GIS: Essential Technology for Urban Growth Management:

Portland, Oregon Metropolitan Area

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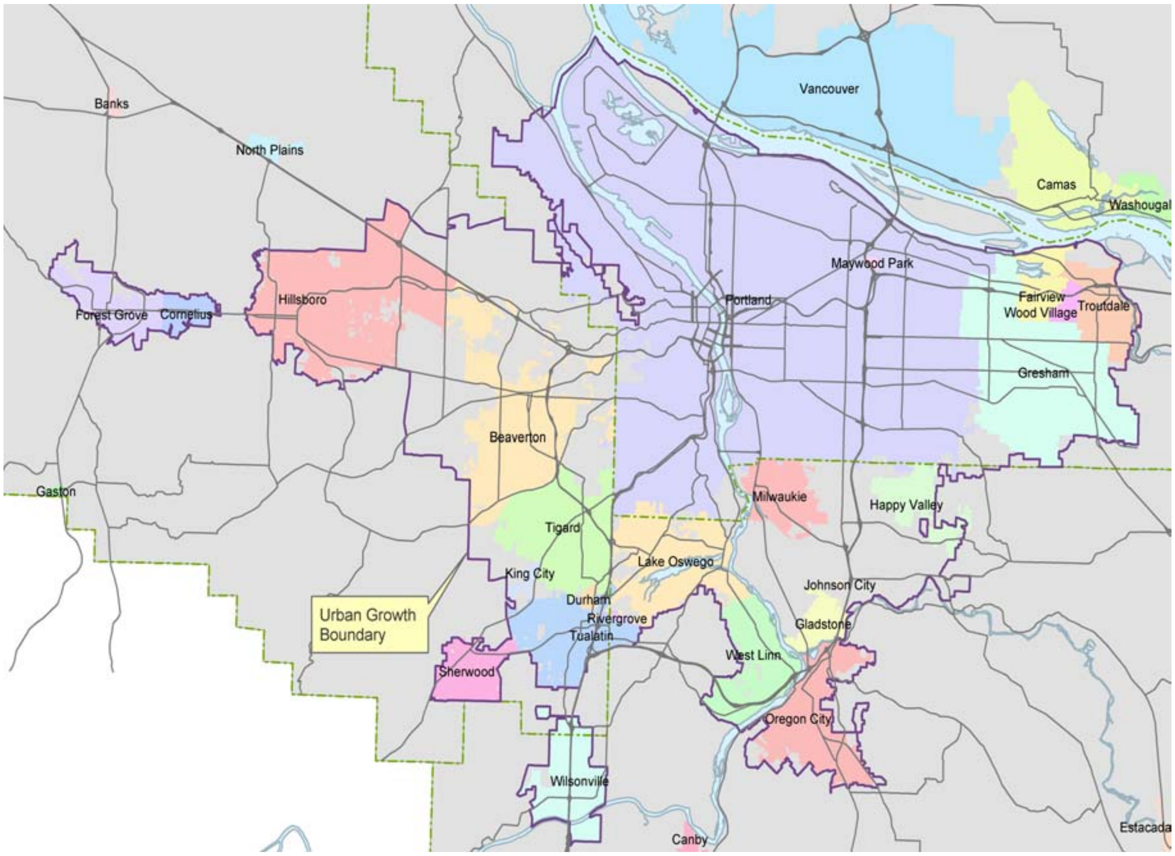
I. Introduction:

The Portland Metropolitan area has a full-featured GIS, available to a broad base of users. The Regional Land Information System (RLIS) has 150 subscribers, consisting of governments, non-profit advocacy groups and businesses. Each calendar quarter the most current data is distributed via CD ROM to its fee-paying subscribers. The product's database design, distribution model, consistency and integrity have contributed to its success and acceptance as the de facto GIS standard for the region. Following is a description of its development, a case study for successful implementation of a metropolitan scale GIS.



