VSF-Belgium

Turkana Livestock Development Project

(TLDP)

Report on the Technical Evaluation

and

Impact Assessment

of

Sub-surface Dams (SSDs)

Luc Vanrompay
March 2003.

Acknowledgement

The team is really satisfied with the co-ordination of the itinerary, presence of community members and quality of the work performed. The travel and accommodation were well organised. The SSD projects are overall a success and creating satisfaction, technically and to the beneficiaries.

List of acronyms used

Bgl	Billow ground level
BOQ	Bill of Quantities
CBWDP	Community Based Water Development Programme
D/S	Downstream
HH	Household
ISF	Ingénieurs Sans Frontières
Km	Kilometre
L/min	Litres per minute
LS	Livestock
M3/h	Cubic meters per hour
PE	Polyethylene (plastic sheet)
PRA	Participatory Rural Appraisal
SD	Sand dam
SSD	Sub-surface dam
TLDP	Turkana Livestock Development Programme
U/S	Upstream
VSF-B	Veterinaries Sans Frontières – Belgium

Table of content

		Page
Summary		
1.	Introduction	6
2.	Objective of this evaluation	6
3.	Methodology used during the evaluation	8
4.	Achievements	8
4.1	TLDP Water development activities and their impact	8
4.2	Community awareness of SSDs and participation	8
4.3	Site selection and quality of SSDs	9
4.4	Impacts of the SSDs	10
4.5	Impact on environment	10
5.	Cost benefit analysis of SSDs	11
6.	Sub-surface Dam technology	11
7.	Lessons learned and recommendations	12

Annexes

1. Notes from meetings/ field visits (table 0-7)
2. Terms of Reference
3. Map of TLDP operation area
4. Map of SSDs sites

Dates of travel and reporting

Field visits from Wednesday 5 to Monday 10 March 2003
Report writing in Lodwar by the team Tuesday 11 and Wednesday 12 March 2003

Composition of the team

Luc Vanrompay, Team Leader
Isaac E. Aremon, VSF-Belgium, TLDP Water Development Officer
Patrick W Mukenya, Deputy District Water Officer
Ekal Isaac Ekiru, Freelance (local) consultant

Summary

TLDP is the livestock development programme under VSF-Belgium, covering the southwest part of Turkana district. The overall aim of the programme is to improve the viability of the pastoralist way of life through improving animal health, increase access to dry season grazing areas, improve opportunities for livestock marketing, and increase pastoralists' involvement in their own development. The programme's component in relation to better livestock health and access to dry season grazing areas is including the increase of livestock drinking water availability at shorter walking distance from the dry season grazing lands. With regard to the delicate environment due to impending overgrazing, TLDP attempts to introduce a new technology for water conservation through subsurface dams (SSDs) in the seasonal "sand rivers".
Most of the Turkana rivers have only water for a few days during the rain seasons. These floodwaters are drained immediately except for water that remains stored subsurface in the sand rivers. Subsurface dams increase the storage capacity, still limited in volume and time, hence not oversupplying the area and minimising environmental degradation.
This report is on the technical evaluation and impact assessment of the 5 pilot projects of subsurface dams constructed in the last two years under TLDP supervision and visits to two potential new sites as identified with the communities.
The objectives of the evaluation were limited principally to the technical standard and quality of the 5 subsurface dams constructed, and the technical appropriateness of the sites selected. In addition, the team was requested to assess the impact of this new technology as perceived by the users' community and assess their need and preferences for alternative water supply sources suitable in the project area.

Technical standard to be sustainable and replicable by the users' community

TLDP had to introduce the new SSD technology for water conservation and supply. The community now endorses this technology and this is part of the success of the programme. But because of failures and flaws in the first 2 projects, the TLDP team had chosen for "improved, strong" SSDs constructed mainly with concrete, whilst the original idea was to introduce all-clay dams. Only the latter are considered sustainable because of the low cost and ease of replication by pastoralists, to have their own involvement maximalised.
The cost of SSDs is even with the used technique very low and affordable (0.4 % of each watering cow). Still pastoralists will not reproduce *concrete* SSDs because of the logistics involved and requirements of cash flow.

The impact as perceived by the communities themselves

The proof of the positive impact as perceived by the communities can be found in their reporting that each the 4 successful dams had increased water supply from the wells: more and larger livestock during longer time after the rains. They only hoped for more. But they also reported that only very short rains had fallen (we were told only one day in October 2002!).
Negative impacts were not reported.

Need for alternative sources of water supply

The people (and livestock) are desperate for water. There is plenty of groundwater available but the existing water lifting devices are complicated and not sustainable. The TLDP is specifically to improve animal health and drilling boreholes to equip with hand pumps or other even more complicated and expensive systems are out of reach in relation with sustainability. Even, boreholes can only supply some 60 livestock units per hour while SSDs can supply hundreds at the same

time. This aspect was extensively discussed with the community memÊers and leaders. They know the difference and that is why they are eager to proceed with more SSDs.

Lessons learned and recommendations

The community dialogue can now have an improved approach, to increase the communities' inputs (cash and kind) and/or the acceptance of the technology of all-clay SSD.
The cost benefit analysis needs to be emphasized to get the communities convinced of the advantages and opportunities of the SSD technology: affordable, simple technology without necessitating external assistance and with appropriate results.
The TLDP water officer needs urgently the opportunity to be more exposed to all-clay SSD construction and reduced cost for sand dams. This is required to reach the target of "appropriate, replicable technology".
To make the TLDP water development component a success it needs urgent action on the introduction of a dam supervisors' programme.

1. Introduction

VSF-Belgium is implementing a livestock development programme in Turkana district since 1999. The overall aim of the programme is to improve the viability of pastoralist way of life through improving animal health, increase access to dry season grazing areas, improve opportunities for livestock marketing, and increase pastoralist' involvement in their own development.

