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URISA

Defining the Boundaries of Practice Between Surveyors and GIS Professionals - Background with Recommendations

SYNOPSIS

Surveyors and GIS professionals each create, analyze, and draw conclusions from maps and associated data. While their respective skills and responsibilities are distinct, there is sufficient overlap to have caused some conflict as to which practices are appropriate to each profession. One might say the "boundary of their professional practices" is somewhat uncertain. Some states have defined the practice of surveying for which licensure is required so restrictively that operation of a public agency's GIS mandates supervision by a licensed surveyor. In some states, GIS professionals are using easily-operated GPS devices to capture the location of new elements for public agency maps - a practice traditionally reserved for licensed surveyors. This paper reviews the current definition of that professional boundary, and outlines some aspects that remain insufficiently precise. Good will and mutual respect have enabled these two professions to arrive at the current "boundary" definition, providing a model for renewed resolution of remaining uncertainties.

BACKGROUND

Surveyors and GIS professionals share common interests and concerns:

- They create and use map-related information
- They serve the public
- They are concerned for the health, safety and welfare of the public
- They share interest in technologies for location-based data
- They provide answers to questions that start with: "Where?"

Nevertheless, in the past, some members of each profession have looked at the other with suspicion, derived perhaps, from incomplete understanding of each profession's expertise.

Surveyors, who are legally responsible for protecting the public's health, safety, and welfare regarding authoritative map-based location, have observed problems caused by the improper use of GIS data by public officials, and also by private entities. For example:

- Using GIS maps and data to determine precise locations on the ground
- Using GIS maps and data without being aware of their quality:
  Accuracy
  Currency
  Data Source
  Method of Compilation
  (This information is referred to as metadata.)

GIS professionals have encountered impediments to their practice when services unique to their expertise, such as incorporating authoritative locational data and documents into referential GIS databases, have been required to come under the supervision of a licensed surveyor.

Currently, many surveyors are learning to use GIS to improve their work product efficiency. At the same time, GIS professionals are learning to use surveyors' tools to capture new map features, to estimate locational accuracy or to document the authoritative location of mapped features. Innovations in mapping technology, such as drone-based aerial photography, automatic photogrammetry, hand-held GPS geolocation, and GIS application templates, are enabling surveyors and GIS professionals to use each other's tools without having the deep technical knowledge that used to be prerequisite. This practice raises legitimate cause for concern about the legal status of maps and map-based analysis, and concern for public safety from decisions made using those maps.

EXPERTISE OF SURVEYORS AND GIS PROFESSIONALS

As the technology allows more overlap in the use of survey, mapping, and geoanalysis tools among professionals, it becomes ever more important to define and distinguish the specific expertise and roles of each profession's responsibility, in order to prevent these concerns from festering into severe problems. Each profession contributes a unique expertise to spatial data creation and to spatial analysis.

Surveyors' expertise includes:

- Measuring and recording the location of boundaries, fixed works and terrain
- Assessing and mitigating the locational errors in maps
- Producing authoritative (source) data/documents for the location of boundaries, monuments, reference points, fixed works, elevation, and the shape of the earth
- Interpreting cadastral law and practices

(Figures 1 and 2 help illustrate Surveyor creation of boundary map data. Figure 3 shows a Record of Survey.)

