9-1-1 Data for Appraisal and Other GIS Applications

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9-1-1 GIS data has a variety of other uses. It can be used to help build and quality control appraisal mapping systems as well as a variety of other planning systems. This paper considers how 9-1-1 mapping information can serve as a source of GIS data "registration and control" in appraisal mapping, be utilized as a source of quality control on the same and other GIS data, and for other planning functions such as solid waste transfer and census support.

Typical 9-1-1 Data

Roads in the 9-1-1 GIS database are represented as "centerlines." The centerline is the map representation of the center of the road. This imaginary line has data linked to it, identifying its name and address information. In New Mexico, 9-1-1 centerlines were usually built with differential GPS.

Driveways in the 9-1-1 system are mapped in much of the same manner as roads, except there are no database attributes describing the driveway, i.e. no drive name. At the end of the driveway is usually a point indicating the location of the house being addressed. The address point represents the front entrance of the house, not necessarily the center of the house. Houses have information such as occupant name, mailing address, telephone number and other notes.

Figure 1: A GPS Breadcrumb Trail in Pecos

Behind all of these GIS features are the GPS data used to locate the roads, drives and houses. SDR prefers to use GPS data as "bread crumbs." The breadcrumb is the location of the GPS antenna every second or two. The positions appear on the map as a line of dots, with the dots closer together as the mapping vehicle slows down and further apart as the vehicle speeds up. Some GPS systems will connect all of the dots in the breadcrumb, but this has disadvantages because bad GPS positions can misrepresent the true locations of the features being mapped. Typical positional accuracies for breadcrumbs collected via differential GPS are about 2-5 meters (6-15 feet).

The breadcrumb trail is the most basic 9-1-1 data that will be used in our appraisal and other GIS applications.

Leveraging 9-1-1 into Appraisal Mapping

SDR has been working with several counties in New Mexico who have different appraisal GIS applications. Counties examined in this paper with digital GIS appraisal data include Cibola, Union, Harding, Rio Arriba, Lincoln and Torrance County. SDR is also working in several other counties that do and do not have digital appraisal data.

With all of these different systems, SDR has encountered varying needs and has observed the following:

- 9-1-1 GIS data and GPS breadcrumbs can be used to "register" and "control" other GIS data such as assessor's mapping data.
- 9-1-1 GIS data can be used to manage parcel addressing and track multiple access points to a parcel.
- 9-1-1 GIS data can be used to update and correct parcel mapping errors such as missing and "paper streets."
- 9-1-1 GIS data can be used to build other GIS applications besides assessor's mapping, such as solid-waste transfer planning, land use, zoning, census and other planning functions.

- GIS data can be easily combined with real-time GPS locations to quickly and accurately determine the accuracy and completeness of appraisal mapping.

The above points are discussed in the following case studies of several counties in New Mexico.

Case Studies

Several examples of the integration of 9-1-1 and appraisal GIS are given below.

Source Appraisal Data

In Cibola County, Darryl McCullough and Jeff Lovato using PC ARC/Info did the parcel digitizing. Coverages were imported into ArcView and then translated from NAD-27 to NAD-83. During this first translation, the coordinate shift of the parcel data was about 2 million foot, thus when the data were first displayed, the Cibola data mysteriously appeared in the Oklahoma panhandle. At first, SDR and Cibola County suspected a bug in the coordinate translation, but it was later determined that the coordinate translation from NAD-27 to NAD-83 involves a single coordinate origin for all three State Plane Coordinate System (SPSC) zones in New Mexico, whereas the old coordinate plane system had a different origin for each zone.

The GPS breadcrumb was the final proof of the correct coordinate translation of the PC ARC/Info parcels.

Ideal Integration

David LaFave using MIMS prepared Lincoln County's data. The MIMS data was exported into DXF and then into ArcView via the CAD Reader extension. The DXF files were then saved as ArcView Shape files and then the coordinates translated from NAD-27 into NAD-83. The control for the MIMS data are the section corners found on the USGS quadrangles, thus the horizontal mapping accuracies are anticipated to be 40 foot.

Generally, the Lincoln County appraisal mapping data fit the GPS bread crumb data quite closely (within a few feet), especially in Carrizozo. But elsewhere in the County, the tight control found in Carrizozo became less reliable, with subdivisions being positionally off from the GPS breadcrumbs by about 40 feet, all of which is within the accuracy of the USGS quads.

In Lincoln County, SDR actually carried the appraisal mapping data into the field in ArcView on a laptop computer interfaced to a real-time differential GPS. Thus, in real time, SDR was able to assess the map accuracy of the appraisal mapping data while collecting roads, drives and house locations for 9-1-1 addressing. This represents a very high degree of GIS/GPS integration with 9-1-1 and Assessor's data.

The next figure is an example from Carrizozo demonstrating how closely the appraisal mapping information matches the GPS data.

