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Mapping cattle trade routes in southern Somalia: a method for mobile livestock keeping systems

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Summary

The Somali economy is the only one in the world in which more than half the population is dependent on nomadic pastoralism. Trade typically involves drovers trekking animals over long distances to markets. A pilot approach for mapping trade routes was undertaken, using the Afmadow to Garissa routes in southern Somalia. The methodology included conducting a workshop with traders to gather preliminary information about the most-used routes and general husbandry practices and training selected drovers to collect data about key features along the routes, using hand-held global positioning system (GPS) devices, radio collar GPS and pictorial data forms. Collected data were then integrated into geographic information systems for analysis. The resultant spatial maps describe the Afmadow to Garissa routes, the speed of livestock movement along these routes and relevant environmental and social features affecting this speed. These data are useful for identifying critical control points for health screening along the routes, which may enable the establishment of a livestock certification system in nomadic pastoral environments.

Keywords

Cattle – Certification – Critical control points – Geographic information systems – Livestock – Nomadic pastoralism – Somalia – Trade routes – Trekking.

Introduction

The Somali economy is the only one in the world where over half the population is dependent on nomadic pastoralism (5). This husbandry system is characterised by herds or flocks that are constantly moved in search of water and pasture, as the seasons progress. Moreover, in contrast to most pastoral systems, which are normally devoted to household subsistence, the Somali system is traditionally oriented towards trade and export (1). After the collapse of the government in 1991, the Somali economy became entirely unofficial; however, it has proven to function effectively and the livestock trade shows considerable resilience, in spite of the total absence of formal institutions (13).

Livestock export in Somalia revolves around three supply chains, two of which supply the Arabian Peninsula with mostly small ruminants and cattle by sea, and the third which supplies the Kenyan market with cattle, overland (Fig. 1). Livestock are traded through a network of markets and participants, located at different levels of the chain. At one end are the primary markets, those closest to production areas and located in villages or temporary settlements near strategic pastures. Livestock are purchased here by petty traders, called 'gaadleys' and 'gedisleys' (2). A gaadley is a small-scale livestock trader

Fig. 1
Map of the Horn of Africa and selected Middle East countries
Arrows indicate final destinations of Somali cattle and small ruminants traded to importing countries

who buys animals at low cost in a market, then sells them later at a profit in the same market, usually a district market. A gaadley may also try to add value to the purchased animals through supplementary grazing and feeding, or by offering treatment for health problems. A gedisley buys animals at low cost in one market and then sells them later in a different market, to exploit price differences between the two. Gaadleys and gedisleys may also assemble batches on behalf of export agents (*wakiil*).

Secondary markets are located along main roads near towns and big urban centres, such as district and regional capitals. These markets are fed by primary markets that are, in most cases, located around them geographically in a satellite system.

Export traders, based in various secondary markets or port termini (such as Bossaso and Berbera), acquire animals directly or through agents, located in various secondary

markets. These agents source their animals either directly from the producers or through petty traders. The number of agents involved depends on the scale of business of the export trader, with large-volume traders managing a network of several agents distributed over a wide catchment area. Animals are conveniently assembled along trade routes and finally trucked or trekked to the port terminus or to the entry point in Kenya and then on to terminal markets. Terminal markets are located in major urban centres and big cities in the importing countries, such as Nairobi and Mombasa in Kenya and Dubai in the United Arab Emirates. It is mostly importers and distributors who operate at this level (15, 17).

In southern Somalia, cattle are trekked by expert 'drovers', hired on a daily basis by agents or directly by exporters. The drovers follow designated stock routes and usually move batches of 100 to 150 head of cattle. The routes used for this trade vary, according to the season. During the rainy season, due to the ready availability of pasture and water, animals move at a slow pace to arrive in good condition at the Garissa market, which is the main entry point in Kenya. During the dry season, animals are usually trekked through routes that have permanent watering points along the way, and the journey is made at night, at a higher speed, to minimise stress.

Over time, but especially since the civil war erupted in 1991, the Somali livestock industry has become increasingly vulnerable and susceptible to restrictive measures. These have been applied by an increasing number of importing countries; e.g. export bans were imposed due to rinderpest in 1983 and to the alleged presence of Rift Valley fever in 1998, 2000 (11) and 2007.

