GC13I-0857: Designing a Frost Forecasting Service for Small Scale Tea Farmers in East Africa

Emily C. Adams[1,2,4], James Wanjohi Nyaga[3], Walter Lee Ellenburg[1,2,4], Ashutosh S. Limaye[5], Robinson M. Mugo[3], Africa Ixmucane Flores Cordova[1,2,4], Daniel Irwin[4], Jonathan Case[5], Susan Malaso[3], and Absae Sedah[6]
(1) University of Alabama in Huntsville, Earth System Science Center, Huntsville, AL, United States, (2) NASA-SERVIR Science Coordination Office, Huntsville, AL, United States, (3) Regional Centre for Mapping of Resources for Development, Nairobi, Kenya, (4) NASA Marshal Space Flight Center, Huntsville, AL, United States, (5) ENSCO Inc./NASA Marshal Space Flight Center, Huntsville Alabama, (6) Kenya Meteorological Department, County Kericho, Kericho, Kenya

Objectives

To minimize frost damage to tea crops by providing frost-potential maps to farmers.

- To use the SERVIR service planning framework to design the Frost Monitoring and Forecasting Service for Kenya.
- To understand the flow of information and decision making landscape for the partners along tea value chain.
- To engage regional stakeholders in co-developing and implementating a successful service.

Study Area

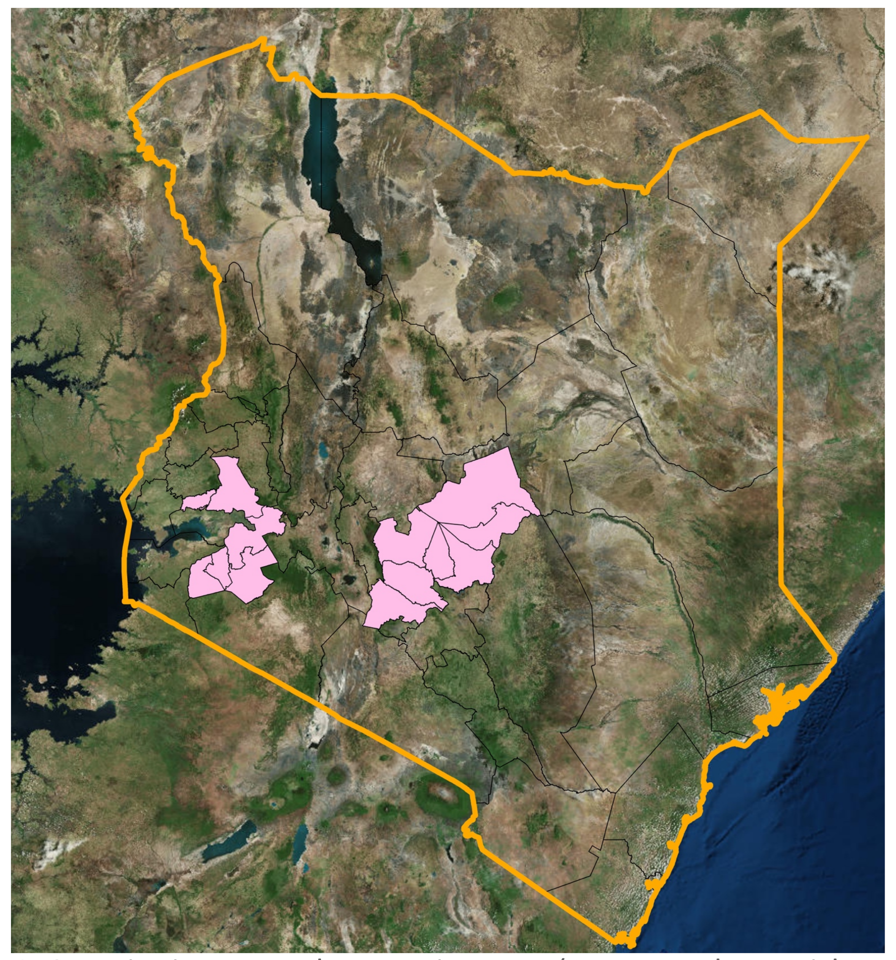


Figure 1. Counties in Kenya where tea is grown (Bomet, Embu, Kericho, Kiambu, Kirinyaga, Kisii, Meru, Murang'a, Nandi, Nyamira, Nyeri, Tharaka-Nithi, Vihiga).

