

Integrated Modeling and Transportation Modeling

DHS Priority Areas Addressed	<input type="checkbox"/> Prevention <input type="checkbox"/> Detection <input checked="" type="checkbox"/> Response <input type="checkbox"/> Recovery <input type="checkbox"/> Education/Risk Communication			
Proposal Section Addressed	Section 5.3.2			
Investigators	TAMU: Doug Tolleson and Michael Ward USC/ISI: Mike Orosz UCD: Tim Carpenter Georgetown: David Hartley			
Objectives	Deliverables	Progress Toward Deliverables	Percent Complete	
To develop a design structure for addressing epidemiologic modeling at multiple scales that can meet the needs of different types of diseases	Think tank			
	Assemble think tank			
	Prepare report on results of think tank			
	Prototype model			
	Complete design of prototype model	<ul style="list-style-type: none"> Transportation Model: Prototypes of a cattle transportation model have been designed and evaluated. Acquisition of validation data is ongoing. FAZD Decision Support System (DSS) design has been completed 	80	
	Complete coding of prototype model	<ul style="list-style-type: none"> Transportation Model: Software has been written and evaluated for the cattle transportation model. Once development of the FAZD decision support system is complete, this model will be a component and middleware written to facilitate intra-model communication. First prototype of the FAZD DSS developed 	80	
Complete report on status of the model and its usability	<ul style="list-style-type: none"> Transportation Model: A complete overview and design specification document on the animal movement model has been written. FAZD DSS: First prototype design specification and user manual completed 	100		

Highlight for Research Briefs

- Transportation Model:
 1. Alpha version, Texas cattle transportation model design, county level of resolution
 2. Beta version, Texas cattle transportation model design, sub-county level of resolution
 3. Alpha version National cattle transportation model design, county level of resolution
 4. Software design for Texas and National cattle transportation models
 5. Basic graphic user interface for Texas and National cattle transportation models
 6. Alpha version, Texas route choice road network design, multiple levels of resolution

7. Alpha version, National route choice road network design, state and interstate highway level of resolution
8. External review of Texas cattle transportation model design
9. Internal review of Texas cattle transportation model, software design
10. Basic Texas cattle demographic data for RVF epidemiological model
11. Design overview specifications documents for cattle transportation model
12. Collaborative relationship with HTU on cattle transportation and route choice models
13. Alpha version design for cattle transportation segment of FAS database
14. Currently designing graphic evaluation tools for model performance attributes
15. Currently pursuing agreement with a national video auction company to provide cattle shipping data
16. Currently pursuing agreement with Canadian Animal ID program to provide international cattle movement data

- **FAZD DSS:**

The first prototype of the FAZD DSS – consisting of the FAZD DSS database management system and a graphical user interface - has been developed. This prototype consists of the core infrastructure of the FAZD DSS and currently supports the Java-ported AusSpread model.

The Concept of Operations (ConOps) is as follows:

- AusSpread model is run (on a scenario)
- Output from the model is imported into the FAZD DSS (a manual process)
- Users can access the data via the graphical user interface (using SQL instructions)
- Users can export a subset of scenario results for use with other systems (such as the FAZD Center “cost” economics model).

A A/B comparison between the Java and MapInfo versions of the AusSpread model is currently underway to confirm the operation of the Java ported model.

Interpretive Summary

Transportation Model:

Prototype livestock transportation models have been developed for Texas cattle at two levels of resolution, 1) using counties as surrogate premises and 2) using voting districts as surrogate premises. In either case each premises has a unique ID and is represented by a polygon in a GIS format. Each polygon is assigned to one of ten premises types (e.g. dairy, cow/calf ranch or feedlot) and populated with a number of animals or assigned a capacity. The state is divided into twelve agro-climatic regions or domains which would be analogous to those used by current epidemiological models. Each domain and premises is assigned attraction factors which determine the probability of animals being transported to that particular domain and premises. Movement of cattle within the model is based upon region of origin, size of operation (i.e. number of animals), as well as breed, age, sex, and weight of animals. The rule base for how cattle move within the system is based on structure of the US cattle industry and either published literature or expert opinion on cattle movement.

The movement engine simulates movement in the cattle industry with a state machine that uses individual processing nodes to represent each step in the processing chain. It receives input from a queue of lots, where each lot is de-queued and processed individually. Once the input queue is

empty, the output queue will contain at least as many lots as the input queue originally held. The engine contains two layers of nodes, which define the logic represented in the premises and entity layers of the data organization: 1) Current Premises Nodes. Performs pre-movement processing, and 2) Destination Premises Nodes. Finds a destination premises. In the cattle transportation model, a *lot* is an entity that represents a group of cattle. In the current version, all animals in a lot share the same class type, breed, weight per animal, age.

Once a “lot” of animals has been created, a vehicle/trailer combination is specified and number of trips required to move the animals calculated. At this juncture a route is chosen and the animals are “transported”. The original design of the transportation model included both an animal movement and a route choice component. We have decided to divide this into two separate models. An ArcView based prototype of the route choice model has been developed to work with the current versions of the transportation model. This effort has also been accomplished at different resolutions, 1) Texas state and interstate highways, 2) Texas rural and county roads and 2) US state and interstate highways.

