



Post Conflict Socio-Economic Recovery of a Disaster Affected Society by Timely Engineering Intervention of Restoration of Blasted Kalmadu Irrigation Scheme with Environmental Mitigation Measures

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Abstract:

Due to the man made blast, entire water stored in Kalmadu irrigation tank passed through the 125 m length and about 15m depth breach. This led the 1397 ha of total irrigable area under gravity irrigation system was abundant for eight seasons. Species recorded of project area identified native, endemic plants 86% and 8% respectively. Fauna and flora found are common and the habitats are secondary in origin. Similar habitats were identified in surrounding, hence no possible threats to any important ecosystems. With the improvements in the dam and its operational efficiency, the overall impact is positive because it would result in a more favourable condition for the aquatic life in the reservoir and the river downstream and this scheme was functional until the year before the blast. EMP was monitored by the Environmental monitoring team at the field and mitigation measures were addressed by the contractor. More than 100,000m³ of earth (SC/GC material) collected from the tank bed was used for the construction for the closure of this breach. Resettled 4641 families with 18335 individuals were used for manual labour which was about 50-75 % of total labours used, to facilitate immediate employment for the IDPs from Kalmadu area with the purpose of uplifting livelihood and mental stability. After the completion of the work the paddy production is 8382 ton/year. Average per capita consumption of 108kg/individual results, 23.6% of the production is self sustain the Kalmadu area and the rest 76.4% is mixed with the national supply.

Keywords: EMP, IDPs, livelihood

1. Introduction

Natural or human-made threat to life, health, property, or environment that negatively affects society or environment is a disaster. Conflict is a major human disasters where, conflict between relatively large groups of people, which involves physical force inflicted by the use of weapons. The ethnic conflict of Sri Lanka has destroyed entire cultures, countries, economies and inflicted great suffering on humanity. One of the most remarkable events was the blast of Kalmadu dam in January-2009 which carried 11.7 million cubic meters of water indented for agriculture and livestock.



Fig.1.1 Time of blast of Kalmadu Scheme in January 2009



Fig 1.2 Location map of Kalmadu irrigation scheme

Nethali aru is the main feeding stream and catchment area of Kalmadu is 68 km² and the total irrigable area under gravity irrigation system is 1397 ha which is 0.2% of total extend of paddy land of Sri Lanka. It consists of 1.575 km long earth embankment with maximum height is 8 m, 122.5 m long concrete clear over fall spillway and two sluices. Bund top level, high flood level and full supply level are 32.46m, 31.40m and 30.18m respectively from mean sea level (msl). Both sluices are tower type with sill level of 22.9m msl. Barrel length and diameter of right and left bank sluice are 50 & 1m, 46.3 & 0.75m and Maximum discharge of 6.2m³/s, 2.97 m³/s respectively. This tank was restored in 1951-1953 to irrigate 182 ha and was subsequently improved to irrigate 1397 ha under gravity irrigation and facilitate livelihood for 4,641 farm families. This entire families were displaced and housed in temporarily operated refugee camps in Vavuniya



Fig 1.3. When breach occurred



Fig 1.4. After breach occurred



Fig 1.5 Govt. operated IDP camps in Vavuniya

Government of Sri Lanka started the resettlement of Kalmadu in mid April 2010. As Kalmadu facilitated the livelihood of the families resettled, it was prioritized by the Ministry of Economic Development to restore the Kalmadu Dam through Emergency Northern Recovery Project (ENReP).



Fig 1.6. Resettlement process

2. Objective

The main objectives of the speedy restoration of Kalmadu irrigation reservoir were

- To speed up the resettlement of the area by improve the livelihood of the 4,641 farm families
- To increase the paddy production of the Kilionochchi district by 11200 mt/year
- To improve the ground water level which was drastically dropped after the breach of Kalmadu dam



- To improve the cascade network of around 20 tanks under Kalmadu tank with the prioritization of Periyakulam tank which is largely benefited.
- To creation of short-term employment to resettled IDPs and long term Economical investment

3. Intervention of Emergency Northern Recovery Project (ENReP)

Base line investigation was done collaborating with Irrigation Department Northern Province and it was identified that the maximum length of breach is 125 m and 15 m depth scour was formed in the breached section and 17 m filling with 90,000 m³ was used to rebuild the breached section.