Service Planning Approach

Project partners along the tea value chain were brought together for a 3 day stakeholder mapping and engagement workshop

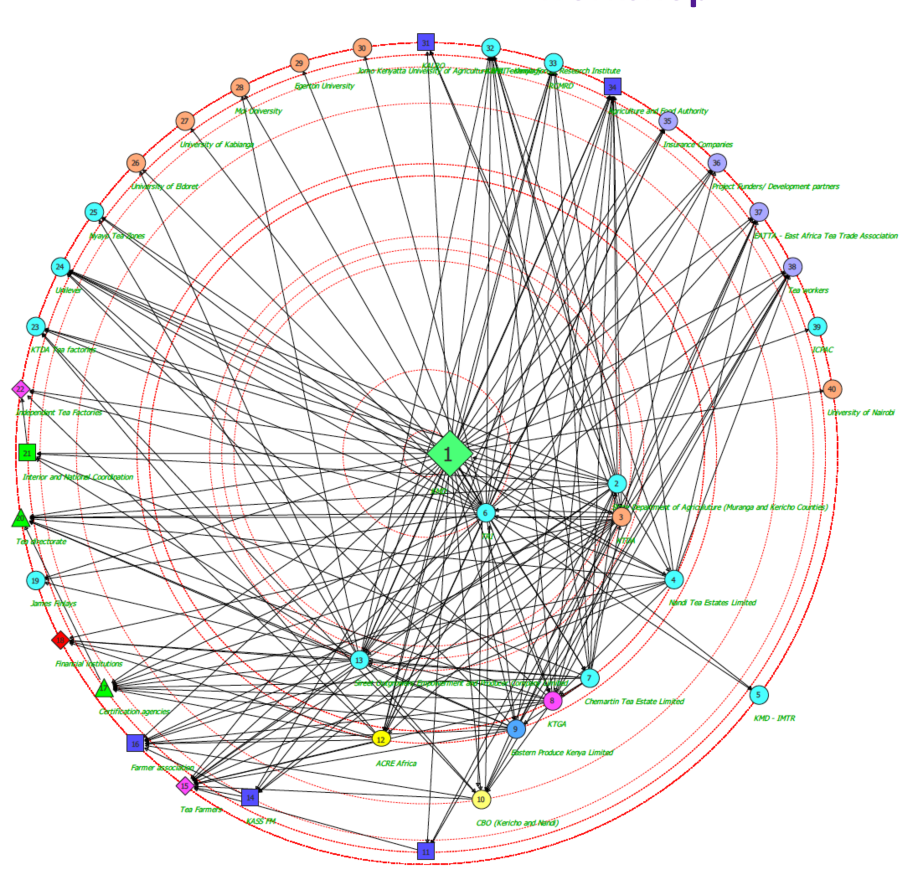


Figure 2. Stakeholder map for the Frost Monitoring and Forecasting Service. Key stakeholders for successful service development include Kenya Meteorological Department (county offices), Tea Research Institute, Kenya Department of Agriculture, Kenya Tea Development Authority, Community Based Organizations, and Insurance Companies.

