And the Cow Jumped Over the...Fence?

Environmental Science

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There are plenty of songs about cows, cowboys, and horses. The first few notes of "Home on the Range" can conjure up mental images of vast ranches, complete with real-life cowboys rounding up the herd for a long cattle drive. In states stretching from as far north as Montana and the Dakotas, to as far south as Texas, raising cattle and other livestock is big business. In spite of the fact that some expansive ranches still exist, raising cattle is more likely to take place in more confined spaces, especially in states where land is a precious commodity.

Feedlots, also known as CAFOs, (confined animal feeding operations) are a common method of raising cattle today. While feedlots offer efficient use of available land resources, they can pose potential environmental threats as nitrates and other nutrients have the potential to seep into surrounding soil and water. For this reason, feedlots are heavily regulated and closely monitored. Harry Redman, a GIS Analyst with the Planning and Development District III, in Yankton, South Dakota, has had firsthand experience with CAFOs. The Planning and Development District is a non-profit local government entity that provides services to local cities, counties, and tribal governments.

Using GPS to Map Cattle Pens

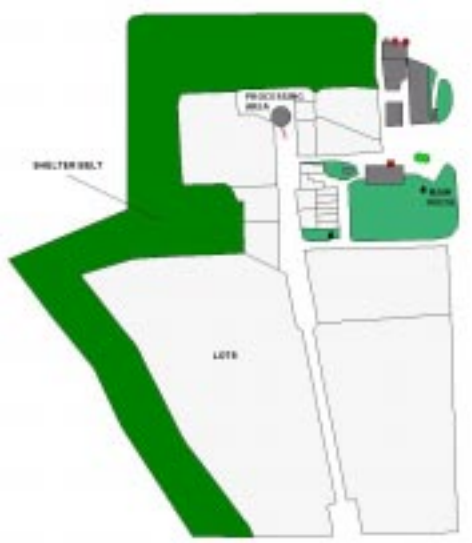
Redman describes the project in detail, "Using a global positioning system (GPS), we mapped a large cattle feedlot in Lincoln County, South Dakota. First, we identified every feature that needed to be collected – points, lines, and polygons – which included almost everything on the feedlot property. After creating a codelist, we used the Leica GS50 receiver to collect all the feedlot data. When we first started, we had a lot of questions, and Leica provided us with training and technical support. When we have questions, the turnaround time for technical support has been very fast, which is great, and very helpful for us."

To date, the District has mapped forty-nine individual feedlot locations. Redman elaborates, "We collected all of the feedlots as a polygon using the Leica GS50 receiver. The Leica unit can calculate the area of the collected polygon in the field immediately after it has been recorded. It took only three days during July and August to complete the work."

In addition to the feedlot itself, the District also collected other features including barns, the feedlot processing area and any buildings, as polygons. In situations where it was difficult to acquire satellite signals, buildings and other objects had to be collected by offsetting them from the GPS location. Redman explains, "Buildings were offset by ten feet. I would walk around the building at a distance of ten feet, holding a measuring tape so that I would keep a constant distance away from the building. The offset function helped me immeasurably, because if I had not offset the buildings, I would've lost satellites and possibly a position lock, as the building itself can block the satellite signals."

In addition to polygons, the District also collected several points including grain silos, diesel gas storage tanks, grain bins, gas pumps and houses. Fences were collected as lines, along with the feedlot's cattle chute. This was done by walking in the middle of the chute and recording an offset in the Leica GS50 GPS receiver either 2 or 3 feet to the left or right side, which gave the location of the chute's fence. It seems that offsetting objects came in handy more than once!

Planning District III used the Leica GS50 GPS/GIS unit to inventory items on the feedlot, including grain silos and cattle chutes. Once the GPS data was collected, the District could easily create maps showing locations of these and other items in the GIS.



After using the Leica GS50 GPS/GIS unit to capture GPS data on the feedlot, Planning District III created GIS maps showing the location of feedlot facilities.