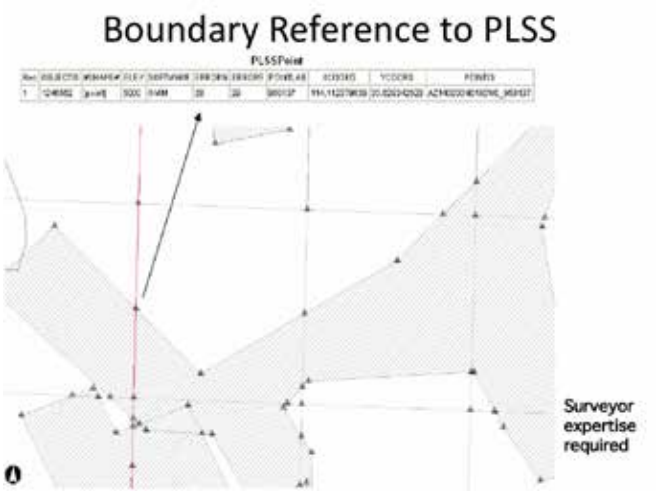

Figure 1

Figure 3

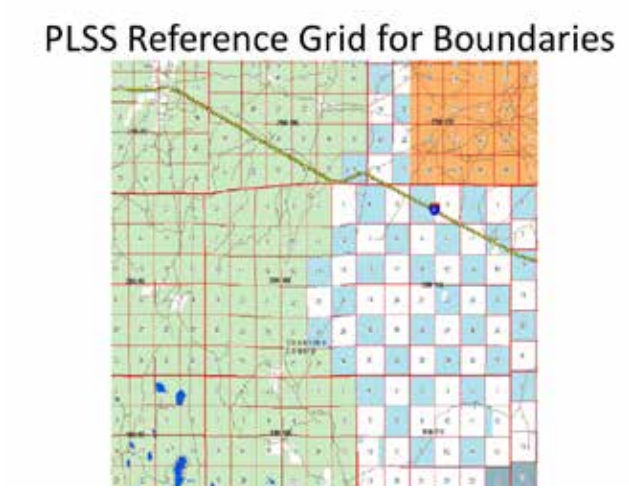

Figure 2

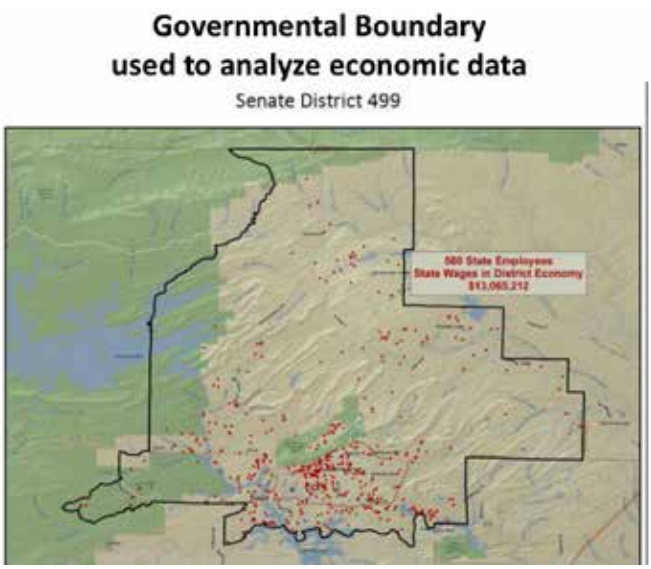

Figure 4

GIS professionals' expertise includes:

- Creating geospatial databases and software applications
- Analyzing the location and characteristics of mapped features
- Compiling and combining geographic data into new, map-based visualizations
- Developing new spatial data from analysis of multiple sources
- Managing GIS systems and operations

(Figures 4 and 5 illustrate referential use of authoritative map data.)

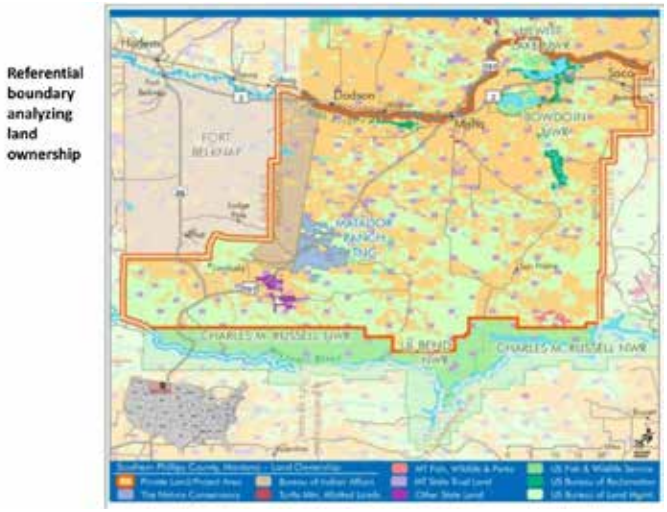

Figure 5

Definition of Land Surveying: State Law and NCEES Model Law

The short lists, above, are an informal summary of the two professions' respective expertise. But summary lists are not sufficient to define and codify what each professional practice should or should not do. A more explicit definition of the "boundary" between these two geospatial professional practices is needed. Actually, the practice of surveying already requires a state-issued license, so surveyor expertise is legally and explicitly defined. While each

