SAPARM
Satellite Assisted Pastoral Resource Management
THE SHEPHERD'S EYE IN THE SKY

Milestone Progress 1 Report (Award Date + Approximately 45 days)

Finalized Memorandum of Understanding between PCI, DRMFSS, DPFSCO, and WFP: PCI has finalized an agreement with the Government of Ethiopia. As the Bureau of Finance and Economic Development (BoFED) is now charged with managing project agreements between US NGO's, the agreement is signed by BoFED and the DPFSCO (see attached). A separate MOU is being signed between PCI and WFP. That letter is still being processed in Rome and should be completed within the next two weeks.

Approval of study methodology by PCI's internal Review Board. An application for the project was submitted to PCI's Internal Review Board on August 29th. The IRB subsequently reviewed and requested response to a series of questions. The team responded to the satisfaction of the IRB and the study design was approved on September 11, 2013 (see attached)

Updated marketing and communications plan: PCI has developed a more precise name for the model as well as a proposed logo. The name for which we will be referring to the project and model from this point forward is *Satellite Assisted Pastoral Resource Management (SAPARM).* We've developed a proposed logo to show partnership involvement and which we would like to use in all documentation and reports from this point forward (see top of page). PCI has attached a revised branding and marking plan reflecting the project name and logo for USAID's review.

Completed woreda field assessment and final confirmation of case/comparison woredas: PCI initiated this process with a list of all of Afar's 30 woredas. From that list we eliminated all woredas that were not exclusively or primarily pastoral. Working with DRMFSCO, PCI's team developed a final list of 6 candidate woredas – sub-divided into two groups based on anticipated different migration patterns. We then selected one woreda within each of those groups based on a combination of knowledge of the area and their experience with drought, general accessability and pairing of case/comparison woredas with adequate distance from each other. The woredas selected were Telalak and Simurobi. A coin was flipped to determine case and comparison woreda. Based on the coin toss, Telalak was assigned as the intervention community and Simurobi as the comparision. Field assessment visits were made to both woredas during the week of July 29th during which time community members participated in a general migration mapping exercise. At that time it was discovered that Simurobi's migration patterns actually overlapped with Telalak's during periods of drought. Therefore, we elected to identify another comparision community for the final candidate list. Megale was selected based on similar conditions of being highly affected by drought and moderately accessible. A site visit was made the week of August 9th. Based on the general migration mapping it was determined that Megale and Telalak migration patterns do not overlap and thus Telalak would continue to serve as the intervention community while Megale would serve as the comparison. A detailed is being conducted for both communities this week which will serve as the basis for integration with the LEAP platform.

Updated project implementation plan with updated evaluation strategy: Attached is the IRB application which outlines PCI's implementation and evaluation strategy. In addition, we are attaching the final draft baseline instrument which has been developed by field and IO team members including Deanne Samuels, Chris Bessenecker, Walleligne Beriye and Mersha Tefsa. In addition, the baseline was submitted for review by Dr. Jay Angerer at Texas A&M's Center for Natural Resource Information Technology (CNRIT). The baseline will be field tested and finalized in the next three weeks. The timeframe for implementation has not changed from that which has been proposed in the Milestone document.

Attachments:

(1) GOE Project Agreement
(2) IRB Approval
(3) IRB Application (Final Evaluation Design and execution strategy)
(4) Final Draft Baseline instrument
(5) Branding and Marking Plan REVISED

SAPARM
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Milestone Progress 2 Report (Award Date + Approximately 135 days)

This milestone report covers deliverables to be completed during the second Milestone (through December 30) as defined in Annex 2 of PCI's Agreement. This includes the following:

- A baseline assessment that includes information on average herd loss in intervention and non-intervention communities, information on the use of technology to make herd movement decisions, current capacity measures of government staff and clan leaders, and any necessary information on potential confounding factors.
- Completed mapping exercise of woreda grazing grounds.
- Completed customization of LEAP parameters to the specific needs of the pilot.
- Status report on training of DPFSCO/EWRD staff on customized LEAP download and community transfer protocol.
- Status report of community sensitization on information for decision making.
- Status report on transfer of data to case woredas.
- Update on data monitored and collected during the reporting period.
- Completed design of a cost-benefit analysis for the study which includes all required inputs and values for the costs and benefits, as well as a brief description of any relevant assumptions and definitions.

Progress towards these milestones:

(1) A baseline assessment that includes information on average herd loss in intervention and non-intervention communities, information on the use of technology to make herd movement decisions, current capacity measures of government staff and clan leaders, and any necessary information on potential confounding factors.

The baseline data was collected in October of 2013. The baseline consisted of a formal survey using a structured questionnaire and was conducted in both intervention and comparison woredas. In addition, it was planned that focus group discussion would be conducted within the targeted pastoral community to obtain information about their migration decision, destination, distance from their community, information sources for decision making, reliability of information, seasons of migration and other related issues. These focus group discussions would help to triangulate information obtained through the survey method.

Survey: The survey (See Attachment 1) was completed among 697 residents split between the case and comparison communities. The final report is still being compiled and should be completed by the next milestone.

Focus Groups: During October 2013, a team of experts from PCI Ethiopia and Pastoral and Rural Development Offices of Megale and Telalak Woreda carried out 8 focus group discussions as part of the baseline data collection process. Participants were carefully selected from different villages of the target kebeles. Kebele Chairmen and other community key informants were invited in all the focus groups. Most of the groups were deliberately arranged to be gender specific. Fifty-six people participated in the focus group discussion. Four sites in each woreda were recommended by the woreda experts to undertake the focus group discussions because of their geographical location and representativeness to the other kebeles in the woredas. Discussion points were broken into six main areas and reflected questions similar to those of the survey questionnaire:

a) migration decisions (destination, distance, migration seasons, information sources etc);
b) reliability, speed and cost of information sources;
c) current herd size and cost (wealth ranking);
d) herd size and loss over the last three years;
e) community copping strategies for 'difficult times'; and
f) relevance of agro climatic information for improved decision making.

Some of the key findings of the focus group were as follows:

(1) Migration patterns can vary based on season, onset of rain and type of animal with distances ranging from 3-14 days;
(2) Long-range migration with all animals requires whole-family movement while shorter, select animal migration may not;
(3) Evaluating current information sources for migration (i.e. Dagu, Scouts and Previous Experience) against the parameters of cost, speed and reliability, Dagu was rated best on cost, slightly above average on speed and below average on reliability; Scouts were ranked best on reliability but somewhat costly and moderately slow; Previous experience was ranked best on cost and speed but very low on reliability.
(4) Proportional piling methods indicate herd losses of 33-69% over the last 3 years across all species with cattle having the highest impact.
(5) Most pastoralist were optimistic about the added value of SAPARM indicating that it would assist them in making better decisions and understanding the progress of the grazing fields.

To determine herd loss and cause, PCI used the *Proportional Piling method.* The method is considered a more reliable measure of herd loss compared to direct questioning (as done within the survey) as it removes the motivation for providing inflated/deflated responses. The method sought to assess average herd losses using a theoretical start point of 100 of each species over the last three years as well as condition and price of surviving animals. The results were as follows:

Table-7 Herd Size and Loss analysis- Megale

Animals that Died			Causes of Livestock Death								Animals that Survived		Conditions Of Survived & Livestock & Average Price								
Species	#	%	Pasture		Water		Disease		Others				Good		Average	Medium		Average	Poor		Average
			#	%	#	%	#	%	#	%			#	%	Price	#	%	Price	#	%	Price
Camel	38	38%	14	37%	5	13%	13	34%	6	16%	62	62%	22	35%	9500	25	40%	6750	13	21%	4400
Goat	35	35%	11	31%	4	11%	12	34%	8	23%	65	65%	29	45%	740	20	31%	435	16	25%	325
Sheep	48	48%	22	46%	5	10%	12	25%	9	19%	52	52%	15	29%	1375	18	35%	800	19	37%	375

Table-8 Herd Size and Loss analysis- Telalak

Animals that Died			Causes of Livestock Death								Animals that Survived		Conditions Of Survived & Livestock & Average Price								
Species	#	%	Pasture		Water		Disease		Others				Good		Average	Medium		Average	Poor		Average
			#	%	#	%	#	%	#	%			#	%	Price	#	%	Price	#	%	Price
Camel	44	44%	15	34%	4	9%	12	27%	13	30%	56	56%	19	34%	13000	16	29%	9000	21	38%	6500
Cattle	69	69%	30	43%	15	22%	19	28%	5	7%	31	31%	5	16%	2500	9	29%	1300	17	55%	900
Goat	33	33%	15	45%	4	12%	11	33%	3	9%	67	67%	30	45%	950	14	21%	450	23	34%	275
Sheep	42	42%	20	48%	8	19%	9	21%	5	12%	58	58%	18	31%	750	28	48%	450	12	21%	325

As the table indicates, pastoralists in Megale do not shepherd cattle but those in Telalak do. Telalak cattle suffered the greatest losses of all species with more than two-thirds dying. With regard to the other species, the mortality rates between the two communities were similar with a variances of only 2-6 percentage points. More than one third of all herd species died over the last three years primarily due to lack of pasture followed by disease and water. Due to proximity of markets, the overall price for animals of various grades are significantly better in Telalak than in Megale. Of the surviving herd, there was little variance between Megale and Telalak of animals classified as being in "good" condition but greater variance among the lower grades (medium and poor). Once the survey results are complete, we can triangulate the data.

(2) Completed mapping exercise of woreda grazing grounds.

Based on a written protocol, PCI conducted a participatory community mapping exercise in both intervention and comparison communities. In Telalak, 22 key informants from kebeles and 4 experts from woreda Office of Agriculture were invited. All the kebeles were represented by one Chairman and one key informant (pastoralists). After a brief introduction of PCI, the

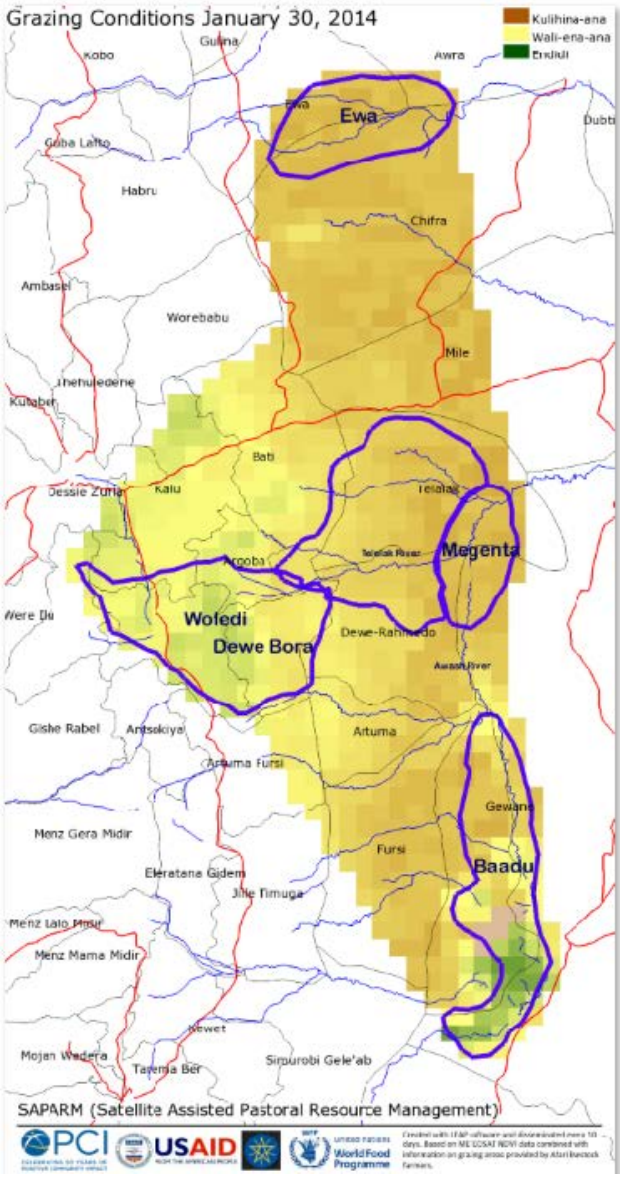
Participatory mapping exercise and end product

project and the objective of the community mapping, PCI laid out using 1:20,000/1:25,000 Thematic and Topographic maps on big tables. Participants were broken into two groups to begin delineating the traditional grazing grounds using both thematic (i.e. rivers, roads, etc) reference points and topographic (i.e. elevations, towns, etc.). Participants not only delineated grazing grounds but indicated whether the location was for 1) wet seasons, 2) the dry season, 3) extreme dry seasons, and 4) in severe drought seasons. Ultimately, the two groups debated and completed the delineations on the topographic map as shown below. Each grazing area was also accompanied by the local name given by the woreda. This process was replicated in Megale.

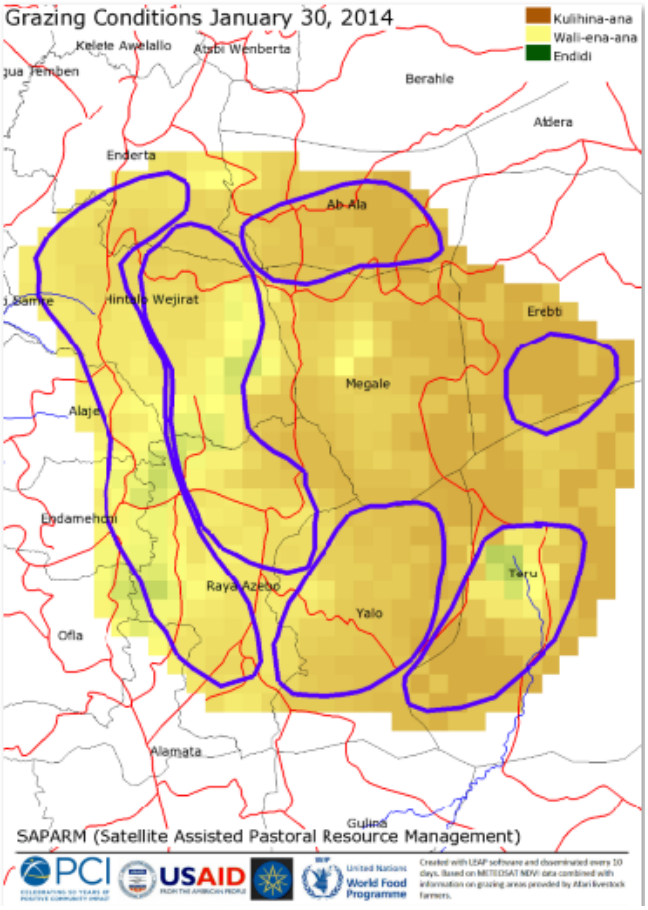
Once complete, PCI cross-checked with host communities (via their woreda administration offices) to determine whether or not pastoralists from the community of origin are permitted to graze in those locations. In all cases, there were no inconsistencies between what the origin and host community stipulated.