Stringent measures adopted after the enforcement of the World Trade Organization Sanitary and Phytosanitary Agreement (19) had a significant impact, due to the poor standard of Veterinary Services around the country. The increasing importance of effective disease surveillance and control and credible animal health certification is now used, in practical terms, as a technical barrier to entering the competitive arena of international trade (16, 18). Establishing a credible certification system is considered crucial to enhance the competitiveness of the Somali livestock industry. However, the establishment of such a system in a pastoral environment poses serious challenges, due to the high mobility of herds and flocks.

The Afmadow area can be considered the prime area for cattle pastoralism in Somalia and assumes an especially prominent role in cross-border trade with Kenya. According to Little (12), this area accounted for about 25% of cattle supplied to traders during the period between 1996 and 1998. This paper focuses on a pilot study to map stock routes and identify risk factors along the main trade routes linking southern Somalia to Kenya. Rambaldi *et al.* (14), Fox *et al.* (10) and Chambers (4) have described processes of integrating local knowledge and geographic information systems (GIS) to produce participatory GIS. A similar approach was used for this study. Data collected on two trekking routes linking Afmadow (southern Somalia) to Garissa (north-east Kenya) are presented as a case study.

Materials and methods

Hand-held GPS systems, radio collar GPS, pictorial feature data forms, ArcGIS (ESRI®) and Garmin Map Source were used for data collection, processing and analysis. The methodology encompassed three main steps:

– a workshop with export traders

– training for drovers

– radio-tracking trade herds and collection and geo-referencing of key features along the trade routes.

Workshop with export traders

A workshop with export traders of livestock cattle was held over two days in Afmadow. The main trekking routes were identified and ranked, according to seasonality and the percentage of animals trekked through each route. Means and times of mapping the routes were discussed and agreed upon. Since the traditional procedure for trekking animals is through the employment of skilled and trusted livestock drovers, their contribution was considered crucial in mapping the routes. Each trader provided two livestock drovers whose ability to write and take GPS coordinate readings was tested. Five qualified drovers were thereafter selected for training.

Drover training

The training, developed for learning at the semi-literate level, included:

– teaching basic skills in marking selected locations with a hand-held GPS

– learning the basic functions of radio collar GPS and how to attach these to the selected animal

– practising how to fill in pictorial data forms (Fig. 2).

Posters were used to show the whole process of data collection and practical exercises were carried out at all stages. The training material was pre-tested and then refined, according to the results of the pre-testing. At the end of training, one drover per herd per route was selected and given equipment, documentation, data collection forms and handouts ready for actual mapping. Written materials were translated into Somali, where necessary.

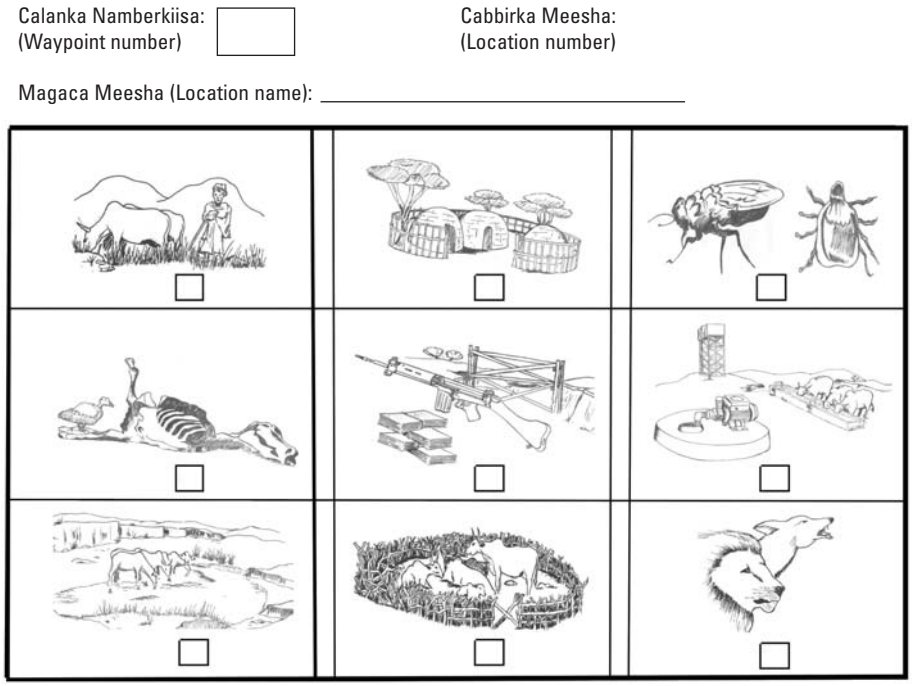

Fig. 2
Pictorial feature data collection form

One extra drover (per herd per route) was employed specifically to look after the radio collar GPS.