Shortage of water in dry/drought season grazing areas is identified as one of the problems limiting access of pastoralist to high areas of pasture potential, thereby increasing their vulnerability to drought. The project identified the need for increased availability of water in these areas as a result to be achieved in order to improve the pastoralists' way of life. With this regard VSF-Belgium has carried out a feasibility study to investigate the improvement of water supply for livestock through construction of Subsurface-dams. The subsurface dam technology is designed to block underground water flow at shallow depth, so that traditional watering points would be lasting longer and new watering points would be created to develop unused grazing areas. The technology is preferred for several reasons: increases the capacity of traditional wells, simplicity and less expensive to construct, replicable and easily maintained by the community, less contamination of water, temporary supply of water and hence it avoid attracting settlement.

TLDP initially promoted the "all-clay" SSDs because of the potential of replication by pastoralists: no need for cash flow to purchase hardware; only local labour required during implementation; easy technique for construction which can be introduced to local workers in the community.

In Turkana District VSF-Belgium has constructed 5 subsurface dams since the inception of the programme. The sites where the subsurface dams constructed includes: Kocheede, Kaekoroeakwaan, Lochoralomala, Nakoporeteworu and Nakuwalet.

The implementation activities includes:

Community dialogue: to create awareness on different water supply systems available, of which subsurface dams, and seeking for community recommendations of sites appropriate for subsurface dam construction.

Technical assessment of sites recommended by the community by a team of geologist and water engineer.

Follow-up community dialogue: to give feed back to the community on the findings of the technical assessment of the sites they had recommended, and facilitate the community action plan formulation.

Prepare Bill of Quantities for construction materials, organise procurement and transport to sites.
Undertake the construction.

Monitor the water table of the traditional shallow wells up-stream of the dam at different distance.

2. Objective of this evaluation

This report is on the technical evaluation and impact assessment of the 5 pilot projects of subsurface dams constructed under TLDP supervision, in the last two years. The TOR are enclosed in the annexes to this report
In addition, we visited other potential new sites.

Technical data

The 5 dams constructed

Name	Technical evaluation	Construction Date/time	Cost KShs	Size wall Length x depth (m)	Size reservoir m3 sand	Water LS units (*)	Cost –benefit KShs per LS unit (**)
Kocheede	Failure	2000 / 4 weeks	Unknown	15 x 2	3 000	37 500	None
Kaekoroeakwaan	Improved	Oct 01 / 8 weeks	300 000	36 x 2.8	10 000	125 000	70
Lochoralomala	Good	Apr 02 / 9 weeks	520 000	42 x 3.5	22 000	275 000	133
Nakoporeteworu	Good	Aug 02 / 8 weeks	480 000	38 x 3	17 000	214 000	135
Nakuwalet	Good	Aug 02 / 6 weeks	420 000	30 x 2.5	15 000	187 500	135

Three potential dam sites visited (***)

Name	Technical evaluation	Construction Date/time	Cost KShs	Size wall Length x depth (m)	Size reservoir m3 sand	Water LS units (*)	Cost benefit KShs per LS unit (**)
Kocheede sand dam *(new attempt)*	Good	Within 2 weeks / 8 weeks	500 000	25 x 4	15 000	187 500	170
Lochwailima sand dam	Good	Within 1 week / 8 weeks	500 000	42 x 3	20 000	200 000	130
Kopeto sand dam	Good	Within 2 weeks / 8 weeks	500 000	42 x 4	20 000	200 000	130

(*) The standard unit of one LS (livestock) unit equals to 3 local cows or 15 local shoats. One LS unit takes daily 25-l water or 50 LS units per m3 water stored. It is roughly estimated that water storage is 25 % of the sand volume.
(**) The cost benefit calculation is based on construction cost per LS unit, and if the LS is left to drink 60 days after the rains.
(***) All three dam sites were originally proposed as sand dams on the communities' request to increase the storage. Though this is against the original TLDP strategy for sustainability and replication of water supply development projects in Turkana, it is considered too late to change the approach for these sites to SSD. See also the comments on future projects (see also further reporting below).

3. Methodology used during the evaluation

The assessment team visited each dam site as per the enclosed itinerary. The community was present on each site and we used during the dialogue with the community the terms of reference as the framework for the dialogue with the communities. Enclosed tables give the basic comments as general information and separately for each site, referring to the items in the terms of reference for the team.

4. Achievements

With reference to the tables in annexe, following is the analyses and consolidation of the field data, arranged per topic.

4.1 TLDP Water development activities and their impact

Except for Kocheede dam, all the TLDP water projects for SSDs have created satisfaction for the community. The community members and leaders expressed their special thanks to VSF-Belgium for the assistance and the opportunity for the totality of the TLDP activities and the experiences with the newly introduced water conservation technology.

The impact of the SSD technology is well appreciated, though the expectations for results were quite higher. These expectations could not be met especially because of the lack of rain in the last rain season (we were told only one day in October 2002!). Still each site had an appreciable increase of the time and quantity of water withdrawing. Most people reported that the existing traditional wells were only for small livestock (the goats) before the SSD construction, but were intensively used by all animals (including the cattle) after construction. This reduced the time of trekking immediately after the rains.

Regarding the project files in the Lodwar office, we can conclude that although improvement is always possible, the files were well documented with records and reports. The preparation work was comprehensive with various external expert inputs.

4.2 Community awareness of SSDs and participation

Every community is asking for more assistance and many sites are ready to start an SSD. Their only complain was that they have to wait too long for getting assistance (financial and supervision), which confirms their eagerness to increase the water supply through the newly introduced SSD technology.

The communities are apparently well aware of the SSDs and fully participated during the preparation and implementation. Water is considered as the priority because it is the basic factor for enhancement of pastoralists' livelihood that can be influenced for development.
They know of faster project implementation when boreholes with hand pumps are provided. The lengthy preparation process for SSDs' construction is part of correct project introduction. SSDs need profound involvement of community during the awareness dialogues through which they are requested to identify sites for SSDs. This is to be followed by technical assessment of the sites recommended by the community, the community action plan preparation and only then the implementation. According to the action plan drawn by the community the first activities are collection of hard cores and sands, which are communities' responsibility to do. It is after this that

TLDP will provide its contribution and technical supervision of the construction. It is only when the community takes initiative and starts implementation of the their own action plan that TLDP will be involved. This is to ensure participation and ownership of the activity – the basic needs for successful SSD construction. If there is a delay in the implementation at all it is because of these requirements.