The current cattle transportation model has also been scaled up to a prototype for the 48 contiguous states. In this version, counties again serve as surrogates for premises. All movement rules apply as previously described. It should be noted that this version was developed to test the scalability of the model as written, not to be used as a national model. The data underlying this version is purely hypothetical. The scaled up version does work well from a programming standpoint, i.e. lots were created and moved with no new bugs or errors encountered. To summarize, the platform is available to build a national transportation model once data of that magnitude is obtained.

All versions of the prototype cattle transportation model can accept input from or transfer output to, other models. There is currently no specific middleware written to accomplish this intra-model communication electronically but for example, an output table from AusSpread containing a list of “out of domain” movements can be input to the transportation model, lots created and model runs performed. This model run then results in a table of information including point of origin and destination. These end points can then be input to the route choice model and a map created showing the origin, destination, disease status and route taken for each lot in the simulation.

An MOU has been established with Lawrence Livermore National Laboratory to collaborate on a project to link the current cattle transportation model logic to the MESA model. Briefly, MESA is a national scale epidemiological model and is operated on a virtual premises database derived from NASS census data. MESA currently relies on coarse transportation logic. This collaboration should improve the transportation aspect of MESA and provide a national premises database for FAZD modeling efforts.

Five test scenarios have been created for evaluating the cattle movement aspect of the transportation models. These vary in breed, age, sex, weight and premises type and location. Each is designed to represent a typical lot of cattle that might be moved and have characteristics which would create a predictable distribution of outcomes. For example, beef steers from small operations should have a high probability of moving through an auction as opposed to a private treaty sale, or Brahman breed feeder animals should have a high probability of going to a southern region feedlot as opposed to a northern facility. These type scenarios provide a consistent framework by which to test not only transportation model functionality but intra-model communication as well. Graphic evaluation tools are being developed to allow the developer or ultimately a user, to create multiple runs of a given simulation and then view plots of the distribution of for instance: movements through auctions versus private treaty sales, movement to various regions or movements to various facility types.

FAZD Decision Support System (DSS):

The FAZD DSS consists of the middleware that links the various models (epi, transportation, economic, and environmental), decision-support tools, and databases into single integrated decision-support system for use by both researchers and decision/policy-makers. The current working prototype consists of the central data management system (i.e., data store), the necessary support linkage to allow import/export operations, and a graphical user interface to allow users access to stored data. Structured Query Language (SQL) instructions are used to access data of interest. The objective of this first effort was to establish the underlying infrastructure to support an integrated modeling environment. As such, data movements between models/decision-support tools and the central data management system is still a manual process. The objective of the next phase (Phase II) is to automate this process.

Currently, the system has been tested with the Java-ported version of the AusSpread model.

Results and Interpretations

Transportation Model:

A prototype cattle transportation model based on the structure of the US cattle industry has been developed. This model will ultimately provide scalability for epidemiological or economic models. Combined, these models will become training tools for policy and decision makers at the local to national scale. This tool could also be used by industry in a proactive manner to design safer or more efficient cattle movement routes and patterns. The stand alone version of this model could be used in classrooms for secondary and undergraduate livestock marketing courses.

FAZD Decision Support System (DSS):

The objective of this first phase was to develop the underlying infrastructure to support a fully functioning integrated decision-support system. A prototype consisting of a central data management system (i.e., data store) and a graphical user interface have been developed. Interaction with this prototype and the AusSpread model (Java version) is primarily a manual process (i.e., import/export of data via SQL instructions).

Technology Transition

Transportation Model:

This project is being merged with the FAS national transportation and movement model project (fund via NCFPD – DHS sponsored National Center for Food Protection Defense). In the initial phase of this project, the FAZD Center developed cattle transportation model will be extended to support interstate movement of beef cattle, dairy cattle, and swine. The ultimate goal of this effort to develop an interstate transportation model that supports all commodity types (including imports and exports) in the food agriculture sector (FAS) and include this model in the DHS/USDA Joint Modeling Operations Center (JMOC).

FAZD Decision-Support System (DSS):

As the FAZD DSS matures, it will become the support structure for on-going FAZD Center research into foreign animal and zoonotic diseases. The goal is to have researchers access various models and databases via the FAZD DSS graphical user interface. In addition, the DSS will support

the FAZD Dynamic Preparedness System (DPS) – a suite of tools and modules that support emergency management training and incident response at the regional level. Finally, opportunities exist in transitioning this technology to the proposed DHS/USDA Joint Modeling Operations Center (JMOC). This transition path is not guaranteed, however, the JMOC is just now ramping up and the Center may be able to leverage the FAS transportation model effort

Status of Funding

Transportation Model:

Current development/support of the FAZD Center transportation model is via project 5. In year 4, this project will receive its own funding. In addition, funding from the FAS national transportation model will be leveraged.

FAZD Decision-Support System (DSS):

A NCE through 31 May 2008 has been requested by USC-ISI. Sufficient funds are available for the team to continue working through the Year 4 funding gap.