Radio-tracking trade herds and collection and geo-referencing of key features along the trade routes

Data were collected through hand-held and radio collar GPS. Using a hand-held GPS, livestock drovers geo-referenced locations with key environmental and/or social features along the route. The observed features, coordinates and location name were recorded on the pictorial feature data form (Fig. 2). Key environmental features of interest were:

– permanent water sources
– seasonal water sources
– good grazing areas
– predators
– disease vectors
– checkpoints
– settlements
– resting grounds
– points where animal deaths occurred.

These features were selected for their potential to increase or decrease disease transmission to and from trade or nomadic herds along the trade routes. At the same time, a radio collar GPS was put on one animal within the trade herd to record geographic coordinates every 15 minutes, so as to map the whole trade route. The time of recording was also stored for each recording point. To ensure accuracy in data collection, the drovers were met at specific locations along the route to check on the accuracy of the data entry and the correct functioning of their equipment.

Data analysis

The data captured by GPS were downloaded into Map Source and then transferred into Microsoft Excel. The data were first converted to database files and then uploaded in ArcGIS as event point layers and converted into shapefiles. Radio collar GPS data were downloaded in the field by the Somali staff, using specific manufacturer's software. Point-to-point 'spatial join' was performed to merge radio collar and drover GPS data into one layer. The resulting merged layer had all the drover GPS points, including recorded features, assigned to the closest radio collar GPS points. The distance between each recorded point was calculated using the Hawth's Analysis (3) tool. Speed of movement was also calculated and multi-line segments corresponding to these speeds were generated. Maps showing trekking routes and trade herd speeds were produced. A multiple linear regression model (MLRM) was then used to determine the effect of each key environmental feature on the speed of the movement. The results were also overlaid with existing environmental data – e.g. normalised difference vegetation index (NDVI) and rainfall estimates (RFE) – to 'verify' the accuracy of recording of the selected features.

Results

Trekking routes

Two trade routes were identified from Afmadow to Garissa and are referred to as Route 1 and Route 2. Route 1, approximately 335 km, involving a trip of 13 days, is the primary route, representing 70% of animal movement. Route 2 measures approximately 429 km, is a 14-day journey, and represents 20% of animal movement.

The first route enables better use of good grazing areas and permanent water resources, whereas the second is limited to the rainy season and exploits the presence of seasonal rainfall. Figure 3 shows the map generated for the two routes, while Table I gives a summary of statistics for the speed of animal movement along the two routes.

Key environmental features and speed

The drovers recorded the positions of all the key environmental features along the routes. These features could be observed singly, together with others or not observed at all. Figure 4 shows a map of feature occurrence (seasonal water points) along the trekking routes, while Figure 5 shows the map of movement speeds along Route 1. An MLRM was used to assess the influence of the recorded features on herd speed, and a forward selection method was used. The MLRM (containing only the features significant at $\alpha = 0.1$) is shown in Table II. The results show that the presence of seasonal water significantly increases speed, whereas that of good grazing areas and resting grounds significantly decreases speed. No significant association at the selected α level was identified for the remaining features.

Table I
Summary statistics of the speed of animal movement along trade routes

Route	Speed (km/h)			Standard deviation
	Minimum	Maximum	Mean	
1	0.16	4.63	1.73	1.09
2	0.46	4.10	1.74	0.99