In 1988, Metro, the Portland metropolitan area's regional government, began development of RLIS, involving local governments and agencies, which over the years have developed in-house systems, using and expanding on Metro's GIS data model. RLIS was designed to be an urban planner's GIS, incorporating data essential for urban planning and growth management. It's region-wide usage for planning and environmental management provides consistent land information across jurisdictional boundaries for GIS programs in government and business, enabling data exchange and sharing of maintenance responsibilities.

II. Pilot Project:

Designing RLIS was a collaborative effort, involving regional, county and city planners. Their objective was to identify the data and functional requirements of a GIS supporting community and regional planning.

Before launching into full development, a pilot project was performed to test feasibility, identify data requirements, data availability, production methodologies, and estimate production man-hours. This was done in the spring of 1989, verifying feasibility and providing a production schedule.

The original project was estimated to require two years of in-house staff time for development of the 544 square mile GIS. By contracting with a consulting firm, development time was reduced by nearly a year, delivering an operational GIS on schedule in 1991.

III. Database Design- Building the Planners' Dream GIS

The first and primary task facing the design group was choosing a base map. For GIS this means defining the basic unit of measure (mother geography). Two measurement units were considered:

- Tax Lots
- Zonal polygons (e.g. Census tracts or traffic analysis zones- TAZ)

Regional planners preferred a zonal system as the least complex and costly. Conversely, local planners expressed their need for a tax lot based system. They were concerned that a larger unit, such as census tracts or block groups, would restrict use of the new GIS to broad area planning. Tax lot level acuity is often necessary for community scale planning, and linking tax lots to county assessor records in a GIS was highly desired. The group's decision to offer this capability later became a persuasive selling point, encouraging the financial participation of local governments in the RLIS project.

The primary reservation of regional planners with a tax lot base stemmed from its inherent complexity, large file sizes and cost of upkeep. They had been warned about the risks of such an ambitious GIS venture by a local university professor, who suggested considering a point-in-polygon system for linking tax lot records to a digital cadastral map, significantly reducing file size and the computational complexity of using tax lot topology.

In the end, the deciding factor was the need for local jurisdictions' financial support, who were willing to share the cost of a GIS, providing it fulfilled their needs. Therefore, since a tax lot based GIS met everyone's needs, the regional planners agreed to take on the daunting task of building such a complex system. Ultimately, this was fortunate, as Metro is now highly dependent on tax lot level acuity. For example, Metro's land use forecasting model, MetroScope, would not be feasible without spatially linked tax lot data.

The primary hurdle to developing a tax lot base was obtaining digital tax lot boundaries. Fortunately, the region's electrical utility, Portland General Electric (PGE), had recently digitized tax lots for its five county service area. Three of these counties were in the Portland metropolitan area. Clark County, Washington data became available for RLIS when the county developed a GIS in 1992.

PGE initially put a price tag on its tax lot layer that would consume 50% of the first year's RLIS budget (non-personnel). Several months were spent negotiating a quid pro quo arrangement, wherein Metro received PGE's CAD file (at no charge) in exchange for returning it in GIS format. PGE management realized the value added to their CAD system and, with Metro committed to quarterly updates, the cost of maintaining the land base in the three Portland counties would fall to Metro.

A contractor was selected for the CAD to GIS conversion and following a 16-month effort, a tax lot base for RLIS and PGE was born. A major portion of the conversion work involved assigning tax lot I. D. numbers to each polygon. These unique identifiers provided the spatial link to land appraisal and other linked records.

Each of the three counties, Washington, Clackamas and Multnomah, agreed to provide tabular tax assessment records. For the first few years, Metro did all tax lot line maintenance, monthly updating using assessment records. However, as the counties developed in-house GIS capabilities, they assumed responsibility for tax lot line maintenance. This transition is complete for two counties and Multnomah is expected take over tax lot maintenance in 2003.