Abstract

Kenya is the third largest tea exporter in the world, producing 10% of the world's black tea. Sixty percent of this production occurs largely by small scale tea holders, with an average farm size of 1.04 acres, and an annual net income of $1,075. According to a recent evaluation, a typical frost event in the tea growing region causes about $200 dollars in losses which can be catastrophic for a small holder farm. A 72-hour frost forecast would provide these small-scale tea farmers with enough notice to reduce losses by approximately 80 USD annually. With this knowledge, SERVIR, a joint NASA-USAID initiative that brings Earth observations for improved decision making in developing countries, sought to design a frost monitoring and forecasting service that would provide farmers with enough lead time to react to and protect against a forecasted frost occurrence on their farm. SERVIR Eastern and Southern Africa, through its implementing partner, the Regional Centre for Mapping of Resources for Development (RCMRD), designed a service that included multiple stakeholder engagement events whereby stakeholders from the tea industry value chain were invited to share their experiences so that the exact needs and flow of information could be identified. This unique event allowed enabled the design of a service that fit the specifications of the stakeholders. The monitoring service component uses the MODIS Land Surface Temperature product to identify frost occurrences in near-real time. The prediction component, currently under testing, uses the 2-m air temperature, relative humidity, and 10-m wind speed from a series of high-resolution Weather Research and Forecasting (WRF) numerical weather prediction model runs over eastern Kenya as inputs into a frost prediction algorithm. Accuracy and sensitivity of the algorithm is being assessed with observations collected from the farmers using a smart phone app developed specifically to report frost occurrences, and from data shared through our partner network developed at the stakeholder engagement meeting. This presentation will illustrate the efficacy of our frost forecasting algorithm, and a way forward for incorporating these forecasts in a meaningful way to the key decision makers – the small-scale farmers of East Africa.