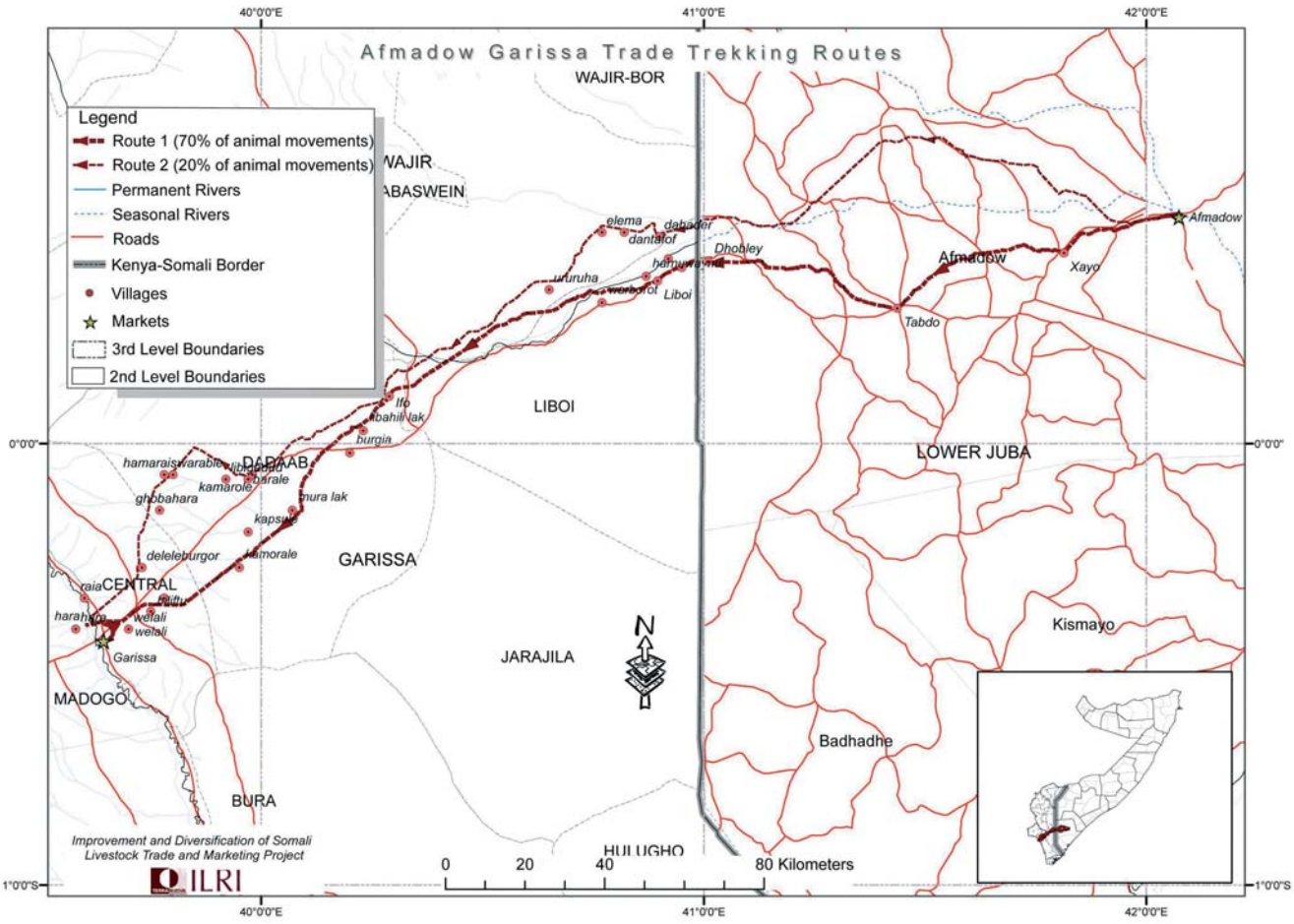

Fig. 3
Map of trade trekking routes from Afmadow to Garissa

The presence of good grazing and seasonal water seems to be spatially correlated (by 'eyeball') to corresponding dekads of May to September 2006, NDVI and RFE, respectively (6, 7, 8, 9). Points where good grazing was observed had higher NDVI values. The same trend was also observed for seasonal water with RFE values. Figure 6 shows a comparison of seasonal water points on Route 2 with RFE.

Discussion and conclusion

This methodology successfully allowed mapping of the selected key features and locations of the Afmadow to Garissa trade routes in Somalia.

The mapping of pastoral trade routes in southern Somalia used an innovative approach, employing Somali livestock