state has its own legislated definition of "the practice of survey," most state's definitions generally follow the recommendations of the National Council of Examiners for Engineers and Surveyors (NCEES). This council is comprised of a representative from each state. The NCEES publishes and updates a Model Law and Model Rules that guide states' legislation that regulates the licensing of engineers and surveyors.[1]

To clarify the respective practices between surveyors and GIS professionals, a Multi-Organization Task Force (MOTF) met from 1999 through 2001 to recommended changes to the NCEES Model Law and Model Rules.[2] The Task Force recommendations derive from careful, professional analyses and deliberation by qualified representatives:

- 13 Months of negotiation
- 32 Task Force sessions
- over 650 hours of professional effort

The Task Force members analyzed, argued, and listened to each other, with mutual respect and a desire to find positive resolution. Clarifying new text, detailed below, was formally adopted by the NCEES in 2003.

The first modification to distinguish the practice of survey from GIS professional practice is a revision to the Model Law preamble:

> *The term "Practice of Surveying," as used in this Act, shall mean providing, or offering to provide, professional services using such sciences as mathematics, geodesy, and photogrammetry, and involving* **both** *(1) the making of geometric measurements and gathering related information pertaining to the physical or legal features of the earth, improvements on the earth, the space above, on, or below the earth* **and** *(2) providing, utilizing, or developing the same into survey products such as graphics, data, maps, plans, reports, descriptions, or projects. …*

[1] See http://www.ncees.org/ Model Law - The Model Law reflects best practices as determined by the NCEES member boards. It is a model for state practice legislation. https://ncees.org/wp-content/uploads/Model_Law_2017.pdf Relevant to this discussion is Section 110.2 (Definitions), B (Professional Surveyor), 4 (Practice of Surveying), page 4.

Model Rules - The Model Rules provides licensure boards with guidelines for engineering and surveying licensing laws and ethics. https://ncees.org/wp-content/uploads/ModelRules-2017.pdf Relevant to this discussion is Section 210.25 (Inclusions and Exclusions to the Practice of Surveying), pages 2 & 3

[2] The Task Force was comprised of these professional organizations:
ASPRS – Photogrammetry & Remote Sensing
ACSM – Survey & Mapping
ASCE – Civil Engineers
MAPPS – Photogrammetry & Mapping
NSGIC – State GIS Councils
NSPS – Professional Surveyors
URISA – GIS Professionals

Two words, emphasized in **bold** above, indicate that **both actions together** define the practice of survey: making original measurements, **and** using them for a survey product (or as discussed later, using them to define "authoritative location"). One can make original measurements (with GPS or with survey equipment) for purposes other than producing a "survey product" and not be classified as "practicing survey." Similarly, one can make maps or plans that are derived from the original measurements or survey products created by others, and not be classified as "practicing survey."

Following the Model Law's general definition of the "practice of surveying" for which state licensure is required, the Model Rules provide additional clarification of professional activities that are included, or excluded, in the definition. GIS professionals should be aware of these distinct activities so as not to find themselves "practicing survey" without a license.

Examples of Land Surveying Definition: NCEES Model Rules

Section 210.25 A of the Model Rules lists the following activities to be included within the "practice of surveying" that must be accomplished under the responsible charge of a licensed surveyor (excerpted, **emphasis added**):

1. The creation of maps and georeferenced databases **representing authoritative locations** for boundaries, the location of fixed works, or topography. ...where that data is provided as a **surveying deliverable**.
2. **Original data acquisition** ... when **used for the authoritative location** of: geodetic control, orthoimagery, elevation and hydrographic, fixed works, private and public boundaries, and cadastral information.
3. **Certification of positional accuracy of maps** or measured survey data.
4. Adjustment or authoritative interpretation of raw survey data.
5. **GIS-based parcel or cadastral mapping used for authoritative boundary definition** purposes wherein land title or development rights for individual parcels are, or may be, affected.
6. **Authoritative (legal) interpretation** of maps, deeds, or other **land title** documents.
7. Acquisition of field data required to **authoritatively position** fixed works or cadastral data relative to geodetic control.
8. Analysis, adjustment or transformation of cadastral data of the parcel layers with respect to the geodetic control layer within a GIS **resulting in the affirmation of positional accuracy**.