The communities' eagerness for SSD projects only proves that the SDD is accepted and hand pumps are considered out of reach.

The hand pump as an alternative water supply system

Most community members reiterated during the meetings their preference for hand pumps, as these would supply water throughout. The people (and livestock) are desperate for water. There is plenty of groundwater available but the existing water lifting devices are complicated and not sustainable. The TLDP is specifically to improve animal health and drilling boreholes to equip with hand pumps or other even more complicated and expensive systems are out of reach in relation with sustainability. Even, boreholes can only supply some few animals per hour while SSDs can supply hundreds at the same time. This aspect was extensively discussed with the community members and leaders. They know the difference and that is why they are eager to proceed with more SSDs.

It is only after re-emphasising the advantages of the SSD that the SSD technology is preferred as the better option because of the large, intensive capacity to withdraw water when needed for the livestock. Still hand pumps would be welcome as standby when the drought will come back. (Actually expected now.)

A hand pump on a borehole is limited to ca 60 LS units per hour, while traditional wells in sand riverbeds produce each 5 to 10 times more. Each SSD has easily 10 traditional wells. Hence SSDs deliver some 100 times more water during the time after the rains, when most required. The people also confirmed that hand pumping of groundwater for LS is too much time consuming and too cumbersome. They prefer the drawing by bucket from shallow wells. It is faster and allows combining forces.

In fact the only hand pump (DUBA) in the area is underused (see the pictures and map in annex). It was 3 months broken down and repaired recently only. The TLDP staff had difficulties to convince the users to bring the cash of only Kshs 2500 to have the repair team from Lodwar. The repairs were small and quickly done. The advantage of safe drinking water from the borehole is yet not really appreciated. Since then only people (we saw only children) come for water because it is faster and easier to take water from the nearby traditional wells. We tested the capacity and found 20 l/min of nice sweet drinking water. This pump could thus deliver water for 60 LS units per hour.

The cost of one hand pump installation (borehole drilling and pump installation) is ca 2 times more as for an SSD (as being done by TLDP). In addition, the community because of the high investment cost cannot replicate hand pumps. SSDs can be replicated without cash (if done with only clay). Most sites have abounded clay available on the riverbanks and/or in the riverbed close to the dam site.

4.3 Site selection and quality of SSDs

All sites were correctly selected and allowed for good SSDs.

The Kocheede SSD, unfortunately, was really a poor job and a big failure. This reason for failure of this site is to be considered as a start up problem. The TLDP people in charge at that time have left.

Though the correct technology was applied with regard to the fact only clay was used, the design and implementation were defective. The wall was not keyed in the riverbed. It was even lying on sand, partly in the sand and sticking out 2 feet above the natural sand level; hence washed away. SSDs should not be above the existing natural sand level, but 1 foot submerged. Unskilled people cannot predict the water forces if the dam wall is sticking out and exposed to the floodwater forces. SSDs can be done without external assistance if this prior condition is implemented.

The Kaekoroeakwaan SSD was poorly constructed from workmanship point of view. The TLDP learned from this site that a pilot SSD should not be left without proper attention and supervision. There were various problems during construction such as collapsing walls due to rains. The wall key might not be done as required. There was lack of water used during construction itself (still the rains were hindering the works?). The concrete was not correctly mixed nor cured. We got the assurances through the interviews that the construction is watertight and that the water supply was increased in quantity and period available, though it rained only one day in October 2002, after the time of construction. The pictures on the wall of the TLDP conference room show the poor and complicated construction works.

The other 3 SSDs are on the other hand “overdone”, as this type of construction cannot be replicated by the community on its own for reasons of high cost. They are done with too many extra precautions against construction and water sealing failures: too strong and too much volume of the wall, too much cement, extra chicken wire for reinforcement and extra PE folio for sealing not really required, and too large wings in the riverbanks.

Nevertheless, these SSDs have confirmed the idea of the new technology. The extra precautions have the advantage that no risk was taken after the Kocheede experience.

4.4 Impacts of the SSDs

The proof of the positive impact as perceived by the communities can be found in their reporting that each the 4 successful dams had increased water supply from the wells: more and larger livestock during longer (doubling from 4 to 8 weeks) time after the rains. They only hoped for more.

But they also reported that only very short rains had fallen (we were told several times only one day in October 2002!).

4.5 Impact on environment

This is the most delicate area of comments. Turkana district is considered as “oversupplied” with water creating unbalance of the long-term survival of the environment. Nevertheless, there was no visible environmental degradation around the SSD water points. The part of project area visited was in fair-to-good condition as per the classification criteria in the Range Management Handbook of Kenya. It is in fact a heavily grazed area needing close monitoring while implementing increased water supply projects.

SSD projects are therefore the most appropriate because of the limited time of water supply. Their location must be related to the dry season grazing lands to reduce the trekking distance resulting in increased animal production.

On the other hand, the water points could not have as yet any negative or positive environmental impact because of the extremely little rains that have occurred since construction. Still, no or only little environmental impact will be expected. Further monitoring will be required.

Most of the area has desert pavement (rubble stones all over) and is difficult to cause further degradation. It is covered with deciduous bush annual grassland, but lacking grass and no perennial grass tussocks to see. There is no degradation such as soil surface wash or wind erosion.

5. Cost benefit analysis of SSDs

The project cost per LS unit is very small as shown in the tables above. The calculations are based on the fact that the LS are left only 60 days to drink from the SSD. One LS unit is e.g. 3 cows.
The external cost for the dams up to now is Kshs 135 per LS unit or Kshs 45 per local cow with an estimated value of one cow of Kshs 10 000 each. Hence the investment cost is 0.45 % only of one cow seen as the beneficiary. This cost will for future projects still reduce as explained below.
This information needs to be spread and emphasized to the community. They could easily pay but need to be convinced.

