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Agence canadienne de développement international

Warsak Hydroelectric Programme,

Pakistan

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Canada

Executive Summary

Introduction

The purpose of this report is to summarise the findings of an evaluation of the Warsak Hydroelectric Program. Fieldwork for this evaluation was carried out in April, May and June 1999; data for the evaluation were collected through document review, key-person interview, focus group meetings, field-site visits, village surveys and case studies. Overall some 50 persons in Canada and in Pakistan were contacted for the study, and about 50 community women and men interviewed.

Development Context

Pakistan currently ranks 138th among all countries of the world on the Human Development Index of the United Nations Development Program. Pakistan is considered a "low human development" country, with Real Gross Domestic Product per capita of US $1,560, compared to US $2,904 for all developing countries. Currently, life expectancy in Pakistan is 64 years, combined school enrolment is 56 percent (male) and 28 percent (female), and adult literacy is 55 percent (male) and 25 percent (female). Health expenditure per capita is about US $13 and there is one physician for every 2,000 people. Thirty eight percent of children under-five years of age are underweight, and access to safe water (rural) is estimated at 56 percent; access to sanitation facilities 38 percent.

Program Description

The Warsak Hydroelectric Program consists of six projects spanning the 1952 to 1991 period and include: the original hydroelectric project to construct a dam on the Kabul River for hydropower generation and to divert water to enable expansion for irrigation of adjacent land; an industrial spare parts project to allow continued operation of the hydropower plant; the Units 5 and 6 expansion project to increase hydropower generation; and three other projects to diagnose and rectify problems associated with powerhouse movement and the displacement of key plant components. Originating in 1952, the program of interventions were administered under the Interdepartmental Group for Technical Assistance (established in 1950), the Economic and Technical Assistance Branch (established in 1958), the External Aid Office (established in 1960), and finally by CIDA, which was established in 1968.

Program Performance

The program achieved significant results between 1952 and 1991. Among these are:

Output Level

Project	Physical Output	Institutional Output	Socio-Economic Output
Warsak	160 MW Generating	WAPDA	Employment of

Hydro-Electric	Plant, Dam, Reservoir constructed. Irrigation diversion for 60,000 hectares (total 950 Cusecs)	250 engineers receive training 2000 WAPDA technicians receive training	7,500 local labourers in construction. Employment of 150 local people for O/M (dam) and 600 (irrigation)
Industrial Spare Parts	Replacement of 3 turbine runners and associated gear	Further training of WAPDA O/M staff (approx. 50)	Minor labourer employment

Program	Physical Output	Institutional Output	Socio-Economic Output
Units 5 & 6 Expansion	Installation of additional 80 MW (2) turbine generators	Further training of WAPDA O/M staff (approx. 50)	Employment of approximately 500 local labourers
Powerhouse Movement I	Cracks/movement study	Minor training for WAPDA/ DSO personnel	N/A
Powerhouse Movement II	Cracks/ movement remediation and monitoring plan	Minor training for WAPDA/ DSO personnel	N/A
Gates Modification	Intake and draft tube gates repaired	Further training of WAPDA O/M staff (about 50)	Minor labourer employment

Hydropower Generation (from WAPDA, 1973)

From commissioning in 1961 until 1997-1998, hydropower generation from the Warsak plant averaged 680 million kWh per year, representing an average plant generation capacity factor of 84 percent. This demonstrates that the Warsak plant has operated reliably since commissioning. In the 1960s, hydropower generated at the Warsak plant was approximately 30 to 40 percent of the total power produced in Pakistan. With increasing power demand from the late 1960s onwards, and with more hydro and thermal generating plants then being constructed to meet demand, hydropower generated at the Warsak plant reduced in significance; currently representing only approximately one percent of national production. However, hydropower generated by the Warsak plant still plays an important role in voltage stabilisation of the national grid, since peak power is provided from Warsak later in the year when other hydro plants have dropped in output due to decreased river flows.

Purpose Level

Irrigation Expansion

Prior to the commissioning of the Warsak Dam, the total area irrigated adjacent and downstream of Warsak was approximately 50,000 hectares (riperian land, Kabul River and Bara Canals). Diversion of water from the Warsak Dam enabled the expansion of

irrigation to an additional 60,000 hectares; an increase of 130 percent. In the irrigated areas, the Institute of Development Studies of the University of Peshawar has documented improvements in area farmers' living conditions (replacing mud houses with brick houses for example), and constructing larger houses (with attached bathrooms, separate kitchens, latrines, and animal sheds for example). These results are largely attributable to the development of irrigated agriculture; and the Warsak Dam played a significant role in this by providing sufficient water to enable more than doubling of the irrigated area adjacent to the Kabul River.

