Spatial Analysis of Mass Burial Carcass Disposal Regulations

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Widespread livestock death can be caused by natural disaster or animal disease, through accidental introduction or as an act of bioterrorism. In any case, the disposal of large numbers of livestock carcasses is a challenging, yet extremely sensitive, component of any recovery effort, in terms of food security, environmental impacts, and economic loss. Proactive planning efforts are vital to the expediency of such efforts, as evidenced by the difficulties experienced in the UK in 2001 in the incineration of livestock carcasses following a Foot and Mouth Disease outbreak. The four most common methods of carcass disposal identified in the current literature are burial, incineration, composting, and rendering. Of these, burial is often the chosen method based on the logistical and economic advantages.

In this study a spatially explicit indexing methodology was used to evaluate mass burial carcass disposal environmental and biosecurity regulations for California, Kansas, Oklahoma, and Texas. The mass burial regulations for each state, as well as relevant geospatial data, e.g. soils, topography, hydrology, and land use, were obtained and used to identify the areas available for mass burial. In general, the results of this work have identified inconsistencies between states, the lack of comprehensive response plans within states, and a lack of readily available, high quality spatial data for site identification.

Methodology

Regulations governing carcass disposal in Texas, Oklahoma, Kansas and California have been collected from various regulatory agencies (Tables 1-4). This information was used to drive the spatial data collection and processing for carcass disposal analysis. Collected data was processed as exclusionary or ranked data. Exclusionary areas are those that were absolutely excluded from activity based on current regulations. Additional data was ranked based on the increasing degree of suitability under less exact regulations, e.g. soil characteristics. The processed data was combined to create a suitability map for each state.

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Table 1. Environmental variables and regulations for Texas.

	Exclusionary Criteria	Distance (ft)	Other Criteria	Source
Burial				
	Depth to water table	2	■■	Natural Resources Conservation Service (NRCS)
	Drinking wells	500	■■	NRCS
	River and stream networks	300	■■	Texas Commission on Environmental Quality (TCEQ)
	Lakes and ponds	300	■■	TCEQ
	100 yr. flood plains	■■	Not allowed	NRCS
	Slope	■■	< 6%	NRCS
	Property lines and residences	200	■■	TCEQ
	Soils	■■	Catastrophic animal mortality management index	NRCS

Table 2. Environmental variables and regulations for California.

	Exclusionary Criteria	Distance (ft)	Other Criteria	Source
Burial				
	Depth to water table	10	■■	State Water Resource Control Board (SWRCB), Regional Water Quality Control Board (RWQCB)
	Drinking wells	100	■■	California Cooperative Extension (CCE)
	River and stream networks	500	■■	SWRCB, RWQCB
	Lakes and ponds	500	■■	SWRCB, RWQCB
	100 yr. flood plains	■■	Not allowed	NRCS
	Slope	■■	< 6%	NRCS
	Property lines and residences	1320	■■	CCE
	Soils	■■	Catastrophic animal mortality management index	NRCS

Table 3. Environmental variables and regulations for Oklahoma.

	Exclusionary Criteria	Distance (ft)	Other Criteria	Source
Burial				
	Depth to water table	2	■■	Agricultural Environmental Management System (AEMS)
	Drinking wells	300	■■	AEMS
	River and stream networks	300	■■	AEMS
	Lakes and ponds	300	■■	AEMS
	100 yr. flood plains	■■	Not allowed	NRCS
	Slope	■■	< 6%	NRCS
	Property lines and residences	300	■■	AEMS
	Soils	■■	Catastrophic animal mortality management index	NRCS

Table 4. Environmental variables and regulations for Kansas.

	Exclusionary Criteria	Distance (ft)	Other Criteria	Source
Burial				
	Depth to water table	10	■■	Kansas Department of Health and Environment (KDHE)
	Drinking wells	1320	■■	KDHE
	River and stream networks	500	■■	KDHE
	Lakes and ponds	500	■■	KDHE
	100 yr. flood plains	■■	Not allowed	NRCS
	Slope	■■	< 6%	NRCS
	Property lines and residences	500	■■	KDHE
	Soils	■■	Catastrophic animal mortality management index	NRCS

Environmental variables collected for this analysis include:

- USGS National Elevation Dataset (NED) – 1:24,000 scale
- USGS National Land Cover Data (NLCD) – 1:24,000 scale
- USGS Soil Survey Geographic Database (SSURGO) – 1:24,000 scale
- National Hydrography Dataset (NHD) rivers and streams – 1:24,000 scale
- NHD lakes and other vulnerable water bodies – 1:24,000 scale
- FEMA flood plains – 1:24,000 scale
- Major and minor aquifers
- Water wells and water table depth

All exclusionary data were merged and rasterized to a 30-m resolution grid and removed from the study area for each state (e.g. Figure 1). The remaining areas were used as a mask for further consideration of the ranked data (i.e. variables with a range of acceptable values), which were ranked on a scale of 0-10. The ranked data consisted of depth to the water table and soil data. Finally, suitability, defined as the maximum membership index (0-10) of the data values for each grid cell, was evaluated and data was re-classified into five categories: Ideal, High, Moderate, Low and Unsuitable (e.g. Figure 2).