6. Sub-surface Dam technology

One of the advantages of SSD technology is that it will use the subsurface water flow, existing after the rains when the floodwater has passed. It is apparent that there is none or only very little subsurface flow in the rivers of the project area. The flood flow precipitating in the sand of the SSD reservoir during surface flow at the time of flooding is the only water that fills the SSDs. The gradients of the rivers and the catchment area are too small or have no actual impact. Nevertheless, the technology still satisfies the needs in as much that the floodwater is used.

The Kaekoroeakwaan SSD was done at no cost to the community as model to promote the technology. There was a slight increase of cost contribution for the next projects. In fact all SSD projects had the financial advantage of getting cash flow for the work contributed by the local workers and community leaders in terms of incentives. This approach has resulted that the SSD projects got full cooperation of the communities during construction, even when they had doubt about the expectations. The SSD technology is now introduced and appreciated due to its positive impact related to the project objective: increased water availability.

The team agreed that future SSD projects should increase the community contribution and emphasize that only clay to be used, whenever possible. SSDs can be done with no cash investments and this advantage is exactly what should be promoted. This technology will be more pursued and for that reason the TLDP water officer will investigate what has been done in Makueni under the Belgian water programme for SSDs.

The communities are yet not ready for this increased contribution approach because of the cash payments for works in the past. Also the fact that the technology shown up to now with the use of plenty of hardware inputs by the donor will make the task difficult to convince them that clay only can do it.

The existing SSDs were not designed as *subsurface-submerged* constructions and designs do not incorporate the fact that the surrounding sand already supports the construction. There are no horizontal forces on the wall, except for the water table pressure, which is small because of the sand acting as barrier.

The clay dam wall top must be submerged for one foot in the sand (as done in the Kaekoroeakwaan and Lochoralomala SSDs). Correct clay compaction of ½ foot thick with 10 % of water mixed in the clay (to result in layers hard as a murram road), is of outmost importance and this aspect is precisely important to be promoted in the pilot projects.

In case concrete is still required; the volume should be minimal and cement use reduced to the absolute minimum. Cement should only be used for foundation and plastering upstream if no clay is available. Downstream backfilling with sand on the clay or rubble stones will do. Otherwise the technology will be too expensive to replicate and the cost benefit aspect lost as future reference.

Sand dams technology

On the other hand some future dam sites can be ideal for the sand dam technology. All communities were asking for this to be implemented, i.e. enlarge the existing SSDs to sand dams. It is now up to TLDP to consider introducing this technology. It is more expensive than SSDs, but will give good results on the sites visited.

But again, the cost involved might be (will be) beyond the community's commitments. Only when they accept the cost-benefit advantages will it be possible to convince them to bring forward the necessary cash to buy the cement. Still, it will be very difficult for them to organise the logistics involved. They have the financial potential and confirmed their willingness and capability to bring forward the cash once they are convinced of the benefits. They surely realize the impact on livestock quality by reducing the losses through large walking distance between the dry season grazing lands and the watering points. In this relation they also referred to the need to improve the marketing of the livestock to improve the cash flow for investments.

7. Lessons learned and recommendations

Future SSD projects

It will specifically be the task of the TLDP team to reach the target of sustainability of the proposed technologies: SSDs with clay and no cash inputs; sand dams with small cash inputs to buy the cement for the minimum possible quantities and reduced other hardware such as chicken wire only where really required (down stream on the surface exposed to flood water forces) and no PE sheets. The SSD and sand dam technology as water catchment are proven to be valid for the community. The team has agreed that after this period of introduction of the new te4chnology, it is time that the construction of concrete SSDs will be gradually reduced whenever possible.

As mentioned above, it is proposed that the TLDP water officer should be more exposed to the real clay SSD by visiting the Makueni clay SSDs. It is a simple technology but must be cautiously introduced by people who themselves are convinced. The latter is not yet the case and thus needs more attention.

Further, the TLDP water activities can now expand on the foundations reached by using the existing experience with local dam constructors to build out a team of local dam construction supervisors who can independently contract their services to the surrounding communities. This was the base of success in the Makueni dam supervisor's programme with more than 36 trained dam supervisors. Some supervisors had more than 42 dams under construction and the total of more than 400 small dams were implemented.

These future dam supervisors should be identified now from the surrounding communities spread over the TLDP area. We were told that some are already identified. They will be together construct one or two SSDs or sand dams. Next they will themselves identify new sites and together with the TLDP staff introduce and supervise the start up of projects.

Pure clay SSDs should be constructed with these identified future dam supervisors.

Comments on preparation of the water projects

Although the existing project files are fairly organized, the record keeping should be improved for further reference for external monitoring and evaluation.

List of requirements for proper action:

Map of the project areas produced during the community dialogue, indicating the communities' areas of living, together with wet and dry season grazing lands and the inventory of existing and potential watering points.

Drawings (or sketches) with dimensions and info of each of the existing site conditions with size of river and traditional wells information as baseline indicators./

Sketches of the existing traditional wells and proposed designs with measurements.

Selection criteria used to identify projects together with the questionnaire for the community dialogue.

PRA report to confirm the communities' priorities and willingness (existing files have the community dialogue reports, documented and available).

Community comments and inputs with available indicators.

Maps (or sketches) and technical assessment info of the watering points in the area for e.g. a radius of 25 km (or half of it) as standard for maximum walking distance for livestock.

Records of the technical assessment visits, design, bill of quantities and construction (similar to the records in the existing files).

Environmental condition indicators.

Records of activities of the TLDP team, before and during the implementation time (similar to the records in the existing files).

Daily records from the site during construction.

Cost benefit analysis.

Final report for each project site.

The final reports will allow the project to evaluate the cost benefit analysis and incorporate the experience for future action planning.

Major items for Lessons learned

Following is the consolidation of lessons learned referring to above-mentioned subjects.
The community dialogue needs an improved approach to increase the community's inputs (cash and kind) and/or the acceptance of the technology of all-clay SSD.

The cost benefit analysis needs to be emphasized to get the communities convinced of the advantages and opportunities of the SSD technology: affordable, simple technology without necessitating external assistance and with appropriate results.

The TLDP water officer needs the opportunity urgently to be more exposed to all-clay SSD construction and reduced cost for sand dams. This is required to reach the target of appropriate replicable technology.