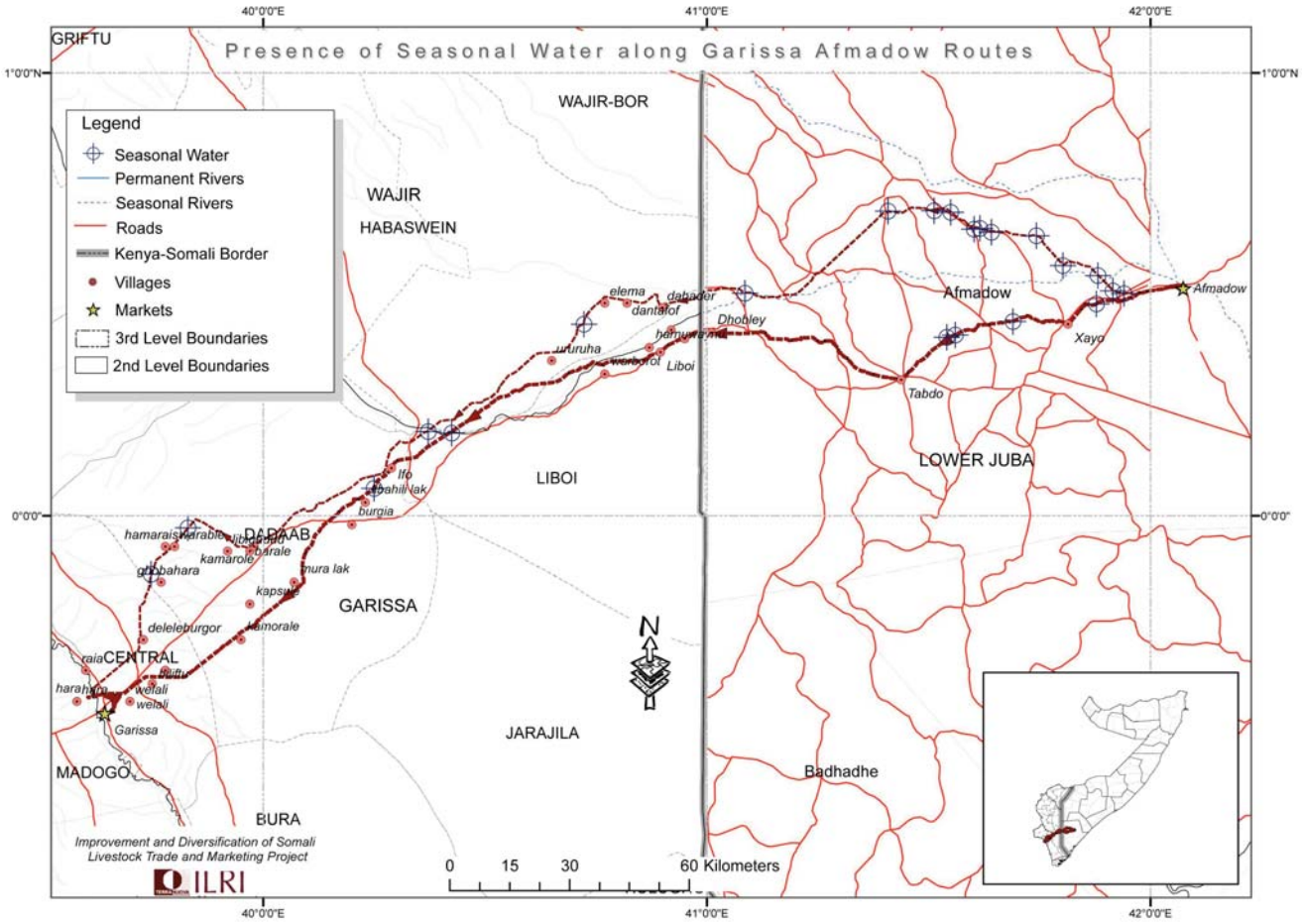

Fig. 4
Map showing points of observed seasonal water sources along the trekking routes from Afmadow to Garissa

Table II
Linear regression model of key features against speed

Variables	Coefficient	Standard error	t	P	95% confidence interval
Constant	2.277	0.371	6.131	<0.01	1.535; 3.018
Resting grounds	–0.898	0.237	–3.794	<0.01	–1.371; –0.426
Good grazing	–0.502	0.269	–1.864	0.067	–0.775; –0.229
Seasonal water	0.524	0.224	1.860	0.066	0.151; 0.897