(3) Completed customization of LEAP parameters to the specific needs of the pilot.

Once the participatory mapping process was completed, the maps were sent to LEAP's developer, Peter Hoefsloot, for integration into LEAP and overlay with NDVI data. This was a consultative process to determine the best presentation of the map to make it simple and accessible to the users. Ultimately it included just the encircled areas of grazing along with the community given name, as well as what we have referred to as LIDs (Locally Identifiable Descriptors – woreda names, rivers, roads, etc.) NDVI data was overlaid for the grazing areas as well as corridors between those areas. All surrounding areas were left white to deter any unintended movement out of the traditional grazing grounds. A key in Afari indicates the high, middle and low ranges of coloration – green, yellow, brown without placing any perceived value on those colors. These maps are now auto-generated every 10 days and are presented as follows:



SAPARM Generated Map for Telalak's defined traditional grazing grounds



SAPARM Generated Map for Megale's defined traditional grazing grounds

(4) Status report on training of DPFSCO/EWRD staff on customized LEAP download and community transfer protocol.

Orientation and training on use, interpretation and dissemination of the SAPARM maps were conducted with Afar DPFSCO/EWRD staff in November. A total of 12 people participated in the workshop (2 - Afar Region BoFED; 2 - Afar regional DPPFSCO, 2 - Megale woreda pastoralist office; 4 - Telalak woreda pastoralist office; 2 - PCI Ethiopia). The purpose of the workshop was to orient stakeholders as to the purpose, process and anticipated results of the innovation and study. PCI clarified the potential value

as well as limitations of the information and how it will be integrated with the existing government extension systems and the Early Warning Information System.
Stakeholders involvement in institutionalizing the ideas of the project and support on challenges encountered were also discussed.

During the discussion, a participant mentioned that pastoralist know every drop of rain if it is within their woreda boundaries. The map will add value if it could cover large area outside the target woreda perimeter (as it does). The participants also mentioned that the idea of the project is really innovative. One of the participants commented that if there is no significant change within ten days, dissemination should not be a must. In addition, participants stressed the importance of setting out a proper dissemination plan. Going out to the community and disseminating paper will not add any value. Instead it is important to discuss the changes in the grazing fields with the community members.

Another crucial point discussed was the connectivity issue which was a challenge in the course of implementation. It was mentioned that government is planning to launch internet service in all Afar woredas so that the connectivity problem will be solved as soon as possible. The last point raised here was about installing a wireless network. The government has completed the necessary payment so that Ethiopian Telecommunication will restart the program very soon in Telalak.

(5) Status report of community sensitization on information for decision making.

Discussion was held with 11 community representatives and 3 woreda focal persons in Telalak for establishing an information dissemination protocol and presentation of finished maps to the target community. Participants were invited to answer the following questions:

Who will involve in the information dissemination process at woreda level?
Who will be the focal person at kebele level?
How the information will reach into the different villages?
How the existing social capitals such as Dagu and Eddo (scouts) will be integrated into the dissemination process?
How the information will be presented to the ultimate users?

Three woreda focal persons were already selected from the woreda Pastoral Development Coordination Office prior to the discussion. The participants agreed that kebele chairman will be the primary contact person at kebele level. However, in his absence, the deputy chairman or anyone in the kebele administration will represent him. It was agreed that the contact person must be someone who can read the map and transfer the information to village level representatives. It was also agreed that a village level representatives who will be responsible for receiving the information from the kebele chairman and disseminating it to pastoralists in their village. In the villages, the existing traditional information sharing systems such as Dagu and Eddo were agreed to be the main tool to reach villagers with the map information. In all the information sharing chains, focal persons can present the information to individuals or group of people. In presenting the map, the focal person explains the legends and other information on the map to the next contact person by using a color map.

(6) Status report on transfer of data to case woredas; and **(7) Update on data monitored and collected during the reporting period.**

To date, three cycles of SAPARM maps have been disseminated (Dec. 10, 20 & 30) just prior to dry season migration for most pastoralists. In total, 132 copies have been disseminated to 11 kebeles with a reach of 16,455 households.

Thus far, 132 maps have been disseminated to 11 kebeles of Telalak in three cycles (i.e. 4 per kebele per cycle). It was agreed that the woreda focal persons were responsible for printing and disseminating the information to kebele contact person. However, because of the absence of connectivity in Telalak, SAPARM/DIV's Senior Research Officer has been printing and presenting the maps to woreda focal persons. Then the maps are presented in each kebele to a group of people led by the kebele chairman. During this process, PCI takes advantage to sit together with the community representatives and discuss other related issues such as weather, migration patterns of the pastoralists, and pasture and herd conditions.

The initial feedback indicates that the maps are highly valued and contributing to migration decision-making. The followings are quotes from what pastoralists about information they saw on the three cycles of maps.

> *"The information saves time, money and energy because it provides us preliminary information on vegetation conditions of our traditional grazing fields."*
>
> *"It validates the information we receive from scouts."*
>
> *"It helps us to make informed decision on where to send scouts"*
>
> *"We would like this information to be permanent"*

(8) Completed design of a cost-benefit analysis for the study which includes all required inputs and values for the costs and benefits, as well as a brief description of any relevant assumptions and definitions.

Final design for the cost-benefit analysis will be conducted once the baseline results have been analyzed. We anticipate having this ready for the next Milestone report.

Attachments:

(1) Final baseline survey

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Milestone Progress 3 Report (March 30)

This milestone report covers deliverables to be completed during the third Milestone (through March 30) as defined in Annex 2 of PCI's Agreement. This includes the following:

- Status report of community sensitization on information for decision making.
- Status report on transfer of data to case woredas.
- Midterm field assessment of project progress based on indicators and methodology approved in Milestone 1.

Progress towards these milestones:

(1) Status report of community sensitization on information for decision making.

A one day sensitization workshop was organized and facilitated by PCI on Mid November, 2013 in Semera. The purpose of the workshop was to create a common understanding among key stakeholders from Afar Regional DPPFSCO, BoFED and Pastoral Development Offices of the two target woredas on the objectives of the project and planned activities. In addition, PCI planned this workshop to clarify the potential value as well as limitations of the information and how it will be integrated with the existing government extension structure and early warning system. Another purpose was to discuss their level of involvement and support on challenges encountered so far. This has been followed up with monthly follow up by PCI's chief project manager to assess whether or not the maps are being understood, used and impacting decisions-making.

Pastoralist quickly picked up that the maps reflects areas of vegetation without distinguishing between types of vegetation (pasture, prosopos, crops, etc.). This has not been an impediment as indigenous

knowledge of the areas on the map allow them to filter the data in a way that enhances decision-making. All indications are that this is actually occurring – which was substantiated by the mid-term review (see below). One interesting aspect this year is that the size of the traditional grazing fields have shrunk even more due to a national level effort executed at the woreda level (including those within host communities) to cordon off land for rehabilitation and large scale natural resource conservation. The pastoralists said "If a single shoat penetrated into the closed areas, we pay 100 Birr." It is still not known to what degree this may limit SAPARM's impact. Nonetheless, the ultimate goal of the conservation effort is to actually increase the availability of healthy vegetation and prevent overgrazing so we view this as a positive measure that, in combination with SAPARM, increases the long-term availability of pasture and improved accuracy in finding it.

(2) Status report on transfer of data to case woredas.

The main objective of the project is to improve pastoral community migration decision through provision of geo-satellite generated vegetation maps that lead to reduced risk of livestock loss. Every 10 days the maps are automatically generated and sent as 163kb [.png] file. These maps were distributed starting December 10, 2013, just prior to the dry season migration for most pastoralists. Orientation and training on use, interpretation and dissemination of the SAPARM maps were conducted with Kebele leaders, EWC representatives and Afar DRMFCC staff between in October and November. Up until the mid-term, nine cycles of SAPARM maps have been disseminated (Dec. 10, 20, 30, January 10, 20, 30, February 10, 20, 30) In total, 352 maps, or approximately 40 copies per cycle are printed out in color by PCI staff and delivered to the Woreda Pastoral Development Office. They are subsequently distributed to kebele representatives. The kebele representatives witnessed that they have received 30-40 maps on average so far from PCI and Woreda Pastoral Development Office. The kebele representatives received the maps in their kebele and they were responsible to distribute the maps to village representative. Their role was not limited to transferring the maps to village representative rather they have been sharing the information to pastoralists through cell phones and Dagu. Kebele representatives have been calling village representatives to kebele centers for short meetings to explain the contents and the legends of the maps. Each village representative has received 4-6 maps on average from kebele representatives thus far. The role of the village representatives has been disseminating the information on the vegetation maps to pastoralists in their village through Dagu. Then pastoralists share the information among themselves through Dagu as usual. Through this process, it is projected that the SAPARM data is reaching much of the 16,455 pastoral households. In fact, they are reporting that information is being shared in adjacent woredas as well.

(3) Midterm field assessment of project progress based on indicators and methodology approved in Milestone 1.

The purpose of the mid-term review was to assess the process and learning thus far from the SAPARM pilot. Specific the objectives were:

1. To review the relevance, quality, and user-friendliness of the SAPARM tool; where possible, assess compliance of users with different aspects of the SAPARM, such as contents and timeliness of the information, etc.
2. To assess the efficiency and effectiveness of the geo-satellite information delivered.
3. To assess the uptake and appropriation of the SAPARM amongst pastoralists.
4. To identify both the motivators/enablers and challenges/bottlenecks that have been encountered and could be opportunities or risks for wider effective uptake

The methodologies include a review of the project proposal, project reports, focus group discussions and field observations. Observation of the both the project areas and the host community was conducted by the review team.

A field work in Afar (Telalak and Megale) was conducted in first week of March 2014 by a team consisting of one senior expert from PCI Ethiopia, three government representatives from Telalak woreda, three government representatives from Megale woreda. A total of six focus group discussions (four in Telalak and two in Megale) were conducted to review overall program progress. In addition, discussion was held with five government representatives with the same purpose. Each focus group included a minimum of six people. Participants were carefully selected from different villages of the target kebeles. Kebele Chairman, four village representative and two pastoralists/beneficiaries were invited in all the focus groups. Discussion sites were deliberately selected from different corners of the woredas to make sure the representativeness of information of target communities. Some relevant observations and conclusions from the Mid-Term review are as follows.

Weather/Climate: Telalak has a bimodal rainfall pattern, with a main wet season from July to September (KARMA) and a short wet season from March to April (Sugum). There is also a very short rainy season in the second half of December (DEDAE'). The rainfall pattern is similar in Megale. The amount and distribution of the main rainy season this year was not adequate. Moreover, there was no DEDAE. During the fourth week of February, there was light rain for three days in Telalak woreda. As a result, the bush in most parts of the woreda turned light green. The grass under the bush is still dry. The pastoralists are not optimistic about the current greenness in their locality because they know the color turns brown in 10 days or so.

Migration: Following the poor Karma (main wet season) and absence of Dedae (short rainy season in December), migration started early in the year in both woredas. More than 95% of Telalak pastoralists were out migrated to the traditional grazing fields at the time of the review. Only teachers, students and kebele leaders have remained in their community. The participants have indicated that more shoats and elderly are migrating due to the lack of pasture in intervention and control communities.

Influence of SAPARM maps: The pastoralists who participated in the focus group discussion, fully agreed that provision of the SAPARM map has improved their decision making in terms of where and when to migrate, where to send scouts. They have even indicated that it has influenced others outside of Telalak. Here are some of the responses:

"This is a new initiative in our community. We want a timely and continuous provision of the map. Before, we have been sending scouts based on nothing. The scouts have been spending a lot of energy to find appropriate grazing fields. Now the maps gave us initial information to decide where and when the scouts should go out. Take for example; Ewa is one of our traditional grazing fields. When we look at the map, Ewa has been dry for the last five months. As a result, no pastoralist has sent scouts or migrated to Ewa in this year"

"The information on the maps is particularly important for camels because camels feed on a bush and we know from experience where the bush lands found. Therefore, if the bush lands are green or light green on the maps, it is possible to send camels without a confirmation from scouts. For example, last December I sent my camels to Dewe Harewa based on the information on the map and the grazing field was good and my camels are still there. However, it is not possible to send shoats and cattle before receiving a confirmation from scouts because the map does not differentiate between trees and grasses."

"We want a continuous provision of the map. We used to rely on Dagu to send scouts. Hearing and seeing are totally different. In Afar, we say 'hearing makes your ear fat'. In other words, hearing makes you rich with information. Seeing is more powerful. That is why we need the map"

"In this year all pastoralists have migrated to those areas shaded with green in the map. Traditionally, we used to migrate to Bati and Ewa areas. This year no pastoralist has migrated to these areas because these two areas were dry on the map"

Issue of over-population: Over-population of certain areas have occurred according to pastoralists however, not necessarily as a result of the maps. For one, due to poor rains throughout Afar this year, many more pastoralists from other areas have been migrating to the same areas that Telalak pastoralists have migrated to. In some cases, there was a sense that if they had their own maps of their grazing areas, they perhaps would have migrated elsewhere. Afari's also have a culture of sharing so if some are worse off in one area. Finally, the positive coping mechanisms of fencing areas for conservation and restoration discussed above has mean fewer than usual pasture areas have been open to the pastoralists forcing more animals into fewer areas. Where the maps may play a role is if information from them (due to Dagu) are transmitted to areas outside Telalak and those areas don't have maps themselves for their traditional grazing areas. This was actually brought up by some of the participants. However, from this process we've learned that the hose community takes their responsibility seriously as well. Each year prior to the dry season a committee is established between the host community and the guest pastoralists to establish rules for use, policing themselves and other issues of coordination. This is a traditional management technique that has worked for many years. A potential positive contribution of the SAPARM maps that representatives have also expressed is that the maps actually help them employ more effective land management as weak (yellow/brown) fields are let to lay fallow and recover while focusing on more healthy vegetation. Further exploration of this issue will be the topic of the next phase of the project.