The subsequent section, 210.25 B, lists the activities that are not considered ("excluded from") the practice of surveying. This "Exclusions" section begins with the following summary paragraph (excerpted, **emphasis added**):

A **distinction** *must be made ... between making or documenting* **original measurements** *in the creation of survey products,* **versus** *the* **copying, interpretation, or representation** *of those measurements. Further, a* **distinction** *must be made* **according to the intent, use, or purpose** *of measurement products to* **determine a definitive location**, **versus** *the use of those products as a* **locational reference for planning, infrastructure management, and general information**. *The following activities are* **not** *to be included within the practice of surveying:*

1. The creation of **general maps** ... for use as **guides** to motorists, boaters, aviators, or pedestrians, ... **educational tools** or **reference** publications, ... **illustrative guides** to the geographic location of any event, ... **advertising** material.
2. The **transcription of previously georeferenced data into a GIS**, provided the data are **not** intended to **indicate** the **authoritative location** of property boundaries, the shape or contour of the earth, nor the precise location of fixed works.
3. The transcription of public record data into a GIS (for **tax maps** and associated records), provided the data are clearly **not** intended to **authoritatively represent property boundaries**.
4. The preparation of **any map document by any federal government agency** that does not define real property boundaries.
5. Incorporating documents or databases prepared by any Federal agency into a GIS.
6. **Inventory maps and databases** created by any organization ... of physical features, facilities, or infrastructure that are wholly contained within properties to which they have rights or for which they have **management responsibility**. The **distribution of these maps** and/or databases **outside the organization** must contain **appropriate metadata** describing, the **accuracy**, **method of compilation**, **data source(s)** and **date(s)**, and **disclaimers of use** indicating that the data are **not a survey deliverable**.
7. Maps and databases depicting the **distribution of natural resources prepared by** foresters, geologists, soil scientists, geophysicists, biologists, archeologists, historians, or other **persons qualified to document such data**.
8. Maps and georeferenced databases ... where the **access to that data is restricted by statute**. (e.g., law enforcement agency maps of crime stats, criminal activities).

Paragraphs 4 and 5 are necessary exclusions because activities of the federal government cannot be constrained by state laws (including the requirement that surveying tasks be conducted by state-licensed surveyors). Paragraph 6 recognizes that organizations such as water utilities have the right to manage (and map) their own infrastructure however they want to. They may be advised to engage licensed surveyors to measure and map their facilities, but they are not required to. Often, however, utility maps are made available to city governments or similar public agencies. To protect those agencies, and the general public, from possibly misusing those maps which may not have been created by a licensed surveyor, the maps are required to include appropriate metadata, as described in paragraph 6.

To recap, authoritative statements of locational position must be made by licensed surveyors when they include original measurements or observations that are used for:

- Legal (authoritative) documentation of location, or
- Assessments of the positional accuracy of maps.

Representative, referential maps and statements of locational position may be made by non-licensed persons, for example:

- Mapping infrastructure facilities for management, planning, maintenance
- Natural resource mapping
- Social and economic mapping

"Referential" means that the position of points, symbols, lines or polygons on the map are derived from authoritative documents, but are not themselves the authoritative description of **locational position**. However, they may be the authoritative description of **characteristic attributes** of the map points, lines, or polygons, for instance, ownership, zoning designation, material, diameter, etc.