Figure 2: Carrizozo GPS Breadcrumb versus MIMS

Caution: GPS Error

However, the user of the GPS must be aware that there can be significant positioning errors generated by the GPS. When the GPS is stationary and its position continuously recording, a cluster of GPS positions show the "spread" of error.

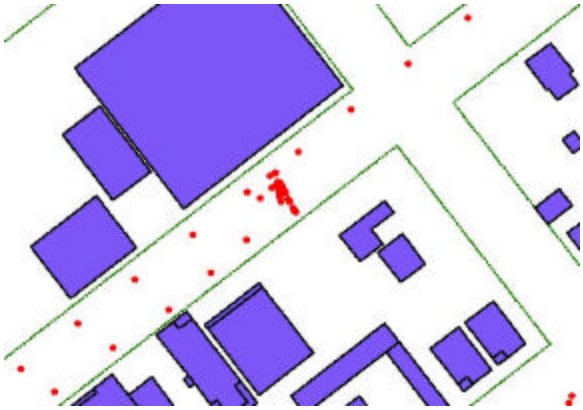

Figure 3: GPS Static Error

The center of the picture above shows a vehicle sitting outside of the County Manager's office for about 20 minutes. The GPS shows the positioning of the antenna every two seconds with a pronounced drift to the southeast of about 35 feet (11 meters). This error can be explained by a number of factors, but it demonstrates that the user should be aware of the sources of error.

Missing Road

Quay County recently finished building their 9-1-1 GIS by themselves. All roads, drives and houses were mapped from the IRS imagery, which was very clear and most homes and

drives could be easily seen. Quay County then carried their data into the field on a laptop with a real-time differential GPS. Below are the roads mapped from the imagery and the GPS bread crumb in blue. Note how the top, right side of the figure below indicates roads mapped with the GPS that could not be seen on the imagery. Thus the GPS has served here as a tool for validating the accuracy of the features mapped with the imagery ("registration & control") as well as a quality assurance tool of the work performed by the County Clerk.

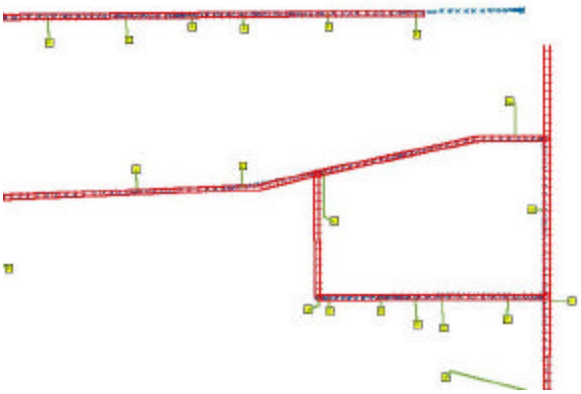

Figure 4: Missing Road in Blue

Which is Right: GPS or Other Data?

An important consideration to make when integrating appraisal GIS data with GPS data from the 9-1-1 system is which database do you update. For example, in Torrance County, Mark McComb acquires parcel-mapping data from local surveyors in an AutoCAD DWG format. Mark also collects his roads using differential GPS so he knows that the breadcrumb is very accurate. But when the breadcrumbs are overlaid with the parcels, there is an obvious miss-match.

But at this point in time, it would require more time and cost to fix the parcel land base. Therefore, the roads for the 9-1-1 system were mapped based on the parcel information, and the GPS was used to provide the relative map information, not \for absolute positioning.

Below is an example of how the land base in Estancia compares to the GPS breadcrumbs. Please note the bias of the land base approximately 45 feet to the east. This error is nominally acceptable because the parcels were based on control from the USGS quads, which are expected to be 40% accurate 90% of the time.

Figure 5: Estancia Parcel Bias versus GPS.

Other Appraisal Data Sources

Levon Sink of Union and Harding Counties exported their FastMap data into DXF. The DXF files were then saved as ArcView Shape files and then the coordinates translated from NAD-27 into NAD-83. Generally, the appraisal mapping data fit the GPS breadcrumb data quite closely. The control for the FastMap data is the quads.

Other Oddities

This is a very rare example. In Cibola County, during the GPS inventory a road was discovered that did not connect to any other road. It seems that the developer of the subdivision was required by ordinance to have a certain amount of road frontage for each parcel. However, some parcels towards the back of a subdivision were purchased by the same owner, so the parcels at the very back no longer needed road frontage, thus the connector roads were never built. It should also be noted, that none of the roads in this subdivision seemed to be constructed to code.

Other GIS Applications

The resulting GIS databases for 9-1-1 and appraisal mapping can be leveraged into several other GIS applications. Examples include appraisal video imaging, land use classification, zoning, and long-range environmental planning.