On The Map

Once the data was collected, Redman used Leica's GIS DataPRO™ software to create shapefiles. "We used GIS DataPRO in the field on a laptop to verify that GPS data was collected properly," says Redman. "The data was already corrected in real-time via a U.S. Coast Guard Beacon so we did not have to post-process. The Leica GS50 is real-time DGPS capable, which is a really nice feature. GIS DataPRO software is unique in that it automatically creates shapefiles. We then take the shapefiles straight into ArcView. That is another really great feature of the Leica software – not having to export from GPS to GIS files, which saves us a lot of time."

The District used both the ArcView and ARC/INFO software packages from ESRI. Once the data is in the GIS it is "cleaned up" (geometry and multipath errors are deleted), and appended to other data already in the system. At the same time the GPS data was collected, District personnel also took digital photos of everything (grain silos, storage tanks, grain bins), and attached the photos to their GPS location in the GIS via ArcView's 'hotlink' feature.

Benefits

Redman says that there are two benefits he has received from working with the Leica GS50 GPS receiver – a personal benefit and an overall project benefit. As a personal benefit, Redman and the rest of the District staff were trained on the GPS equipment. According to Redman, "Leica's service, support and training were extremely beneficial. We learned how to create a codelist (a database used to collect features in the field), and how to configure the unit. Before that, we thought you just fired up the equipment and got going. The project really increased my knowledge of GPS – in college we studied mostly GIS." From a project standpoint, Redman says that, "District staff learned how to problem solve, offset, and troubleshoot in the field, all of which are very valuable skills."

Results

The use of GPS greatly helped the District in the feedlot project. Prior to using GPS, the District resorted to "heads-up" digitizing over aerial photography. The photos were used to identify and record the locations of structures. However, aerial photos quickly become outdated and the resolution was inadequate for the project. For example, some structures were not visible in a 30 meter resolution image. Before learning about GPS, the only alternative would've been to hire a survey firm to perform the data collection, but now the District has the internal knowledge to send out their own staff to do it. Using GPS has two additional advantages over using images: 1) a user can record specific attributes in the field that can't be seen on an aerial photo (for example, the number of nozzles on a gas tank), and, 2) GPS can give a finer accuracy, typically submeter, than most aerial photos.

Before mapping feedlots, the District was already using GPS for another project involving mapping roads for the South Dakota DOT (Department of Transportation). In 1994, the equipment that the District was using was only accurate to 5 meters, which was acceptable then, but not today. After the DOT project was over, the District realized that GPS would be perfect for the feedlot project and began to look around for a GPS receiver that could achieve better accuracy. The Leica GS50 GPS/GIS receiver fit the District's needs perfectly.

What the Future Holds

The District sees a promising future for the use of GPS within its organization. Redman explains, "At the same time that we mapped the feedlots, we also used the Leica equipment to drive a mile in each direction around the facilities and map neighboring homes. In the GIS, we could then add a 100 or 1000 foot buffer around each rural residence to see if the feedlot was affecting any of those structures. If it wasn't, then the rancher had a better case to prove that he/she was in compliance with local zoning ordinances. While in the office, we tried to locate digital data of private wells in the county, if there were any, so that we could prove that any wells were not being contaminated by feedlot runoff."

Redman says that the possibilities for using GPS are endless. In addition to water contamination, the District used GPS to record roads and rural structures within a county. "GPS road and structure data can play a vital role in starting up a new CAFO, as all new structures must be located within a certain distance from a hard surface road and from a rural occupied structure. ArcView GIS can quickly and efficiently illustrate all local zoning regulations so that the new facility would be in compliance. In the future, we may use the GPS to record the number of cows, and then we can calculate the actual number of cows per holding bin in the GIS. The only problem I see is actually working in and around the cattle. The cattle have charged us a couple of times, and once I actually had to jump over the fence to escape!" Ah – such are the hazards of field work.