Fig 3.1 breached section of the dam



Fig 3.2 Part of the washed off sluice



Fig 3.3 washed off section of the Rip-rap

Demining was facilitated by Sri Lankan Army. Borrow area Investigation, topographic survey, design and work plan were carried out by Irrigation department. Dam Safety Review was done by DSRP of DSWRPP and Environmental Assessment was carried out by ECL. As a result of it socio - economical priority, Ministry of Economic Development allocated 130 million through Emergency Northern Recovery Project (ENReP) for the restoration of Kalmadu irrigation reservoir.

4. Socio - Economical Benefits

Farmers from the Kalmadu were unable to cultivate for 8 consecutive seasons due to the unavailability of water and they are directly benefited through this intervention. 4,641 families having 18,335 people are directly benefited and 1000 families are benefited by agricultural labourers, machine operators, traders and business, millers and transporters after the intervention. Cost Benefit Ratio is 15.64 of this intervention



Table 4.1: Population Distribution in the Kalmadu Command Area by GN Division

GN Division	Families	Population
Kandawali	586	2,348
Periyakulam	874	3,305
Kalamadunagr	1,127	4,481
Dharmapuram West	645	2,586
Dharmapuram East	812	3,197
Puliyampokkanai	597	2,418
Total	4,641	18,335

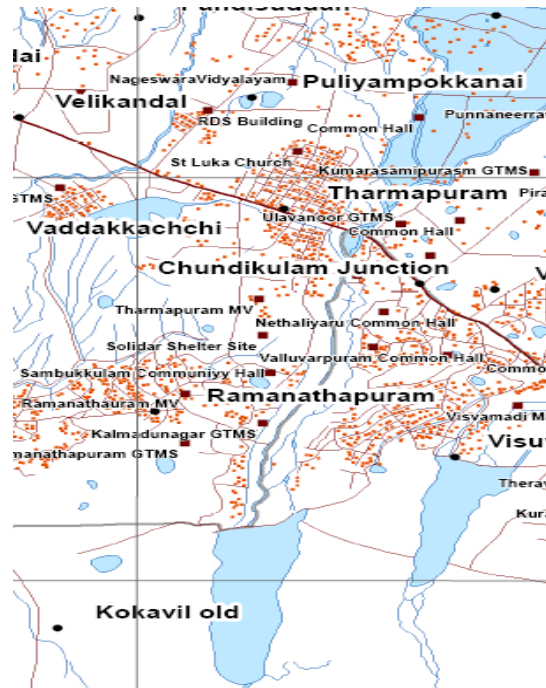


Fig 4.1 Kalmadu Command Area

Restoration of the tank was the main boost for the successful resettlement of IDPs in the Kalmadu Scheme area and its peripheral areas because the livelihood of them is dependent on the availability of this water resource. There are about 20 minor tanks fed under the Kalmadu tank and they not only provide irrigation water under gravity but also recharge the groundwater aquifer enabling abstraction of water for drinking, domestic uses and lift irrigation as well as for various industries and cattle. Groundwater augmentation is also important to maintain home garden trees. As a result of these 2 hospitals, 9 schools, 20 kovils and a Church are also benefit with water supply.

5. Physical Components of the Project

The primary component of the project was to restore the breached section of the dam and the RB sluice, improve dam safety, remedial repairs and rehabilitation of civil components. The interventions included mainly the following:

- Placement of coffer dams upstream (U/S) and downstream (D/S) of the breach section to enable dewatering for excavation for foundations;
- Construction of zoned earthen embankment with a central clay core and homogenous fills on the u/s and d/s sections using semi pervious soil. The new embankment was keyed into existing left and right bank embankments;