Street and Address Map Base: In addition to the tax lot base map, planners needed the ability to match addresses to street centerlines and perform other functions requiring a street network. To fill that need, a base layer of streets and addresses was developed. The U.S. Census Bureau's 1990 TIGER line file served as the base for this project. Streets are now the alternate base layer in RLIS and are used for transportation, vehicle routing, thematic mapping, and display/analysis of zonal information such as census data and transportation information for TAZs.

Since its initial development, the streets/address layer is being continually improved, using data from state, regional, and local sources. Street address records from PGE meter service locations and 911 responders have aided in development of a master street address file. Currently, Metro is conducting a major upgrade to the file's accuracy, using a grant from the State Office of Emergency Management.

Selecting Overlays: Having selected the base maps for the foundation of RLIS, planners selected the following map overlays.

The primary RLIS data layers are:

- Tax lots
- Aerial photography
- Vacant land
- Developed land
- Land use
- Zoning
- Comprehensive plans
- Transportation (streets, rail roads, transit, bike routes, etc.)
- Parks and open space
- Rivers, streams, wetlands and watersheds
- Tree canopy and vegetative land cover
- Flood plains
- Steep slopes
- Soils

- Elevation contours
- Political boundaries (cities, schools, service districts, etc)
- Places (e.g. hospitals, fire stations, city halls, etc.)
- Building permit records
- U.S. Census

Since its launch in 1991, the number of RLIS layers has grown from 19 to more than 100. The current RLIS metadata can be viewed on the Web at: http://mazama.metro-region.org/metadata/.

Multi-jurisdictional Sharing of Development and Maintenance

Development of RLIS involved integrating data from the region's cities and counties into an integrated whole. A decade ago, the only data in digital format were the tax lot lines available from PGE. Local governments provided paper maps and Metro, with the assistance of a contractor, digitized them using the tax lot lines as the reference base.

Following digital conversion of the core RLIS layers, cooperative agreements were developed with local governments for development of ancillary layers and the ongoing maintenance of all layers. These agreements emerged from RLIS user gatherings, where the principal was developed that: *the agency bearing the greatest risk from errors in a particular layer, should have responsibility for its maintenance and accuracy.* For example, the property tax assessor is the logical maintainer of cadastral information and the planning departments of property zoning.

A Responsibility Matrix was negotiated and has become an informal contract, establishing each jurisdiction's role and responsibility for RLIS. For each layer, RLIS members are indicated as a <u>developer</u>, <u>maintainer</u> or <u>user</u>. Of course, a member can be included in all three categories, Metro being the primary example.

GIS Responsibility Matrix

Example Addressing a Subset of RLIS Layers

Jurisdiction	Tax lots	Aerial photos	Vacant Land	Developed Land	Land Use	Zoning	Comp Plans	Streets	Parks
Metro	**D/U**	**D/U**	**D/M/U**	**D/M/U**	**U**	**D/U**	**D/U**	**D/M/U**	**D/M/U**
Clackamas County	**M/U**	**U**	**U**	**U**	**D/M/U**	**M/U**	**M/U**	**M/U**	**U**
Multnomah County	**M/U**	**U**	**U**	**U**	**D/M/U**	**M/U**	**M/U**	**U**	**U**
Washington County	**M/U**	**U**	**U**	**U**	**D/M/U**	**M/U**	**M/U**	**U**	**U**
Clark County, WA	**D/M/U**	**U**	**U**	**U**	**D/M/U**	**M**	**M/U**	**D/M/U**	**U**
Portland	**M/U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**M/U**	**U**
Tri_Met	**U**	**U**	**U**	**U**	**U**	**U**	**U**	**U**	**U**
Beaverton	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Hillsboro	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Forest Grove	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Tigard	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Tualatin	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Wilsonville	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Lake Oswego	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Oregon City	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**M/U**	**U**
Milwaukie	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**U**	**U**
Gresham	**U**	**U**	**U**	**U**	**U**	**M/U**	**M/U**	**M/U**	**U**
Port of Portland	**U**	**U**	**U**	**U**	**U**	**U**	**U**	**U**	**U**

D = Developer **M** = Maintainer **U** = User

Vacant Land- The Essential Growth Management Layer

Because the primary purpose for RLIS is monitoring land development and future growth capacity, accurate measurement of available land was tantamount to success. The procedure for this annual inventory of vacant land is summarized below.