To make the TLDP a success it needs urgent action on the introduction of a dam supervisors' programme.

TLDP should produce accurate and complete maps with inventory of existing watering points together with the community (such as the PRA maps done on the ground) and with knowledge of the existing desk top info, to make sure that the site selection is correctly indicated on the map.

The environmental impact with regard to grazing land degradation and water availability down stream is minimal if not existing. Further monitoring should confirm this. SSDs are the most appropriate water supply facilities for the project area.

Some alternative water supplies are not immediately appropriate for the scope of the TLDP: hand pumps are too slow for livestock watering requirements; dams and pans are too expensive. Sand dams are more expensive and still beyond the communities' financial reach. Improvement of the existing traditional wells and springs will be incorporated where SSD or sand dams are implemented

0. All dams	***Comments** (except **Kocheede**)*
1. Implementation activities	
1.1. Community dialogue	Most people confirmed their satisfaction about being involved during the initiation of the projects. More attention required for baseline info (maps, etc., see general report).
1.2. Technical assessment of sites	Was correctly done with knowledge of the team members.
1.3. Follow-up community dialogue	The community members were involved during the confirmation of the sites.
1.4. Bill of Quantities	Done correctly. Could reduce costs if only clay for SSD and not introduce sand dams.
1.5. Construction	As the result of the bad experience with **Kocheede** and **Kaekoroeakwaan** SSDs the construction of the other 3 SSDs was "overdone".
1.6. Monitor the water table	Little is done. The visits have shown that this matter is more complicated because of the major increase and intensive use, as more and larger LS is brought to the wells, thanks to the increased water available (see figures in annex).
2. Objectives of the evaluation	
2.1. Technical standard and quality	The team has reviewed appropriate technologies and improvements for each site.
2.2. Impact (community opinion)	The first reaction was negative. Only the comparison with alternatives has lead to approval of the positive impact. No negative impact observed.
2.3. Alternative sources	The borehole with hand pump was requested but not preferred as LS water source alternative after discussions. Good groundwater is available at shallow levels.
3. Terms of Reference:	
3.1. Suitability of the design	Only clay SSD design should be preferred. TLDP had chosen for concrete because of the reduced risk for this pilot project approach. Next projects will include the purely clay SSD design.
3.2. Appropriateness of the sites	All good sites.
3.2.1. Accessibility to community	As per the communities' request, close to settlements and reducing trekking distance to dry season grazing lands.
3.2.2. Suitability geo-hydrological	Best possible sites, though no or little subsurface water flow available.
3.2.3. Topography for construction	Best possible sites, good riverbanks, and good reservoir/wall volume ratios.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Improved but only small because of lack of rains (see 1.6).
3.3.2. Water table/availability up/down	No impact noted downstream, and also upstream.
3.3.3. Period that the community is staying	The elders and settled community staying behind when most of the LS has moved to the dry season grazing lands, are not influenced by the SSD siting. The siting does not increase the staying time but reduces the trekking distance immediate after the rains.
3.3.4. Distance covered to get water	The walking distance for the herds (and the herders) was reduced for a limited time after the rains (see tables).
3.3.5. Number of house holds/livestock	Between 10 to 30 / 3 000 to 8 000 (see tables).
3.3.6. No. of traditional wells before/after	Between 5 and 10 / 10 and 15 (see tables).
3.3.7. Changes in vegetation	No impact observed.
3.3.8. Environmental impact	No impact. SSD reservoirs are to small compared to the flood flow. No or little subsurface flow after the rains exists. This could be cut off not flowing to the wells downstream.
3.4. Cost-benefit	Enormous. Referring to the analysis the external cost is less than one percent of the cost of the LS benefiting.
3.5. Communities' view	Various. Referring to the general comments, the people need more information to be convinced about the advantages of cost benefit and technology.
3.6. Subsurface dam technology	More appropriate than anything else e.g. dams, pans, groundwater.
3.7. Alternative livestock water supply	None, except for springs and more expensive groundwater development, sand dams, earth dams and pans.
3.8. Lessons learned	The TLDP should move forward on SSDs as per the general comments.

1. Kocheede	*Comments*
1. Implementation activities	This site was very poorly handled during the implementation phase. The clay wall is washed away.
1.1. Community dialogue	The community complains there was no dialogue before or during the implementation. Though the site was their preference as there is no alternative available. Water was expressed as a need with high expectations for assistance.
1.2. Technical assessment of sites	The community claims that no real assessment happened. No evidence is available on site or in the TLDP office.
1.3. Follow-up community dialogue	There was none. They requested a water pan, not a SSD
1.4. Bill of Quantities	No BOQ or costing available. No file in the TLDP office.
1.5. Construction	Very shoddy job. Done by people from Lodwar with no local community participation or TLDP supervision. Mud and rubble used. No evidence of any excavation. Wall swept downstream. Still some parts visible.
1.6. Monitor the water table	No impact. The people claim that they have during and after the rains some 10 000 animals coming to the wells.
2. Objectives of the evaluation	
2.1. Technical standard and quality	The site is very good but an unqualified attempt is made to make a SSD with only clay, not compacted and no water used during construction. The trench for the dam wall was only one meter deep in the sand, not keyed in the clay riverbed. The dam wall is completely washed away.
2.2. Impact (community opinion)	No impact. Presumed taken for a ride. Lost trust and confidence. They need the dam to shorten the distance between the dry season gazing land and watering points. This is the only available site and desperately needed.
2.3. Alternative sources	Nakurimuyen traditional sources at 10 km away. Closer to the dry season grazing land is the Lokwakit spring (12 km away), which is small in size and only short in time after the rains.
3. Terms of Reference:	
3.1. Suitability of the design	Very wrong – very poor. Despite fine clay available is abundance, the wall was placed on the bed of river sand.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Could be more easily accessed if bushed cleared. But accessible to livestock.
3.2.2. Suitability geo-hydrological	Hills on both sides of the river; most probably originating in the hills.
3.2.3. Topography for construction	Clay could be used for subsurface dyke. An earth dam (with pan) could also work.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Found three wells dry. Have many more after rains with some 10,000 LS getting water (mostly shoats).
3.3.2. Water table/availability up/down	Possible upstream (not because of wall). No wells down stream.
3.3.3. Period that the community is staying	Normally 1 month with good rains.
3.3.4. Distance covered to get water	Grazing: Moruangikiliok, Kapokornyetom & Nakorikwanga (10, 15, 20 km res.) + 15 km = approx. 20 – 30 km
3.3.5. Number of house holds/livestock	200 (now scattered) / ca 10 000 (mostly shoats & camels)
3.3.6. No. of traditional wells before/after	Approx. 4 to 5 (usually). Now only one.
3.3.7. Changes in vegetation	No baseline to compare with. Area currently experiences dry spell.
3.3.8. Environmental impact	Would have no impact except for cutting off surface flow but there are no users downstream.
3.4. Cost-benefit	No info available, but comparable to the other SSDs (see general report).
3.5. Communities' view	This site is strategic for dry season grazing; construction can be revisited, and site not to be abandoned. Add water pan. Think of borehole in future at Lokwakit & Nangorekit
3.6. Subsurface dam technology	This site is appropriate for SSD (see general report).
3.7. Alternative livestock water supply	A sand dam, with the spillway directed to the water pan. The latter will silt up and act as sand pan – not cost effective. Protection of the spring, the existing alternative + hand pumps on boreholes nearer to the grazing lands.
3.8. Lessons learned	Reliance on non-technical results to poor workmanship.

