Livestock Drought Management Tool

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Contents

Summary

In August 2010, the Food and Agriculture Organization (FAO) sub-Regional Emergency Office for Eastern and Central Africa (REOA) contracted the International Livestock Research Institute (ILRI) to develop a proto-type "Livestock Drought Management" (LDM) decision support tool for use by a range of emergency and relief planners and practitioners throughout the region. The tool, which is still conceptual rather than operational, links the concepts of Drought Cycle Management (DCM) with the best practice in livestock-related interventions throughout all phases of a drought, from normal through the alert and emergency stages to recovery. The tool 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 Normalized Differential Vegetation Index (NDVI) captured by the NOAA AVHRR system. The tool suggests that the best indicator for sensitivity is livestock body condition (LBC). It combines these two indicators, using expert opinion, to define the phase of the Drought Cycle. The hazard data has currently been parameterized for Kenya, but can be used in any of the REOA countries. At the moment, the missing item is good quality data for sensitivity. Additionally, experts did not agree on how to define the phase of the drought cycle. The tool requires pilot testing in a few local areas before it can be rolled out everywhere.

Introduction and rationale for a "Livestock Drought Management Tool"

The importance of timely and appropriate interventions to save livestock during droughts is agreed to by many who work on drought relief in pastoral areas of East and Central Africa (ECA). Livestock are a critical asset for pastoralists, and loss of livestock due to drought has a negative impact on pastoral livelihood strategies through loss of milk production, loss of revenue from livestock sales (which is often used to purchase grain) and the loss of the asset value of livestock who die. In the most recent 2008-9 drought some districts in Kenya reported mortality rates over 50% (Zwaagstra et al., 2010). These high loss rates, when coupled with recurrent droughts ECA has experienced since 1997 are cause for concern. The concern that the emergency relief community does not appreciate the importance of saving livestock assets in emergencies has prompted a number of initiatives to improve planning and response, most notably the Livestock Emergency Guidelines and Standards (LEGS) (Watson and Catley 2008).

Timeliness of interventions to support livestock is critical because most interventions should be implemented before livestock are so weak they will die. Pastoralists have a number of coping and adaptive strategies to protect livestock assets which they typically implement during droughts: chiefly moving the animals to areas with better forage and water, selling some animals, splitting herds or exchanging animals, or over time changing herd species composition (Morton et al 2001). Interventions aimed at supporting these strategies have to be timely. For example, commercial destocking is more successful done early so that the animals fetch higher prices. Supplementary feeding needs to target breeding stock with sufficient time so that they stay healthy. Conflict resolution to enable pastoralists to move to key grazing areas needs to be done in advance, before large numbers of animals are in need of pasture. Late interventions are costly and unhelpful (HPN 2006; PACAPS 2008).

A different concern motivated the development of Drought Cycle Management (DCM) and the more recent concepts of Disaster Risk Reduction (DRR) (IIRR 2004; ISDR 2009). These two frameworks understand drought as a hazard which is always present in the drylands of East and Central Africa (ECA). Any given area or community is therefore always in some phase related to current, recent or impending drought. The drought cycle spans from normal through to alert/ alarm, emergency and then into recovery. This may be over a period of one to seven years. Thus relief programming should focus on the whole drought cycle, including normal and recovery, rather than just alert and emergency. This is even more important given the frequency of droughts in ECA and the consequent herd losses from which many pastoralists cannot recover. There are many activities that can be implemented during the normal phases (or the good years between droughts) to reduce vulnerability and enhance resilience such as repairing water sources, working on market infrastructure, etc. This is a time when herds are growing or recovering. It is also extremely important to prepare for the alert and emergency phases of droughts before they occur. Finally, recurrent failed rainy seasons have a much more devastating effect than short duration droughts followed by a sequence of multiple good rainy seasons. These are all reasons to plan drought-related activities to protect livestock throughout the whole drought cycle, and to monitor droughts as they unfold.

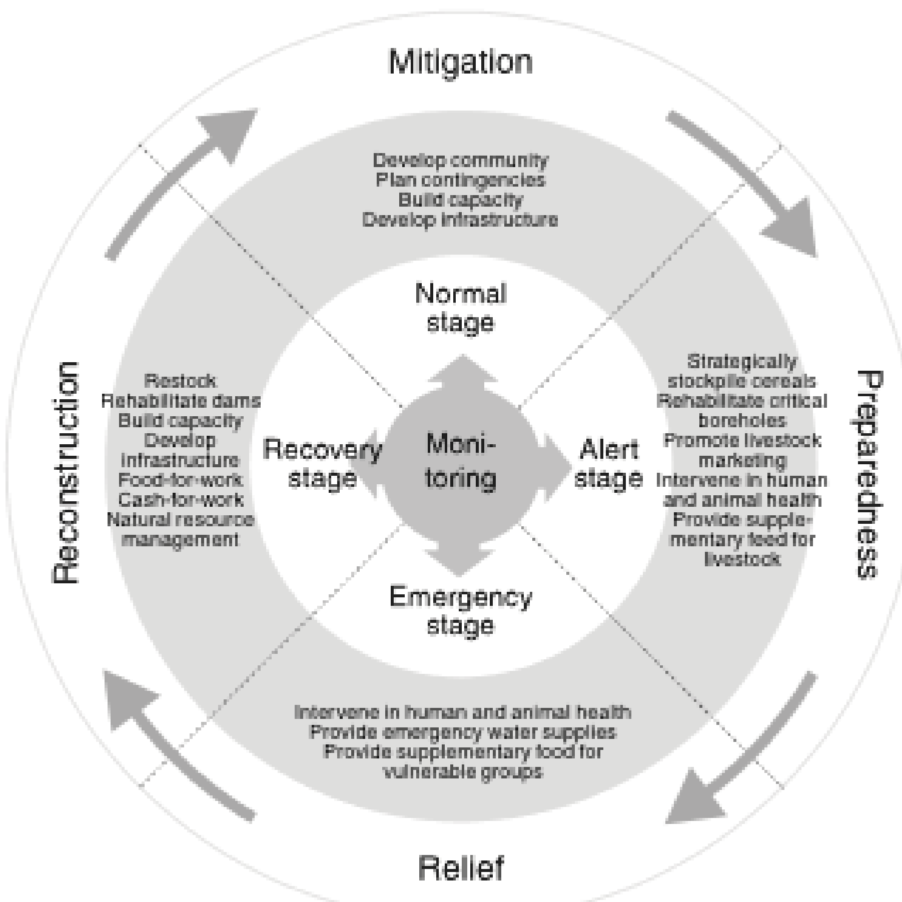


Figure 1: Drought cycle management (IIRR, 2004)

A recent evaluation of the 2008-9 drought response in Northern Kenya (Zwaagstra et al., 2010) include the following findings which point to the need for better and more objective monitoring of the drought cycle and livestock related interventions throughout it.