Enablers/Bottlenecks: A full scale involvement during the phase-in stage and gradually downsizing PCI's participation to zero level is one objective behind this project. In order to realize this, linkages with existing government structures is imperative. The woreda Pastoral Development Office is the main government partner of the project at woreda level and has a structure which extends from woreda

center to kebele level. In terms of human resource, the woreda Pastoral Development Office has the capacity to take-over and sustain the positive impacts of this intervention beyond the project period. However, it is still important to strengthen the office in terms of materials and trainings. For example, the office has only 3 motorbikes to cover 11 kebeles which is much less than the number of staffs working in the office. The sustainability of this project depends on availability of transportation facilities. Internet connectivity is also important in order for them to receive and print the maps themselves. Enablers include the high demand for the maps by community, the low cost (even with PCI printing and distributing down to the woreda level) and simplicity of the intervention making it easy to transfer and scale.

Milestone 4 Progress Report (June 30)

This milestone report covers deliverables to be completed during the fourth Milestone (through June 30) as defined in Annex 2 of PCI's Agreement. This includes the following:

- Update on project implementation including any challenges and successes encountered, as well as any data collected and analyzed during the reporting period.

- Status report on transfer of data to case woredas.

Progress towards these milestones:

(1) Update on project implementation including any challenges and successes encountered, as well as any data collected and analyzed during the reporting period.

As of June 30 the critical dry season in Afar, including Telalak and Megale ended prompting the return of many pastoralists back to their communities of origin. In early June, PCI began the process of planning for the final evaluation. As we had just completed focus group discussions as part of the mid-term, the final evaluation would focus primarily on an endline population-based survey in both Megale and Telalak. As of the end of June the survey had been completed and data entry and cleaning initiated. After a one day dissemination workshop on the findings of the survey, a final endline report will be completed by end of August.

WFP representatives in Rome and Addis continue to be engaged in the project. Prior to the end of the project, WFP and PCI will joint give a five day training for 20 Regional and woreda level experts in Afar on the integration of the application of SAPARM using the LEAP platform. Peter Hoefsloot, developer of the LEAP platform for WFP and responsible for integration of SAPARM within LEAP, has shared our work with the government of the Netherlands and other non-profits he is associated with who work with pastoralists in West Africa. This has led to discussion of potential prototyping/scaling in West Africa as well. This, in part, will hinge on the final results. PCI and WFP will also give presentation on the progress and results of the project to DRMFSS at national level.

Chris Bessenecker, the Technical Project Supervisor for the project, travelled to Washington D.C. at the end of April and met with Peter Khaemba and other members of the DIV team to talk about the project and present the mid-term results. Several strategies related to scaling were discussed. Another trip in July is scheduled to present the preliminary findings of the final evaluation.

If the results of the final evaluation mirror the success we observed through mid-term analysis, PCI will seek to submit for a Phase 2. Under that phase, one focus will be on the best method to ensure continuous dissemination (i.e. government, non-profit, private sector) as well as exploring methods to amplify positive outcomes related to natural resource management and mitigate any potential negatives.

(2) Status report on transfer of data to case woredas.

As discussed in Milestone Report #3, the main objective of the project is to improve pastoral community migration decision through provision of geo-satellite generated vegetation maps that lead to reduced risk of livestock loss. Every 10 days the maps are automatically generated and sent as 163kb [.png] file. These maps were distributed through June 10, 2014. Through this process, it is projected that the SAPARM data has reached much of the 16,455 pastoral households.

PCI

CELEBRATING 50 YEARS OF POSITIVE COMMUNITY IMPACT

Reaching Pastoralists
Through Geo-Satellite Information
for Improved Decision-making

Project Completion Final Report

SAPARM

Satellite Assisted Pastoral Resource Management

THE SHEPHERD'S EYE IN THE SKY

August 2014

1. GENERAL INFORMATION

Project Title:	**Reaching Pastoralists with Agro Climatic Data for Improved Decision- Making**	
Contact Details:		
Name of focal point:	**Primary**	**Secondary**
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2. PROJECT SUMMARY

Organisation:	Project Concern International (PCI)
Project Manager:	Mersha Tesfa
Location of Project	Telalak and Megale Woredas of Afar region
Duration:	One year
Start Date:	August 1, 2013
End Date:	July 31, 2014
Reporting Period:	Annual performance Report
From:	August 1, 2013
To:	July 31, 2014
Sector of Intervention:	■ Climate Change; Disaster Risk Reduction
Target Population: The number of households that benefited from the project directly in the case woreda (Telalak) is 6,025 where 97% are pastoralists and the remaining 3% are agro-pastoralists.	

List of Acronyms

ACF – Accion Contre le Faim

BCR – Benefit Cost Ratio

BoFED - Bureau of Finance and Economic Development

CNRIT - Center for Natural Resource Information Technology

DPFSCO – Disaster Prevention and Food Security Coordination Office (Regional body)

DRMFSS - Disaster Risk Management and Food Security Sector (National body)

EWRD - Early Warning and Response Directorate

FAO - Food and Agriculture Organization

ILRI - International Livestock Research Institute

LBC - Livestock Body Condition

LDM - Livestock Drought Management

LEAP - Livelihoods, Early Assessment and Protection

NDVI – Normalized Differential Vegetation Index

NPV – Net Present Value

PCI – Project Concern International

SAPARM – Satellite Assisted Pastoral Resource Management

VAM – Vulnerability Assessment and Mapping

WFP – World Food Programme

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1. GOE Letter of Agreement
2. MOU with World Food Programme
3. Participatory Community Mapping Protocol
4. Detailed Mapping Report
5. IRB Approval
6. Endline Survey

I. PROJECT SUMMARY

Pastoralism in Ethiopia, and Africa more generally, is characterized by a high reliance on livestock as a source of economic, social and physical wellbeing. As such, strategic mobility to access water and grazing resources is critical to their survival and resilience. Yet, the accuracy of determining where and when to move herds is based on traditional methods that have inherent limitations and increasing unreliability. The consequences can be devastating with irreparable losses that have immediate and long-term consequences for both pastoral livelihoods and well-being. Each year pastoralist must make a critical determination on where to move herds in order to find adequate pasture. The principle tools for decision-making are indigenous knowledge (IK), scouts and information sharing via oral communication. Indigenous knowledge, which is based on generations of relatively predictable patterns, has become increasingly unreliable as climate and ecologies have witnessed dramatic changes. While scouting is more accurate, it is time and resource intensive, and limited to the line of sight of the scout. The value of oral communication, in many ways depends on the quality of IK and scouting that informs it. The magnitude of this problem is immense with more than 6 million pastoralists in Ethiopia and approximately 225 million pastoralists on the African continent using comparable low-tech approaches for determining herd migration. In the target area for the pilot, pastoralists were losing 22% of their herds each year with the principle cause being lack of pasture. This loss represents $11.7 million USD for that community alone.

If the precision in identifying specific areas of adequate pasture within thousands of kilometers of traditional grazing territory can be improved, it could have a substantial impact on pastoral resiliency as well as the need for emergency food aid. Conventional practice is to use geo-satellite derived agro-meteorological data in a top-down, disaster response approach. This approach limits access, interpretation and action to a select group of decision-makers once loss has already occurred. PCI sought a way to put satellite derived information directly in the hands of pastoralist on a continual basis to incorporate into their migration decision-making process throughout the year and increase their accuracy in finding pasture.

SAPARM, which stands for Satellite Assisted Pastoral Resource Management is a fusion of high technology with local structures, knowledge and practices. The resulting product is a customized local grazing map digitized and overlaid with NDVI (Normalized Differential Vegetation Index) - a measure of photosynthetic activity. The digitized maps are auto-generated and emailed every 10 days. PCI distributed the maps as paper printouts through local government and community networks at the woreda (i.e. municipal) level cascading down to the village and individual level via at a ratio of 1 map for every 120 households. The approach minimized costs while maximizing uptake through integration with customs and practices results in a model that is easily scalable. A comparison community where no maps were distributed was also part of the pilot design.

Results show this approach was very successful reaching close to 80% of pastoralists who reported using the maps for migration decision-making. All users found the maps to be accurate in identifying adequate grazing areas with 57% stating it was very accurate. Over half the respondents felt the maps were now their most important source of information for grazing decision-making and all felt the maps could reduce livestock death and improve animal condition. Ninety percent of pastoralists felt SAPARM positively contributes to pasture management by allowing poor pastures to lay fallow while 43% also felt it could contribute to overgrazing in some areas. Herd mortality rates dropped by almost half (47%) after introduction of the maps, compared to the previous three years in the intervention community and was consistently lower for all species of animals. The comparison community also witnessed a 36% drop but this was

less consistent and conclusive with some rates being higher than some of the index years. The resulting drop in mortality in the intervention community represents over $8 million USD less in losses compared to previous years. A benefit cost ratio was calculated at $47.59 with a net present value of $5.36 million USD.

II. BACKGROUND

A. CONTEXT

Pastoralism in Ethiopia, and Africa more generally, is characterized by a high reliance on livestock as a source of economic, social and physical wellbeing. As such, strategic mobility to access water and grazing resources is critical to their survival and resilience. Yet, the accuracy of determining where and when to move herds is based on traditional methods that have inherent limitations and increasing unreliability. The consequences of walking for days only to find inadequate pasture can be devastating with irreparable losses that have immediate and long-term consequences for both pastoral livelihoods and well-being. The principle tools for decision-making are indigenous knowledge (IK), scouts and information sharing via oral communication (in the Afar region of Ethiopia it is called *Dagu)*. Indigenous knowledge, which is based on generations of relatively predictable patterns, has become increasingly unreliable as climate and ecologies have witnessed dramatic changes. While scouting is more accurate, it is time and resource intensive, and limited to the line of sight of the scout. The value of Dagu, in many ways, depends on the quality of IK and scouting that informs it. The magnitude of this problem is immense with more than 6 million pastoralists in Ethiopia and approximately 225 million on the African continent – all whom must make critical migration decisions using the same or similar approaches for determining herd migration.

The immediate costs of not finding adequate grazing grounds for pastoral herds is significant. During the 2011 Horn of Africa drought, affected areas in Ethiopia alone experienced an estimated 60% loss in cattle, 40% in sheep and 25-30% in goats (FAO, 2011) and between 50-100,000 human deaths – mostly children (DIFID). Baseline results for the pilot community for this project demonstrate average annual losses of 21% and $11.7 million dollars in market value – in just one community. Hundreds of millions of dollars are spent annually on food aid to compensate for such losses, yet it represents only a fraction of the market value of what was lost and can in no way substitute for the long-term productive value of the asset.

If the precision in identifying specific areas of adequate pasture within thousands of miles of traditional grazing territory can be improved, it could have substantial impacts on pastoral resiliency as well as demand for emergency food aid. Conventional practice is to use geo-satellite derived agro-meteorological data in a top-down, disaster response approach. This approach limits access, interpretation and action to a select group of decision-makers once a drought is underway and losses have already been incurred. PCI sought a way to put this information directly in the hands of pastoralist on a continual basis to better inform their own decision-making process throughout the year and increase their accuracy in finding pasture.

B. THE INNOVATION AND THEORY OF CHANGE

In August, 2013 PCI was awarded a $100,000 Phase I Development Innovation Venture's grant to pilot an innovation we called ***SAPARM*** for Satellite Assisted Pastoral Resource Management. SAPARM was a collaboration with the World Food Programme and the Government of Ethiopia's Disaster Risk Management and Food Security Sector (DRMFSS). The one year pilot was completed on July 31, 2014 with PCI leading the design and implementation. SAPARM developed customized local grazing maps together with the community, digitized those maps and overlaid them with NDVI (Normalized Differential Vegetation Index) - a measure of photosynthetic activity. The digitized maps were auto-generated and emailed every 10 days to PCI. They were then distributed as paper printouts through local government and community networks at the woreda (i.e. municipal) level cascading down to the village and individual level via *Dagu*. The use of existing government and community systems and communication methods was intended to

minimize costs while maximizing dissemination, uptake, integration with current customs and practices and ability to quickly scale.

PCI's Theory of Change proposes that even in severe, drought prone areas, available pasture is not being reached due to the lack of accurate and timely information. If pastoralists have the tools to increase their accuracy in identification of pasture through a sustainable, cost-effective continuous feed of satellite generated NDVI data, it will lead to increased capacity to find available pasture, decreased herd losses, greater resiliency and reduced requirements for drought-related food aid. At the start of the project we projected a preliminary benefit cost ratio (BCR) of $17.65 if a 15% reduction in livestock loss could be achieved (see Section IV. Cost-Effectiveness and Competitive Landscape for actual results).

III. PROGRAM DESIGN AND IMPLEMENTATION

A. GOALS AND TARGETS

As a Stage I DIV Project, PCI sought to (1) Demonstrate the feasibility of continuous transfer of geo-satellite information to pastoralists for herd migration decision-making; and (2) Evaluate the impact the data has on decision-making, livestock loss and need for external aid. PCI aimed to implement this pilot in one woreda (i.e. municipality) in the Afar Region of Ethiopia. Afar is a remote, drought prone, highly pastoral region of the country that has been significantly affected by climate change. In addition, a comparison community was selected in the same region in order to ascertain the difference in change and estimate attribution.

B. IMPLEMENTATION DESCRIPTION

The pilot was divided into three principle phases –

Phase 1 - Start-up (Aug-Nov): Site selection, partner agreements, baseline assessment, map development;

Phase 2 - Execution (Dec-May): Training/Orientation, distribution and mid-term review

Phase 3 - Final assessment and analysis (Jun-Jul): Population-based survey, analysis and community/government debrief.