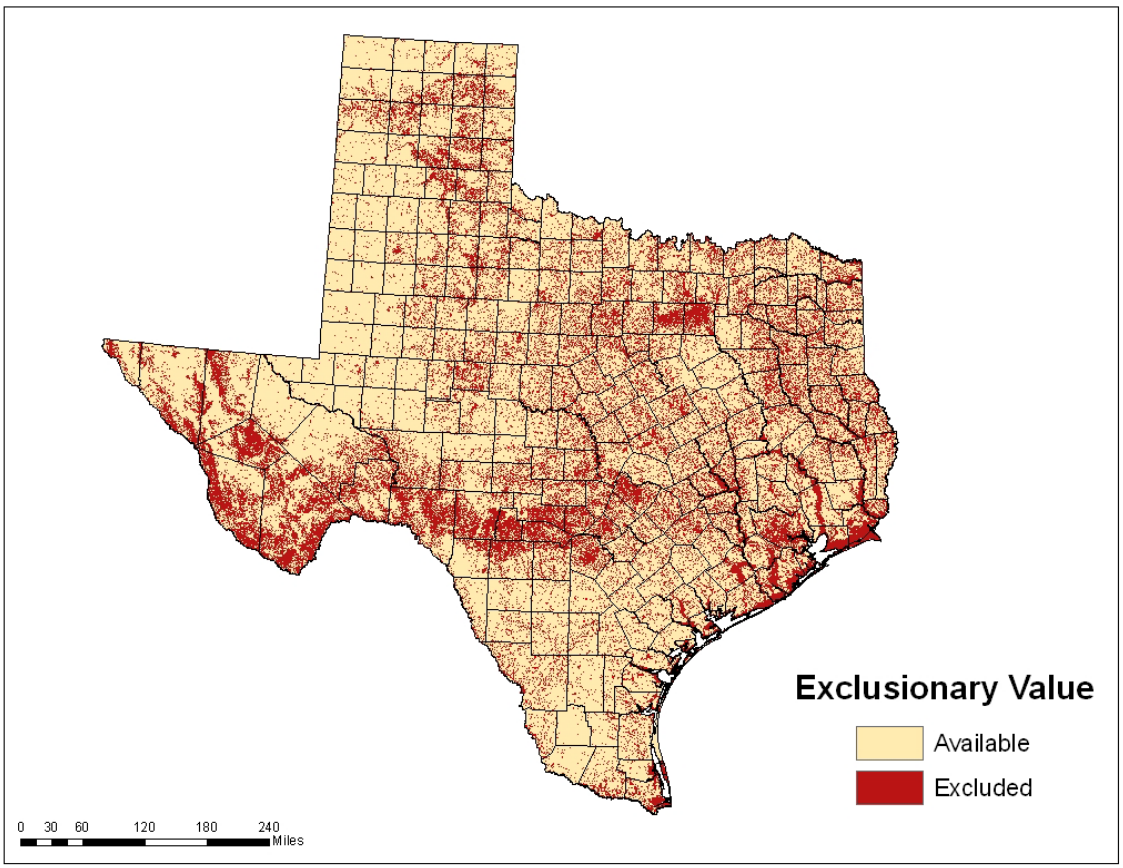

Figure 1. Exclusionary areas for Texas derived from state regulations.