Methodologies and Preliminary Results

Frost Monitoring

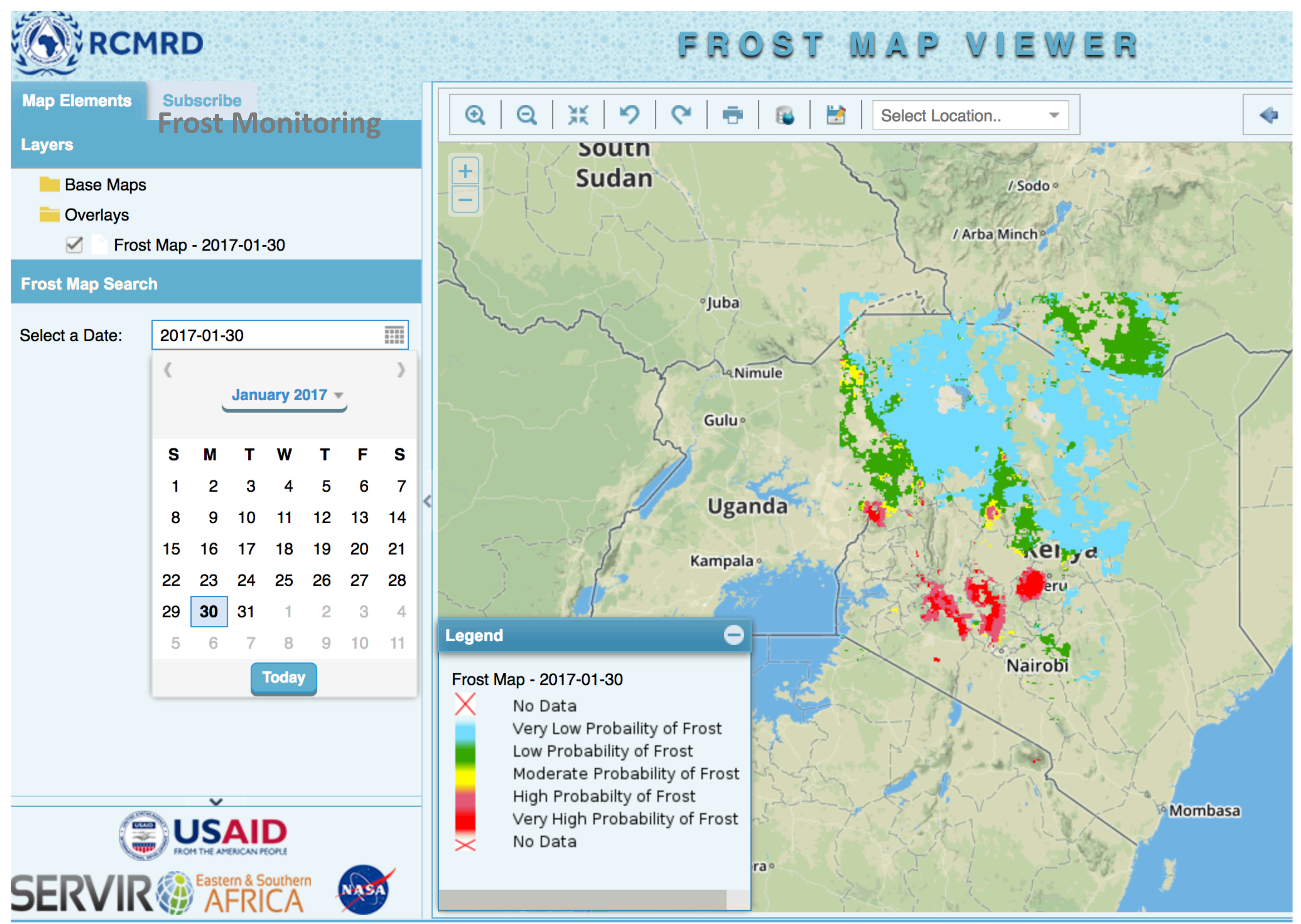


Figure 5. *In situ* frost observations and the MODIS Land Surface Temperature were used to produce a logistic regression model to determine the probability of frost occurrence. The results are loaded into the Frost Map Viewer webpage.