1. The warnings in the ALRMP Early Warning Bulletins were largely based upon deteriorating human and livestock conditions - the EWB emphasizes socio-economic indicators related to livelihoods and human nutrition - in conjunction with a few environmental indicators such as water availability in dams or pans. In this case, the EWB is "tracking" or "confirming" a situation that is already in serious decline, the response of livestock and human condition to drought, rather than providing an early warning that precedes the deterioration of the condition of livestock and people. The EWB combines drought hazard indicators, such as rainfall, with indicators that describe the response of people and livestock to such drought hazard. These response indicators are affected not solely by drought. Other factors like poverty have an impact on malnutrition, which is chronic in many areas. Problems arise when including a chronic indicator like malnutrition in a drought early warning system. Chronic food insecurity in areas such as Turkana led to this district being classified in 2008 and 2009 as in alert, even though the NDVI indicated plenty of green vegetation. Obviously, there was reason to give an alert from a humanitarian perspective because of the chronic malnutrition, but there was little reason to give an alert for livestock or start the implementation of livestock based drought management interventions. In contrast, a district like Kajiado experienced in 2008 and 2009 the worst drought in 30 years, but the EWS did not classify the situation as an emergency because the malnutrition indicators were not elevated. Obviously there was no reason for an emergency from a food aid perspective, but the EWS failed to signal an emergency with respect to livestock. Ideally, the EWS would have indicated an emergency for livestock in Kajiado and an emergency for food aid in Turkana. At present the system does not make such separate warnings, and it is not very specific on the urgency for livestock based interventions, as the early warning system tracks human nutrition rather than livestock condition. Furthermore the mixing of a hazard (drought) with chronic social indicators (food insecurity), leads to a situation where these chronic indicators mask the message that there is a hazard.

2. This situation, where chronic indicators blur the message of an emerging hazard is to be avoided in an early warning system. One of the main authors of the report concludes that improvement is still needed in both the quality and the timeliness of the data collected for the EWB, in order to clearly define the drought cycle phase[1]. For the purposes of monitoring livestock – related needs, a new model is needed.

[1] Personal communication, Lammert Zwaagstra.

Similar issues were reported to delay livestock saving interventions in Ethiopia during the 2005/6 drought, which severely affected pastoral areas (Pantuliano and Wekesa, 2008).

These issues provide the background to this "Livestock Drought Management Tool," which aims to support timely and appropriate livestock-related interventions in pastoral communities throughout the Drought Cycle (in Normal, Alert, Emergency and Recovery phases) in all countries in the REAO (Eastern and Central Africa). It stems from the recognition that early warning and monitoring information for livestock interventions should be simple (i.e. based upon as few, easily monitored or collected variables as possible) but also based on as good quality data as is possible. It also recognizes that livestock –related interventions require their own logic which is related to the activity of livestock keeping, rather than humanitarian situations (PACAPS 2008). Finally, often communities and agencies operating at the local level, district and national governments, as well as international donors, need a tool to classify drought phases objectively, to remove the delays and questions which plague planning and implementing drought relief interventions, particularly in relation to saving livestock assets.

Approach of the Livestock Drought Management (LDM) Tool

The tool is organized into two steps. The first helps to conceptualize how indicators of the drought hazard and indicators of livestock sensitivity could be combined to define the DCM phase for a given geographic location. This step is based on a framework which evaluates drought risk as a combination of hazard and sensitivity:

$$\text{Risk} = \text{Hazard} * \text{Sensitivity}.$$

The hazard indicator measures the intensity and severity of the drought in terms of its impact on rangeland vegetation, which is the forage livestock have available to graze on. Lack of rainfall has a direct negative impact on forage growth. The sensitivity indicator should reflect how livestock are faring in spite of the drought – e.g. are pastoralists able to move the livestock to other areas, is the drought of short enough duration that most livestock can endure it. The evaluation of hazard and evaluation of sensitivity are then combined to decide which phase of a drought cycle a given area is in.

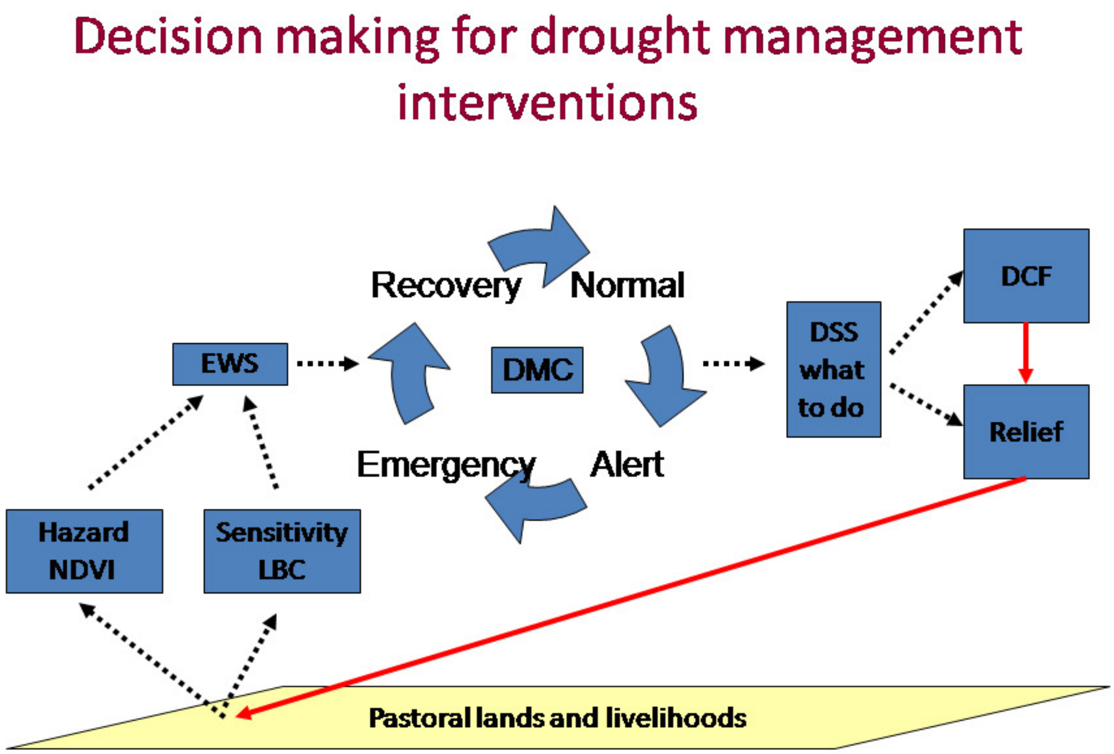


Figure 2: Decision making for drought management interventions

The second step allow users to link the evaluation of phase of the DCM with the tools for planning interventions (using LEGS for alert, emergency and restocking). The phase of the DCM dictates the sort of livestock interventions that should be considered, although designing these interventions requires local information and community involvement. This transparent decision about the stage of a drought and an early indication of the drought's impact on livestock should facilitate more timely livestock-related interventions.

Expert knowledge is critical to the initial and further development of this tool. At the moment there is no consensus on several important components of the tool: how to interpret the severity of the drought hazard, the best sensitivity indicator to use and how to evaluate it, and what the thresholds are that should trigger a movement from one phase to another of the drought cycle. We held an expert consultation (see appendix for list of participants) to gather advice on these issues, as well as to discuss the potential for using the tool to improve emergency and disaster risk reduction programming throughout the region. As discussed later in the document, further work on all three of these components is still necessary.

Conceptual tool for defining drought cycle phase

Indicators of drought hazard

A drought is a commonly occurring natural hazard, which is defined as a period when an area receives below average precipitation over extended periods, of several months to multiple years. Distinction is made between meteorological drought, which is the above mentioned shortfall in precipitation, and agronomic drought, a shortfall in soil water available for plant production, which may be the result of land management and reduced infiltration of water in soils rather than meteorological drought. Drought diminishes the (primary) production of crops and rangeland vegetation and the secondary production of livestock, which depends on primary production. Droughts have strong impacts on social and economic situations in the areas affected, as a result of this shortfall in primary and secondary production.

Table 1 summarizes a sequence of processes related to drought. The biophysical part of this system includes the oceanic oscillation in sea surface temperature (SST) such as the ENSO and IOD which are thought to drive drought in East Africa; precipitation which is determined in addition by convective processes that are affected by the warming of the land; the infiltration of moisture in the soil, which apart from rainfall also depends on infiltration enabling soil surface processes; and the primary and secondary production and livestock mortality which depend on this.