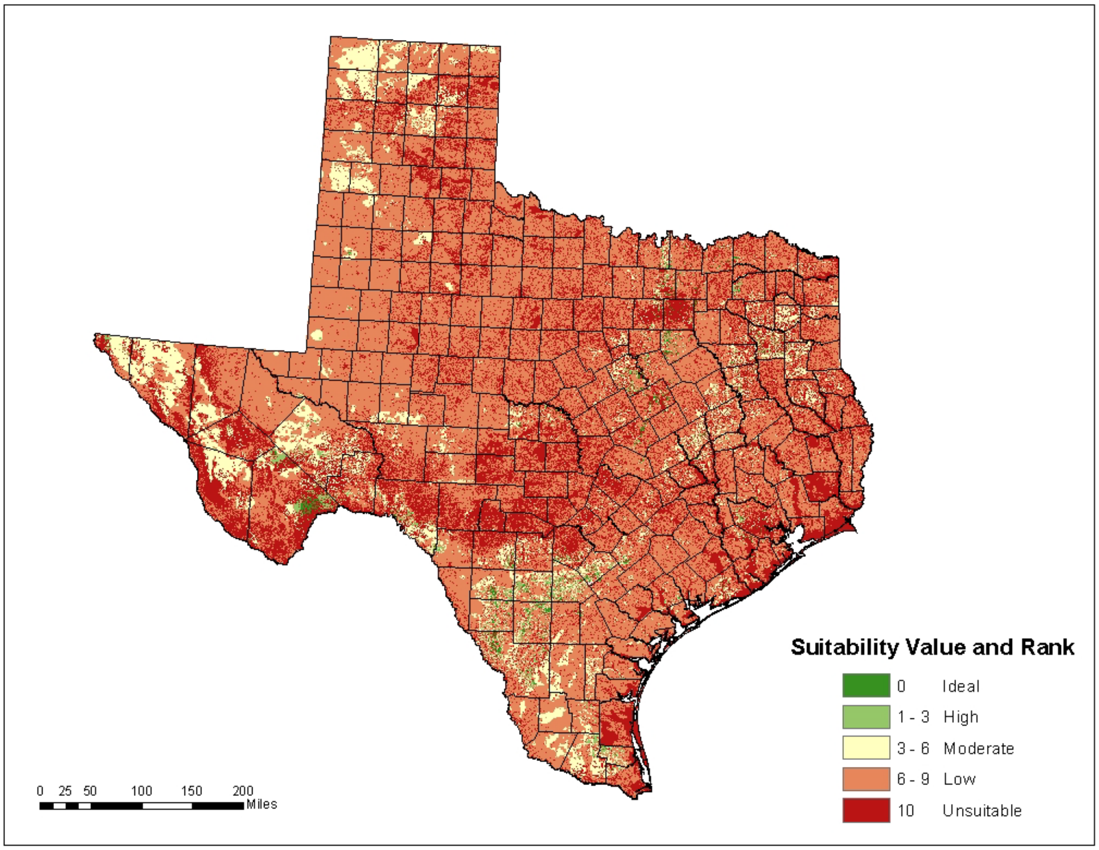

Figure 2. Mass burial suitability for Texas.

Issues

The main issues identified through this analysis are the inconsistencies between state regulations, the lack of comprehensive response plans within states, and a lack of readily available, high quality spatial data for site identification.

Regulations vary greatly between states as well as within states among the responsible agencies. Obtaining this information can be difficult at best and generally involves discussions with numerous people from various agencies. In many cases, state agencies are currently in the process of drafting these regulations. Further, there is a general lack of consensus on emergency response procedures and who will ultimately have jurisdiction, county, state, or federal agencies, depending on the scale of a particular event. These issues could be particularly problematic when dealing with events that cross state or international borders.

Finally, there is a lack of readily available, high-resolution spatial data that can be used for site identification. Often data that is needed for this type of analysis is protected and/or difficult to obtain, e.g. private property boundaries and public drinking well locations. Further, some data is simply not available in geospatial format or for the entire U.S. at this time, such as high resolution soils data.

For this study, the NRCS provided the catastrophic animal mortality management ranks for the SSURGO II datasets for Texas and Oklahoma. At the time of this analysis, however, these rankings were not available for California and Kansas (data was scheduled for release for the entire U.S. in mid-July of 2006). Further, SSURGO II does not exist for the entire U.S. and will not be available until soil surveys are completed for each state. For the counties in this study that were missing SSURGO data, the USDA-NRCS STATSGO data was used.

Unfortunately, there is not a cohesive link between the two datasets, and the NRCS animal mortality index rankings do not exists for the STATSGO data. Based on conversations with NRCS staff, the most readily available surrogate was the STATSGO trench type sanitary landfill index. Because these two ranking indices do not match, a method was established to join the two datasets using a common ranking index.

In order to link the SSURGO and STATSGO datasets, the STATSGO data was manipulated. The STATSGO trench type sanitary landfill index is comprised of three to four categories for each individual STATSGO MUID: slight, moderate, severe, and limitation. Composition percentages are on a scale of 1-100. The composition percentage for each category was first multiplied by 0.01 to convert the scale to 0-1 (similar to the SSURGO ranking scale). The composition percentages were then multiplied by a weight. The slight classification was assigned a weight of 1, moderate had a weight of 5, severe and limitation categories were assigned a weight of 10. For each STATSGO MUID, the weighted compositions were added together to determine the "rank" of the individual MUID. This "rank" fell in the range of 0-1; therefore, it was comparable to the SSURGO ranking system.

With similar ranks assigned to both the SSURGO and STATSGO data, soil data for all of Texas and Oklahoma could be utilized in further suitability analyses. While the exclusionary criteria for each state are well-established, the soil ranking methodology is questionable. The soil ranking procedure will be more solid when each state has digital SSURGO II data for every county.

Conclusions

Based on the issues identified through this analysis, there is a need for a comprehensive response plan for the U.S. which would help speed recovery efforts and minimize costs after a catastrophic event, either introduced or natural.

Further, there is a need for high resolution spatial data for site identification. Without these data, suitability maps tend to overestimate the available area for carcass disposal activities, thereby creating more work for first responders during an event. Accurate suitability maps would not only reduce the field work for first responders, but reduce the cost and time associated with recovery efforts.

In addition to environmental variables, more practical information could be cataloged prior to an event that could include availability of heavy equipment, contacts for local/state experts, as well as protected cultural and endangered species locations, etc.