Developing the Vacant Land Inventory

Aerial photography is the primary source for identifying vacant land. Each year Metro purchases true color digital ortho-rectified[1] aerial photography for the region. Aerial photography interpretation was first used by Metro in 1991 to develop an inventory of vacant land, using 1.2-FTE person hours. The inventory is updated annually, using current building permit records and aerial photos. Developing the inventory required inspecting each photograph, overlain with the half-million tax lots within the Portland metropolitan area. Each year two GIS technicians spend two months updating the inventory. The interpretive decisions they make are rule-based and intentionally limited in order to control any bias they might introduce. They must only determine whether a tax lot is *vacant* or *partly vacant* or *developed.* No consideration is given at this point to suitability for building, zoning, redevelopment potential, or any other criteria. These determinations are made in subsequent steps in the production of the buildable lands database. The inventory is an annual development snapshot using July photography. It is not updated between annual aerial flights.

[1] Ortho-rectification provides a three dimensional correction of the photography so that the photo is "draped" over the landscape, providing improved registration of the photos to the ground and to other GIS layers.

Metro's Vacant Land Definitions

Each tax lot has one of four attributes: vacant, partially vacant, under development or developed.

1) Vacant tax lots have no structures, appreciable improvements or identifiable land use.
2) Developed lots have improvements and specific land uses. For example, a paved parking lot is developed but an unpaved lot is vacant, even though some equipment may appear to be stored there.
3) Partially developed lots have 1/2 acre or greater of vacant contiguous area. The vacant portion is added to the vacant land database
4) Lots under site development in an initial stage of development (such as road grading and earth movement), but development is substantially incomplete and they are therefore considered vacant.

- Parks and open spaces are treated as developed, being unavailable for development.
- At this stage, no consideration is given to whether the land is buildable. That is, environmentally constrained from development, due to hazards or protective regulations.