Incorporating Surveyors Data

In Mosquero, a comprehensive survey of the town was just completed for water and other utilities. This data was provided in an AutoCAD format to Pete Callahan who then wanted to overlay the information with the 9-1-1 system. Unfortunately, the engineering data did not match the 9-1-1 GIS. Apparently the surveyor did his work in NAD-27, so the data was then translated into NAD-83. The data still did not match the 9-1-1 GIS and the GPS breadcrumb so the

engineering drawings were shifted 300 foot to the east and everything then matched.

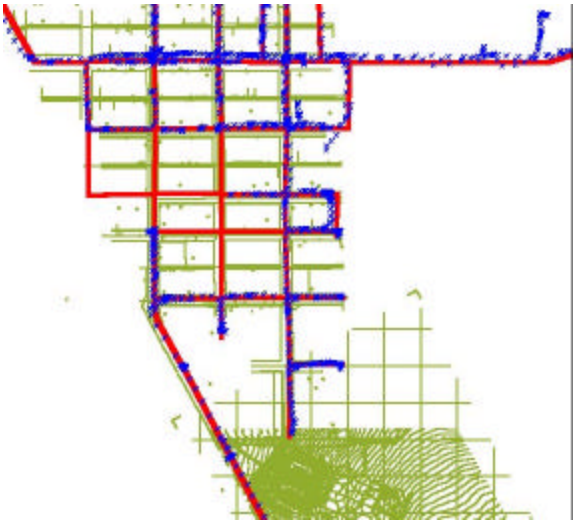

Figure 6: Mosquero Engineering Data

This is significant because a person not trained in any surveying can now perform quality control on the work of surveyors and adjust their coordinate system errors.

Appraisal Video Imaging

While most of SDR's work in New Mexico is related to GIS for 9-1-1 and acequia mapping, we also have considerable experience in appraisal imaging systems. SDR developed the core technology used by Mobile Video, one of the Nation's largest video appraisal imaging companies. This integration includes the linking of appraisal GIS data and GPS positioning with video image capture for each property.

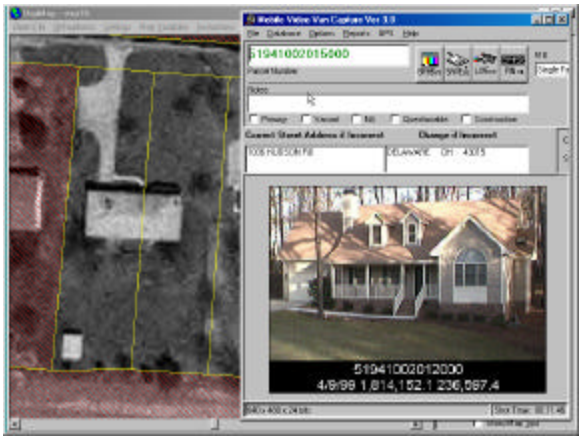

Figure 7: Appraisal Video Imaging

The image capture system above incorporates GPS, laser offsets, the appraisal land base, ortho imagery, and a video camera with a frame-grabber. Note the image to the right with the branded GPS coordinate, date, time and parcel ID.

Land Use Planning

Of importance in Rio Arriba County is the protection of the wetlands and alluvial soils along the Rio Grande, especially north of Espanola along a high-growth corridor to Taos. Georgia Valdez is responsible for addressing and Moises? Gonzalez is responsible for wetlands planning, and together, they are attempting to anticipate the growth of urbanization along the Rio Grande corridor. Key to all of their work is the parcel fabric on which the land use classifications are made.

Below is the land use and zoning map of Espanola being used to extend similar land use planning further up the Rio Grande.

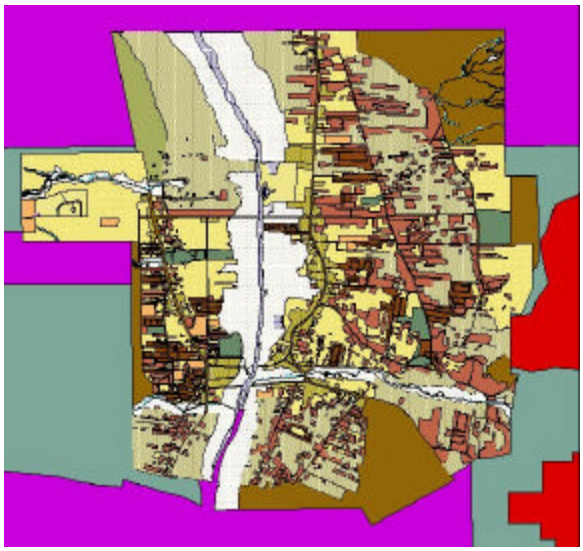

Figure 8: Espanola Land Use

Summary

SDR has found that it is straightforward and easy to integrate 9-1-1 data with appraisal data. The greatest integration task is the coordinate translation from one coordinate system to another. This integration can also include surveys, engineering plans, and be used for other GIS purposes such as solid waste transfer and land use planning.