- Readjustment or stabilization of the slope of the upstream and downstream face of the dam using suitable earth material,
- Replacement of collapsed riprap on a gravel fill after stabilization of the upstream slope of the dam to protect from erosion;
- Turfing of the d/S side slope of the dam;
- Cleaning of vegetation, backfilling of sink-holes and, resurfacing of dam crest surface with gravel;
- Placement of a toe filter and a drain in the d/S toe of the embankment to ensure adequate drainage of the semi pervious fill;
- Construction of a 1.2m diameter tower type sluice in the existing RB embankment (few meters right of the breach) in place of the blasted sluice;
- Repairs to the 122.5m long concrete body of the spillway;
- Arresting scours in sections of the stilling basin of the spillway by placement of rubble;

6. Project Implementation Strategy

The project was funded by the Ministry of Economic Development through Emergency Northern Recovery Project (ENReP). The Project Management unit (PMU) of ENReP established in Vavuniya was responsible for procurement, overall monitoring, financial control, and coordination of project activities. The implementing agency of this project was the Provincial Irrigation Department of Northern Province through its Irrigation Engineer's office in Kilinochchi.

During the visit of the World Bank mission to Kilinochchi District, they have advised PD - ENReP to obtain the assistance from the Dam Safety Review Panel and one of the environmental consultant of Dam Safety and Water Resources Planning Project funded by the WB,

- To provide consultancy service required for borehole investigation data for foundation details required for the designing of breached section of the embankment;
- To provide design section of the breach;
- To provide borrow area investigation plan;
- To provide the Environmental Report.

Consequentially, Dam Safety Review was entrusted to DSRP of DSWRPP and Environmental Assessment was entrusted to ECL by single source procurement method by ENReP with the special approval of World Bank and Ministry of Economic Development.

6.1 General Approach and Methodology Adopted by Environmental Consultant

The basic information and data regarding the proposed rehabilitation of the Kalmadu Tank was provided by the relevant staff of the ENReP and the Provincial Irrigation Department at Kilinochchi. The team of consultants together with the staff at Kilinochchi Irrigation Office visited the dam site, its catchment area and the proposed quarrying sites to obtain first hand information of the site.

During the conflict, all the people who lived in the Kalmadu scheme have been evacuated. The same families lived in the Kalmadu scheme were resettled and information about those settlers regarding their demographic data, land use pattern, production, livelihoods, etc., reported before their evacuation were collected from the relevant Government Officers. The study team thus depended on detailed qualitative interviews of the government officials, primarily, the Divisional Secretary, Deputy Director Irrigation, Irrigation Engineer, and Development Officer who have jurisdiction over the Kalmadu Scheme.



Collection of secondary data and information from official documents was not possible because almost all government buildings were destroyed along with the documents during the conflict. The data and information available were either collected from archival sources elsewhere or from the memories of the serving officials.



Fig. 6.1 Environmental Consultant at site



Fig. 6.2. Geological investigation surveys at site

Information and data obtained from the relevant publications and research were used to identify impacts and draw up mitigation measures which respond to project needs and for the acceptable of all stakeholders.

The potential impacts of the project, both during and after completion of the project, were assessed considering mainly the following:

- Socio-economic impacts, both direct and indirect impacts, regarding positive and negative effects due to the proposed project;
- Natural resources, particularly water related impact, on downstream areas with and without the project;
- Impacts on water quality during and after construction and long-term sustainability of water resources;
- Impact on terrestrial and aquatic ecology;
- Impact of traffic and transportation during construction;
- Impacts of noise, dust, odour, etc., during construction;
- Any impacts on culturally, religious or archaeologically significant areas; and
- Impacts of O&M after completion;

Moreover, the available alternatives, such as “no project” option, different design, technologies and operational strategies, etc., were assessed to ensure safety, cost effectiveness, appropriateness under local conditions and available resources, etc.



The required mitigation measures to minimize any significant adverse impacts, as well as monitoring plans with responsibilities and institutional arrangements to ensure implementation of such mitigation measures were also addressed. The impact assessment, recommendation of mitigation measures and Management Plan were prepared in accordance with the World Bank guidelines and regulation (Environment Assessment OP/BP 4.01, Dam Safety OP / BP 4.37).