Table 1. Various processes related to drought, associated indicators and available methods for measurement

Process	Indicator / state variable	Measurement
ENSO[2], IOD[3]	Sea surface temperature (SST)	In situ buoys and RS of SST
Precipitation	Rainfall (mm/unit time)	In situ measurement; RS - CCD; TRIM
Soil moisture infiltration	Soil moisture content	In situ measurement and RS based models
Primary production	Biomass	In situ measurement and RS vegetation indices
Livestock production	Livestock condition and stocking density	In situ assessment
Livestock mortality	Recorded mortality	In situ observation

How suitable are these various processes and their associated indicators to monitor drought hazard and forecast deleterious impacts for the purposes of implementing interventions geared towards avoiding mortality losses of livestock assets? A suitable drought early warning indicator should fulfill a number of criteria:

1. **Timeliness** – a good hazard indicator gives a signal early enough to allow sufficient time for the implementation of interventions to avoid losses of livestock.
2. **Reliability** – a good hazard indicator should be a reliable predictor that adverse drought related impact threaten the target objects of our interventions; a shift in drought cycle management status from normal to alert or from there to emergency status implies that costs will be made. Ideally a hazard indicator does not fail to detect a hazard or give a false alarm; to frequent errors make an indicator unsuitable.

[2] ENSO, El Nino Southern Oscillation, is a quasi regular oscillation of the temperatures of the South Eastern Pacific between the El Nino phase with colder waters along the South American coast, associated to higher rainfall in East Africa, and the la Nina phase with warmer waters associated to drought in East Africa.

[3] IOD, the Indian Ocean Dipole is an irregular oscillation of sea-surface temperatures between a positive phase with above average SST and greater precipitation in the western Indian Ocean and opposite SST and rainfall conditions in the east Indian Ocean is associated with drought in Indonesia and Australia, while the negative phase of the IOD with increased SST and precipitation in the eastern Indian Ocean, and cooler and drier conditions in the west is associated to drought in east Africa.

3. **Synoptic** – a good hazard indicator is synoptic, e.g. it provides information representative for a larger geographical universe.

Long term rainfall prediction - SST imagery and oceanic oscillation patterns inferred from this are the timeliest possible indicators of drought related livestock mortality. These indicators are however not a very reliable predictor because oscillation patterns do not explain all rainfall anomalies and SST imagery also does not provide geographical synopsis of the drought condition of the land where livestock reside. Long term rainfall predictions, derived from anomalies in oceanic circulation patterns, are useful as an indicator to set a general, geographically non specific, alert stage. However, long term rainfall models based on oceanic circulation anomalies do not have potential to trigger operational drought management activities, as they are rather weakly related to rainfall patterns and do not allow assessing the geographic variation in rainfall over land. It would be advisable to accompany such long term predictions with information that clarifies its limitations for operational use in drought cycle management.

Table 2. Suitability of various drought hazard early warning indicators according to three criteria

Indicator	**Timeliness**	**Reliable predictor**	**Geographical**
Oceanic oscillation	++++	+/-	---
Rainfall	+++	++	---
Vegetation greenness	++	+++	+++
Livestock condition	+	++++	---

Rainfall records - Rainfall is the most obvious indicator of drought, as it is defined as a shortage of rainfall. It is a timely indicator of drought as it provides a signal few weeks before the vegetation responds, and many months before livestock dies. A few disadvantages of rainfall is that information was so far relying on records from few scattered rainfall stations. The density of operational rainfall stations in the drylands of North Kenya is for example below 1 station per 10,000 km^2, which is far too little to provide reliable and geographical synopsis[4]. Also, there are few stations with continuous and reliable long term rainfall record, as most stations in operation for longer periods have significant gaps in data collection which complicates the use of rainfall records for assessing drought hazard.

Vegetation greenness - Vegetation indices are based on measurement of the spectral reflectance made by satellites orbiting the earth. Green vegetation has low reflectance in the

[4] The quality of remotely sensed predictions of rainfall is continuously improving. We recognize that CCD and TRIM systems have potential, and it would be worthwhile these options further in the future.

visible, including the red, part of the spectrum, and high reflectance in the near infra red part of the spectrum. Dead and senescent vegetation has low reflectance in the visible and the near infra red part of the spectrum. The Normalized Differential Vegetation Index (NDVI) is an index which reflects the greenness of the vegetation. It is close to 1 for dense green vegetation and lower, normally below 0.2, for water, bare soils and dead vegetation. The index is based in reflectance in the near infra red (NIR) and that in the red (R) part of the spectrum and calculated as follows:

$$NDVI = (NIR-R)/(NIR+R)$$

There is a variety of satellites recording the reflectance of the earth surface in the red and near infrared. For vegetation monitoring purposes medium and low resolution imaging devices are ideal, as they generate imagery on daily or more frequent basis. For this study we have chosen to use the NOAA AVHRR data set, which has somewhat lower spatial resolution than the other two systems but covers a much longer time span than both other systems, and makes it thus an attractive data set to look for anomalies in NDVI.

Table 3. Medium and low resolution remote sensing systems that provided NDVI at near daily basis.

System	**Resolution**	**Operational since**
NOAA - AVHRR	8 x 8 km	1983
SPOT VEGETATION	1 x 1 km	1998
MODIS	0.25 x 0.25 km	1999

NDVI is less timely than information rainfall and oceanic patterns, but anomalies in NDVI still precede losses in livestock condition and livestock mortality, as it takes time for livestock to deplete forage resources, and livestock fat reserves mean that it takes time before lose body condition to the point where they are at risk of mortality. A further advantage of using NDVI of NOAA AVHRR is that it has a continuous record of 28 years of monthly NDVI values and accounts for geographical variation.

Livestock body condition - Livestock condition is a reliable indicator of the likelihood an animal will die. It is however, not a very timely indicator, as it may be too late to respond when animals develop poor body condition. Livestock body condition may furthermore not be representative as only few households are typically surveyed.

Given the above considerations of timeliness, reliability and geographic synopsis, we propose using NDVI rather than rainfall as a hazard indicator in livestock based drought early warning.

Indicators of sensitivity:

Livestock body condition (LBC): For a livestock intervention tool, the indicator of sensitivity should directly reflect how animals are managing to stay healthy during the drought. Declining availability or quality of both forage and water means livestock have less to eat and drink. In a normal dry season, pastoralists can move with their animals in search of grass and water. In protracted droughts such as those of 2005/6 and 2008/9, grazing vegetation and water became very scarce in a number of districts, and pastoralists traveled very long distances with their animals. Conflict and insecurity restricted mobility especially in Northern Kenya, Uganda, and parts of Ethiopia. Dry season grazing areas may therefore be unavailable even if they are green. In other places, supplementary feed maybe available for purchase (e.g. hay or nutrient blocks). Livestock body condition should reflect how well pastoralists are managing to find water and feed, as it will decline when animals have insufficient water and feed (Nicholson and Sayers 1987). Livestock body condition is therefore an integrated indicator of the sensitivity of livestock in a given area to an ongoing drought (or recovery from drought).

A number of condition scoring guides exist. NR International has posted guidelines for sheep, goats and cattle specifically for developing countries on the website: http://www.smallstock.info/index.htm as part of the Livestock Production Programme funded by the UK Department for International Development (DfID). These condition scoring guidelines rely on an assessment of how fat or thin an animal is, using hands and images. Animals can be scored on scales of 1-5 or 1-9 (Nicolson and Sayers 1987), where 1 is emaciated and 5 or 9 is very fat. We propose such a scoring assessment as one way to evaluate livestock body condition, as it can easily be done in the field by pastoralists.