Village Electrification

Village electrification prior to commissioning of the Warsak plant was primarily concentrated in NWFP (509 villages) where small hydropower plants existed. Only 100 villages in Punjab Province had electricity prior to 1960, and none in Sindh or Balochistan Provinces. During the decade of the 1960s, up until 1968 (the date of Mangla Dam/Plant commissioning) when the Warsak plant was the primary source of power in Pakistan, village electrification expanded to a total of 2,207 villages. Provincial totals were: NWFP 938 villages; Punjab 1,105 villages; Sindh 224 villages; and Balochistan 10 villages. Clearly, power generated from the Warsak plant enabled the rapid expansion of village electrification, particularly in populous Punjab Province. Village electrification brought two kinds of benefits: increased opportunities for employment and small business development resulting in increased purchasing power; and a reduction in the domestic work load of women, allowing more time and opportunities for family life and productive activities, and providing access to information and entertainment.

Goal Level

Improvements in Socio-Economic Conditions

Improvements in socio-economic conditions in the Warsak area are primarily attributable to the establishment and expansion of irrigated agriculture, proximity to the major and rapidly-expanding urban centre of Peshawar, and services and facilities provided through the US Narcotics Control Program (tribal areas). The Warsak Hydroelectric Program has made some contribution to overall improvement of socio-economic conditions by enabling the significant expansion of irrigated agriculture.

Improvements in Electricity Generation Capacity

Initially (1961 to 1968), substantial domestic hydroelectric generating capacity was established by the Warsak plant; some 30 to 40 percent of national generating capacity at the time. Since expansion of domestic generation capacity was a high priority of GOP, and import of electricity from (hostile) India neither feasible nor desirable, the initial impact of the Warsak Hydroelectric Program was very beneficial. Additionally, training and capacity-building of Pakistani energy managers, engineers, technicians and tradesmen provided at the Warsak Dam and plant proved very beneficial as WAPDA

went on to plan, design and construct bigger hydroelectric plants at Mangla (1968) and Tarbela (1977).

Key Factors Explaining Program Results

The following are four key factors that facilitated the programme's achievements, ranked from strongest to weakest:

Innovation and Creativity

Faced with very significant physical and managerial constraints, the CEAs, CIDA and WAPDA exhibited a high degree of innovation and creativity to ensure that the Warsak Hydroelectric Program was implemented and produced intended results. Abrasion of turbines presented a severe and chronic problem from commissioning onwards. This was addressed by the provision of on-going and generally responsive Canadian technical and financial support for spares and repairs. WAPDA technical staff and local artisans proved very adept and skilled at repairing and rebuilding worn equipment, and then the local private sector successfully accomplished the fabrication of replacement turbine equipment, to substitute for imports.

Powerhouse movement diagnosis and remediation required innovation and creativity since at the time the cause (AAR) was not well understood and remediation measures a matter of experimentation. While the CEA's diagnosis was correct, proposed solutions have only been partially effective since the AAR process is continuing longer than expected; requiring continued innovation and creativity to solve.

Project management difficulties, particularly during the Units 5 & 6 Expansion Project, were severe, and included unsatisfactory performance by the prime local contractor resulting in significant implementation delays. CIDA responded in a flexible way by assigning more direct responsibilities to the CEA, and allowing more local sub-contracting, which enabled the project to be completed on budget.

Relevance

At the time of independence in 1947, Pakistan had an estimated 70MW of electricity generation capacity against a requirement of approximately 300 MW. Most of the electricity was then supplied through the grid system established by the British in combined India. Given the relationship with India in the aftermath of partitioning of the sub-continent and vast surface water resources within Pakistan (especially in the northern part) the need for hydroelectric power generation was strong and development feasibility was high.

The program was in line with the objectives of the Colombo Plan: the assistance offered was essentially for the long term economic development benefit of Pakistan, and both Canada and Pakistan participated and co-operated in the Warsak program, which was the largest capital aid program in Pakistan at the time.

Appropriateness

Overall the stakeholder groups are very satisfied with the program. The Government of Pakistan and especially WAPDA management and engineers associated with the Warsak Program are highly appreciative of the Canadian contribution and technical assistance. The assistance was provided essentially without conditions, at a critical time in the early years in Pakistan when power generation and generation security were vital needs. In fact, they consider Warsak as the first "training institution" in Pakistan for dam engineering, and this was very appropriate since most engineers and technicians trained at Warsak went on to apply their skills at subsequent hydropower programmes in Pakistan. WAPDA engineers and technicians were readily assigned (250 engineers and 2,000 technicians in 1952-1961) to the program as counterparts and line staff. It was deliberate decision on the part of GOP to post personnel to Warsak to receive training from the CEA. The Momand, Mulagori and Afridi tribes have also shown satisfaction with the results of the Warsak project in terms of electricity supply to their areas and irrigation water for their barren land.