2. Kaekoroeakwaan	*7.6 Comments*
1. Implementation activities	This site had many construction problems and flaws.
1.1. Community dialogue	Piloting the main essence. The community is not convinced. This pilot project was for reference.
1.2. Technical assessment of sites	Done correctly
1.3. Follow-up community dialogue	Preferred Kakuramosing site before Kaekoroeakwaan.
1.4. Bill of Quantities	Refer to the model in annexe. Still it is questioned if this BOQ was really implemented (see pictures at TLDP conference room).
1.5. Construction	Failures and hidden flaws. Controversy surrounded workmanship. Unsure about keying of rock and compaction of cement & rubble stones. Improper curing. Wall should have been higher. (Pictures taken during construction are available in the TLDP conference room as example of problems during construction and poor workmanship.)
1.6. Monitor the water table	Done (see 1.6 in table 0 All dams).
2. Objectives of the evaluation	
2.1. Technical standard and quality	As in 1.5 above – not very impressive.
2.2. Impact (community opinion)	Disappointed with the results. Our visit has improved their opinion. Still are expecting improvements. It might be required to dig out the dyke and improve some parts after investigation or even enlarge to a sand dam as pilot project for sand dam with minimal hardware inputs.
2.3. Alternative sources	Trek to Lokiriama at 12 km and Lochor-alomala at 15 km. The SSD is required to reduce walking distance.
3. Terms of Reference:	
3.1. Suitability of the design	The design is OK but not implemented. PE sheeting additional precaution. Chicken wire use not sure.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Fine
3.2.2. Suitability geo-hydrological	No percolation at banks. Fair; one side has loos formation.
3.2.3. Topography for construction	Lateral flows effective. Subsurface flow possible.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Increase more then 2 fold as before only small LS was allowed to the traditional wells and after also large LS + the period increased from 4 to 8 weeks. The team found the dam dry. No impoundment up to 3 m bgl
3.3.2. Water table/availability up/down	No changes. No rainfall to base judgement on.
3.3.3. Period that the community is staying	The site is close to the communities settled area. The animals stay 1 to 2 months. No noted difference since no appreciable rainfall.
3.3.4. Distance covered to get water	Pastureland at 10 km + watering at Lokiriama at 12 km = 22 km
3.3.5. Number of house holds/livestock	HH: 140 / LS: 3000 (mostly shoats before – also large LS after.
3.3.6. No. of traditional wells before/after	4 wells – no much change
3.3.7. Changes in vegetation	No noted changes. The area is considered good to fair in rangeland condition.
3.3.8. Environmental impact	Not an issue. Downstream has it own extensive catchment.
3.4. Cost-benefit	Even with all flaws, the cost benefit is still high.
3.5. Communities' view	Initial hopes frustrated, repeat construction, and increase walls height. Reconsider SSDs at Kakuramosing – coupled with well & hand pump, and spring protection. Exposure tour for community. Increase number of workers
3.6. Subsurface dam technology	This site cannot be used to evaluate the SDD technology because of the (hidden) flaws.
3.7. Alternative livestock water supply	Have seen large LS passing now to Lokiriama.
3.8. Lessons learned	Workers and project staff were not ready do handle this job.

3. Lochoralomala	***Comments***
1. Implementation activities	Well submerge SSD.
1.1. Community dialogue	Consultations made.
1.2. Technical assessment of sites	Done
1.3. Follow-up community dialogue	Agreed. Expressed need for SSDs. Also at Ngakibelbeletio & Lomuroy, both down stream of the current site;
1.4. Bill of Quantities	Same as the one in annexe.
1.5. Construction	Wall not visible (bgl). Top side = 0.6 m. Wings should have been raised as concrete is used.
1.6. Monitor the water table	Done (see 1.6 in table 0 All dams).
2. Objectives of the evaluation	
2.1. Technical standard and quality	Perfect. Assuming basement rock reached and keyed in.
2.2. Impact (community opinion)	Yet to realise. No rains up to now.
2.3. Alternative sources	Currently using Kapok (10 km), Lokiriama (8 km) and Kapel (5 km).
3. Terms of Reference:	
3.1. Suitability of the design	Good. Assuming all dimensions constructed as per the cross sections. Is partly sand dam.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Good.
3.2.2. Suitability geo-hydrological	Subsurface flow possible (will be kept in reservoir). Boulders on upstream. Rocks on banks not consolidated; could leak.
3.2.3. Topography for construction	Loos formation on left side. Small lateral seepage in future possible.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Dry now but intensive use before. Good wells against RHS bank, which is rock. Ideal for well improvement.
3.3.2. Water table/availability up/down	Traditional wells (6 m deep) on upstream in use. None on the downstream.
3.3.3. Period that the community is staying	None around
3.3.4. Distance covered to get water	(Ref. 2.3) to Kapel 5 km + 8 & 10 km as in 2. 3 = 13 – 15 km
3.3.5. Number of house holds/livestock	HH= 100 / LS= 4000 (10 HH permanent)
3.3.6. No. of traditional wells before/after	Before 10, now 10 still
3.3.7. Changes in vegetation	Not very sure. Seems to be as during time of baseline.
3.3.8. Environmental impact	Not an issue. Pastureland 4 – 8 km away. Shoats/kids along riverine as before
3.4. Cost-benefit	Very good dam for cost benefit impact reference (see report).
3.5. Communities' view	Do more beyond SSD. Exposure tour to SSDs and SDs succeeded. Faiths after SSD yields improve the 2 traditional wells upstream.
3.6. Subsurface dam technology	Refer general report. This dam is the best sample for the TLDP. Still need to review the potential for clay.
3.7. Alternative livestock water supply	SSD to SD. Provide well with H/P – alongside SSD. Traditional well improvements.
3.8. Lessons learned	Planning to take into considerations that water sources so developed are for both livestock & human. Think of quality. Migration patterns offers a back-log (human, shoats & kids)