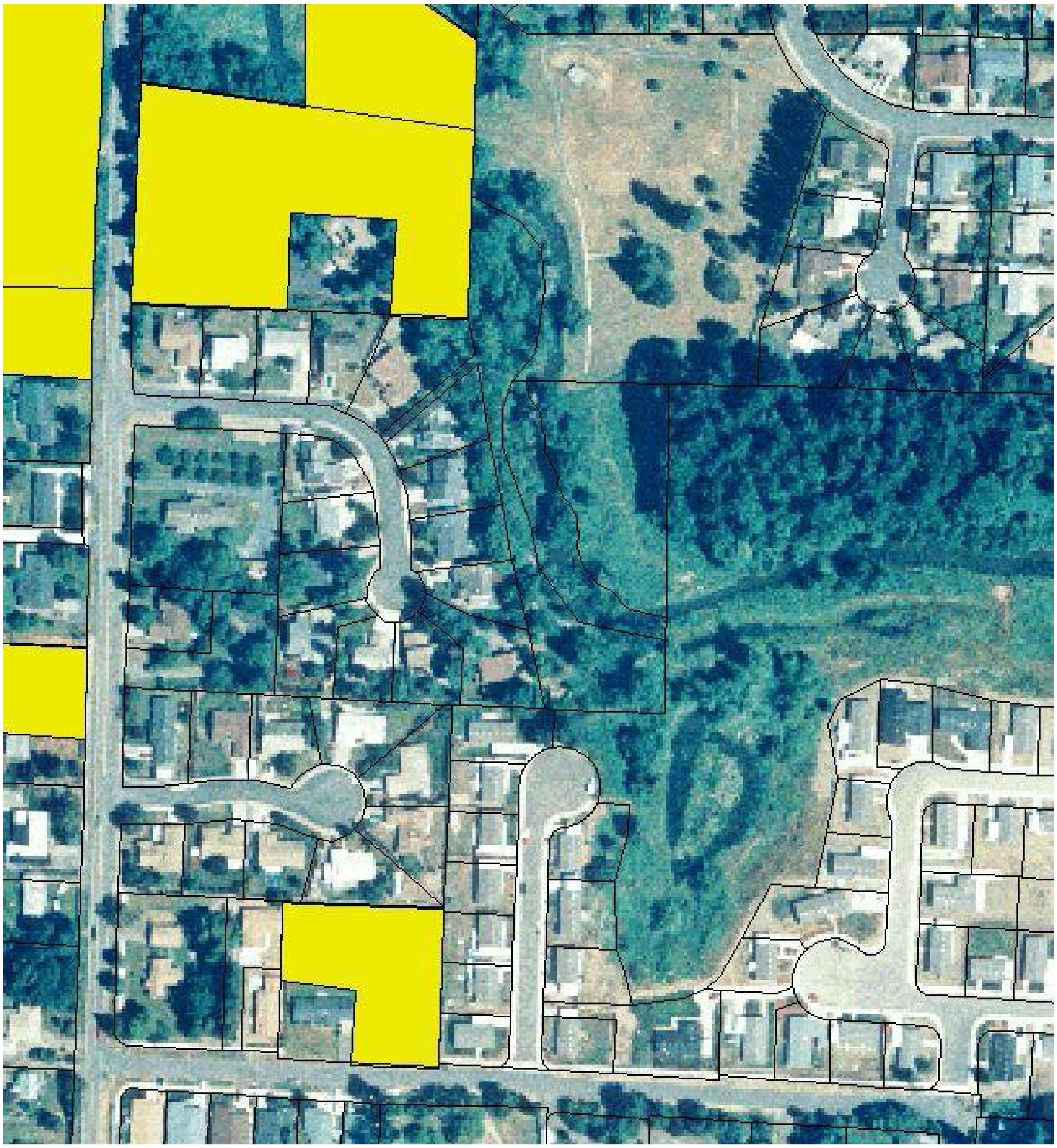
These rules have remained unchanged for the 11 years Metro has been monitoring vacant land with the GIS.

Metro's purpose for the vacant land data is to determine the amount of vacant land available for development inside the UGB. The tax lot level inventory is the most disaggregate form of the data and is later combined with other GIS data to produce the final buildable lands supply available to the planners.

The Half-acre Rule for Partially Developed Lots

Because many developed lots have vacant land remaining to accommodate further development, a method for identifying partially developed lots was devised. To assure that the remaining vacant land was of adequate size to actually support further development, the “half-acre rule” was adopted. Examining these parcels led to the conclusion that one-half acre was the logical and practical minimum for addition to the inventory. The following illustration shows the application of this rule to partially developed lots with more than ½ acre of remaining vacant land.

Example of Partially Developed Lots



However, it was recognized that areas of less than one half acre could support development. Therefore, to reconcile this under-count potential, Metro has conducted supplemental in-fill surveys of residential and non-residential lots. A projected rate of in-fill development is now factored into growth capacity calculations.

Maintaining the Vacant Land Inventory

Building Permits

Building permits used in the vacant land study are limited to new construction over $50,000 to exclude permits for remodels and alterations. The permits are mapped as indicators, but are not totally reliable in pinpointing every newly developed lot. Therefore, close scrutiny of the aerials is necessary to identify every lot developed since the previous year's inventory.