Variations in State Law Definitions of Surveying

The NCEES Model Law and Rules are advisory. Each state enacts its own laws governing licensure of professional services, including surveyor services. Each state has a slightly different definition for "the practice of survey" and slightly different licensing procedures. As a result of state-by-state variance, some state licensing laws actually limit legitimate GIS activities (Figure 6):

- Colorado, Maryland, and Oklahoma limit the transfer of cadastral data into a GIS to licensed surveyors.
- Iowa, Mississippi, North Carolina, Florida, and South Carolina allow only a licensed surveyor to create, prepare, or modify GIS data (see endnote).

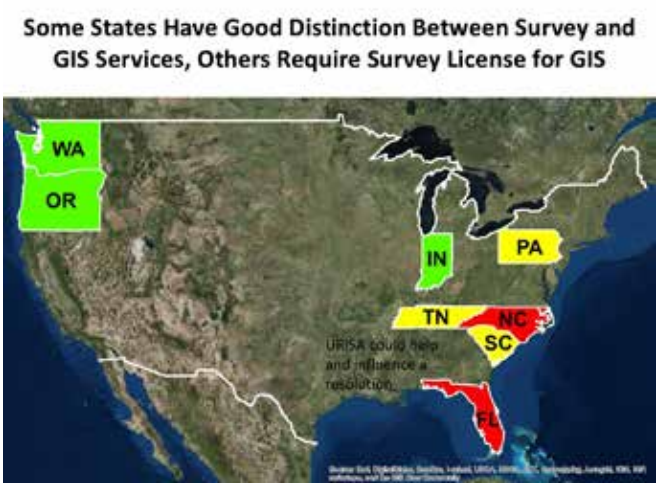

Figure 6

- Oregon and Indiana have endorsed the NCEES model law and written their state licensing requirements accordingly (see endnote).

What is the Definition of "Authoritative"?

The surveyors and legislators who advocated for state licensing laws that restrict legitimate activities of (non-licensed) GIS professionals possibly were motivated by a concern that public agency geodata could be used improperly by the general public. For example, if someone used the mapped boundary lines on a tax map to determine the legal boundary of a property parcel, they would be giving inappropriate credence to a non-authoritative data source. Tax maps are not the authoritative document for boundary location. The widespread accessibility of maps electronically, through GIS applications, increases the possibility that maps could be used for purposes beyond their actual accuracy, depiction, or currency. This could negatively impact public safety, health or welfare.

As the "Inclusion" section of the Model Rules uses the language, "original data acquisition ... when used for the authoritative location of … ," it is necessary to consider what "authoritative location" means. The NCEES doesn't specifically define it. Here are some suggestions:

Authoritative:

- Meeting clearly defined standards such as geospatial deliverables that have been sealed by a licensed or certified professional
- Being presented as trustworthy and competent when used to describe products, processes, applications, or resulting data
- Having legal standing in a court of law
- Authoritative Data can be officially certified and are provided by an entity that is designated by an authority to develop or manage such data for a specific business purpose.[3]

Authoritative Location:

- A location that can be relied on as the basis for making other determinations
- A location determined by a body with sufficient authority to require adherence to its determination of that location
- Location determined by a legal opinion or legislatively designated process
- Locational coordinates in a public agency's official record for an object's location (or position). (Other maps, or GIS databases, may use, display, or even modify those coordinates in **referential** maps, without "practicing survey without a license," because those maps would not be the document of record for the object's "authoritative location.")

Survey Products:

- Documents designated by a government authority as the descriptor of authoritative location (for cadastral boundaries, fixed works, topography)
- Data/Maps become authoritative and garner legal status when the government says they do, e.g., when they are adopted by ordinance

This is a contentious topic, so the original MOTF agreed to leave its meaning ambiguous until more specific language could be agreed upon. Perhaps another Multi-Organizational Task Force should be organized to finalize a specific definition. Caution is advised, however, because opening the question of defining "authoritative location" could reopen the entire issue of defining the boundary of professional practice.