4. Nakoporeteworu	***Comments***
1. Implementation activities	Looks like a sand dam; 2 m above river sand level.
1.1. Community dialogue	Consultations made, especially on site selection
1.2. Technical assessment of sites	Confirmed done. Various river sites / sections checked
1.3. Follow-up community dialogue	Current sites perennial use of wells. Later to reconsider Narisae (U/S) and Ngikukus (D/S)
1.4. Bill of Quantities	Same as per annex. This is more a sand dam.
1.5. Construction	Downstream of wall not trapezoidal – too slant not stepped. RHS chiselled to rock. Need more than 8 workers.
1.6. Monitor the water table	Done (see 1.6 in table 0 All dams).
2. Objectives of the evaluation	
2.1. Technical standard and quality	Strong, but ensure D/S part of wall be slant, not stepped. Better erosion protection required. Use large boulders.
2.2. Impact (community opinion)	Yes. Still having high hopes.
2.3. Alternative sources	Currently using Nayapar (10 km) and Lokiriama (8 Km)
3. Terms of Reference:	
3.1. Suitability of the design	OK. Assume all dimensions constructed as per drawings cross sections
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	No problem. Was in use for existing, good traditional wells.
3.2.2. Suitability geo-hydrological	Appropriate. Can perform better with good flash floods. Subsurface flow possible due to hills and valleys.
3.2.3. Topography for construction	Excellent. Corner upstream more than 50 m. (Excavated earth still on site)
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Dry – no water now but will be when floods come. Big well existing.
3.3.2. Water table/availability up/down	Cannot confirm due to dry wells
3.3.3. Period that the community is staying	1 month only (cattle depleted). If good rains, even 2 ½ months
3.3.4. Distance covered to get water	(Ref. 2.3) Grazing Kapoei (15 km) and Ngikomunei (10 km) + watering (10 km & 8 km res.) = 25 & 18 km
3.3.5. Number of house holds/livestock	HH= 15; LS= ca 3000. No changes. Waiting rains.
3.3.6. No. of traditional wells before/after	Before 4, now 2 (moved elsewhere).
3.3.7. Changes in vegetation	Lack of rainfall; just fair.
3.3.8. Environmental impact	Not an issue. No flash flows. Pastureland also 10 to 15 km away. More sand on upstream.
3.4. Cost-benefit	Very good dam for cost benefit impact reference (see report).
3.5. Communities' view	No benefits yet. May be due to rain. Increase wall height. Another SSD downstream. Hand pump in locality (CCB). Protect Nayapar spring
3.6. Subsurface dam technology	Is more a sand dam. Well positioned. Will perform maximum.
3.7. Alternative livestock water supply	See general report.
3.8. Lessons learned	Downstream erosion protection needs attention. Rubble stones to make downstream slope + large boulders.

5. Nakuwalet	*Comments*
1. Implementation activities	Good SSD but sticking ½ foot out of river level, leading to unnecessary corrosion.
1.1. Community dialogue	Undertaken along side other programme activities. Not happy with the bias for SSD. Prefer more hand pump option or large dam or sand dam.
1.2. Technical assessment of sites	Confirmed done. Various sections along stream assessed.
1.3. Follow-up community dialogue	High expectation on new technology, based on acute water problems.
1.4. Bill of Quantities	
1.5. Construction	Good. Trained foreman worked with community.
1.6. Monitor the water table	Done (see 1.6 in table 0 All dams).
2. Objectives of the evaluation	
2.1. Technical standard and quality	Good; if constructed as per drawing
2.2. Impact (community opinion)	Fair. Lack of appreciable rainfall causing disappointment. Depleted layer.
2.3. Alternative sources	N^O of livestock deployed water Lokiriama (5Km) the trading and administrative centre. The river has there many wells and one hand pump. Many camels and cattle were passing during visit.
3. Terms of Reference:	
3.1. Suitability of the design	Trapezoidal shape concrete, mud internally, chicken wire around, key in rock. Polythene sheet additional precaution.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Fine
3.2.2. Suitability geo-hydrological	Clearly a good river for SSD. It will create extra storage.
3.2.3. Tor graphy for construction	Ideal site for extension to sand dam and later water pan on the RH riverbank, with appropriate silt traps. Gradual gradient. Right bank for spillway.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Dry at the time of study. WT 3 m bgl (upstream). Increased use – before only small LS – now also large LS + period of watering extended from 4 to 8 weeks
3.3.2. Water table/availability up/down	Available upstream. Tradition wells downstream mostly in use. No influence – have different catchment
3.3.3. Period that the community is staying	2-months. But increased influx of livestock. Area is continuously settled.
3.3.4. Distance covered to get water	Lochoralomala (5Km) + Pasture (15Km) = 20 Km away from dry season grazing lands
3.3.5. Number of house holds/livestock	200 households, livestock 3000 at any one time (seen about 3000 during our visit, passing to downstream wells).
3.3.6. No. of traditional wells before/after	11 always. Variance has been on water table
3.3.7. Changes in vegetation	Not much change.
3.3.8. Environmental impact	Not an issue. See general report.
3.4. Cost-benefit	Very good dam for cost benefit impact reference (see report).
3.5. Communities' view	High expectation on SSD preferring SD. Other SSDs (4No) downstream of the current site. Hand pump on shallow well for back up.
3.6. Subsurface dam technology	Has some impact. Good pilot project. Low cost. Easy maintenance but dependent on rainfall
3.7. Alternative livestock water supply	Incorporate well with hand pumps
3.8. Lessons learned	This could have been good clay SSD. Missed opportunity to introduce clay only SSD.