Phase 1 - Start Up

Site Selection**:** PCI proposed the Afar Region of Ethiopia due to large populations of pastoralists, drought vulnerabilities and PCI's in depth knowledge and experience there. Afar is located in the northeast region of Ethiopia bordering Eritrea and Djibouti. It is comprised of 30 woredas (i.e. municipalities) and has a population of approximately 1.6 million. The process of site selection began with a list of all of Afar's 30 woredas. From that list, woredas that were not exclusively or primarily pastoral were eliminated. Working with representatives of the region's Disaster Prevention and Food Security Coordination Office, PCI's team developed a final list of 6 candidate woredas divided into two groups based on likely differences in migration patterns. It was important that the final intervention and comparison communities not share the same grazing grounds in order to avoid the potential for influence that information leakage from intervention to comparison could have on migration patterns. Woredas from the two groups were paired based on general similarities as well as anticipated differences in grazing areas. The optimal pair was Telalak and

Simurobi. A coin was flipped to determine intervention and comparison woreda resulting in Telalak being assigned as the intervention woreda. Field assessment visits were made to both woredas during the week of July 29th during which time community members participated in a general migration mapping exercise. At that time it was discovered that Simurobi's migration patterns actually overlapped with Telalak's during periods of drought. Therefore, PCI elected an alternate community from the final candidate list. Megale was selected based on similar conditions of being highly affected by drought and moderately accessible. A site visit was made the week of August 9th. Based on the general migration mapping it was determined that Megale and Telalak migration patterns did not overlap. Thus Telalak would continue to serve as the intervention community while Megale would serve as the comparison. Beyond this distinction, Telalak and Megale share the same Afari culture as well as a number of demographic, livelihood and environmental similarities:

Table 1: Characteristics of Study Communities

Characteristics*	Telalak (Intervention)	Megale (Comparison)
Population	42,179	30,999
Average HH size	7	7
% Exclusively Pastoral	71%	90%
Traditional Grazing Area (km sq.)	4,747	4,786
Ave. herd size	57	57
Ave annual rainfall (2009-2013)	574mm	429mm

*: Population from 2012 projection of 2007 census; % pastoral, grazing area and herd size from project baseline; rainfall derived from LEAP for grazing areas.

Partner Agreements: PCI worked closely with two partners and received advisory support from a third.

Government of Ethiopia

PCI finalized an agreement with the Government of Ethiopia regarding implementation of the pilot on August 3, 2013. The Bureau of Finance and Economic Development (BoFED), charged with managing project agreements with NGOs and the Afar Regional DPFSCO (Disaster Prevention and Food Security Coordination Office) signed the agreement along with PCI (Attachment 1). This agreement assured authorization to perform the pilot as well as stipulated commitments on the part of the government for participation. This included DPFSCO assigning point persons at the regional and woreda levels to receive and disseminate SAPARM maps as well as participation in monitoring and evaluation activities. The DPFSCO is the regional arm of the Disaster Risk Management and Food Security Sector (DRMFSS). DRMFSS, and particularly the Early Warning and Response Directorate (EWRD) within it, is responsible for the general management and overall coordination of early warning, disaster risk monitoring, and response to disasters at national level. The directorate works in collaboration with regional, zonal and woreda level offices. The EWRD apparatus has been designed to receive a continuous flow of trigger data from the kebele on up through the national level, to be used in combination with other data sources for early warning and response efforts.

World Food Programme

PCI also signed a Letter of Agreement (LOA) with the World Food Programme who developed the Livelihoods, Early Assessment and Protection (LEAP) platform used by the GOE for monitoring geo-climactic conditions (Attachment 2). The agreement outlined organizational responsibilities and the right to leverage its LEAP software (see inset) to generate the customized NDVI maps. PCI worked closely with WFP's country-based team as well as the Headquarters' Rural Resilience Branch and its Climate Change and Disaster Risk Reduction Office in Rome responsible for management of LEAP. In Addis, WFP's Vulnerability Assessment and Mapping (VAM) is responsible for supporting DRMFSS on the application of LEAP. PCI also worked closely with LEAP's developer, Peter Hoefsloot, contracted by WFP to develop LEAP, to develop, digitize and automate map generation. In preparation for the DIV proposal submission PCI travelled to Rome to finalize project design and detail of the execution process. During that time, PCI consulted with several experts on climate, spatial analysis and resilience. The Climate Change and Disaster Reduction Office has led the development of LEAP and have been very supportive of the proposed innovation of this tool. WFP is deeply engaged in the emergency programming and early warning structures in almost every country on the continent.

> Livelihoods, Early Assessment and Protection (LEAP): LEAP is an early warning software system initially developed in 2006 as a crop loss index tool to support crop insurance schemes within the country. However, its use and content have expanded to become a core tool in the government's risk management framework as well as a guide for disbursements of the government's Productive Safety Net Program (PSNP). LEAP provides agro-meteorological data from various satellite-derived (and some ground-based) sources on a decadal (every 10 days) basis. LEAP data is overlaid on a map that can be defined by states, regions, zones, woredas and even livelihood zones. Currently LEAP is set up to map data based on administrative parameters (i.e. states, regions, zones, and woredas).

Texas A&M's Center for Natural Resource Information Technology (CNRIT)

Dr. Jay Angerer from Texas A&M's Center for Natural Resource Information Technology served as an informal advisor. Through its Livestock Early Warning System (LEWS) efforts initiated in 1999, Texas A&M has been a leader in the use of geo-spatial data on grazing and water resources to improve early warning for pastoralists. They have used their intricate mapping tool (see Section VI: Cost Effectiveness and Competitive Landscape) in East Africa, Mali and Mongolia to improve early warning of impending drought. Their role under this project was limited to sharing experiences and lessons learned regarding the Livestock Early Warning System (LEWS) as well as providing recommendations on measurement.

Pastoral Communities

In preparation for the design and implementation, PCI held several meetings with government and community leaders representing the various kebeles in both intervention and comparison woredas. PCI explained the purpose of the research, the requirements for each community and sought community approval to implement and participate.

In addition to these key stakeholders, PCI consulted with experts from Tufts University Feinstein International Center, FEWS NET, USGS, the Livelihoods Integration Unit (LIU) project and others, all of whom have been supportive of this endeavour.

Baseline Assessment: A mixed methods baseline was conducted in October of 2013 employing both a population-based survey and structured focus group discussions. The major thematic areas of the baseline survey were information sources and their reliability for migration decision-making, destination of movement, seasons of migration, herd size and composition, and mortality for the last 3 years. A total of 679 household interviews and eight focus group discussions were conducted within the two communities (See Section IV and V for a description of the methodology and major findings)

Mapping: Based on a mapping protocol developed by PCI (Attachment 3), a participatory community mapping exercise was conducted in both intervention and comparison communities. The mapping was done over two separate visits. An initial visit was made to consult with a small group of key informants to identify the farthest limits of the community's traditional grazing grounds using a small administrative map of the region for delineation. This allowed PCI to then acquire larger topographic and thematic maps that would encompass the identified territory. PCI used 1:200,000/1:250,000 scale maps based on the area indicated in the initial visit. The second mapping exercise was more inclusive. In Telalak, 22 key informants representing each kebele and 4 experts from the woreda Office of Agriculture were invited. All the kebeles were represented by one Chairman and one key informant (pastoralist). After an initial orientation to ensure map comprehension, participants were broken into two groups to begin delineating the traditional grazing grounds - one using the thematic map (i.e. rivers, roads, etc.) and the other using the topographic map (i.e. elevations, towns, etc.). Participants delineated grazing areas indicating whether the location was for 1) wet season, 2) the dry season, 3) extreme dry seasons, and/or 4) severe drought conditions. Ultimately, the two groups discussed and completed the delineations on the topographic map. PCI asked the representatives to give a name for each grazing area delineated that would be understood by pastoralists. This process was replicated in the comparison community of Megale. (See Attachment 4 for detailed mapping report.)

Participatory mapping process

Once complete, PCI cross-checked with host communities identified on the maps (via their woreda administration offices) to verify whether or not pastoralists from the target communities were permitted to graze in those locations. In all cases, permission to graze was verified.

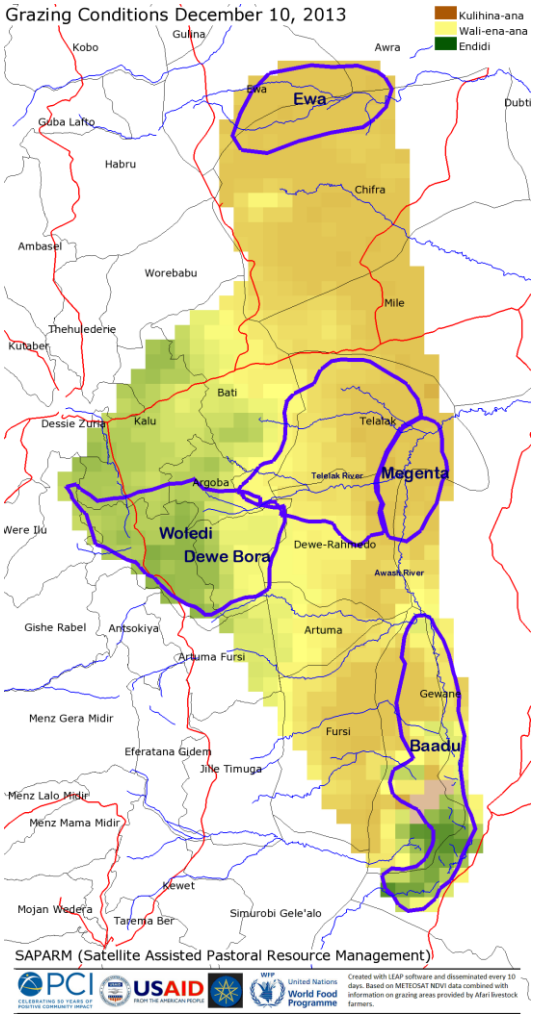
Once the participatory mapping process was completed, the maps were sent (both scanned and original) to LEAP's developer, Peter Hoefsloot in the Netherlands for digitization and overlay with NDVI data (see inset for explanation of NDVI). This was a consultative process to determine the best presentation of the map to maximize utility and comprehension. The maps included the areas of grazing along with a name for that areas given by the community, as well as what we have referred to as LIDs (Locally Identifiable Descriptors – woreda names, rivers, roads, etc.) NDVI data was overlaid for the grazing areas as well as corridors between those areas. Each pixel on the map represents 10km^2. All surrounding areas were left white to deter any unintended movement out of the traditional grazing grounds. Color codes using a simple key were provided in Afari (local language) at the top right corner of the map indicating the high, middle and low range of variation in photosynthetic activity. These maps were then auto-generated and auto-emailed on a decadal basis. The entire mapping process per woreda took approximately 5½ days. This included ½ day for the community mapping and five days for digitization. The digitization process included creating a shape file of the grazing areas with control points, creation of an ArcGIS project, setting up the woreda into MapServer to enable automation, automating extraction of NDVI data, and attaching email addresses to the map. This process will take approximately 3 days in future efforts now that the process has been developed and tested. (See following page for sample maps)

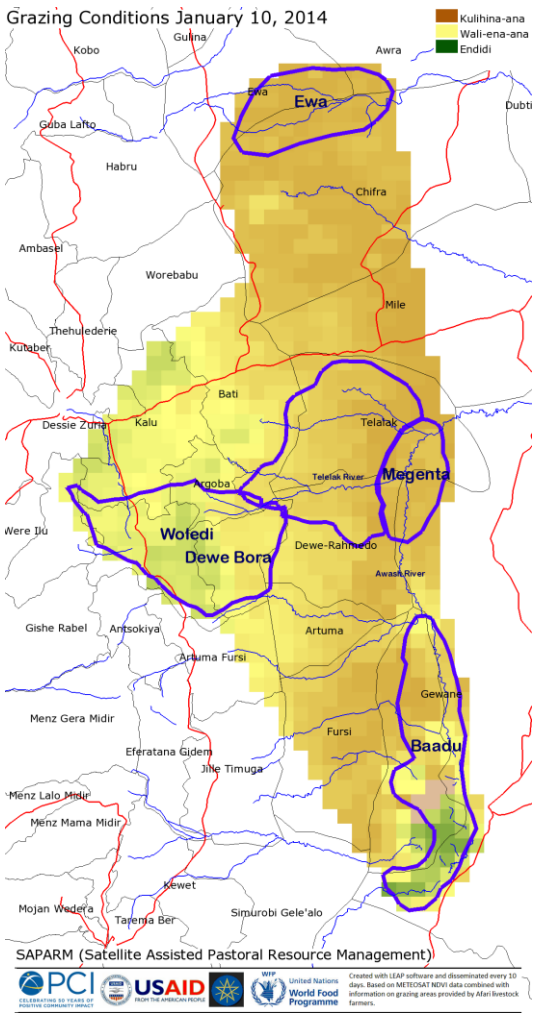
Phase 2 - Execution

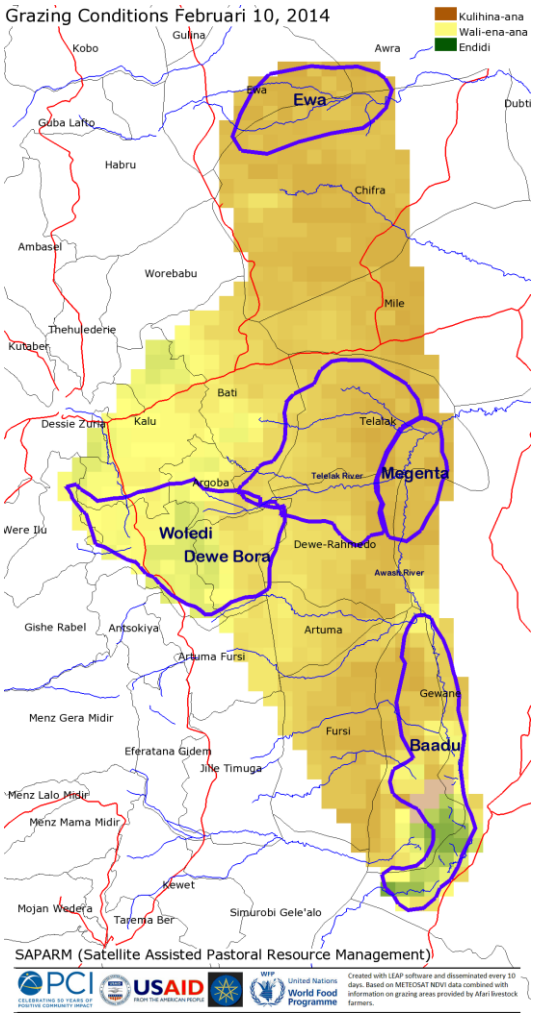
Training and Orientation: A one day sensitization workshop was organized and facilitated by PCI in November, 2013 in Semera (regional capital for Afar). The purpose of the workshop was to create common understanding among key stakeholders from Afar Regional DPFSCO, BoFED and each of the woreda's Pastoral Development Offices on the objectives of the project, planned activities and to clarify roles. PCI also laid out the potential value as well as limitations of the information and how it

NORMALIZED DIFFERENTIAL VEGETATION INDEX

The Normalized Differential Vegetation Index (NDVI) is one of the principle tools used within LEAP as well as other early warning monitoring systems. NDVI is considered by PCI, WFP, DRMFSS and Texas A&M to be the best composite indicators of grazing given its simplicity, reliability and extensive (global) coverage. NDVI is calculated from the visible and near-infrared light reflected by vegetation. Calculations of NDVI for a given pixel (in LEAP, a pixel represents approximately a 10km^2 area) result in a number that ranges from minus one (-1) to plus one (+1); A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of vegetation. The index value is converted into a color table ranging from brown (low NDVI) to green (high NDVI). The NDVI images used are based on the geo-stationary satellite METEOSAT second generation imagery (MSG2) and have a spatial resolution of 3km^2. NDVI has been used since the early 1980s and is considered highly reliable when compared to ground level observation. Its limitation is that it cannot distinguish between different types of biomass. Thus its integration with indigenous is critical. For example indigenous knowledge of farming areas or high concentration of prosopis (invasive non-edible weed) will be important factors in determining whether certain healthy vegetation areas based on NDVI are also appropriate for grazing.