Including livestock body condition in a spatially explicit decision support system depends on the possibility to record and map geographic variation in livestock body condition. The current ALRMP does not collect information on livestock body condition. The ALRMP does survey a relatively large sample of households in a number of sentinel sites within every district. Adding systematic recording of livestock body condition would allow collection of information on within-district variation in livestock body condition.

Feedback from experts: at the consultation on 23 November (see appendix for list of participants), we proposed LBC as the sensitivity indicator and demonstrated how it could be mapped each month. In the Kenya monthly EWB, local experts report on whether LBC has improved or declined. Reaction from the experts consulted on 23 November was mixed. Although LBC is a direct indicator of how well pastoralists are able to keep their animals fed, several experts felt that evaluating LBC using the condition scoring guides was too subjective to practically implement in the field. LBC evaluation would have to be standardized throughout administrative reporting units. However many agreed that LBC is already used by pastoralists to evaluate their animals' status, and that LBC determines the price (to some extent) paid for animals in the market.

Livestock prices were therefore suggested as an alternative indicator to monitor sensitivity. The logic here is that market prices for livestock fall during droughts as livestock body condition declines. A second component may be that there are more livestock in the market as pastoralists try to destock so as to have fewer animals to manage during the drought, and hence prices decline. Grain prices, conversely, will rise in a drought. Thus Terms of Trade (ToT) between livestock prices and grain prices could be a valuable alternative sensitivity indicator, as it indicates how the purchasing power of pastoralists is doing. Price data need to be carefully interpreted in context, however. First, not all herders will sell livestock during a drought, as they need a minimum herd size to recover after the drought is over (Morton et al 2001). Second, other factors such as disease can also affect market prices. Third, if food aid is made available the ToT livestock: grain may be distorted. Thus market prices need to be considered in the local context – e.g. the geographical area served by a given market. The number of livestock being sold each month, which is monitored by the Kenyan EWB system, might also be an indicator if one assumes that herders try to destock weaker animals in greater numbers as the drought unfolds.

Milk production was also suggested as an alternative sensitivity indicator, as lactating cows will cease milk production if there is insufficient water and feed. Also milk plays a very important role in pastoral household nutrition. However, it is unclear whether the milk yield data can be accurately collected without an improvement in the collection of real time data.

Finally, for whichever sensitivity indicator is used, the experts stated that it is better to evaluate the trends in sensitivity rather than the current status. Thus LBC or ToT has to be evaluated with respect to the previous month: is it stable, improving or worsening.

Classify hazard and sensitivity to define the Drought Cycle Management (DCM) phase

Classify hazard: The hazard information in the LDM tool is based on NDVI captured by the NOAA AVHRR system. Other early warning systems use monthly NDVI information to assess drought hazard, which is less meaningful in case of livestock, because livestock are resilient to failure of rains for a single month, as livestock can survive short droughts because of residual forage resources and animal fat reserves. Loss of livestock assets becomes an issue in the case of failure of one or two subsequent rainy seasons. Given this resilience of livestock to short duration of below average rainfall, we therefore use a one- year running average of NDVI (RA-NDVI-1), as an indicator of drought hazard. The LDM tool calculates the standard deviation of the RA-NDVI-1 from the long term mean NDVI, and uses this standard deviation as an indicator of the severity of the drought hazard.

Feedback from experts regarding NDVI: During the consultation we asked experts for feedback.
One concern raised is that NDVI does not reflect the type or quality of vegetation nor how much biomass is available. Answer: NDVI is an excellent indicator of biomass because many studies have shown that it is closely related to biomass. It is not an indicator of vegetation quality.

A second question pertained to the possibility of monitoring key resource areas and how green they are? Answer: This is possible with NDVI data, however the system described here is aimed at supporting decision making regarding livestock based interventions, not to zoom in to analyze the state of specific key resource areas.

Classify sensitivity: The next step in the tool is to define sensitivity as low, medium, or high. LBC can be graded on a scale of 1 to 5 or 1 to 9. In any given month, the LBC can be compared to the previous month so that it can be evaluated as improving, worsening or stable. Thus a series of categories as follows could be created (if 1 is very poor and 5 is very good):

- Very poor and worsening
- Very poor and stable
- Poor and worsening
- Poor and stable
- Poor and improving
- Average and worsening
- Etc., up to

- Very Good and stable.

For ToT between livestock and grains it is a bit more difficult to know how to classify this on a scale of 1 to 5, without local historical market trend data that have been analyzed during several drought cycles. However, the same categories as shown above for LBC could theoretically be created, and the ToT could be evaluated relative to the previous month. These ToT data would need to be interpreted in the local context and by administrative unit.

The same is true for milk production, although again it would be important to evaluate trends in milk production over a drought cycle in order to determine thresholds for very poor, poor, etc. It would also be necessary to separate out thresholds by breed type (this is true for all three sensitivity indicators).

The other important indicator for ability to cope during a drought is ability to access key dry season grazing resources. This would reflect options that pastoralists have for mobility, particularly in combination with information about conflict areas. This was deemed important because most pastoralists will move with their animals if there is a local scarcity of grazing vegetation or water. However, this sort of local information needs to be obtained with communities and regularly updated. This would be supplementary information to complement the framework of the LDM tool.

Upgrade with 5 year running average to further account for previous experience: The model described so far considers the risk of losing individual animals due to drought. It does not consider that droughts might have less disastrous effects after a number of good years when herd size is large and per capita livestock wealth high. Preliminary analysis of animal stocking density in Kadjiado revealed that stocking density is strongly related to the five year running average of NDVI (RA-NDVI-5), and hence we used this RA-NDVI-5 as a proxy for stocking density and average per capita livestock wealth.

In the final classification step, the tool evaluates each area against the deviation of the current month's RA-NDVI-5 from the long term average of this indicator. Areas for which current RA-NDVI-5 is above the average are moved down a phase in the DCM cycle, e. g. Emergency turns into Alert. This is an extra step to account for variation in stocking density and per capita livestock wealth.

Decide which DC phase: The final step in the tool is to combine hazard and sensitivity to determine the drought cycle phase an area is currently in. As explained in the appendix, the tool classifies the DCM phase using a matrix like the one below:

	NDVI anomaly					
LBC status	**+**	**-0.5**	**-1.0**	**-1.5**	**-2.0**	**--**
Very poor	Emergency	Emergency	Emergency	Emergency	Emergency	Emergency
Poor	Alert	Alert	Emergency	Emergency	Emergency	Emergency
Average	Normal	Normal	Alert	Alert	Emergency	Emergency
Good	Normal	Normal	Alert	Alert	Alert	Alert
Very good	Normal	Normal	Alert	Alert	Alert	Alert

At the moment, these classifications do not reflect expert consensus on how to classify the combinations of hazard and sensitivity. During the expert consultation we asked people to define the classes during a group exercise using the matrix below. The only agreement was in the classes indicated. For the other classes the experts disagreed as to whether a category was alert, alarm, emergency, recovery or normal. It was particularly difficult to distinguish between "normal" and "recovery" in part because of differences in opinion about the meaning of normal. If drought is "normal" and ever present hazard, then this category does not apply. Rather we should use the terms "alert", "alarm," "emergency" or "recovery". A counter argument is that short term dry spells should be considered "normal". Participants also agreed that the DCM for any month had to be evaluated relative to the previous month, again especially for deciding between normal and recovery (e.g. were conditions improving or worsening).