The project through its environment officer confirmed the adherence of the Environmental Management Plan by the contractors during the construction period and the O&M staff during the operations. The required contract stipulations to safeguard the environment were also monitored. Further, the information disclosure prior to commencement of the project was also addressed.

6.2 Observation and, Recommendation by Dam Safety Review Panel and Plan of Implementation

The DSRP visited the site, examined the design, estimate and construction programme and given their observation and recommendation. The observation, recommendation, question raised to implement the recommendation and the planning and implementation strategy adopted are given below as a tabulated manner for easy visualation of the scenario as a glance.



Fig 6.3 Dam Safety Review Panel with PD – ENReP and Deputy Director of Irrigation Kilinochchi

6.2.1. Breached section of the dam

Observations made and Repair needs	Plan adopted during Implementation
1. Placement of coffer dams in both u/s and d/s area of the breached sections keeping adequate space for foundation excavation and repair works. Dimensions are to be determined after taking measurements and construction drawings.	Coffer dam axis and cross section was changed for u/s and d/s, leaving adequate space for repair works. Estimate was revised to accommodate this.
2. Dewatering and clearing of the foundation area to be conducted by using adequate number of pumps having suitable capacities, and pumping will be a continuous work till foundation works are completed.	4 Nos. 100 mm pumps were used to carry out this task. In addition to these two standby pumps of same capacity was made available at the site for avoiding interruptions during construction.
3. Once the foundation is exposed, geological studies to be conducted with taking few bore holes investigations to ascertain the validity of the design	After the completion of de-silting, bore hole investigation was done before the earth filling commences with the assistance of NBRO, a recognized government institution accepted by PD ENReP, to ascertain the validity of the



assumptions on the subsurface conditions.	design assumptions on the subsurface conditions. Cost for bore hole investigation was incorporated as provisional sum in the re-casted estimate
4. Identified borrow areas are located along the periphery of the reservoir and there is a need to conduct soil tests to ascertain the soil compaction limits.	As far as possible, borrow area were located along the periphery of reservoir and soil tests were conducted by the Engineering Materials Laboratory of the Department to ascertain the soil compaction limits.
5. Design of the bund section with u/s and d/s slops (1:3 and 1:2.5) is accepted and there is a need to conduct slope stability analysis.	Slope stability analysis was done by the design engineers and DD (Design) of the Irrigation Department approved this.
6. Design of the rip rap and the d/s toe filter and drain arrangement as per given drawings are accepted. Toe filter should be in a position to arrest all seepage water even at FSL and above.	Puddle core was provided to curtail all seepage lines. However as a precautionary measure a toe filter also was placed to collect all seepage water when the water level is at HFL.

6.2.2. Status of the u/s embankment and the rip rap

Observations made and Repair needs	Plan adopted during Implementation
1. As per the accepted designs u/s section of the bund to be rehabilitated by removing loose and organic materials and refilling with properly selected material from borrow area and compact in stages.	This suggestion was incorporated in the specification.
2. Gravel layer to be placed and compact before placing rip-rap	This suggestion was incorporated in the specification.
3. Introduce the rip rap up to the top of the bund level is the present day's requirement, which has been accepted by ID considering stability and environmental conditions.	This suggestion was incorporated in the estimate.
4. Replacement of a new sluice/outlet works instead of damaged one is planned to place on the left area of the breached section. Foundation investigations of the selected location are vital to design the sluice.	This task was given to NBRO and based on their findings design was done by the design engineers with the help of DD (Design) and constructed accordingly.

6.2.3. Bund top and d/s embankment

Observations made and Repair needs	Plan adopted during Implementation
1. Need to construct the d/s embankment of the dam as per designs. Embankment to be protected by turfing and maintaining.	This suggestion was incorporated in the estimate.
2. Top of the bund where depressions and cracks are visible should be excavated and removed according to the specifications and subsequently refill with compacted earth.	This suggestion was incorporated in the estimate and specification.