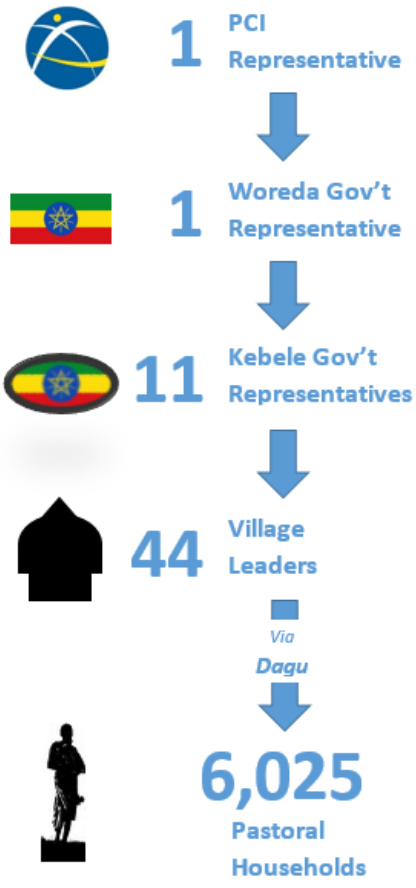
SAPARM Maps of Telalak's Grazing Grounds showing the first dekad of the first 3 months of the dry season

will be integrated with the existing government Early Warning System and extension structure. Another purpose was to discuss and enlist their involvement and support of the government. A total of 10 people participated in the workshop. Of these, two were from Afar Region BoFED, two from Afar Region DPFSCO, two from Megale woreda pastoralist office and four people from Telalak woreda pastoralist office.

Participants quickly comprehended that the maps reflect areas of vegetation without distinguishing between types of vegetation (pasture, prosopis, crops, etc.). Used in combination with indigenous knowledge of the areas, the map allows them to filter the data in a way that enhances decision-making.

Dissemination: Map dissemination initiated just after December 10. A critical part of the dissemination strategy was to integrate the maps into existing structures and processes (institutional and community) used for early warning and migration decision-making rather than creating a parallel system. This made the innovation extremely efficient and cost-effective (see results). Maps were printed and delivered over 11 decadal cycles (approximately 50 maps per cycle) between December 10, 2013 and May 30, 2014 by PCI's SAPARM Program Manager. The 50 maps were handed over to Telalak's Pastoral Development Official who subsequently divided the maps among Telalak's 11 Kebele representatives. Kebele representatives, who convene regularly, would then take their 4-5 maps allocated to them and provide them to leaders within the villages that comprise the kebele. Directly and via dagu, the village leaders would then analyse and share information on vegetation changes represented on the most current map. Thus, for the cost of printing and delivering 50 of SAPARM maps to one woreda contact point, the project effectively reached 6,025 households every 10 days (see inset). That's a ratio of 1 map for every 120 households. Over the course of the intervention this amounted to about one ream of paper (550 sheets) distributed.

Figure 1: SAPARM Dissemination Model



Mid-Term Review: In March of 2014, PCI conducted a mid-term review of the project with a team consisting of one senior expert from PCI Ethiopia, three government representatives from Telalak woreda, and three government representatives from Megale woreda. A total of six focus group discussions (four in Telalak and two in Megale) were conducted with kebele representatives to review overall program progress. In addition, discussions were held with five government representatives from Telalak and Megale as well as focus group discussions with representatives from three host communities (Bati, Argoba and Dewe Bora). (See Section V. Findings for results).

Phase 3 - Final assessment and analysis and debrief

Final Evaluation: The final evaluation was completed in June and analysis conducted in July and August. (See IV: Evaluation Design and V: Findings for more).

Debrief: Meetings were held with regional and woreda representatives in June to share the preliminary results of the project and discuss potential next steps. During these meetings there was a clear indication from Telalak representatives that they would like the dissemination of the SAPARM maps to continue affirming the value the information has had in making appropriate decisions for herd migration. The representatives of Megale requested for the initiation of the SAPARM map dissemination so that they can also benefit from the information.

C. CHALLENGES

Determining and sourcing the appropriate type, scale and area of coverage of maps for the community mapping process was initially a challenge. The maps had to adequately cover the community grazing grounds which extended beyond administrative borders and had to be of sufficient scale to achieve the detail and accuracy for community comprehension and accuracy. Ultimately, we sourced the maps from the Ethiopian Central Statistics Agency (CSA) requesting non-standard maps covering three different regions with a 1: 240,000 scale. With a short orientation, this was easily understood by the community and an effective tool for detailed mapping of grazing areas.

Another challenge faced by the project was how to ensure receipt of the maps at the woreda level. During the design process PCI originally envisioned integrating the maps directly into the LEAP program and having representatives at the regional DPFSCO, who have been trained on LEAP and have the software on their computers, download the maps from LEAP every 10 days and relay the information to their woreda counterparts in Telalak by phone. Ultimately, we decided to submit the maps directly via email in the form of a *.png* image. This was simpler, more direct and automated requiring less steps on the part of the receiver. Secondly, we decided rather than the regional DPFSCO, PCI would receive, print out and deliver the maps to Telalak directly (at the time of initiation, Telalak did not have internet service). We chose this option for the Proof of Concept phase as we were principally interested in whether or not the maps, would be disseminated and used effectively if provided at the woreda level. In the future, woredas will most likely be able to receive the maps directly as woreda connectivity is a key priority of the government and more woredas are coming on line every year. In fact, during the course of the past year, Telalak has acquired internet connectivity. This will be a key part of sustainably scaling in Phase 2 and beyond.

Determining reduced need for food aid, a part of our original cost-benefit model proved to be too difficult to measure for a number of reasons. First and foremost, food aid, even when warranted based on the merits of the household impact, may not be triggered. Emergency food aid only gets deployed for declared emergencies. Even if a household loses their entire herd, aid will likely not be triggered unless the loss is of sufficient scale geographically and recognized by the central government. Second, one year is too small to measure such a change. Vulnerability (and resiliency) typically accrue over time leading to large scale impact and subsequent response. Thus, the easing of need for food aid response as a consequence of the intervention may not be

known for several years. While this benefit, and the monetary value associated with it, is a legitimate variable for cost-benefit analysis, we ultimately decided not to apply it for the reasons cited above. Instead, we focussed solely on the market value of reduced herd losses – a direct and more verifiable measure.

IV. EVALUATION DESIGN

PCI designed an impact evaluation to assess four overarching areas: 1) The feasibility and effectiveness of continuous transfer of geo-satellite information to pastoralists for herd migration decision-making; 2) Perceived utility of those maps among users; 3) The impact the innovation had on decision-making, livestock loss and need for drought-related aid; and 4) Potential unintended (positive and negative) consequences of the approach. As an initial requisite step, the project team submitted an application to PCI's Internal Review Board (IRB) on August 29th which laid out the study design, objectives and considerations. Approval was provided by the IRB on September 11, 2013 (see Attachment 5)

The study design incorporated a mixed-methods approach using an experimental study with an intervention and comparison group, as well as qualitative data gathered through monitoring visits and focus groups. A pre- and post-intervention survey was implemented in both the intervention and comparison communities in order to quantify changes in key outcome indicators over the course of the intervention period. The survey included 60 questions looking at demographics, herd size and herd loss, and sources of information for migration decisions and herd mortality data for the last three years (baseline) and intervention period. A final analysis was made by comparing selected indicators for baseline and endline in both communities, analysing potential determinants and confounding factors associated with the results (see Attachment 6 for endline survey).

Table 1: Survey data categories

Indicator Category	Description
Demographics	Age, sex, primary livelihood, household size of respondents
Current Livestock Size, Condition and Value	Number of animals by type and condition with estimated value of animals by condition
Current Livestock Size, Loss and Distressed Sales	Number of animals that died or the pastoralist was forced to sell
Migration Decisions	Number of days spent in migration, sources of pasture information, perception of information sources, accuracy and usefulness of maps

For the baseline, a total of 602 surveys were conducted — 308 in Telelak and 294 in Megale. In Telelak, nine of the 11 kebeles were sampled and in Megale, five of the eight kebeles were sampled. Attempts were made to reach all kebeles in both woredas, but it was not possible due to distance, accessibility, and resource limitations. For those kebeles from which respondents were sampled, the number of respondents was evenly split among the kebeles since accurate population data is not available. PCI selected clusters within each kebele – clusters being communities of 4-8 households – based on a geographic convenience sample, for which the

enumerators entered the kebele from four different directions. This helped ensure that clusters from all locations within the kebele were represented in the sample and systematic bias was minimized. Then enumerators interviewed up to four households within each cluster as long as the respondents met the minimum criteria of being 18 years or older and having migrated at least once within the previous calendar year. Clusters included in the sample were at least 1 kilometer apart from each other.

A mid-term review was conducted in first week of March, 2014 by a team consisting of one senior expert from PCI Ethiopia, three government representatives from Telalak woreda, three government representatives from Megale woreda. A total of six focus group discussions (four in Telalak and two in Megale) were completed to review overall program progress. In addition, discussions were held with five government representatives with the same purpose. Each focus group included a minimum of six people. Participants were carefully selected from different villages of the target kebeles. The kebele Chairman, four village representatives and two pastoralists/beneficiaries participated in each of the focus groups. Discussion sites were deliberately selected from different corners of the woredas to make sure the representativeness of information of target communities. During the mid-term review, PCI also met with three host community representatives (Bati, Argoba and Dewe Bora) – the most common destinations for Telalak pastoralists. In Bati, PCI met with the head of Woreda Office of Agriculture while the other two discussions were held with community members. A total of 16 community members participated in the two discussions.

The endline survey, included a total of 628 households - 305 in Telelak (intervention) and 323 from Megale (control). The same convenience cluster sampling technique employed during the baseline survey was used during the endline survey. The baseline and endline sample sizes provide a 95% confidence level and a +/- 6% margin of error. However, because kebeles were not randomized within the woreda, results might skew towards representing kebeles that were part of the survey sample because they were accessible.

The primary limitation to the evaluation methodology was the ability to take a random sample of all households within the study areas. As explained in the research methodology section, some households were not included in the sample due to distance, accessibility, and resources. Therefore, results might be skewed towards those households that were accessible by project staff. In addition, as with all research using inferential statistics, a sample was used to generalize results to the entire populations of Telelak and Megale. Throughout the report, the statistical significance of results is clearly stated. Based on the sample sizes used for this analysis, we can infer results with a 95% confidence level and +/- 6% margin of error. It should also be noted that all results are self-reported by the respondents. Data points such as herd size, estimated herd value, vaccination rates, and distances or number of times migrated were not independently confirmed.

PCI plans to scale up the use of the SAPARM maps to assist pastoralists in Ethiopia with decision making. As such, future research will be conducted in up to 10 woredas. PCI will continue to use a case control methodology measuring change from probability samples at baseline and endline, with a qualitative mid-term review. In this phase, PCI attempted to quantify the value of food aid provided to the woredas in the study area, and thus the value of food aid that could be saved through implementing SAPARM. This outcome proved very difficult to measure and unreliable

due to limited data sources and an imprecise formula for quantifying food aid savings. In future phases, PCI will not directly include the value of food aid as an outcome, but instead proxy outcomes such as community resilience or vulnerability indices. In addition, PCI will design endline survey questions to determine how information is shared by those who directly used the maps to others in their community, as well as compare outcomes for those who directly used the maps versus those who received second hand map information.

V. FINDINGS

The findings presented are organized under the four areas outlined in the Evaluation Design section. Findings are drawn from all the activities, surveys and focus group discussions conducted during the one year pilot. At the end of this section we also discuss potential attribution.