t: t-test value
P: probability

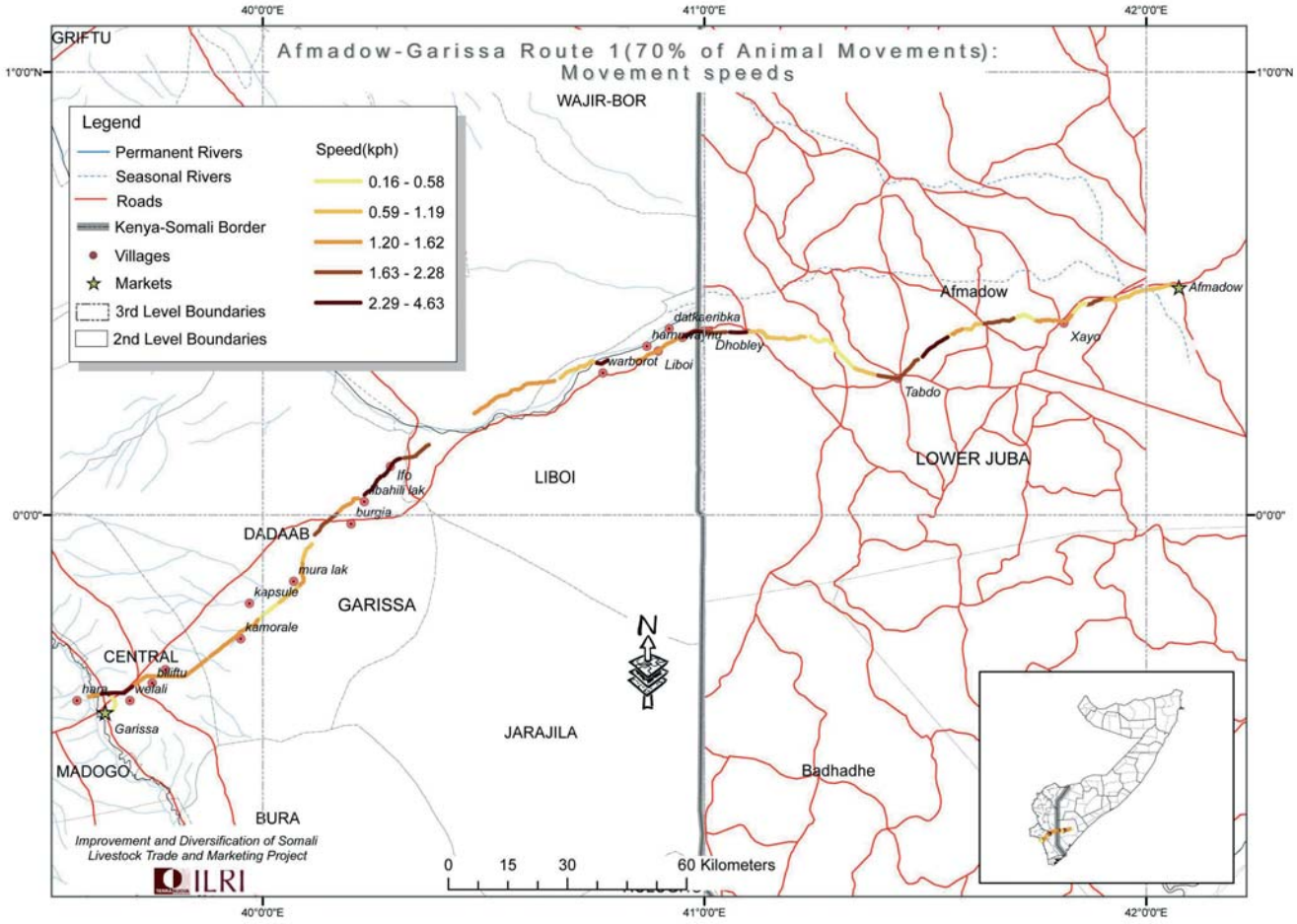

Fig. 5
Map showing movement speeds along the trekking routes from Afmadow to Garissa

traders and drovers, together with user-friendly, data-gathering tools. The approach was adapted to the specific export-oriented Somali livestock marketing system, which relies on drovers trekking animals from Somalia to Kenya.

The use of GPS and pictorial data forms proved easy for the drovers to master. This can be attributed to the specific design of these information-gathering tools. Pictorial forms enabled the semi-literate drovers to identify and relate the pictures to the environmental features. The use of radio collar GPS on the animals was readily accepted by the traders; this was due to their initial involvement in and understanding of the purpose of the study and the minimal impact of the equipment on the animals.

Although the process in this pilot study was accepted and implemented quite successfully, there are potential challenges in data collection during trekking, including errors by the drovers and malfunction or loss of a GPS radio collar. A drover may make mistakes in completing the forms or a GPS may malfunction, due to extreme weather conditions or physical damage. The GPS collar might also be lost through confiscation by militias at checkpoints or in stock thefts by bandits. Nevertheless, some measures can be taken to minimise these obstacles. Field checks can be carried out at agreed locations to assess the overall work progress and check the GPS, and corrections made as necessary. The risk of losing the GPS radio collar can be reduced by concealing the animal with the collar in the middle of the herd. More than one GPS can be used, to make up for any loss or malfunction that may occur.