Metadata, Intended Use, and Misuse of Maps

The intended use of a map as it is constructed governs whether the mapping activity requires supervision by a licensed surveyor. Is the map to be used for determining the authoritative location or is it referencing that location for other purposes? The "Exclusion" section of the Model Rules described whether a map-related activity requires surveying licensure, or not, according to the **intent or use** of the map product. If the map is used for the following purposes, then supervision by a licensed surveyor is required:

- Determining the authoritative location of real property boundaries or defining legal boundaries that involve taxation or delivery of public services (for instance, zoning, school districts, election precincts)
- Engineering design location of fixed works
- Locating elevation contours or shape of the earth for engineering design, land development, etc.
- Creating survey control and geodetic control
- Determining and certifying map accuracy

If the map is used for depicting general locational reference, or for planning and management, survey licensure is not required. For example:

Figure 7

[3] Oregon Geographic Information Council and Oregon GIS Program Leaders' report https://www.oregon.gov/geo/GPL%20Documents/AuthoritativeData_GPL_120815_rev3.pdf

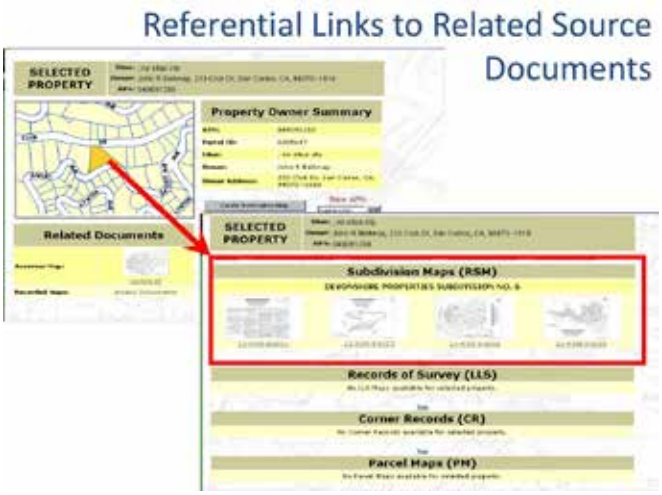

Figure 8. GIS referential maps should explicitly link to authoritative sources.

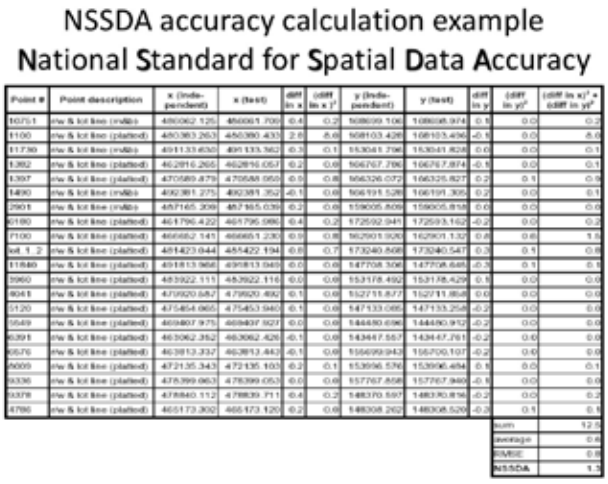

Figure 9

- Infrastructure inventory and maintenance
- Planning and analysis
- Environmental management
- Social, demographic, economic, tax maps (they identify parcels but do not determine the parcel boundary location)
- "Operational boundaries" used for internal management (for instance, police deployment areas, public works maintenance areas, public health clinic service areas) - See Figure 7: dispatch maps to guide fire department response.
- Guides, educational, advertising maps

A map's purpose (intended use) should determine when GIS professional services need to be under a licensed surveyor's supervision. The activities under the practice of surveying involve **making original observations and creating original, authoritative survey products**. The **reuse** of such source information by GIS professionals should **not** be designated as the practice of surveying.