Partnership

The Warsak Hydroelectric Program resulted in the establishment of significant and enduring partnerships at three levels. Bilaterally, the GOP and CIDA developed an excellent relationship based on trust and respect, leading to a long-term commitment for energy sector development. At the corporate level, WAPDA and the CEAs involved in the program (particularly the original CEA) established durable working relationships, resulting in long-standing communications networks that continue now. At the individual level, there are a number of examples of enduring personal and professional relationships between CEA expatriates, WAPDA staff and Warsak area residents.

Policy Trends and Issues

While the Warsak Program was not designed and implemented under Infrastructure Services Policy principles and objectives, there are linkages between the impact of the program and other sectors. Private sector development was enhanced through development of the irrigated agricultural sector and through crop diversification, particularly in the area adjacent to the dam, and through marketable skill development of local labourers and artisans. By contributing to general improvement in socio-economic conditions in the area, in part by irrigation and village electrification, basic human needs were addressed, including improved access to education and health services. Similarly quality-of-life improvements resulted in part from improved access to information (radio, television) and reduced women's domestic workload (household appliances).

Lessons

- The Warsak Hydroelectric Program has created a great degree of goodwill between Pakistan and Canada; in particular, many senior GOP officials view Canada's aid and development program both practical and professional, without political or economic strings attached.

- The program, although focused on the provision of infrastructure, did result in substantial institutional strengthening and capacity-building of WAPDA. But this was not fully planned or articulated, and could have been more beneficial if comprehensive HRD planning had been part of the program design.
- Fewer resources have been put to infrastructure projects over the past decade. It is concluded that the Warsak Hydroelectric Program may have had influence over CIDA's programming in Pakistan in the medium term, but has now been overshadowed by CIDA's reorientation of its priorities towards infrastructure services. But the experiences gained from the Warsak Program should contribute to future programming plans.
- Programmes with multiple objectives should be designed and planned to meet all objectives adequately. While the primary objective of the Warsak Hydroelectric Program was to provide facilities for electricity generation, another important objective was to enable the irrigation of adjacent settled and tribal land. However, project planning, implementation, technical and financial support concentrated almost entirely on the electricity generation objective, and less attention was paid to the irrigation objective.
- Quality at entry and thorough risk assessment (technical, economic and socio-economic) are indispensable for the management, implementation and ultimate success of large infrastructure interventions.
- Regular reviews of policies and programmes are essential, so that lessons learned (and results, outcomes and impacts) can be identified and fed into interactive policy development and program planning.
- A partial result of the Warsak Program, in terms of cash labour, village electrification and irrigation development, was reduced poverty in the Warsak irrigated area but not alleviation the underlying causes of poverty although poverty reduction was not an objective of the initial program.
- CEA implementation and program management contracts should be carefully managed. Both executing agencies and beneficiary institutions need to jointly screen and evaluate local contractors for suitability, and actively monitor and supervise their work.
- The Warsak Hydroelectric Program was implemented in partnership with WAPDA, but it is not possible to assess the degree to which WAPDA actually participated meaningfully in program planning and implementation decision-making, beyond operational-level issues. Local beneficiaries of the Warsak Program, both from village electrification and irrigation did not effectively participate in program planning or implementation, beyond the employment in construction that resulted, which is not what is meant by participation in current terms. Had they done so, the results, particularly in the irrigation development component, may have been substantially improved, by more local support and assistance. It is to be considered though, that at the time of program implementation participation was not a norm or developmental objective/process.
- The provision of large infrastructure facilities (such a dam and powerhouse) can lead to the creation of dependence (or at least expected long-term support) for facility operation, maintenance and rehabilitation on the part of the host country. Adequate attention to appropriate technology, capacity building, and economic cost recovery of

infrastructure facilities may lessen the dependency that tends to be created, and CIDA should emphasise these elements in project design.

- While there is some evidence of women benefiting from the intervention, they did not play a key role in the planning and implementation of the program. While this was the norm in earlier days, it is not anymore. Gender balanced planning and implementation at the institutional and beneficiary level is integral for optimal and sustainable results for programmes of this magnitude.

Conclusion

The Warsak Program resulted in a positive contribution (direct and indirect) to socio-economic development in the settled and tribal areas adjacent to Warsak, and to WAPDA as the energy sector management organisation for GOP. These contributions include:

- development of the energy sector in Pakistan, and stabilisation of energy output in the long term;
- capacity-building and skills development of core WAPDA staff;
- local employment and skills development;
- skills development (WAPDA and local artisans) later impacting at the macro and micro-levels with the migration of labour abroad and remittances back to families in Pakistan;
- increased agricultural production, crop diversification, food availability and cash crop cultivation;
- village electrification expansion, raising living, standards generally and stabilising socio-economic conditions in the settled and tribal areas;
- reduction in women's domestic work burden, increased personal comfort, access to information and entertainment through village electrification;
- rise in overall time available for women for productive and non-productive activities through village electrification; and
- (anecdotal) reduction in vector-borne diseases such as malaria and dengue.