The data collected by the drovers are considered important in accurately documenting the existing trade routes, as well as recording the threats, risks and environmental characteristics of the routes during trekking. If these data are analysed, together with other available data, further information on livestock trade and marketing can be obtained. When the relationship between the key environmental features and the speed of animal movement was examined, it emerged that the decisions of the drover and the reactions of the livestock determined the specific ways in which speed was affected. It was expected that the presence of good grazing, seasonal water and permanent

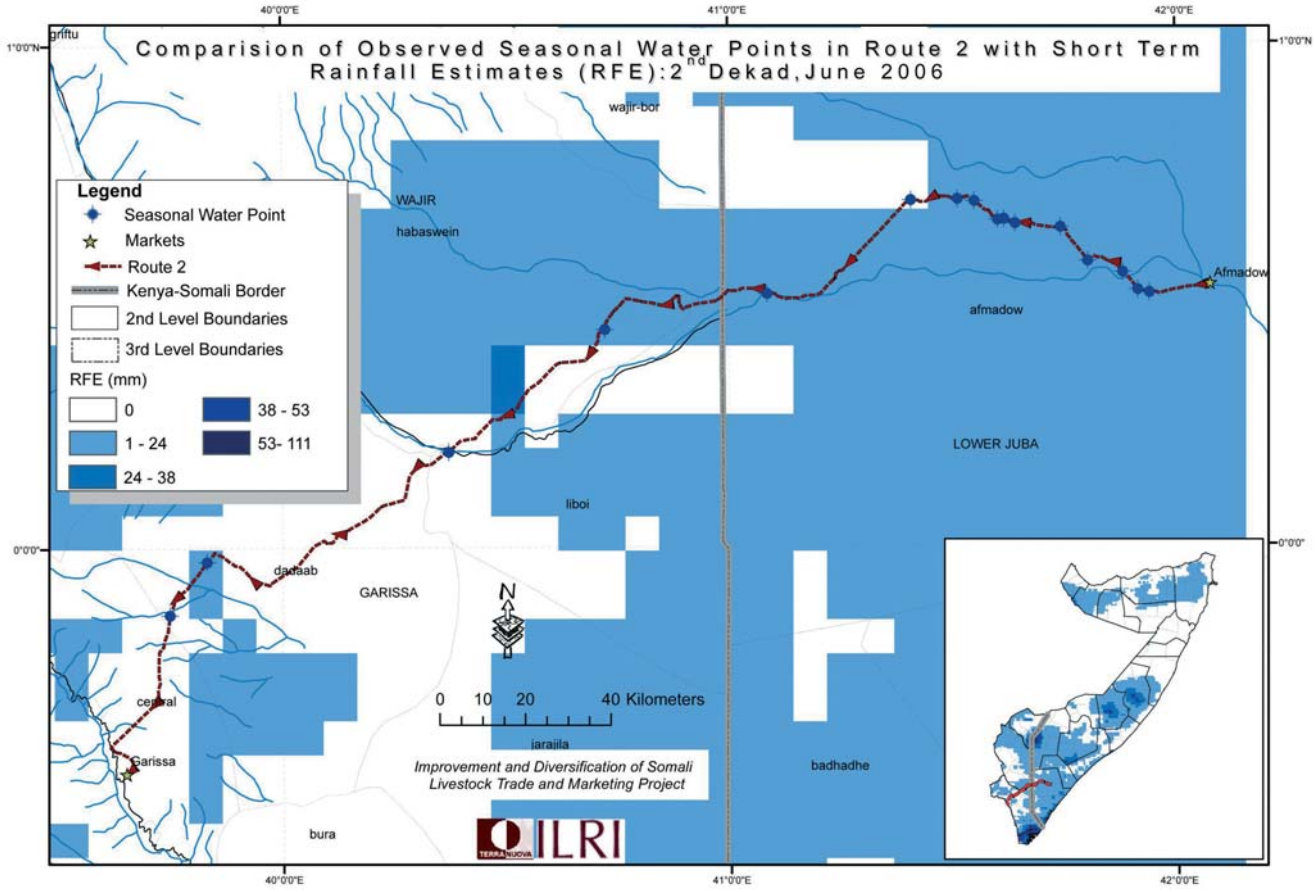

Fig. 6
Map showing comparison of seasonal water points with rainfall estimates on Route 2 from Afmadow to Garissa

water would reduce speed while settlements, predators and vectors would increase speed. The results of the regression analysis (Table II) showed that the availability of good grazing decreased speed significantly because animals stopped to graze; however, availability of water increased speed. This could be because animals often hurry towards water. Resting grounds reduced speed, as expected.