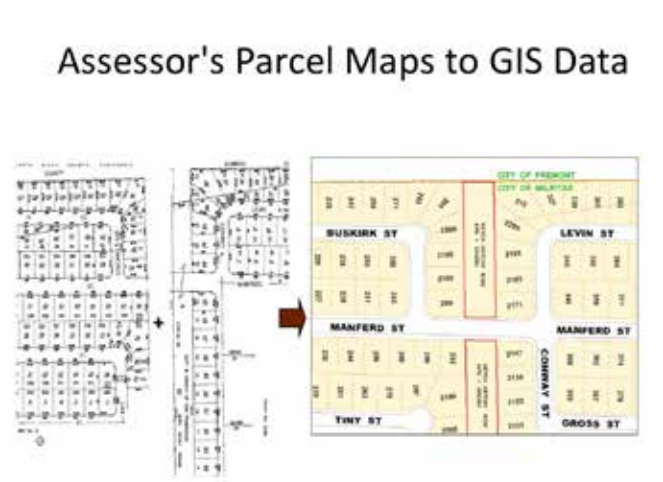

Figure 10. Assessor maps are not locationally authoritative, but do authoritatively identify land parcels.

In order to reduce the possibility of GIS maps being used improperly, GIS products, whether electronic or hard copy, ought to embed the following information:

- PURPOSE – Statement of the intent or purpose of the geographic representation
- REFERENCE – Explicit linkage to original, authoritative source documents (Figure 8)
- DISCLAIMER – "This map is NOT a professional survey product as defined by following sections of the (state) Business and Professions Codes ..."
- METADATA – Documentation of the quality of the map's data, including:
  - Locational Accuracy (and method used to determine the accuracy)
  - Date of Data Capture
  - Source Documents
  - Method of Compilation
  - Reference Ellipsoid
  - Projection
  - Coordinate System Zone
  - Measurement Unit (U.S. Survey Foot, International Foot)
  - Datum / Datum Tag
  - Epoch Date
  - Velocity Model used

Accuracy Does not Distinguish Survey Maps from GIS Maps

Sometimes, GIS map products are distinguished from surveying products by referring to a map's accuracy. This is erroneous. Both kinds of maps can be created with the same locational accuracy.

Figure 11. Land parcels can be adjusted to match orthophotography, however, the creation of the orthos should be supervised by a licensed surveyor.

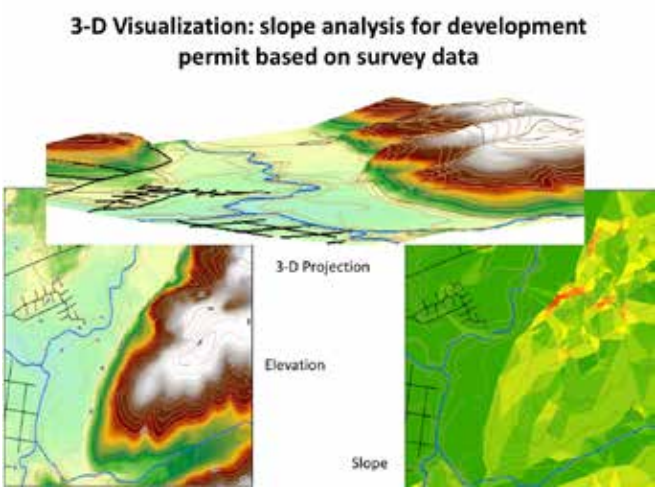

Figure 12. GIS visualization of elevation data.

And, in electronic form, both kinds of maps can be enlarged beyond their constructed accuracy, thereby appearing to be more accurate than they actually are. What is important is knowing the accuracy of a map.

Map accuracy depends upon the methods used and resources expended to build the map. How accurate should a map be? The purposes for which the map is to be used should set the requirements for map accuracy:

- Moderate - used for reference
- High - used for cadastre or engineering
- Maximum - used for control or geodesy

Determining a map's accuracy is a complex, technical process for which surveyors are educated and trained.[4] One particular difficulty is that different areas of a map may have different accuracy. Mitigating, or adjusting for the errors, is another specialized skill that surveyors learn. Neither of these skills is normally included in the GIS professional curriculum. Figure 9 illustrates how map accuracy is calculated.

We should be concerned with the language public agency GIS professionals use when discussing a boundary, or distance to a boundary, with a property owner (who may be concerned about a permit, variance or some such use restriction). Public officials, when referring to GIS spatial data should use phrases like:

"It appears that your property may be [included/excluded] from the [use restriction boundary]. To ascertain with certainty, you are advised to engage a licensed surveyor to make the actual measurements."