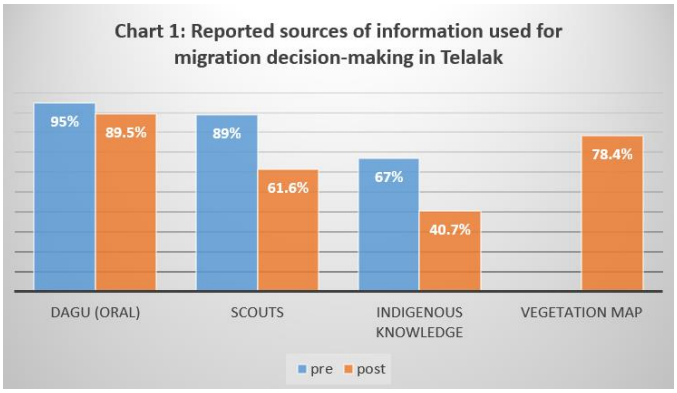
A. FEASIBILITY OF CONTINUOUS TRANSFER OF GEO-SATELLITE INFORMATION TO PASTORALISTS FOR HERD MIGRATION DECISION-MAKING

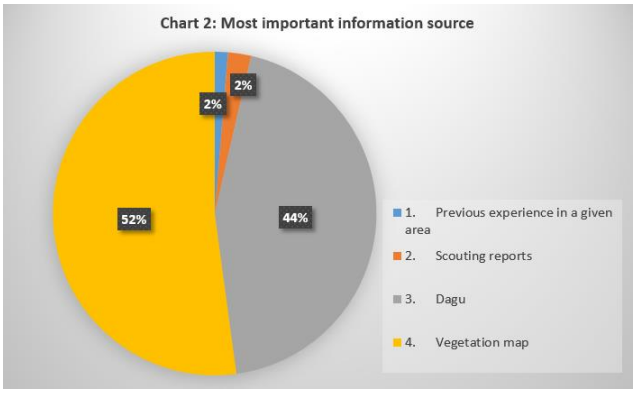
PCI developed a simple, systematic process for developing customized traditional grazing maps with satellite-derived data for assessing grazing conditions. The combination of community mapping, host community verification, digitization and NDVI overlay resulted in maps that were auto-generated every 10 days and auto-sent to designated email addresses. The process developed by PCI and LEAP's developer requires approximately 3 ½ days after which no further human resource investment is required for development or updating.

The project demonstrated that a low-cost, continuous delivery of maps to remote, disperse and highly mobile populations is possible. By leveraging existing structures and communication methods as described in the dissemination model on page 12, PCI achieved a high level of distribution at low cost and low level of effort. The dissemination strategy of providing paper maps at a ratio of approximately 1 map for every 120 households, and delivering those maps to one designated woreda official proved successful in broadly reaching the entire community. Endline results show that 78% of the 6,025 households were in fact using the maps for migration decision-making (See Chart 1 below) confirming that the maps, or information derived from the maps, were at least reaching that percentage of the population. Respondents from the mid-term review noted that the information was being disseminated even beyond the woreda as relatives in adjoining woredas (whom share common grazing grounds) were also getting the information. It is not clear from our assessment what percentage of those reporting use of the maps actually saw them or were provided the information via *Dagu*.

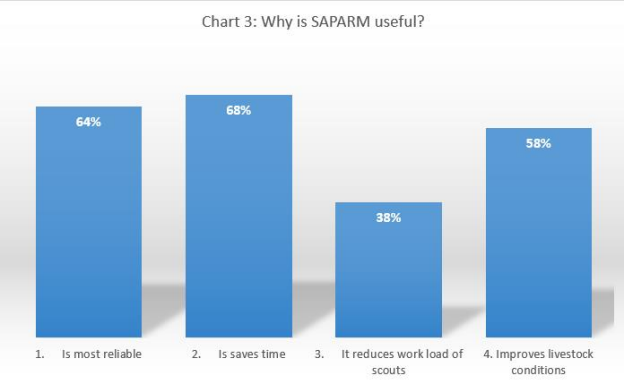
B. PERCEPTIONS OF THE USEFULNESS OF THE INNOVATION AMONG INTERVENTION COMMUNITIES

The endline survey showed that the SAPARM maps (referred to as the "vegetation maps") were used broadly and considered an important and reliable source of information for migration decisions. As Chart 1 indicates, 78% of respondents reported using the maps for migration decision-making post-intervention. The vast majority (98%) of that group used the maps in combination with one or more of the other sources suggesting that the maps are being integrated with traditional methods. As the same time, reliance on the other methods trended downward (compared to baseline) with the introduction of the SAPARM maps – particularly IK and scouting.





Not only did the maps achieve widespread use, but were quickly ranked the superior source of information by most pastoralists. When asked what single source of information they considered to be the most important for migration decision-making, a majority of survey respondents in Telalak stated that the SAPARM maps were the most important (Chart 2). This is a remarkable outcome given that the technology was just introduced. Another interesting aspect is the interplay with the other sources. At baseline, 71% of respondents stated that Dagu was becoming less reliable, but in a stark reversal, the same percentage at endline found Dagu becoming *more* reliable. In contrast, the majority of respondents in Megale (comparison) both at baseline and endline found Dagu to be getting less reliable (84% and 68% respectively). This suggests that the SAPARM maps not only have intrinsic value but may be improving confidence in the reliability of information disseminated through oral communication. In a subsequent question, nearly all who used the maps found them to be *somewhat accurate* (47%) or *very accurate* (57%). This is a key indication that the NDVI values derived from the satellites were actually reflected conditions found on the ground. This validation is likely what contributes to the high value ascribed to the maps.



All those who reported using the maps also stated that that the maps were *somewhat helpful* (34%) or *very helpful* (66%). When

asked why, multiple reasons were given including reliability, time savings and improved livestock conditions (See Chart 3). More than a third also noted that it reduces the workload of scouts. The value of added efficiency also surfaced during the mid-term focus groups. Statements such as the following were made by focus group participants:

> *"The scouts have been spending a lot of energy to find appropriate grazing fields. Now the maps gave us initial information to decide where and when the scouts should go out."*

C. IMPACT THE INNOVATION HAD ON DECISION-MAKING, LIVESTOCK LOSS AND NEED FOR DROUGHT-RELATED AID

Decision-making

The findings above confirm that the maps were used, perceived to be accurate and valued by pastoralists. During the mid-term review, PCI used focus groups to assess how the maps were influencing decision-making amongst the pastoralists. From those discussions, it became clear that the pastoralists were monitoring the maps closely and it was in fact influencing herd movements. In particular a key decision was made to avoid migration to the northern grazing ground called Ewa, which was consistently dry this year. One pastoralist shared how the map influenced his and other decisions:

> *"Take Ewa for example; Ewa is one of our traditional grazing fields. When we look at the map, Ewa has been dry for the last five months. As a result, no pastoralist has sent scouts or migrated to Ewa in this year"*

Another focus group participant shared….

> *"In this year all pastoralists have migrated to those areas shaded with green in the map. Traditionally, we used to migrate to Bati and Ewa areas. This year no pastoralist has migrated to these areas because these two areas were dry on the map"*

Another participant shows how the maps are used in combination with indigenous knowledge of the grazing grounds and specific herd requirements…

> *"The information on the maps is particularly important for camels because camels feed on a bush and we know from experience where the bush lands are found. Therefore, if the bush lands are green or light green on the maps, it is possible to send camels without a confirmation from scouts. For example, last December I sent my camels to Dewe Harewa based on the information on the map and the grazing field was good and my camels are still there. However, it is not possible to send shoats and cattle before receiving a confirmation from scouts because the map does not differentiate between trees and grasses."*

One of the potential consequences of improved decision-making was a reduction in average number of days travelled. Compared to the baseline, the average number of days travelled during the dry season decreased by 30% in Telalak. In contrast, herd travel in the comparison community increased from baseline by 10%. Within Telalak we looked at the amount of days travelled as well as number of times herds moved amongst those who reported using SAPARM versus those who reported not using SAPARM. On average those that reported using the maps travelled less and moved fewer times during the year compared to those that did not. The difference was statistically significant for number of times moved but not for number of days travelled. However, it is difficult to know where those that stated they did not use SAPARM were indirectly influenced as was pervasive and information they received via *Dagu* may have ultimately been derived from the maps.

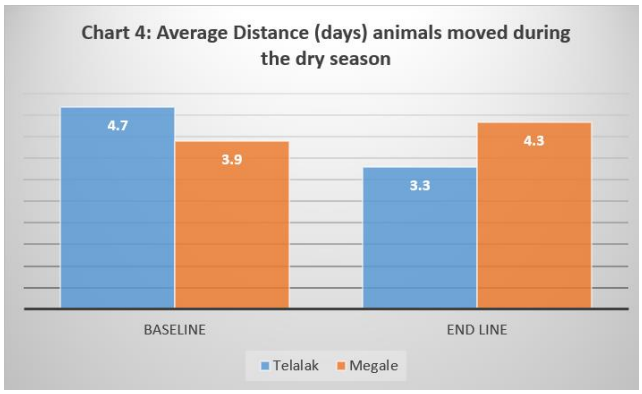
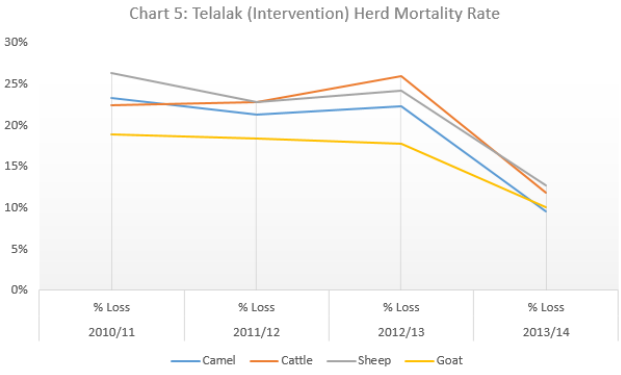


Table 2: Differences in frequency of movement and days travelled by reported use of SAPARM

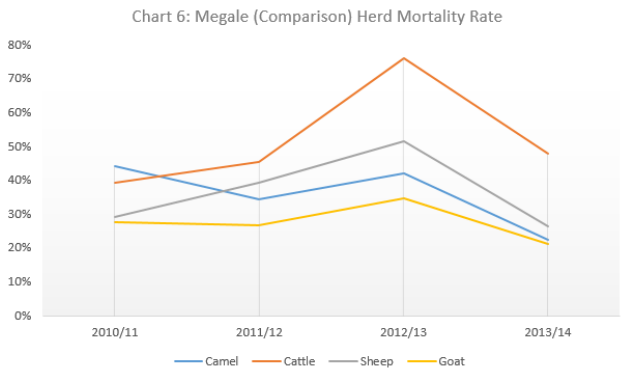
	Used SAPARM (N=238)	Didn't Use SAPARM (N=67)	Significance
# Times Moved	1.87	2.28	0.002
# Days Travelled	3.23	3.55	Not Significant

Livestock Loss

Ninety-nine percent of respondents in Telalak reported that they believe that the SAPARM maps can help reduce future livestock death and improve animal condition. At baseline, we documented reported herd size, number of deaths and cause of mortality by animal type for the previous three years by household. This process was triangulated by using the proportional piling method during baseline focus group discussions – both of which resulted in similar outcomes. Taking into account all animals and all deaths, Telalak was experiencing an average annual herd mortality rate of 21% and Megale a 36% mortality rate. Camel and cattle demonstrated the highest vulnerability in both communities. While the mortality rates in Telalak held fairly consistent year over year and by species, Megale's rates presented greater variation - including a particularly high mortality rate for cattle in 2012/13 (See Chart 5 & 6). The most frequently sited cause for mortality in both communities was lack of adequate pasture, followed by water in Telalak and disease in Megale.

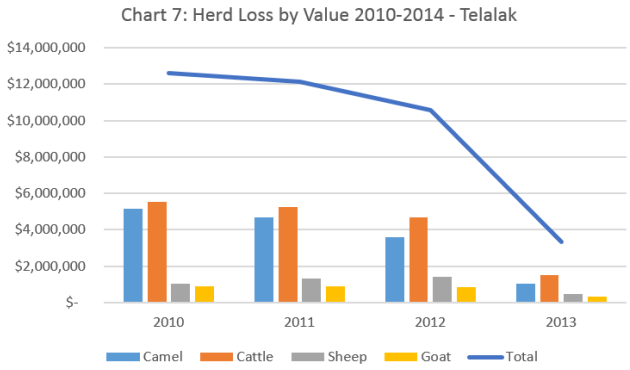


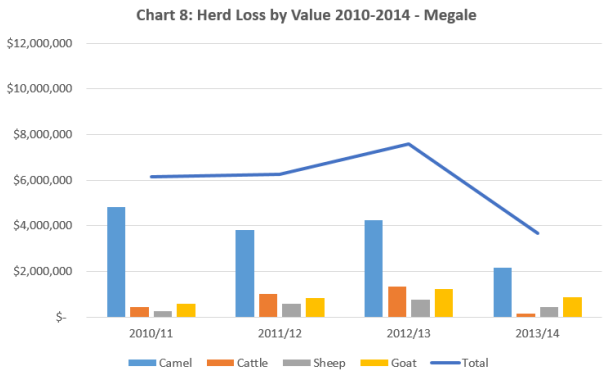
As chart 5 & 6 reveal, both communities showed declines in mortality in 2013/14 relative to the previous three year average. In Telalak (intervention), the mortality rate was nearly cut in half from a 21% average (2010/11-2012/13) to a rate of 11% this year – a 48% reduction. Megale (comparison) saw a decline from its three-year average of 36% to 23% - a 36% decline. However, on further examination, Megale's reduction was less conclusive. For example, the mortality rate for cattle at endline was actually higher when compared to two of the three reference years (2010/11 and 2011/12). Goats and sheep as well presented only moderately lower rates relative to the first two baseline years. Moreover, 2012/2013 was a particularly bad year in Megale which has the effect of skewing the 3-year average upward. In contrast, the mortality rates in Telalak were quite consistent across all baseline years for all animals varying by only a few percentage points. Equally the reductions were clear and consistently large for all animals when compared to the three year average as well as each of the three reference years.



Loss by Value

The difference in loss between Telalak and Megale is even more pronounced when evaluating it in terms of the monetary value of animals lost. Based on local market value for animals in moderate condition, population, average herd size and composition, and the mortality rates for each species, the aggregate losses in Telalak for the previous three years averaged $11.7 million USD per year or $1,995 per household. Based on the mortality rate this year, that loss plummeted to $3.3 million overall and $550 per household – a 72% reduction (Chart 7).