6. Kopeto (new site)	***Comments***
1. Implementation activities	Community eager to start. Implementation delayed for assessment visit. Wide riverbed.
1.1. Community dialogue	Done to satisfaction. Excellent results seen on site and during meeting. Need info as per above comments on preparation of the water projects.
1.2. Technical assessment of sites	Documented.
1.3. Follow-up community dialogue	Embraced the approach, ready to start.
1.4. Bill of Quantities	Refer to annex. May reduce hardware inputs.
1.5. Construction	Materials collected by community already on site waiting for the project: sand, clay, rubble stones; access road cleared. Casual labour is tedious job.
1.6. Monitor the water table	People and LS are still drawing water at 1.5 m bgl.
2. Objectives of the evaluation	
2.1. Technical standard and quality	Expected to be of good quality. Will be concrete SSD.
2.2. Impact (community opinion)	Improved recharge of traditional wells. Central point from grazing areas.
2.3. Alternative sources	Watering within Kopeto riverine and Ngataparin (8km)
3. Terms of Reference:	
3.1. Suitability of the design	No problem if constructed to plan. This side was ideal for clay SSD, plenty available. But now no more changes possible as community is ready with materials for concrete construction.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Okay. Central point from grazing areas.
3.2.2. Suitability geo-hydrological	Very good. Large reservoir length. Many traditional wells confirming impervious riverbed. The SSD will increase height of water table.
3.2.3. Topography for construction	Gentle slope upstream to increase infiltration and percolation.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Not very dry. Still 3 to 4 wells 2 m bgl operational.
3.3.2. Water table/availability up/down	Upstream wells at least 2-m bgl.
3.3.3. Period that the community is staying	Are staying close to the site.
3.3.4. Distance covered to get water	Grazing Moruangidirin, Kapel, Kakore, Ngirokipi (3, 4, 7 & 10 km) hence 11-18 km
3.3.5. Number of house holds/livestock	HH 150 / livestock = 6000
3.3.6. No. of traditional wells before/after	3 wells existing to increase after intervention.
3.3.7. Changes in vegetation	Riverside vegetation always fair to good. Many green trees.
3.3.8. Environmental impact	Not an issue currently.
3.4. Cost-benefit	Will be very good dam for cost benefit impact reference (see report).
3.5. Communities' view	Start immediately tedious work other streams for SSD consideration are Ngakainin, Akuja-ekalale
3.6. Subsurface dam technology	Refer general report
3.7. Alternative livestock water supply	
3.8. Lessons learned	SSD are well promoted with communities waiting for assistance.

7. Lochwailima (new site)	*Comments*
1. Implementation activities	Ideal site for sand dam. Many good wells. Continuous subsurface flow to be harvested.
1.1. Community dialogue	Perfectly done, but need info as per above comments on preparation of the water projects
1.2. Technical assessment of sites	Reallocated the dam axis to reduce wall volume.
1.3. Follow-up community dialogue	Agreed on site.
1.4. Bill of Quantities	Prepared. Refer to annex. Will be concrete construction.
1.5. Construction	Community contributed materials on site (sand, ballast rubble stone) is ready. Access road cleared.
1.6. Monitor the water table	Many wells still operational. Existing small subsurface flow will be kept in reservoir. Is now over rocky bottom of riverbed.
2. Objectives of the evaluation	
2.1. Technical standard and quality	Expected to be of good quality
2.2. Impact (community opinion)	Foresee impoundment of a lot of water on the upstream
2.3. Alternative sources	Nakatwan (15 km), Kosipir (10 km) & Lobole (12 km)
3. Terms of Reference:	
3.1. Suitability of the design	No problems anticipated if constructed as required. Chiselling of major importance.
3.2. Appropriateness of the sites	
3.2.1. Accessibility to community	Easily accessed
3.2.2. Suitability geo-hydrological	A real good site, which will impressive results. Catchment undulating backwards.
3.2.3. Topography for construction	Narrow river section. Hard rock formation not fair below ground. Protruding rock to be part of the wall. Reliable wells existing upstream. Good for sand dams.
3.3. Changes (community opinion)	
3.3.1. Water table/availability in dam area	Traditional wells existing; continuous recharged. Dam will keep WT high.
3.3.2. Water table/availability up/down	Many upstream wells in 3 m deep.
3.3.3. Period that the community is staying	Period may be increased with the intervention.
3.3.4. Distance covered to get water	Grazing Rikinei (6 km) and Kalobosomoe (6 km) hence distance = 16 – 21 km
3.3.5. Number of house holds/livestock	Approx. 300 HH in sub-location; livestock over 10,000 (shoats, camels, and donkeys)
3.3.6. No. of traditional wells before/after	8 no traditional wells existing in dam area.
3.3.7. Changes in vegetation	Dries during drought. Riverine will suffer but only a small area of it.
3.3.8. Environmental impact	Minimum impact expected (If any).
3.4. Cost-benefit	Will be very good dam for cost benefit impact reference (see report).
3.5. Communities' view	Raring to start construction immediately. Work to take 2 months. Engage about 20-workers. Reconsider SSDs at Poya, Lochor-Angigilae, and Nayanae-Arodo. Repair hand pump.
3.6. Subsurface dam technology	This SSD or SD will be an excellent reference of increased water from sand rivers.
3.7. Alternative livestock water supply	Repair Lochor-Edome hand pump. Community management and improve 2-tradition wells along river.
3.8. Lessons learned	Effective community dialogue enhances community participation.