[4] See National Standards for Spatial Data Accuracy, FGDC-STD-007.3-1998. Geospatial Positioning Accuracy Standards. Part 3: *National Standard for Spatial Data Accuracy,* developed by the Federal Geographic Data Committee https://www.fgdc.gov/standards/projects/accuracy/part3/chapter3

Is GIS a Profession?

This question confuses two issues. GIS is a technology. Some people see it simply as software that can be used by anyone (for example Google maps), even if the user is not aware that the application is GIS! Others may see GIS as an integrated system comprised of software, data, database structure, and the professional skill to use these components effectively. A source of contention between surveyors and GIS professionals has been that licensed surveyors sometimes view non-licensed GIS professionals as "less than" full professionals. Are GIS professionals practicing a profession? Professions are generally defined by having the following characteristics:

- Specialized body of knowledge
- Defined mission
- Formal organization
- Common language
- Specialized training
- Culture and lore
- Code of ethics
- Licensing or certification of competency

According to these criteria, GIS is a profession, albeit a much newer one than surveying.

GIS professionals have the unique knowledge and experience to perform the following professional services:

- Compiling and combining authoritative map data into referential visualizations (Figures 10, 11)
- Geospatial needs analysis and business process analysis
- GIS application and interface design, testing, implementation
- Cartographic data visualization (Figure 12)
- Geographic database design (logical and physical)
- Spatial data modeling (database classification; construction

of connective data relationships including topology; management of a consistent internal spatial reference system)
- Geographic analysis (for example, SQL query and spatial query; buffer and overlay recombination; density and cluster analysis; spatial interaction analysis; cartographic modeling; spatial process analysis; surface analysis)
- Spatial data quality analysis
- GIS architecture and system engineering (hardware, software, network, peripheral and mobile devices and communications; web services; security architecture)
- GIS management, system administration, and data maintenance
- Geospatial standards and metadata creation and maintenance
- Geocomputational algorithms, models, agents, simulations
- Network analysis and location-allocation modeling
- Geospatial statistics

Authoritative and Referential Documents

The authoritative location for property boundaries is determined by agreement of adjacent property owners. That agreement may be arrived at through a judicial proceeding if other methods fail.

A hierarchy of evidentiary documents are used to inform adjacent property owners of the location of their common boundary. The most important documents include survey products such as Records of Survey, Corner Records, Subdivision and Tract Maps, Property Deeds, and the chain of reference to previous documents describing the boundaries and ownership of the subject land. Production of these documents (and interpretation with regard to determining the location of property boundaries) requires supervision by a licensed surveyor.

Most other depictions of property boundary lines are referential. Their depiction on a map has been interpreted from the original documents, but that map does not provide "determining evidence" of the boundaries. These maps (and GIS-based geodata) are intended for all the other purposes of geographic information, aside from locational determination. Referential maps should **not** require supervision of a licensed surveyor.

Land cover maps, for example, being used to indicate the areas set aside for environmental protection, typically are created by a professional with environmental expertise. They may define the boundary line of protected areas, either by field inspection, or by fiat (e.g., "1,000 feet from the average high water mark"). They should be depicted on a map as referential. If a property owner wanted to contest the boundary, he/she could hire a surveyor to determine whether the owner's property was actually inside or outside of that 1,000 foot buffer.]

CONCLUSION

GIS professionals should be aware of their specific state's legal definition of "the practice of surveying," which describes the activities that require state licensure. Although most states' laws derive from the NCEES Model Law, there is variation in how states incorporate the Model Rules. GIS professionals should also be aware of any proposed changes to their state's licensure laws that might impact their ability to practice GIS as they do currently. GIS professionals should engage with surveyors in their states, establish a dialog and share concerns so misunderstandings don't occur on either side. Hopefully, this document can assist that dialog.

By understanding the distinctive, yet complementary, services that surveyors and GIS professionals provide, both types of professionals can work together to ensure their work products are suitable for the intended purposes, and that they protect the public's health, safety and welfare. As non-licensed map makers, it is up to GIS professionals to ensure that their geodata and maps include the metadata information necessary for them to be used appropriately.

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