The average herd loss for the previous three years in Megale was $6.6 million for the community overall and $1,505 per household. In 2013/14 the aggregate loss dropped to $3.6 million and $832 per household – a 45% reduction. The relative difference between Telalak and Megale as it relates to value is not only due to the higher reduction in the mortality rate in Telalak, but herd composition and market value as well. While a typical Megale household will have almost twice the number of animals of a household in Telalak (64 animals compared to

39), they will possess far fewer cattle and many more goats. The market value of cattle and camel is 5-10 times the value of goats. Hence, as Chart 7 and 8 show, the monetary value gained from reduced livestock loss will be greater where livestock composition includes higher value animals. Another factor was that the overall local market value of animals in Megale runs 12-70% lower than the local market values in Telalak. This also contributed to the relative difference in lost value.

Need for Drought Related Aid

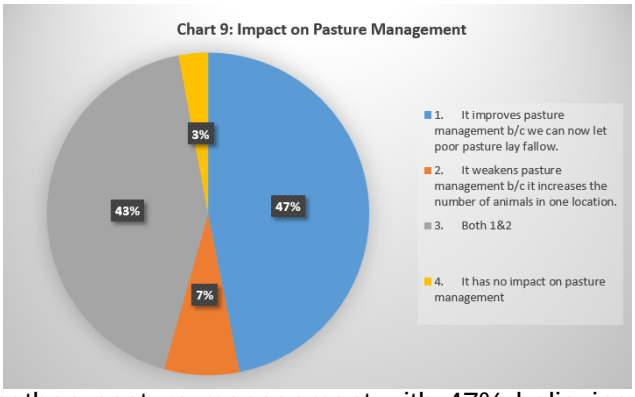
As noted in the Challenges section, PCI ultimately chose not to measure need for drought related aid due to the complexities in trying to do so under this pilot – particularly within such a short time span. If the application of drought related aid was tied to clear, objective measures that quantified need at the household level, and subsequently applied uniformly resulting in prompt distribution of aid, this would be a simpler measure to evaluate. The challenge is that the method for determining drought related need (as described in the section on Cost- Effectiveness and Competitive Landscape) is not prompt, uniform, nor measured at the household (i.e. micro) level. We do believe this innovation can significantly affect need for drought related aid when implemented and measured at a sufficient scale. In the next phase of the project we will consider proxy measures that assess associated vulnerability measures that ultimately trigger assistance.

D. POTENTIAL UNINTENDED (POSITIVE AND NEGATIVE) CONSEQUENCES OF THE APPROACH.

Changing grazing patterns can have potentially positive or negative consequences on host communities and pastures that are either selected or declined for use. One critical aspect of our design was to limit NDVI data to cover only long established traditional grazing grounds of the pastoralist group in question. All areas on the maps that were not a part of these designated grounds, or the corridors between them, were simply left white. Moreover, the grazing grounds identified by the pastoral community had to be validated by the host community. In this way we mitigated potential conflict and undesired movements outside what has been established as accepted grazing grounds. Within those physical parameter however, higher concentrations than normal of animals in certain areas (i.e. areas identified as being green on the maps), as well as lower concentrations in other areas (areas identified as yellow or brown) may have subsequent impacts for those pastures.

With regard to movement and potential conflict, we saw no evidence that pastoralists travelled outside their designated traditional grazing areas (and there would have been no incentive to do so based on the maps since those areas were whited out). PCI debriefed both the pastoral community representatives as well as host community representatives near the end of the project. Neither group reported any conflict this year as a consequence of changes in migration. Host communities participants did say that animal populations crossing their border is generally unpredictable. The number might be large or small depending on the situation in Afar and other grazing areas. All three host communities interviewed noted that national conservation efforts as well as pasture/farmland conversion are increasingly diminishing and possibly eliminating large

tracts previously available for grazing. This is already occurring in some areas with pastoralists renting private grazing fields within the host community as an adaptive measure.

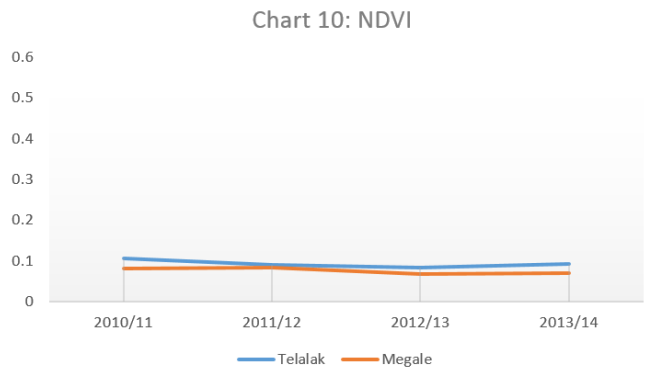


During the final assessment we asked survey participants if they felt the SAPARM maps would improve pasture management (because poor and moderate pastures would be allowed to recover); weaken pasture management (because there would be too many animals in one location); have not impact on pasture management; or serve to both strengthen and weaken at the same time for the reasons noted above. Overall, 90% of pastoralists felt SAPARM would strengthen pasture management with 47% believing it exclusively strengthen management and 43% believing it would both strengthen and weaken pasture management. Only 7% felt that it would have a purely negative effect and 3% felt it would have no impact. On the potential benefits, we had been hearing this from pastoralists since the planning of the project. Without the maps, the likelihood of animals arriving at a destination of moderate to poor pasture would be high. Rather than risk moving them again, pastoralists would simply stay further weakening an already degraded area. With the maps, those areas would be avoided allowing them the opportunity to regenerate.

For those that responded that it would have negative or mixed impact, we asked what could be done to mitigate the potential negative impact. The vast majority felt that host communities should impose limits on the number of animals they permit and pastoral communities should coordinate to regulate how many animals are permitted to enter certain areas. One of the host communities, Bati, shared that they and neighbouring pastoralist woredas, Adaar and Telalak, used to develop a joint natural resource management plan which has been implemented in the border areas of the two communities. Though they had a joint plan, the participation of the pastoral community has been extremely limited. A key component of Phase 2 would be to build in a joint host/pastoral mechanism to monitor and limit herds based on the carrying capacity of the land.

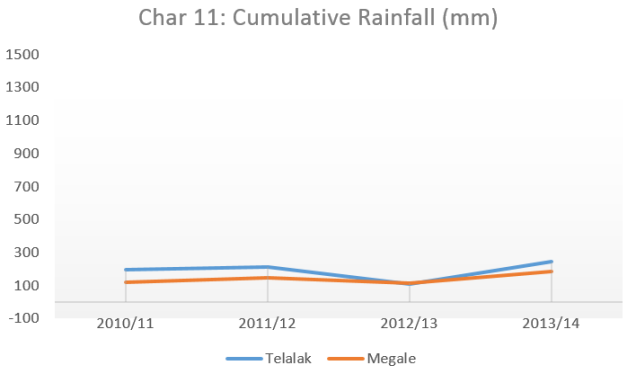
E. ATTRIBUTION

The reduction in mortality observed post intervention is impressive. Determining what may have contributed to the drop in mortality is critical to understanding the value and role SAPARM may have played. Several factors, not related to the presence of the SAPARM maps, could have impacted the dramatic change in mortality rate in Telalak as well as the more moderate changes observed in Megale which did not receive the maps. These include changes in rainfall, NDVI, vaccination rates, herd size and composition, amongst other possible confounders.



Looking at average NDVI year-on-year from 2009 through the study period in 2013/2014, we can see minimal variation related to vegetation availability within each communities traditional grazing grounds. PCI looked at the weighted 10 day average of NDVI values for each grazing area in both communities during the months of intervention (Dec-May), which included the dry season, and compared to the same months over the previous three years. The highest NDVI value in Telalak was 0.1184 in 2010/2011 and the lowest was 0.0948 in 2012/2013, with a range of 0.0236. In Megale, the highest recorded NDVI was 0.1063 in 2011/2012, and the lowest was 0.0861 in 2012/2013, with a range of 0.02. Looking at the average NDVI from 2010-2012 compared to the study year of 2013/2014, we saw small changes — the difference in Telalak between the 2010-2012 average and the study period average was 0.0026 and the same comparison in Megale was 0.009. These changes are unlikely to alter the amount of pasture land available each year. No values for any years observed significantly surpassed the 0.1 threshold which characteristically is considered areas of barren rock, sand, or snow. The 0.2-0.5 threshold is characterized as the *sparse vegetation* range.

We did witness a change in average cumulative rainfall for both Telalak and Megale, when comparing 2010/11-2012/13, with the intervention period experiencing 74mm more rain that the previous three year average in Telalak and 55mm more than the previous three year average in Megale. It is a possible confounding variable that could lead to reductions in herd loss although given that the additional rain had no evident impact on NDVI, it is unclear what impact the marginal change in rainfall had.



In each community we also looked to see if there was any correlation at the household level between herd size and mortality as well as the percentage of the herd comprised of goats (the most resilient of the herd species) and mortality. Generally, it would be plausible that fewer animals, or a greater percentage of the herd being goats, could lead to a higher overall survival rate. However, as Table 3 demonstrates, we found no significant correlation between these factors and mortality.

Table 3: Correlations Between Mortality Rate and % of Goats in Herd/Herd Size [1]		
	Telalak Mortality	Megale Mortality
% of Goats in Herd	-0.006	-0.029
Herd Size	0.024	0.087

PCI also looked at vaccination rates during the baseline and endline surveys to identify any changing patterns in the rates at which animals are vaccinated. The survey asked whether the respondents vaccinate all, some, or none of their animals by different types of animal. There was no significant change in either woreda from baseline to endline, suggesting that this was not contributing to the in mortality from baseline to endline. In fact, more households at endline responded that only some or none of their animals were vaccinated.

F. CONCLUSIONS

It is clear from the results of the pilot that the SAPARM maps were effectively disseminated and extensively used by pastoralists in determining herd migration. Almost 80% of respondents reported using the maps for migration decision-making. In some cases the maps were replacing traditional methods but mostly used to improve or enhance such methods it ways that saved time and resources. All users found the maps to be accurate in identifying adequate grazing areas with 57% stating it was very accurate. Over half the respondents felt the maps were their most important source of information for grazing decision-making and all felt the maps could reduce future livestock death and improve animal condition. Ninety percent of pastoralists felt SAPARM positively contributes to pasture management by allowing poor pastures to lay fallow while 43% also felt it could contribute to overgrazing in some areas. There was a precipitous drop in herd mortality rates over the intervention period (47%) compared to the previous three years in Telalak. This drop was similar for all herd species when compared year over year as well as the historical average. The comparison community also witnessed a 36% drop compared to their three year average but was less conclusive when looking at individual species and comparing year over year.

VI. COST-EFFECTIVENESS & COMPETITIVE LANDSCAPE

A. COMMON PRACTICE

The predominant practice for addressing drought-related livestock losses are active monitoring of weather and conditions which triggers response-driven actions executed once a drought is underway and damages have already been incurred. Responses includes water trucking, construction of water points, destocking/restocking, health interventions and emergency food assistance. Of these, the provision of emergency food assistance is by far the largest investment. In 2012, the Joint Humanitarian Requirement for Ethiopia (which collectively defines the estimated resource needs for emergency assistance by the government, UN and NGOs) was $363 million. Of that total, WASH, health and nutrition, agriculture and education interventions collectively made up $70 million while food aid made up the remaining $293 million, or 80% of the total. Mostly

[1] Using Pearson Coefficient of r = +/- 1.0. P value is below 0.05 at the 95% confidence level.

imported, emergency food assistance is a resource-intensive intervention. This practice, while essential and necessary for saving lives in the midst of a crisis, is an expensive and inefficient approach to addressing what is effectively a challenge of deteriorating livelihoods and vulnerability to climate change. Compensatory in nature, it is also a poor substitute for the loss experienced by the pastoralist – in our analysis of an Afari livelihood zone, it only covered one fifth of what is lost in livestock.

The use of geo-satellite data for agro-climactic monitoring in developing countries has been around since the mid-eighties, with the U.S. being a lead proponent through FEWS NET. However, the application has been primarily in service of the response-driven efforts noted above. There is no doubt that this has and will continue to be a valuable tool to more accurately predict impending droughts and render earlier responses. LEAP, in fact, was developed primarily to achieve this objective. Linked to Ethiopia's risk financing program (PSNP) LEAP is intended to identify drought earlier triggering the release of contingent funding to extend/expand the government's safety-net program to those in need during the crisis. In Ethiopia, the hope is that LEAP will reduce the response time from an average of 8 months down to 3 months through its integration with PSNP. Yet, in its current form and application, it will not help pastoralists find grazing resources and will not trigger a response until a disaster is declared. In fact there are communities in northern Afar who have suffered significant livestock losses over the last few years with no triggering of assistance even with LEAP in operation.

B. COMPETING SOLUTIONS

Based on our analysis of competing solutions, SAPARM is unique in its form and application compared to similar efforts to use technology to assist pastoralists. The following are four comparative projects that have used geo-satellite data linked to pastoral livelihoods that merit attention and can be contrasted to PCI's approach.

Livestock Early Warning System (LEWS): In collaboration with National Agricultural Research System in Kenya, Ethiopia, Uganda and Tanzania, scientists at Texas A&M University funded by USAID (1997-2003) through the Global Livestock Collaborative Research Support Program developed the LEWS. LEWS monitored forage conditions for six countries in north east Africa with over 500 monitoring sites located across 12 monitoring zones. LEWS provided point-based assessment of forage conditions simulated by the PHGYROW (hydrologic based plant growth simulation) model. Unlike NDVI, PHYGROW estimates grazing demand based on forage conditions of specific plant life linked to preferred forage and volume for different animals.

Karamojan Peace Cluster: The greater Karamojan Cluster encompasses regions within north-eastern Uganda, South Sudan, north-western Kenya, and southwest Ethiopia. These regions are inhabited by nomadic and semi-nomadic pastoralists where conflict over grazing and water resources has been endemic and heightened during periods of drought. Among other peace mitigation efforts, LEW's model for forage mapping was used to forecast impending scarcity and react early to minimize the potential for conflict.

Pastoral Surveillance and Early Warning System: Action Contre la Faim (ACF) International and its partners have developed a pastoral surveillance and early warning system for national and regional levels and currently being piloted in Mali. The tool creates map products using geo-

satellite data to assess the relative abundance or scarcity of biomass at the end of the rainy season and of surface-water bodies over a given year compared to an index period. This information is presented at national and regional levels.