	NDVI anomaly					
Trend LBC/ ToT	**+**	**- 0.5**	**-1.0**	**-1.5**	**-2**	**--**
Very poor stable	E	E	E	E	E	E
VP improving	E	E	E	E	E	E
Poor worsening				E	E	E
Poor stable				E	E	E
Poor improving						
Average worsening			Alert	Alert	Alert	
Average stable						
Average improving						
Good worsening						
Good stable						
Good improving						
Very good worsening	N					
Very good stable	N	N				

Special case of classifying recovery: Currently, the LDM tool does not include "recovery" as a phase. This is because of multiple difficulties in classifying this phase, as reflected in the previous discussion. Furthermore, recovery from a drought is both short and longer term. When the rains begin again after a long drought animals are still weak and vulnerable to disease. Thus NDVI may show signs of recovery but LBC may not. Furthermore, if pastoralists have lost a lot of livestock during a long drought, full herd recovery can take 2- 3 years for goats, 5 years for cows, 7 for camels. It is not clear if there should perhaps be two evaluations of recovery: immediate LBC or ToT or milk production, and longer term herd recovery.

Decision about Livestock interventions to implement

Initially the LDM tool was also intended to link the DCM phase to appropriate livestock interventions, particularly those in LEGS. However, consultation with experts plus familiarity with how LEGS is designed makes it clear that choosing and planning interventions requires community input and planning as well as other indicators. Thus at the moment the LDM tool just provides a structure for linking the drought cycle phase to interventions. The tool is linked to the LEGS trees, as explained in the appendix. However, answering the questions in the LEGS trees automatically requires additional information, so this tool does not supplant this step. The added value is that the tool only lets users consider decision trees for interventions which are appropriate to the current drought cycle phase. For example, during the Alert phase someone will not be able to choose to consider water trucking, as this is an emergency intervention. Furthermore, if next month the drought phase has changed, then users will have to consider a different set of interventions.

Feedback from experts about using and improving the LDM:

After the stakeholder workshop we asked the participants to answer questions about the tool to add to the substantial feedback we received during the workshop.

Utility of the tool: all respondents indicated that the tool is potentially useful and they would like to see it made operational, with some modifications. The information in the tool helps to estimate livestock condition and forage availability. It can be used to identify priority areas and potential hotspots. In its current form it does not give very early warning, however, but rather monitors ongoing trends. This information is useful for deciding how the drought is progressing and which drought cycle phase an area is in. During the workshop a participant stressed that interventions should also be planned during normal or good periods as well to support herd growth.

Who should use the tool: the tool will be useful for both national and more local level government decision makers. It could help with the more transparent allocation of funds to areas that are identified as in need. Development agencies could also benefit from knowing which areas are priorities and which sort of livestock interventions will be needed (e.g. destocking or supplementary feed, etc.). Government decision makers will also benefit from the information on planning for suitable interventions. A couple of people remarked that the current tool should be integrated with existing tools, for example it could be inserted into the Integrated Phase Classification as an additional layer linked to the maps.

Additional information to include:
Everyone agreed that it would also be useful to track milk production, but that this should not be a separate tool. The quality of data on milk yields currently is also a constraint, unless better methods for real time data collection in the field become standard practice.

Several participants stressed the need to link the tool to local or "ground-truthed" information, particularly on mobility and constraints to this: either conflict or ethnic. Another type of information participants thought was important was some indication of the type and quality of vegetation – e.g. if an area is infested with prosopis or other species that cattle do not like to eat or which are not very nutritious.

During the workshop several people suggested linking this tool to seasonal forecasts of precipitation, to add earlier information, but also to help people evaluate how long the current drought cycle phase might last.

Next steps to operationalize the tool

During the consultation with experts we discussed the desirability to further develop this tool and the steps that would be required to operationalize it. The following activities were appropriate:

1. An operational system would require better data on LBC, which requires implementation of accurate and reliable methods for monitoring LBC. Including livestock body condition in a spatially explicit decision support system depends on the possibility to record and map geographic variation in livestock body condition. In Kenya, the current ALRMP does not collect information on livestock body condition. The ALRMP does survey a relatively large sample of households in a number of sentinel sites within every district. Adding systematic recording of livestock body condition would allow a way to collect the information on within district variation on livestock body condition. This could be done for any administrative unit in any country in the region.
2. Operationalization would require review model performance in one or more pilot districts. Once it has been demonstrated that it works in one district, it would also be necessary to assess how robust the model is in order to extrapolate it to other areas and countries within Eastern and Central Africa. It might require re-parameterization for different districts or countries.

3. Operationalization would require improved parameterization of the values in the table linking NDVI and LBC to phase of the DMC. An option to consider would be to develop a self learning (neural net) algorithm, which would recalibrate the parameters using observations on livestock body condition and mortality
4. Given the above it is advised to implement the tool first in one to two districts, addressing points 1 to 3, and then roll out when satisfactory performance has been achieved.
5. Add data that provide early warning, either rainfall if it is available, or combine with seasonal precipitation forecasts. FEWS NET currently issues a quarterly food security outlook for East Africa based upon seasonal precipitation forecasts which are translated into impacts on food production and food security (see www.fews.net). Under the Global Livestock CRSP, the Livestock Early Warning Systems (LEWS) project worked on forage condition monitoring and forecasts in Ethiopia, Uganda and Tanzania (from 1997 to 2003). Under the Livestock Network and Information Systems Project (LINKS), funded by USAID in collaboration with FEWS NET and ALRMP in Kenya, forage conditions were predicted 30, 60 and 90 days in advance (this project ended in 2006). This LDM tool could be linked to a similar system.
6. Another point is that the tool could be linked to a greater range of interventions than only LEGS. LEGS emphasizes Alert and Emergency activities with a few recovery interventions. At the moment there are no guidelines for additional recovery activities nor “normal” activities. Additionally, if the tool is trusted by both local and national decision makers, it could be a transparent method for triggering the release of contingency funds that would allow for faster response and flexible programming right at the onset of a drought.

References cited:

Humanitarian Practice Group. 2006. Saving lives through livelihoods: critical gaps in the response to the drought in the Greater Horn of Africa. HPG Briefing Note. Overseas Development Institute, London.

IIRR (International Institute for Rural Reconstruction) 2004. Drought Cycle Management: a toolkit for the drylands of the Greater Horn of Africa.

ISDR (International Strategy for Disaster Reduction) 2009. Drought Risk Reduction Framework and Practices. UNISDR, Geneva.

Livestock Emergency Guidelines and Standards Project. 2009. Livestock Emergency Guidelines and Standards. Practical Action Publishing, Bourton on Dunsmore, UK.

Morton, John, David Barton and Cary Hendy. 2001. Drought Contingency Planning for Pastoral Livelihoods. Natural Resources Institute Policy Series 15. The University of Greewich, UK.

Nicholson, M.J. and A.R. Sayers. 1987. Repeatability, Reproducibility, and Sequential Use of Condition Scoring in *Bos Indicus* Cattle. Tropical Animal Health Production 19: 127 – 135.

PACAPS (Pastoral Areas Coordination, Analysis and Policy Support). 2008. Trigger happy? Why we need to rethink the signals which determine humanitarian intervention for a more timely response. PACAPS Discussion Paper 2, USAID RELPA.

Pantuliano, Sara and Mike Wekesa. 2008. Improving drought response in pastoral areas of Ethiopia: Somali and Afar regions and Borena zone of Oromiya region. Humanitarian Practice Group, Overseas Development Institute, London.

Watson, C. and A. Catley. 2008. Livestock, livelihoods and humanitarian response: the Livestock Emergencies Guidelines and Standards (LEGS). Overseas Development Institute Humanitarian Practice Network, London.

Zwaagstra, L., Z. Sharif, A. Wambile, J. de Leeuw, N. Johnson, J. Njuki, M. Said, P. Ericksen, and M. Herrero. 2010. An Assessment of the response to the 2008-2009 drought in Kenya. A report to the European Union Delegation to the Republic of Kenya. International Livestock Research Institute, Nairobi.