Migrating to More Accurate GIS Data

Metro's policy is to regularly update the GIS data and incorporate data improvements available from local governments. For example, the positional accuracy of the tax lot and street base maps are being systematically improved by local governments, as digital spatial data becomes more integrated into their business operations. This integration is greatest in public works, tax assessment and planning departments. GIS layers are also being improved over time; for example, in 1996 the parks and open spaces inventory was updated, adding some 2,000 acres to the parks database and simultaneously deducted it from the vacant lands inventory.[2]

Users of Vacant Land Data

The vacant land inventory has moved beyond its original purpose, monitoring land supply for urban development, and has gained a broader user base in the

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[2] The majority of this change resulted from Metro's purchase of open spaces, enabled by a $135,000,000 bond measure approved by the voters within Metro's jurisdiction.

community. Local governments and real estate developers are the two largest user groups. Cities and counties have incorporated the data into their planning information database and developers use the vacant lands inventory to find land available for construction. Other users include environmental groups, neighborhood associations and sundry organizations that benefit from vacant land information.

IV. GIS: The Engine for Metro's Land Use Modeling Program

Ultimately, the true value of an information system with the complexity and scope of RLIS is realized in its role in modeling applications.   A land information system can be used as a *descriptive* tool – allowing a detailed picture of the landscape at a given time; and, if structured correctly, can provide insight into change over time. RLIS is now moving into a *prescriptive* role as a critical part of Meto's growth simulation model: MetroScope

RLIS has enabled development of an integrated land use/transportation urban activity simulation model (MetroScope). RLIS and MetroScope are proven tools for addressing Metro's Chartered and state mandated responsibilities for the region's urban growth boundary (UGB).

MetroScope integrates four models and RLIS land information to simulate future land development/redevelopment. Visual representations of model outputs are produced through the linkage to RLIS. The four models that interact within the MetroScope framework are:

The **GIS database and tools** contain the land and development data inputs and maintain the spatial relationships between data elements.
The **economic model** predicts region-wide employment by industry and the number of households in the region by demographic category.
The **travel model** predicts travel by mode (bus, rail, car, walk, or bike), road counts and travel times.

The tandem **real estate location models** for residential and non-residential location predict the locations of households and employment; also the amount of land to be consumed by development, the amount of built space produced, and the prices of land and built space by zone in each five-year incremental iteration.

MetroScope allows the testing of a wide range of growth management policy scenarios. The model's primary inputs are:

- **Land Availability and Capacity**, including zoning and plan designations, environmental constraints, and the parameters to identify land that will be developed. **RLIS** is the primary source for these model inputs
- **Cost of Development**, including specifications of cost per square foot to build.
- Assumptions about **changes in demographics** (income, age, and household size) which are applied through the economic model, as well as assumptions about **changes in employment** (by industrial sector).
- Assumptions about **changes in transportation infrastructure and transit availability** are applied through the travel model.

Metro is currently using the land information in RLIS and MetroScope policy scenario simulations to determine the amount of land required to accommodate the next 20 years of growth and where to expand the UGB. Six policy scenarios have been developed and modeled for input into the decision making process.

V. Conclusion

RLIS has proven to be a successful and highly useful product. Its envisioned purpose as a region-wide information system for planning and growth management has been met and exceeded, providing capabilities not originally contemplated. In 1997 the system was privileged to be selected from a national and international field of candidates to receive ESRI's exemplary GIS award.

Some project success factors include:

- The emergence of robust GIS software in the '80s: ESRI's Arc/Info GIS.
- Availability of digital tax lot lines from the region's electric utility- PGE (Portland General Electric).
- Region-wide GIS standards were established early on and subsequently adopted by local jurisdictions and other RLIS users.
- Cooperative data sharing with local governments from the beginning.
- Metro's role as a regional government to coordinate development of regionally consistent land information and transportation modeling.
- State mandated local government funding for Metro's growth management program until 1993.
- State mandated regulatory responsibilities, requiring comprehensive land information and mapping capabilities.
- A suburban/urban political partnership addressing growth management and transportation planning.
- Passage of state legislation allowing market pricing for RLIS products to partially offset maintenance costs.