency of provinces and their commitment to the subjects of environment and forestry, which have been devolved after the 18th Amendment to the Constitution. However, the capacity of the provinces remains limited to address these new responsibilities.

6. CONCLUSION AND THE WAY FORWARD

Pakistan needs to take a series of measures to address the issue.

6.1. Increasing Water Supply through Recycling and Desalination

The policy-makers need to rethink water policy by urging the recycling of wastewater as is done in Israel and Singapore based on the principle of private sector

participation and optimal pricing of water. This needs to be coupled with increased investment in cost-effective brackish groundwater and seawater desalinization to improve water supply.

6.2. Expand Both Local Level Surface and Groundwater Storage Capacity

We need to increase effort and investment in local water systems in both cities and rural areas to store and use rainwater to build local resilience against drought. Also, there is a need to increase efforts for groundwater recharge, local level surface-water storage, and rehabilitation of dams to regain storage capacity.

6.3. Reduce Demand for Water by Improving Water Use Efficiency and Efficient Groundwater Management

Need to set efficiency standards for domestic and industrial water use in both rural and urban areas. Also, there is a need to support conservation and water efficiency practices in the farm sector. This should be supplemented by sustainable groundwater management for all uses. Redesigning urban bylaws to allow vertical construction and discouraging urban sprawl will help protect forestry, green areas and soil. This will help in the recharge of groundwater.

6.4. Reforms and Governance

There is a need to fill the vacuum between policies, reforms and their implementation by devising a detailed implementation plan. The government needs to institute a major paradigm shift that promotes the more judicious use of water. This will include water infrastructure maintenance, water conservation technologies and awareness-raising. There is also a need to resolve the disconnect between provincial (water, food and agriculture, and environment) and federal (climate changes) issues through better coordination.

6.5. Regional Cooperation

A region-wide institution for shared water resources should have mechanisms and processes for: the exchange of data and information; help to forge more robust water sharing treaties, especially concerning hydrological variability and climate change; and be able to address the issue of pollution and promote better flood management. This will help South Asia in holistic river basin management, making water from a source of conflict into a source of cooperation. A regional-level green fund along with a shared pool of resources for best practices for green growth as well as successful practices for community-based disaster risk reduction and social safety nets can also benefit all. Similarly, common adaptation strategies may be adopted keeping in view shared eco-systems such as glaciers, rivers, mountains and rains as well as the common interest of countries and prevention of conflict. This could also involve conducting joint studies on the extent of glacial melt, creating joint mitigation and adaptation techniques and watershed management, sharing information and improving flood-forecasting systems. A regional-level climate change mitigation strategy may include ways to unlock regional renewable energy potential.

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