6.2.4. Technical considerations of the Project

Observations made and Repair needs	Plan adopted during Implementation
1. 3 Nos. drawing prepared to fill the breached section have been examined and observed that they are accepted as per irrigation department standards. Centre	Based on the suggestion necessary provision was made in the specification and estimate



<p>core section in clay and filling the homogeneous fill with semi pervious SC type soil is accepted with possible modifications as per next comment. Slopes are accepted 1:3 for u/s and 1:2.5 for d/s.</p>	<ul style="list-style-type: none"> • To mix fine sand with clay for puddle core construction and • To introduce transition zone to facilitate the abrupt changes in permeability of the adjacent zones.
<p>2. Clay core is highly impervious, and it shrinks and swells more than other earthen materials. Due to this nature it is advisable to mix with fine sand or gravel. Observed that transition filter material has not been designed in between clay core and other pervious zone material. This transition zone material will facilitate the abrupt changes in permeability of the adjacent</p>	
<p>3. Excavation of terrace of the existing bund section for refilling surfaces to be attended as per designs, and also properly selected borrow materials to be compacted to meet the properties</p>	<p>This suggestion was incorporated in the revised estimate and specification.</p>
<p>4. There is a need to conduct few bore holes to check the sub surface material around the foundation area of the breached section. Instructions from a geological engineer to be obtain in this regard.</p>	<p>After the completion of de-silting, additional bore hole investigation was done with the assistance of geological engineer of NBRO, to ascertain the validity of the design assumptions on the subsurface conditions.</p>
<p>5. Toe filter and the drain drawings are according to irrigation standards and should construct covering to collect seepage water for measurements. This drainage filter arrangement should be constructed in such a way that neither the embankment nor the foundation material get clog the filter arrangement.</p>	<p>This suggestion was incorporated in the estimate and specification.</p>
<p>6. Proposed to widen the bund top road up to 4.0m as some sections are minor, and limiting to 2.0m</p>	<p>This suggestion was incorporated in the revised estimate and specification.</p>
<p>7. New RB Sluice to be design by competent personnel and recommended that ID engineers are having the capacity to undertake such designs</p>	<p>Designs of RB Sluice was done by design engineers with the help of DD (Design)</p>
<p>8. Quality control of the construction materials, compacted earth in layers, concreting works, etc to be check as per standard specifications by competent engineers</p>	<p>Materials laboratory operated by the Irrigation Department was deployed and one retired DDI was employed by the project to handle the quality control aspects of this work.</p>

6.2.5. Observations made on the estimate

Observations made and Repair needs	Plan adopted during Implementation
<p>1. Rates are finalized according to ID rates of the Kilinochchi regional office, and there will be a possibility of escalation in prices due to increase in haulage distances to transport the construction</p>	<p>Provisions were made in the estimate to meet price escalation.</p>



material.	
2. Borrow areas to be finalized after attending to soil investigations, and compaction to be attended as per specified specifications and test results should be accepted and certified by the DD.	This suggestion was inbuilt in the ID quality control mechanism
3. Provision of bore hole drilling and sub base soil sampling is required as per geologists instructions	Provisions were made in the estimate to meet this suggestion.
4. Pumping of water and removal of silt and debris from the foundation of breeched section cannot be estimated properly. Hence there will be an escalation in prices in these items	Provisions were made in the estimate to meet this suggestion.

7. Procurement facilitation and Project Implementation

The revised estimate incorporating all the inputs from World Bank, DSRP, NBRO, environmental consultant and detections given by PD ENReP, was submitted by Provincial Irrigation department for procurement facilitation in May 2010. World Bank clearance was obtained as an urgent nature within short period. Similarly bids are invited, evaluation was carried out immediately and the work was awarded by July 2010.



