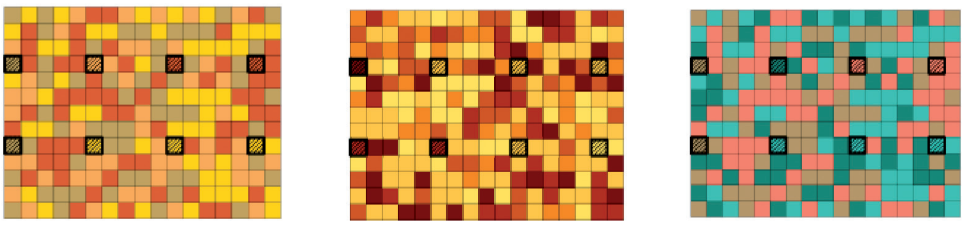
Annex 2: Livestock modeling

The predictor layers used in the WI mapping exercise for cattle, camel, chicken, pig, goat and sheep densities and cropping percentage were themselves derived by modelling a set of point or administrative level data for these variables. This Annex describes how this was done.

The underlying process of livestock and crop distribution modelling is covered extensively in FAO (2007). Once the available agricultural statistics have been collected, standardised, enhanced with supplementary data and adjusted for the extent of land deemed suitable for livestock production, the resulting data provide a sound base for statistical distribution modelling. The model then relies on the use of raster images to store both observed (or training) data (i.e. livestock densities) and all the predictor variables. Statistical relationships are established between observed and predictor variables using values extracted for a series of regularly spaced sample points, as illustrated in Figure A1. The resulting equations are then applied to all the pixels in the predictor images, to produce a predicted distribution map.

Figure A 1. Schematic livestock and crop distribution modeling.

Observed density - A x (Predictor 1) + B x (Predictor2)



Step 1: Convert all data maps to images with same pixel size (resolution)

Step 2: Extract values for observed values of livestock density, and for each predictor variable at fixed sample points (hatched squares)

*Step 3: Calculate a regression equation of the form: Observed density = Constant + A * (Predictor 1) + B * (Predictor 2) + …*

The technique can therefore be used to predict livestock or crop distributions in areas for which no livestock data are available, i.e. filling in gaps. Moreover, because predicted distributions are produced at the resolution of the raster imagery, the models generate heterogeneous distributions within polygons that have only a single observed value, thus disaggregating the original data. For limited datasets therefore, the method has the major advantage of both filling in gaps and refining the level of detail that can mapped.

A wide variety of predictor variables is used in the modelling process, embracing environmental, demographic, climatic, agricultural, topographic, and infrastructural factors. The majority of environmental and climatic parameters are derived from either public domain global datasets (elevation, land use and land cover, human population), from GIS processing (distance to features such as roads and towns) or from the MODIS satellite imagery referred to in the main report.

It is by no means certain that relationships between target and predictor variable are linear, and it is therefore advisable to test non linear relationships. This is achieved by numerically transforming the variable values prior to statistical analysis. Models were thus assessed with dependent and independent variables in both their un-transformed state, and with the natural logarithmic transformation applied.

The predictors of animal density are also unlikely to be consistent from region to region, and the modelling process should therefore be run at several different spatial scales to provide a range of predictive relationships appropriate to specific areas. As well as administrative level analyses, an ecological stratification was used on the assumption that the factors determining animal distributions are likely to be similar in areas with comparable ecological characteristics, thereby allowing a) more robust statistical relationships to be established between training data and predictor variables and b) more realistic predictions of livestock densities in other parts of the same analysis zone for which data are not available.

The modelled outputs for cattle, camel, chicken, pig, goat and sheep densities, and for cropping percentage, from the Gridded Livestock of the World (GLW), are illustrated in Figure A2 and Figure A3, respectively.

Figure A 2. Livestock densities: a) cattle, b) camel, c) chicken, d) pig, e) goat and f) sheep.

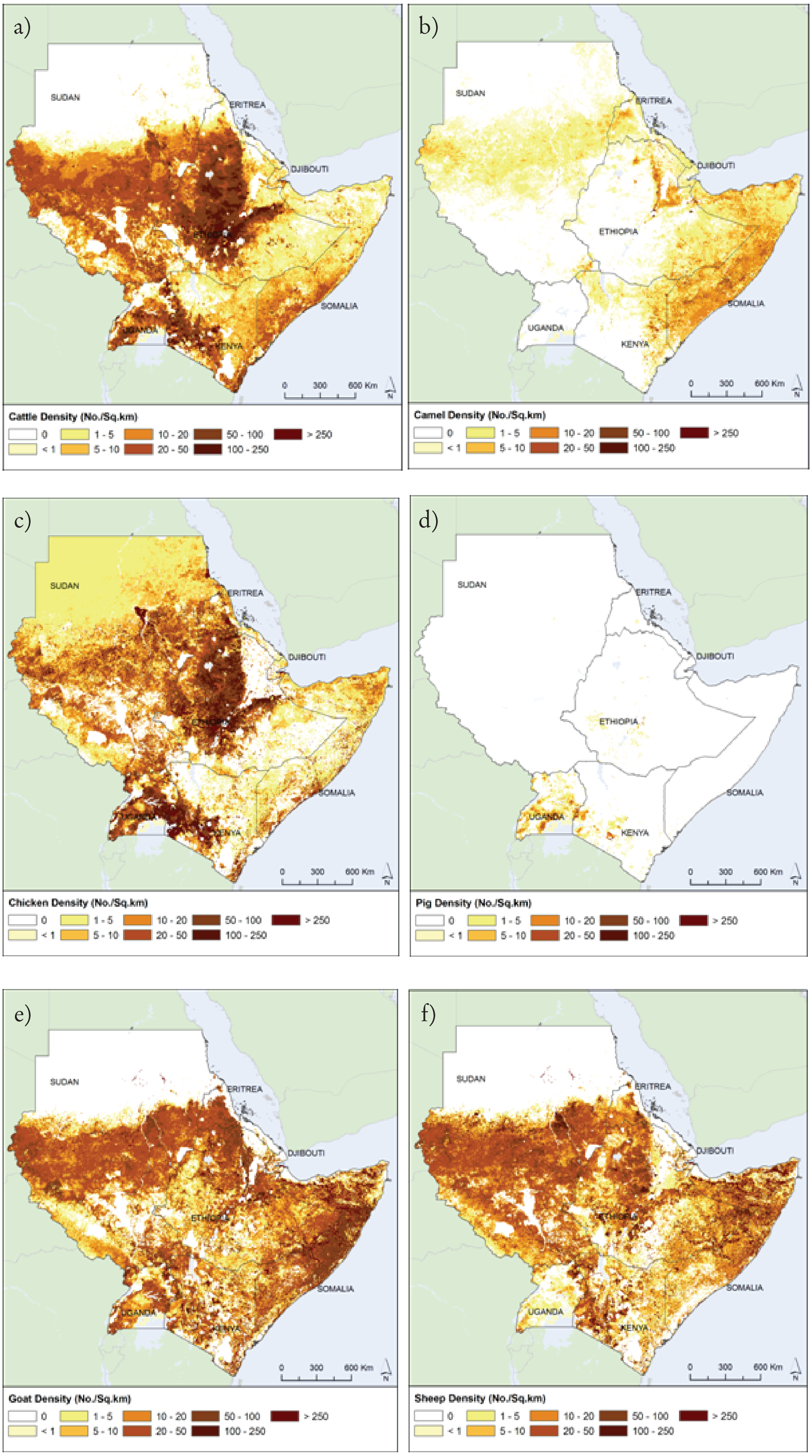


Figure A 3. Cropping percentage.