Livestock Drought Management Tool: In August 2010, the Food and Agriculture Organization (FAO) contracted the International Livestock Research Institute (ILRI) to develop a proto-type "Livestock Drought Management" (LDM) decision support tool which uses data to indicate the severity of the drought (hazard) and the ability of livestock to survive the drought (sensitivity). The hazard information in the LDM tool is based on NDVI captured by the NOAA AVHRR system. The sensitivity information is based on livestock body condition (LBC).

PCI has met with Jay Anger, who heads Texas A&M's efforts on LEWS and also with Richard Caroulton of WFP who was involved in the Karamodjan Peace Project. We've also met with ACF's representatives of the Pastoral Surveillance and Early Warning System. While we have not met with anyone from ILRI, they have provided a detailed report on their conceptual model (Erikson et al, 2010). The commonality between these four approaches and PCI's proposed innovation is that they all use geo-satellite imagery to evaluate pasture conditions. Beyond that, the models diverge. We believe that PCI's approach offers a design specifically purposed, and with distinct advantages for use by pastoralists that are absent in the other models. It is not that these other models are inherently weak, rather they were designed more for the purposes of early warning than as a resource for pastoral decision-making. Some of the differences are as follows:

Simplicity

The system used by the LEWS project, Karamodjan Peace Cluster and the Pastoral Surveillance and Early Warning System is based on a more complex data model than NDVI. In the case of LEWS, maps are created based on variation in biomass linked to a particular type of animal, herd size and demand. This requires a more intensive effort at collection, including the use of ground-based monitoring points. In order for LEWS to create a geo-statistically correct analysis, they have to locate a minimum of 30 spatially stratified monitoring points in each of 11 zones (330 points) across four countries. Data has to be gathered from these sites physically and updated regularly. Moreover, the analysis is inherently more complex. The Pastoral Surveillance and Early Warning System uses biomass and hydrological anomalies rather than actual vegetation or water availability in order to assess relative change. This requires a more sophisticated analysis. The ILRI tool, while simpler than LEWS, still relies on a formula that requires generating data on livestock body condition (LBC) for which they have yet to find a good quality proxy and experts have not been able to agree on how to define.

PCI's approach is to use NDVI only. NDVI indicates the current biomass condition (i.e. greenness) – nothing more. Both Texas A&M and WFP concur that NDVI is a very good composite tool with decades of reliability and historical data. Our belief, which is reinforced by our results, is that NDVI is easily interpreted and represents 80% of the information value needed by pastoralists which can then be complimented with indigenous knowledge of the predominant plant species in their grazing areas. With satellite-produced imagery as the only input, the investment and recurrent level of effort are significantly diminished.

Localization

SAPARM localizes data to the specific grazing grounds of a particular community. The extensiveness of grazing areas combined with the required specificity of knowing where to move herds on an on-going basis means that information should be spatially detailed, current and capable of covering the entire grazing area. NDVI allows specificity down to a $3km^2$ area ($10km^2$ through LEAP) and is updated every 10 days. These customized maps therefore provide a much more targeted and useful dataset for pastoralists. In contrast, LEWS, Karamodja, Pastoral Surveillance and Early Warning System, and the Livestock Management Tool does not localize their mapping. LEWS is based on a model dependent on ground-based monitoring points, it cannot define with the same resolution and specificity the actual conditions within an area outside those monitoring points. As the Karamodjan project was reliant on LEWS, its data tended to be more generalized for geographic areas and therefore ultimately less helpful for the purpose we are proposing. In part, this is due to the fact that these systems were developed more for predicting and managing general area drought-related crises than for defining specific localities for herd movement. ACF's Pastoral Surveillance tools are designed for regional and national monitoring. The ILRI tool has not yet been implemented but it is also aimed more at early warning rather than support for herd migration decisions.

Integration

PCI's approach requires no new systems, tools, or human resources to implement the innovation. In fact, part of the innovation and capacity for scale is that it is designed to seamlessly integrate into existing systems at the government and community levels. At the government level, PCI is taking an existing system (i.e. LEAP) that the Government of Ethiopia is using at national level (and increasingly at state levels), adding customized grazing maps and reversing the information flow. As described in the mapping and dissemination process above, once the maps are digitized, they can be automatically emailed every 10 days. Once delivered to the woreda, existing systems and processes take over eliminating the need for costly infrastructure or human resources. As connectivity expands in Ethiopia and throughout Africa, the ease at which these maps can be integrated without assistance from PCI will be even greater (see next steps for Telalak). Other pastoral countries, such as Kenya, have similar structures and systems for early warning that will facilitate integration. LEAP is easily transferrable but other systems that capture NDVI could also be used. At the community level, the information is disseminated using existing communication systems and practices for grazing area identification. The information is not meant to replace IK or the use of scouts but rather to leverage and complement them by expanding their observation platform and doing so on a continuous basis. LEWS in East Africa suffered due to the complexity in the required management and limited consideration of the need for integration.

Current vs. Forecasted or Relative Orientation

LEWS, Karamodja, the Pastoral Early Warning and Surveillance System, and ILRI's Drought Management Tool are geared toward forecasting and analysis of impending drought conditions rather than relaying existing grazing conditions for effective decision making. While forecasts are important to farmers in determining what and when to plant, herders are more interested in what's

occurring right now within their expansive area of operation. This is supported by Roncoli et al (2002) who found that pastoralists do not use forecasts to support livestock management decisions because they make their decisions based on outcomes of rains rather than forecasts of rain. Speranza (2009) also notes that pastoralists do not move on the basis of forecasts but on actual reported conditions. While LEWS and the Karamodjan Peace Cluster use of LEWS was extended to pastoralists to support decision-making, this has been secondary to its application as an early warning/conflict mitigation tool and again limited geo-spatially by the input data. ACF's tool measures the anomaly (or change) in vegetation and water relative to historical data. While this may be an important indicator for early warning monitoring, its utility is limited for pastoralists who are more interested in what is or isn't available now. PCI's approach provides ongoing NDVI data that show current conditions with high geo-spatial resolution and tied specifically to their grazing areas. This allows pastoralists to monitor changing conditions and respond quickly to what is currently happening on the ground.

Impact and Attribution

The case/control study and cost-benefit analysis of reduced livestock loss PCI has applied under DIV are new and unique contributions and will provide valuable learning in order to move the state-of-the-art forward. Karamodja focused primarily on the use of LEWS and other interventions to reduce conflict. This was, in fact, measured through the project and the collective interventions were found to reduce conflict. LEWS in East Africa was focused more on the process of development of the tools and execution within the various countries. It therefore did not measure impact or evaluate cost/benefit. ACF has been in project development and has not yet measured the impact of its tool. ILRI's Drought Management Tool is at the conceptual stage and has not been tested.

C. COST BENEFIT

PCI has calculated a Benefit Cost Ratio of $47.59 and a Net Present Value of $5.37 million under the pilot. The cost incorporates the full grant amount, as well as investment and recurring costs by WFP and the Government of Ethiopia over a one year period. The benefit is calculated as the market value of the reduced herd losses in Telalak minus the value of the reduced herd losses in Megale applying the same time horizon of one year (see table below).

BCR
$47.59

NPV
$5.36 Million

Cost		Benefit	
DIV Grant (Covers investment and recurring costs for 1 year pilot)	$100,000	Valuation of reduction in herd loss in Telalak (intervention) current year from valuation of average annual herd loss based on previous three years ***minus***…	$8,463,012
WFP Cost share (covers portion of consulting fee for digitization of grazing maps)	$12,600	Valuation of reduction in herd loss in Megale (control) current year from valuation of average annual herd loss based on previous three years.	$2,978,785
GOE (Estimated valuation of hours GOE employees spent on SAPARM activities)	$2,640		
Total	**$115,240**		**$5,480,000**

Some important considerations in analysing the BCR and NPV are:

- While the total grant amount was included, a significant portion of that grant was actually spent on evaluation of the program as opposed to investments in the innovation's development and recurring costs of implementation.
- The short time horizon (one year) actually reduces the benefit-cost ratio as the benefits would continue to accrue in out years without any additional investment costs (only recurring costs);
- Valuation of benefits does not include the reduced need for drought related aid (for reasons already discussed) even though we believe this to be a potentially important benefit;
- Benefit valuation uses only the most direct benefit of herd loss reduction and does not attempt to measure other potential direct or indirect impacts such as the productive value of reduced time moving herds, long-term productive value of the animal saved or social and economic impacts of increased resiliency;
- Assumption applied was that the total net value of herd loss reduction in intervention community minus the value of reduction of the control community could be attributable to SAPARM (see attribution).

This analysis uses both longitudinal data on mortality rates in both case/control communities to derive CBR. Reduced value of herd loss was calculated by comparing average herd loss value for 2010-2012 compared to the study year of 2013. Baseline and endline survey respondents were asked to provide the number of animals of each type (camel, cattle, sheep, goat), the quality of the animal (good, moderate, poor) and the local market value of each animal based on their quality. The survey also asked the respondents to report how many animals of each type died for the current and two previous years (baseline) and then again at end line. Based on the population size in each community, PCI was able to calculate the total estimated herd loss per community and value of that loss using the local market value of an animal in moderate condition. In Telalak, the annual average herd loss value pre-intervention (2010-2012) was $11.78 million. The post-intervention (2013/14) herd loss value was $3.32 million - a reduction of $8.46 million. In the control area of Megale, the average herd loss value for 2010-2012/13 was $6.67 million while the loss in 2013/14 was projected at $3.69 million, for a reduction of $2.98 million. The net

benefit used for attribution in Telalak assumes that the benefit ascribed to the comparison community (i.e., a $2.98 million reduction) would have also occurred in the intervention community regardless of the presence of SAPARM maps and therefore subtracted from the total in Telalak. While the herd composition and market values are different between the two communities, this was one way within the limited scope of this study to account for any potential other mitigating effects.

VII. SCALING PLAN (PUBLIC SECTOR PROJECTS ONLY)

A. SCALING PATH

As indicated in the original proposal there are there are 6.6 million pastoralists or agro-pastoralists in Ethiopia. On the continent there are approximately 255 million pastoralists; roughly 45% of the Africa's land mass is pastoral; and up to 44% of Africa's GDP is derived from pastoralism. Globally, 36 developing countries have pastoral populations greater than one million. In most parts of Africa and many parts of the developing world, pastoralist continue to use traditional low-tech methods for identifying pasture and making migration decisions. Thus the need and opportunity for scaling this type of innovation is substantial.

For Stage 1 (Proof of Concept) of DIV, direct beneficiaries were defined as pastoral decision-makers on herd migration and were the target recipients of the SAPARM maps. Indirect beneficiaries were other household members who will benefit from improved decision-making and loss mitigation. Direct and indirect beneficiaries for the intervention community were 6,029 and 36,154 respectively, or 42,183 beneficiaries in total.

For Stage 2, PCI will seek to expand the study to 5 intervention and 5 control woredas in Afar over two dry seasons. For Stage II scaling PCI has calculated direct and indirect beneficiaries as 43,333 and 260,000 respectively based on an average woreda population of 52,000. As in the Stage 1 phase, we will likely pair woredas that share common characteristics but operate in different grazing areas. This extended coverage as well as extended time period will allow us to validate the results of Phase 1 in a broader and more varied set of case and control communities, as well as prototype direct continuous application without PCI assistance (in Telalak and other communities with internet connectivity). For Stage 2, PCI will invest even more rigorously in the research and study of impact by engaging a dedicated third-party research partner – Notre Dame University (Initiative for Global Development). In addition, we will expand efforts at the national level to plan integration of SAPARM into its application of LEAP in pastoral areas as well as initial investigations in Kenya as part of our preparation for a potential Stage 3. An additional component will be to reinforce existing structures of communication/collaboration between pastoral and host communities to monitor and manage migrations relative to carrying capacity of the available pasture.

For Stage 3 we've proposed scaling to 80% of all pastoral and agro-pastoral populations in Ethiopia and 20% in Kenya. This results in 5.1 million beneficiaries with 865,000 direct and 4.3 million indirect beneficiaries. In ten years it is difficult to say how many beneficiaries there could be. Part of that determinant will be based on governments and communities recognizing the value of the model and adopting it nationally. However with 251 million pastoralists on the continent alone with a common need for this type of information, we believe the space exists for significant

expansion. We placed the 10 year estimate at 19.8 million (3.3 million direct and 16.5 million indirect beneficiaries). This represents roughly all pastoral populations in Kenya and Ethiopia combined which is approximately 8% of the total pastoral population on the continent.

B. PUBLIC INVESTMENTS

For Stage 2, the principle stakeholders would continue to be WFP and the GOE. In Telalak the relevant government offices in the woreda have committed to run and own the process. If they can acquire the necessary office equipment such as color printer, motorcycle and access to the SAPARM maps every ten days, they have committed to make sufficient copies of the maps and disseminate the information the way it was done with PCI over the last year. As they have just received broadband internet this year, this is now feasible and will be a good test of sustainability. WFP is following up the intervention with a LEAP training to DIV project woreda and regional stakeholders with an estimated cost of $2,550 which they have committed to do as part of the project. With an expansion of study to 10 woredas, involvement of the regional DPFSCO would expand. While they have been engaged thus far in woreda selection and participated in the assessment and debriefs, PCI would want to see them actively monitoring SAPARM maps and engaging woreda counterparts on effective distribution. A more active engagement of DRMFSS will be sought by PCI and WFP at the national level. This will start in Stage 2 with an initial workshop to present the results of the pilot followed by strategic discussions on possible approaches to scale the innovation nationally.

Outside interest has also been expanding. PCI has agreed to work with Action Contre le Faim (ACF) and SNV to adapt their *Pastoral Surveillance and Early Warning System* (see competing solutions) using the SAPARM approach with European funding. Representatives from Google's Global Impact Awards heard about SAPARM and reached out to PCI to learn more. As a result, they are evaluating SAPARM for possible support through this initiative (https://www.google.org/global-impact-awards/). Some of PCI's private investors have expressed interest in supporting some of the needed items for continuity of distribution in Telalak and initiation of distribution in Megale for the coming dry season.