Appendices

Quick guide to using the LDM tool
Participants at the stakeholder consultation

Quick guide to using the LDM tool

Installation

To install the LDM tool, extract the zip file containing the installation files and follow these instructions:

- Execute and install the file MapWinGIS45OCXOnly.exe. This will install the mapping components that are necessary for the LDM to work on your computer.
- Restart your computer.
- Execute and install the file Setup.exe. This will install the LDM on your computer.
- The setup program will add the LDM tool inside the Windows Programs Menu.

Starting the tool

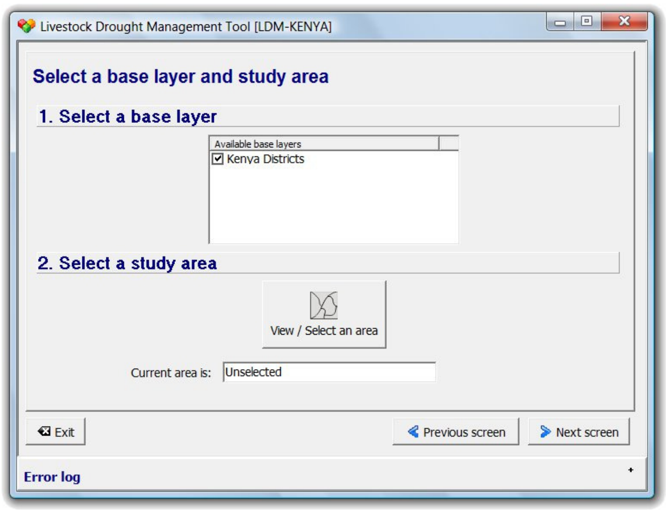
To start the tool click on the Windows Start Menu and locate the sub-menu Livestock Drought Management tool inside the Programs Menu. To open and begin using the tool, click on the Livestock Drought Management tool icon. The cover page of the LDM will appear at the center of your screen (see below).

The LDM Wizard Interface

The LDM tool interface has been designed in the form of a Wizard. This means that the user utilize buttons like “Next” and “Previous” to navigate through a series of steps that leads to a result. Usually at each step the user needs to indicate or set variables that determine the results.

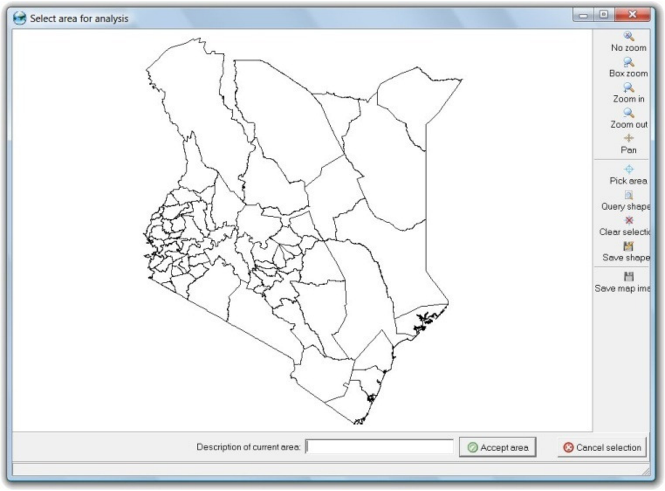
Step One: Select an Study Area

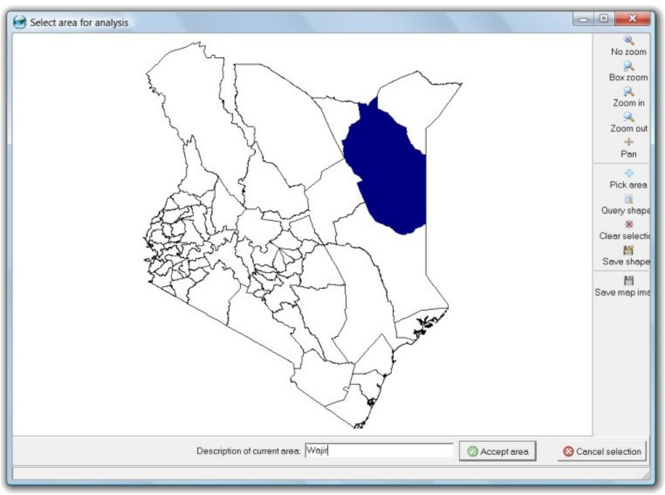
The first step of the LDM tool is the selection of an area of interest for analysis. To select an area, choose one of the available base layers in the *Available base layers list.* After this, click on the *View / Select an area button*. The *Select area for analysis window* will appear. After accepting an area, click on the *Next screen button.*



The select area for analysis GIS window

The *select area for analysis window* allows the user to choose geographical areas as study areas. To select an area, click on the *Pick area button*. Then click on any shape of the map. Each selected area will turn purple. To clear the selection, click on the *Clear selection button*. To accept the selection, indicate a description (e.g. the name) for the area and click on the *Accept area button.* To cancel this screen, click on the *Cancel selection button*. After the selection is accepted, the window will close and the user will return to the first step, with the most recent selection set as the current area.


Select area for analysis
No zoom
Box zoom
Zoom in
Zoom out
Pan
Pick area
Query shape
Clear selectio
Save shape
Save map ima
Description of current area:
Accept area
Cancel selection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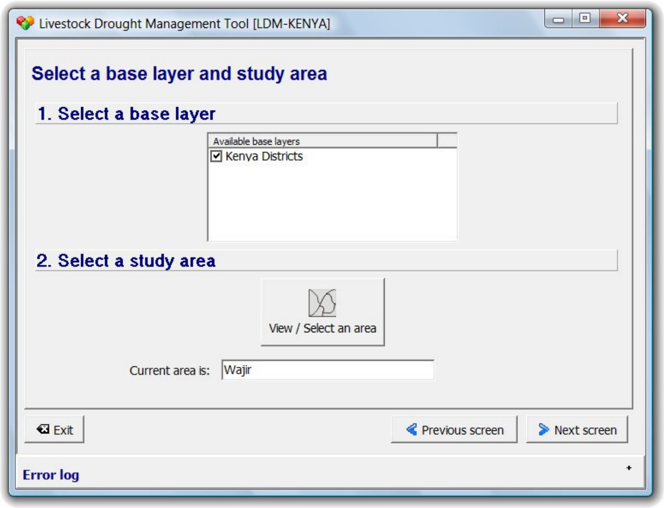
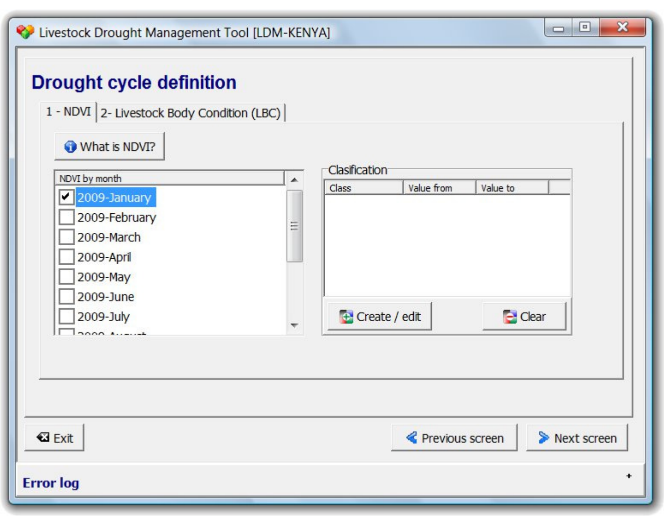