Fig 7.1. During construction



Fig 7.2. During construction

Table.7.1 Project Activity taken place during Restoration of Kalmadu Tank

Tank breached	Jan. 2009
Project Identification by ENReP	Dec.2009
Investigation Surveys, Design & Estimation by ID	Jan. 2010
Review of Estimate by World Bank	Feb. 2010
Dam Safety Consultant Report received	Mar.2010
Environmental Consultant Report	May. 2010
Estimate approved	May. 2010
World Bank Clearance	June. 2010
Bids Invited	June. 2010
Work awarded	July. 2010



Environmental Monitoring Committee formed	Aug. 2010
Work Commenced	Aug. 2010
Bore investigation done	Aug. 2010
Field Quality Control established	Aug. 2010
Deployment of QC staff of ID (Central Irrigation Department)	Aug. 2010
Bore investigation done	Sept. 2010
Work stopped due to heavy shower (prog.40%)	Oct. 2010
Work re commence	May. 2011
Work completed	Nov. 2011
Water issue started after eight season	Nov. 2011



Fig 7.3 Trench filling across the bund section



Fig 7.4. Trench filling across the bund section



Fig 7.5. Sluce barrel construction

Provincial Irrigation with the leadership of Deputy Director Irrigation Kilinochchi supervised the construction activity with the help of PMU-ENReP and Central Irrigation Department. In the mean time the Environmental Monitoring Committee formed by Divisional Secretary Kandaveli with the guidance of environment officer of ENReP confirmed the adherence of the Environmental Management Plan by the contractors during the construction period.



The construction activities were suspended with the physical progress of 40% in October 2010 due to heavy rainfall. All the precautionary measures were taken against the erosion in completed work by placing sufficient sand bags to cover the new fill in the breach section and partially completed sluice barrel. Again in the construction activities were recommenced in May 2011 after six month in accelerated way and completed by November 2011. During latter part of construction filling of tank also allowed with full observation. This led the water issue to farmers in November 2011 itself.



Fig 7.6. Completed u/s embankment



Fig 7.7. Completed d/s embankment



Fig 7.8. Completed sluice



Fig 7.9. Sluice outlet transition and toe area

8. Recommendation and Conclusion

Major repairs works as proposed for the breached sections have been completed satisfactory and the Project is in operation after 8 lapsed cultivation seasons. This achievement is remarkable due to

- The livelihood of more than 4650 farm families has been consoled due to supply of needy water requirement for their agricultural and other domestic purposes.
- Assuring the economic gains as water management and safety of the Project component are in sustainable status



Fig.8.1. First cultivation after breach closer



Fig 8.2. Inland fishing in Kalmadu scheme, added lively hood for the resettled community

As far as the safety of the dam and its appurtenant structures and the operational efficiency of the system are concerned, following recommendations need to be implemented

- Preparation of maintenance manual considering the risk based items as priorities for periodic implementation, other than normal routine maintenance works.
- Preparation of instrument based monitoring system, to assess the status of dam behaviour more professional manner than visual observations
- Preparation of an inspection program in three levels;
 1. For technician level to conduct normal inspection following the maintenance and monitoring practices,
 2. To conduct at senior dam engineers to further checks and attend for any trouble shooting works,
 3. Independent dam experts to review the dam to study, analyse the reports to finalize more effective recommendation as far as the safety measures are concerned.
- Preparation of a structured training program covering the dam related workers, for technicians, engineers, senior engineers and others responsible for decision making position in Northern Provincial Council.
- Mitigate the Environmental impacts may threat for timely water releases, dam safety concerns, sedimentation of the reservoir etc. by enforcing the regulations of Irrigation Department of NPC.

Following additional works also propose for the further assurance of the safety of the scheme

1. Balance works of the earth dam, the u/s and d/s areas as proposed as the interface of the repairs section and the old dam may have threats on behaviour due to varying water levels of the reservoir.
2. Flood inflow analysis as the present weather pattern is changing due to global climatic changes
3. Periphery of the reservoir beyond the HFL, a belt of 100 m to avoid any soil erosion and debris flows, and also to obtain a more smooth flow rather than flash flows.

After the completion of the project the paddy production is 8382 ton/year from this scheme. Average per capita consumption of 108kg/individual results, 23.6% of the production is self sustain the Kalmadu area and the rest 76.4% is mixed with the national food supply.



*Development with forethought leads
sustainable recovery of the nation*

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