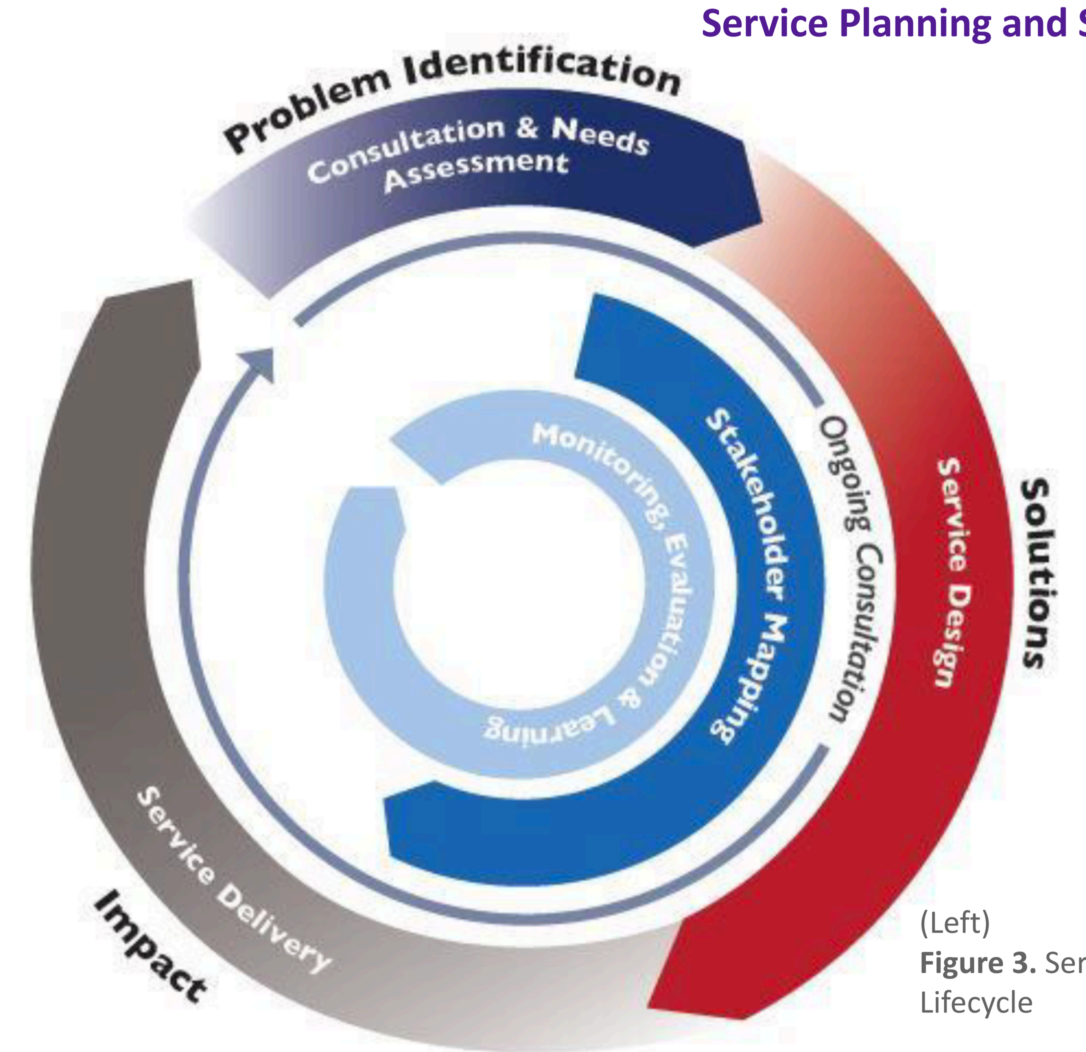
Acknowledgements

We would like to acknowledge the support of the stakeholders who attended the workshop and continue to be engaged with service design and implementation.

We would also like to recognize University of Alabama in Huntsville Earth System Science Center, and the RCMRD and SERVIR teams for their support

Methodologies and Preliminary Results

Service Planning and Stakeholder Engagement



(Left)
Figure 3. Service Planning Lifecycle

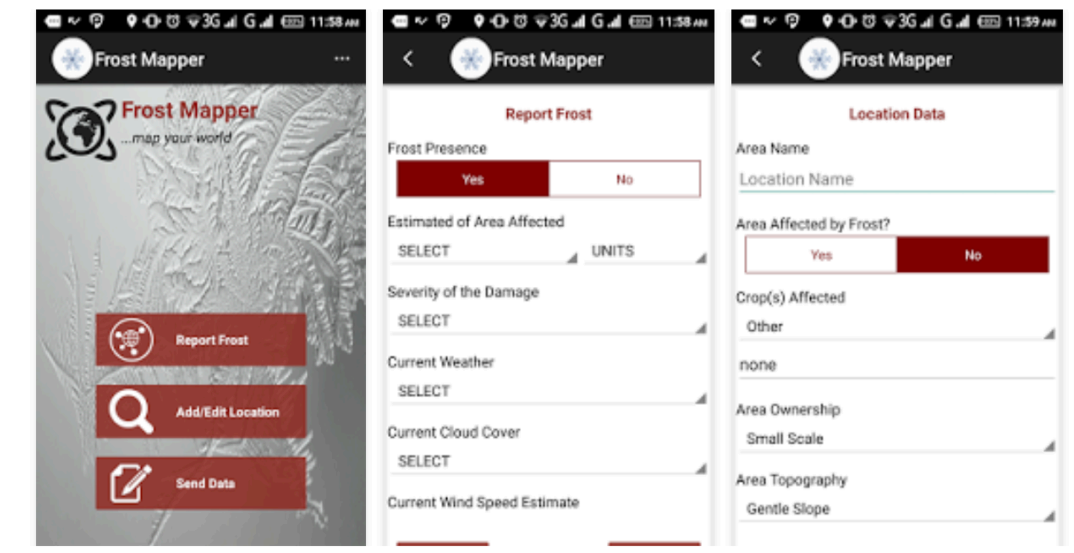


Figure 4. Frost Mapper App developed by RCMRD to collect field observations of frost