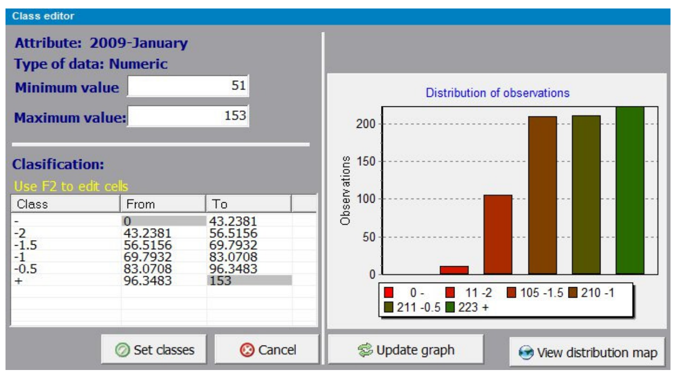
Step two: Selection of NDVI and Livestock Body condition data

In the LDM tool the stages of the Drought Cycle Management (DCM) -- Normal, Alert and Emergency-- are defined as the combination of NDVI (Hazard) and Livestock Body Condition (LBC) (Sensitivity). The LDM tool has monthly NDVI and LBC data. Each month, users can define the DCM phase based upon the hazard and sensitivity data. Before creating a combination, both NDVI and LBC data must be separated into a series of classes. This is called classification. In addition to the current data, the LDM tool also gives users the option to upload new data as it becomes available (see page 10).

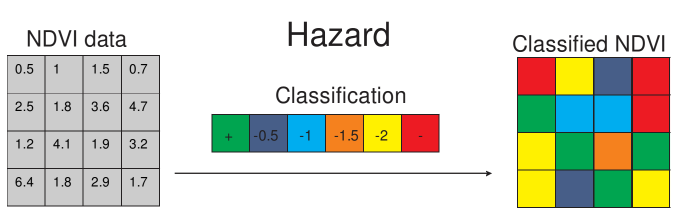


The hazard information in the LDM tool is based on NDVI captured by the NOAA AVHRR system. Other early warning systems use monthly NDVI information to assess drought hazard, which is less meaningful in case of livestock, because livestock is resilient to failure of rains for a single month, as livestock is capable to survive short droughts, because of residual forage resources and animal fat reserves. Loss of livestock assets becomes an issue in case of failure of one or two subsequent rainy seasons. Given this resilience of livestock to short duration of below average rainfall the tool uses a 1 year running average of NDVI (RA-NDVI-1), as an indicator of drought hazard. The LDM tool calculates the standard deviation of the RA-NDVI-1 from the long term mean NDVI, and uses this standard deviation as an indicator of the severity of the drought hazard.

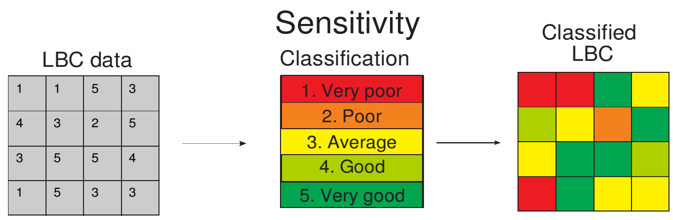
To classify NDVI or LBC for a given month, select the month and click on the *Create / edit button*. The *class editor sub-window* will appear.



By default, the LDM tool classifies the RA-NDVI-1 for the current month into six classes, based on the standard deviation of the current month's RA-NDVI-1 considering the variation of the monthly RA-NDVI-1's since 1982. The class boundaries distinguishing the six classes were as follows: 0; – 0.5; -1; -1.5; -2, or greater than -2 standard deviations.

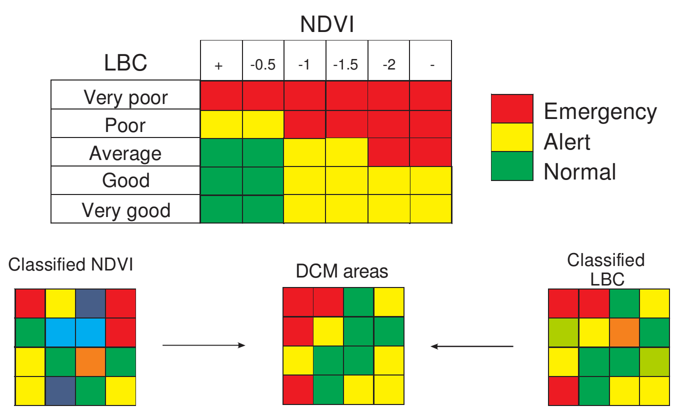


By default, the tool also classifies the LBC data into five distinct classes representing five different categories of livestock body condition: very poor to very good.



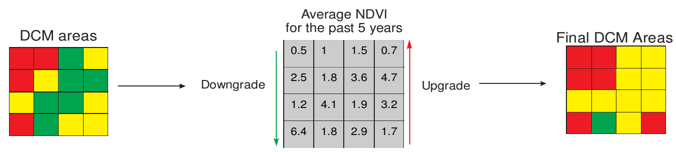
To accept the classification, click on the *Set classes button*. The *editor sub-window* provides a graph showing how the observations for the month have been allocated to different classes. Also by clicking on the *View distribution map button* the user can access a geographical representation of the distribution of classes in the study area.

Once both RA-NDVI-1 and LBC are classified, click on the *Next button*. The LDM tool will combine both layers and generate three final classes representing the three stages of the DCM. This combination is generated by matching the different classes of RA-NDVI-1 and LBC to the three stages of the DCM. The LDM tool provides a screen to set these parameters (see page 10).



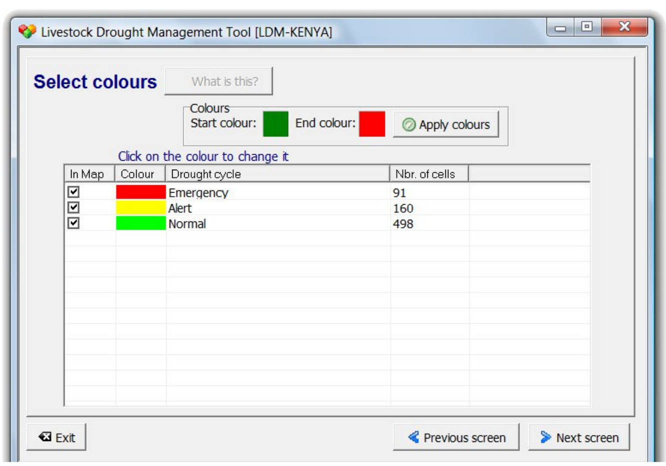
The model described so far considers the risk of losing individual animals due to drought. It does not consider that droughts might have less disastrous effects when after a number of good years herd size is large and per capita livestock wealth high. Preliminary analysis of animal stocking density in Kajiado revealed that stocking density is strongly related to the five year running average of NDVI (RA-NDVI-5), and hence we used this RA-NDVI-5 as a proxy for stocking density and average per capita livestock wealth.

In the final classification step, the tool evaluates each area against the deviation of the current month's RA-NDVI-5 against the long term average of this indicator. Areas for which current RA-NDVI-5 is above the average are moved down a phase in the DCM cycle, e. g. Emergency turns into Alert. This is an extra step to account for variation in stocking density and per capita livestock wealth.