The other key features in the study did not significantly affect the speed of the trekked animals. However, some of those factors could play an important role in the decision-making process when choosing the trekking route. This hypothesis should be investigated further.

At a later stage, this information – merged with other existing epidemiological and movement data for nomadic livestock – will be used to identify potential high-risk points for the spread of diseases along the marketing chain. Such points may enable the establishment of critical control points along the trekking routes, where relevant screening of trade herds and flocks can be implemented for surveillance and certification. The same methodology will be used to examine other routes for cross-border trade in cattle with Kenya, to provide a comprehensive picture of the situation in Somalia.

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Cartographie des routes commerciales empruntées par les bovins au sud de la Somalie : une méthode de suivi des systèmes d'élevage itinérants

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Résumé

La Somalie est le seul pays au monde où plus de la moitié de la population vit du pastoralisme nomadique. Cette activité donne lieu à de longs trajets à pied lorsque le bétail est conduit vers les marchés de bestiaux. Les auteurs présentent les résultats d'un projet pilote de cartographie des routes commerciales, qui a porté sur les routes reliant Afmadow à Garissa au sud de la Somalie. Dans ce cadre, un atelier a été organisé avec les marchands de bestiaux afin de recueillir des informations sur les routes les plus fréquentées ainsi que sur les pratiques habituelles d'élevage, et un certain nombre de conducteurs de bétail ont été formés à la collecte d'informations en temps réel sur les principales caractéristiques des trajets, au moyen de dispositifs GPS, de récepteurs manuels GPS et de descriptifs graphiques. Les données recueillies ont ensuite été intégrées et analysées au moyen d'un système d'information géographique. Le système a permis d'obtenir des cartes spatiales décrivant les routes reliant Afmadow à Garissa, la vitesse des déplacements du bétail le long de ces routes et les facteurs environnementaux et sociaux affectant la vitesse des déplacements. Ces données seront utiles pour déterminer quels sont les points de contrôle critiques à prendre en compte lors du suivi sanitaire de ces routes, ce qui permettra de mettre en place un système de certification du bétail dans les systèmes d'élevage pastoral nomadique.

Mots-clés

Bétail – Bovins – Certification – Déplacement à pied – Pastoralisme nomadique – Point de contrôle critique – Route commerciale – Somalie – Système d'information géographique.

Cartografía de las rutas de comercialización de bovinos en el sur de Somalia: un método de seguimiento de los sistemas de ganadería itinerantes

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Resumen

La economía somalí es la única del mundo en que más de la mitad de la población depende del pastoreo nómada. Generalmente, el comercio exige que los arrieros recorran largas distancias con los animales para llevarlos a los mercados. Los autores describen un método experimental para cartografiar las rutas comerciales, aplicado a las rutas que van de Afmadow a Garissa, en el sur

del país. Se empezó organizando un taller con los comerciantes para obtener información preliminar sobre las rutas más utilizadas y los métodos habituales de cría e impartir formación a determinados arrieros para que a lo largo de la ruta fueran recogiendo datos sobre una serie de características básicas, utilizando para ello sistemas GPS de mano, collares radiolocalizadores GPS y formularios gráficos. Después se introdujeron y analizaron los datos obtenidos en sistemas de información geográfica. Los mapas resultantes describen las rutas de Afmadow a Garissa, la velocidad de desplazamiento de los rebaños en esas rutas y las principales características ambientales y sociales que a lo largo del camino influyen en esa velocidad. Estos datos son útiles para determinar los puntos críticos de control donde conviene instalar puestos de inspección sanitaria, lo que puede servir para establecer un sistema de certificación del ganado en zonas donde prime el nomadismo pastoral.

Palabras clave
Bovinos – Certificación – Ganado – Pastoreo nómada – Puntos críticos de control – Rutas comerciales – Sistemas de información geográfica – Somalia – Trashumancia.

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