Frost Forecasting

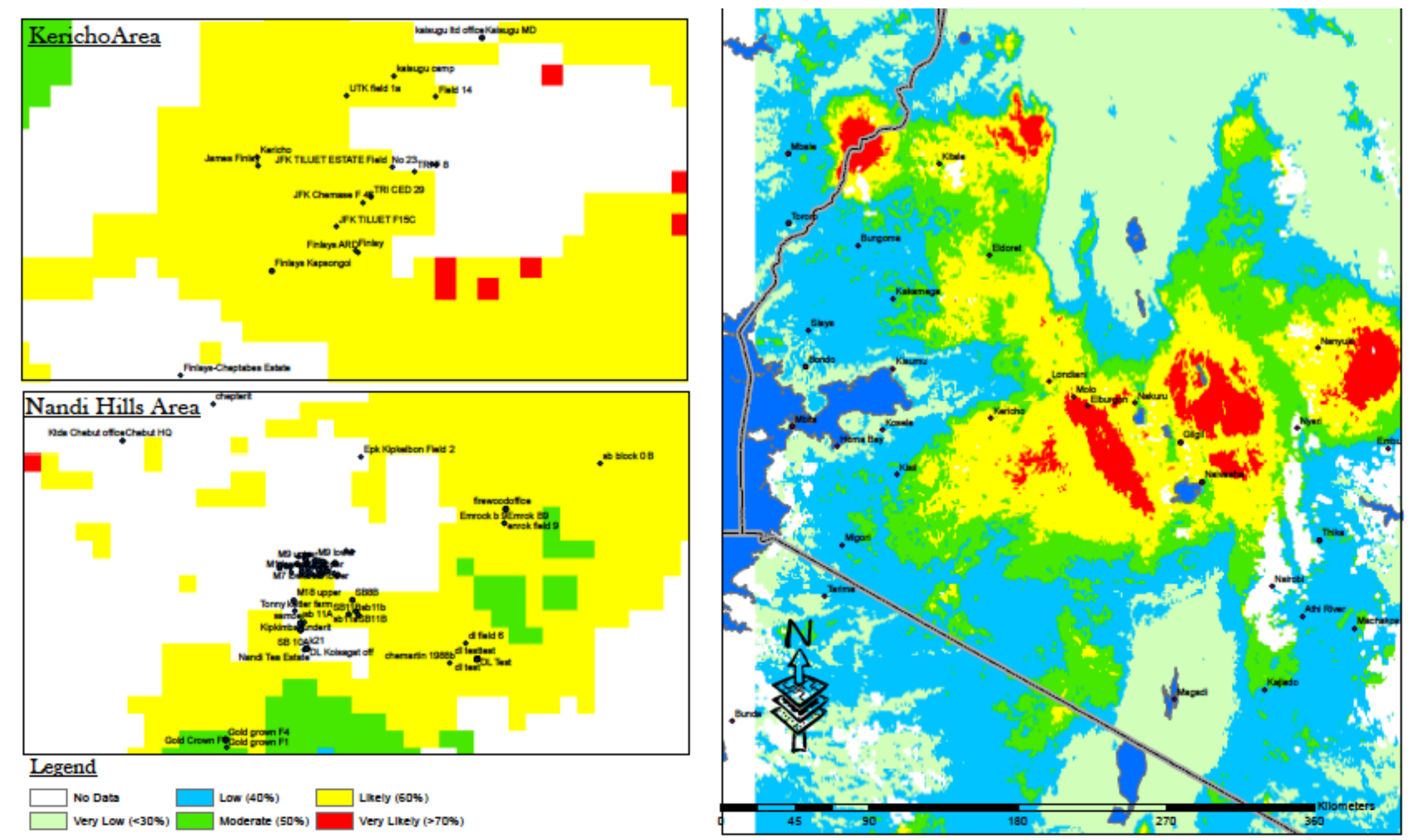


Figure 6. A sample frost prediction map to be sent to end users. The Unified Environmental Monitoring System (UEMS), which incorporates the NCAR Advanced Research WRF (ARW), was implemented to produce a daily 72-hr forecast. Variables including 2-m air temperature, relative humidity, and 10-m wind speed were incorporated into an algorithm to calculate frost potential. This algorithm is currently under sensitivity testing and hindcast analyses to produce a more accurate product.

Questions?
Contact
emily.c.adams@nasa.gov