Step three: Select colours

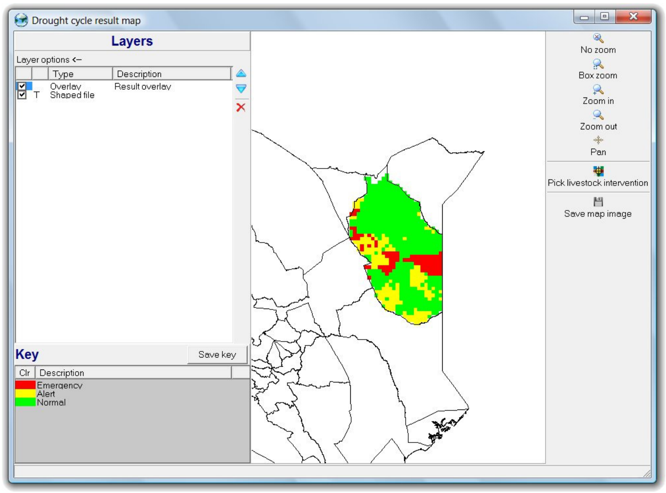
After the combination has been completed and the DCM phase is defined, the user can change the colours assigned to each DCM cycle stage. To change the colour, click on the colour; the tool will allow you to pick a different one.



By clicking on the *Next button,* the LDM will show the final Drought Cycle result map.

The Drought Cycle result map

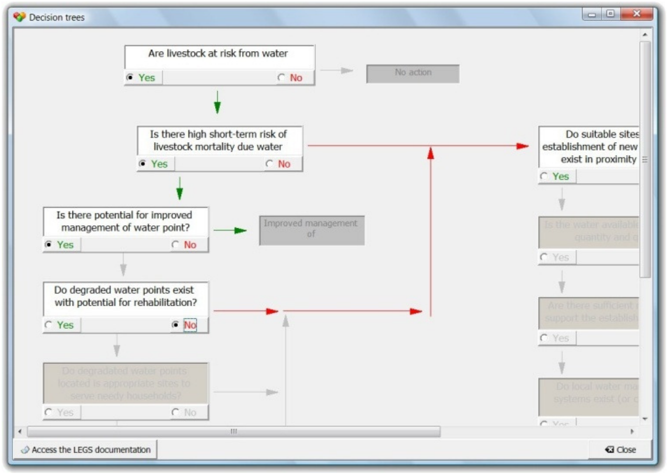
The result map shows the product of combining NDVI and LBC to define the different stages of the DCM within the study area indicated in step one.



An interactive version of LEGS

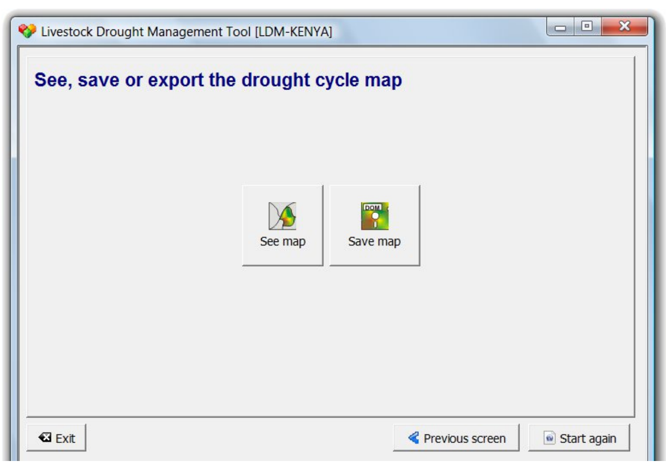
The LDM tool has an interactive version of the decision trees provided by the Livestock in Emergencies Guidelines and Standards (LEGS, FAO, 2009). Once the DCM phase has been defined, the user can go to the decision trees for interventions appropriate to the DCM phase. To access the trees, click on the *Pick livestock interventions button.* The *decision trees window* will appear.

Each tree can be accessed through different buttons, for example, the button *Water provision* will take you the LEGS tree related to water.



Each decision tree has a button to access the original LEGS documentation in PDF format.

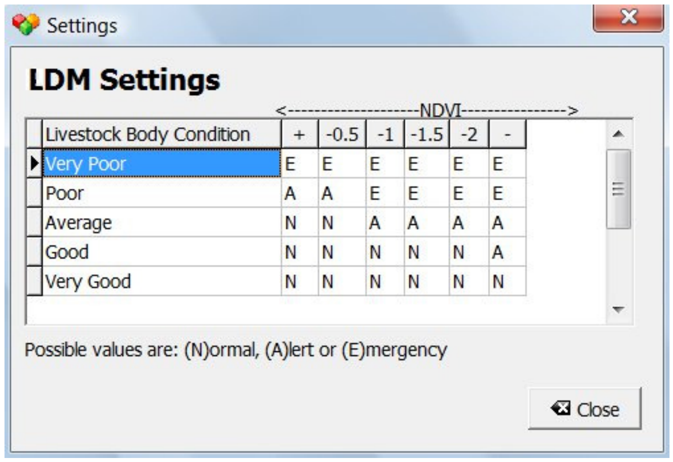
To return to the LDM Wizard close the *Drought Cycle result map window*. In the final page of the tool the user can save the final result, view it again and start the process from the beginning.



Combining NDVI and LBC to define the phases of DCM

The LDM tool has a sub-window where the user can reset how to combine the NDVI and LBC with the phases of DCM. To access this window go to the cover of the tool and click on the *See /*

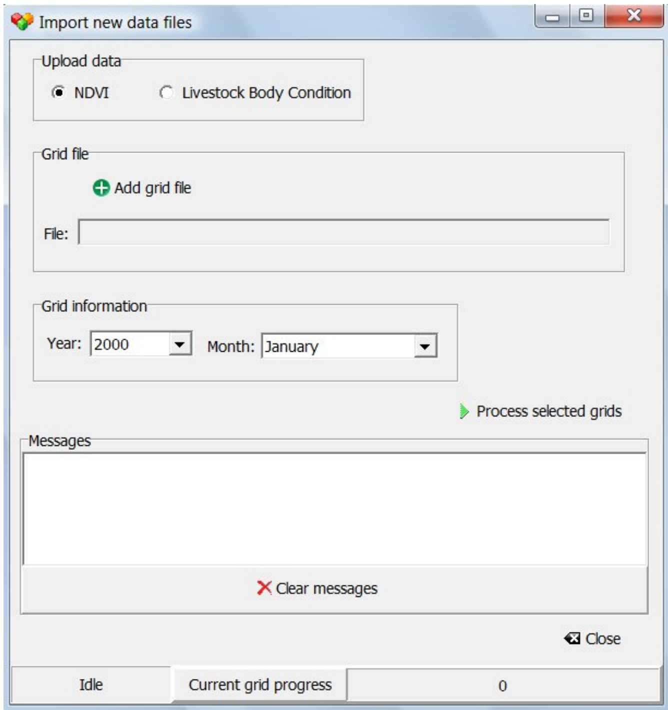
modify settings label. The *settings window* will appear. The user can manually change the classifications for each combination of NDVI and LBC.



Livestock Body Condition	+	-0.5	-1	-1.5	-2	-
Very Poor	E	E	E	E	E	E
Poor	A	A	E	E	E	E
Average	N	N	A	A	A	A
Good	N	N	N	N	N	A
Very Good	N	N	N	N	N	N

Uploading new data into the tool

New NDVI and LBC can be uploaded into the LDM tool. To access this feature go to the first screen of the tool and click on the *Update NDVI and Livestock Body Condition label*. The *Import new data files window* will appear.



To upload new data select either NDVI or Livestock Body Condition and click on the *Add grid file button*. A standard Windows dialog will appear to select the file from your computer. Choose the year and months of the data you want to upload. If the month already exists in your LDM tool you will be prompted to update the current data or cancel the operation. Once this information is indicated, click on the *Process selected grids button* to upload the data into the LDM tool.

Attendees at the 23 November stakeholder consultation

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