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REMOTE SENSING DATA: APPLICATIONS AND BENEFITS

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The Denver Regional Council of Governments (DRCOG) is a member-driven Council of Governments comprised of 55 county and municipal governments from across the greater Denver (Colorado) area. In its sixth decade of service, DRCOG is proud of its collaborative approach to protecting and enhancing the quality-of-life that make our region such an attractive place to live, work and play. Specific focus areas include mobility, service to older adults, environmental quality, planning for the future, public safety, and the provision of high-quality information for sound decision-making.

DRCOG has statutory responsibilities under both State and Federal law to plan for the region's future, particularly its transportation infrastructure and overall growth and development. The signature product of this process, *Metro Vision*, embodies the collective vision of our member governments for the region and provides policies to guide where, when, and how much growth will occur across the region.

DRCOG's stewardship of this regional planning process has garnered many national awards and attracted international attention. We are rightly recognized as a world leader in collaborative, "bottom-up" regional planning.

A hallmark of our regional planning process is the timely, accurate and objective data that informs all of the visionary policies embedded in *Metro Vision*. Geospatial data – information about the physical, social and economic make up of our region – is vital to this process.

DRCOG is a major producer and consumer of geospatial data, large volumes of which derive from remote sensing (RS) technologies. DRCOG is therefore appreciative of the Committee's interest in the role of remote sensing data in regional planning, and grateful for the opportunity to present our views on both the opportunities and impediments to making the information derived from RS technologies more broadly available.

REMOTE SENSING DATA USE IN DENVER METRO REGION

Federal investment in research and development has and continues to be a significant driver in the growth and expansion of the nation's geospatial information industry. DRCOG and its member governments leverage this investment in significant ways on a daily basis. We manage our urban environment, monitor the quality of our natural resources, plan for the future, and make informed choices about where to invest our scarce resources all with the help of data derived from remote sensing technologies.

Across the Denver metro area and the state of Colorado as a whole, local, regional and state agencies have come to rely on data derived from three general types of remote-sensing technologies:

- Aircraft-based aerial photography
- Multi-spectral data
- LIDAR and related technologies

AERIAL PHOTOGRAPHY

DRCOG and our member communities have relied on film-based aerial photography for many decades. High-quality orthophotography provides local communities with spatially accurate, distortion free base data layers critical to all of their planning, public safety and governmental management functions.

Since 2002, DRCOG has led a successful consortium of public and private participants to jointly acquire high-quality digital aerial photography for the DRCOG region, exploiting the collective buying power of 30 individual organizations. We repeated the effort in 2004 and 2006. and planes are currently in the air collecting 2008 imagery. This year, the project expanded well beyond the territorial limits of the DRCOG member region, allowing our neighbors in Weld and Grand Counties to also benefit from this joint purchasing power.

The benefits to our member governments and all the other public and private sector participants are very tangible. High-quality, high-resolution digital orthophotography of the type we're collecting typically cost $100-$150 per square mile. By contrast, the average cost for participants in the 2006 project was a mere $11 per square mile. The average cost for DRCOG members was less than $1 per square mile.

Colorado has a great tradition of this type of grass-roots, collaborative, goal-focused effort. DRCOG's public-private consortium model is mirrored in the Colorado Springs area, the emerging nine-county (15,200-square-mile) Sangre de Cristo Regional GIS Cooperative, and in the communities on the Western Slope.

Recently, the State of Colorado acquired statewide aerial photography under the auspices of the US Department of Agriculture's National Agriculture Imagery Program (NAIP). This program allows state and local entities to leverage regular aerial photography acquisition efforts by the USDA to obtain statewide photography for a fraction of the total cost. Colorado was able to take advantage of this effort in 2005 resulting in the first complete coverage of the entire state all acquired at one time. The

State would never have been able to afford this photography if not for the NAIP program. The data is now used widely by numerous federal, state and local entities, as well as the private sector and universities.

MULTI-SPECTRAL IMAGERY

The broad availability of space-based multi-spectral sensors (MSS) in the 1970s and 1980s extended and enhanced the functionality of traditional aerial photography, providing local, regional and state-level planners with a cost-effective way to analyze and map critical environmental processes across large geographic areas. Multi-spectral imagery offers a number of data products from across the electro-magnetic spectrum providing information that is imperceptible to the naked eye.

Many communities across the DRCOG region now utilize Color-Infrared (CIR) imagery, for example, to map impervious surfaces and monitor surface runoff and downstream water quality. CIR data also plays a key role in both the tactical and strategic aspects of wildfire management across the region. Douglas County, for example, recently acquired LANDSAT 5 data for mapping vegetation and modeling fuel loads in the Pike National Forest and other heavily vegetated parts of the county. Other cities and counties across the region have similar mapping programs.

Broader applications of MSS-derived data include mapping the massive Pine Beetle infestation in our mountain counties.

LIDAR AND RELATED TECHNOLOGIES

Light Detection and Ranging (LIDAR) and other related ranging technologies (Interferometric Synthetic Aperture Radar – IFSAR – for example) are becoming increasingly important to communities up and down the Front Range as acquisition costs decrease and data from these sensors become more widely available.

LIDAR provides an extremely cost-effective method for collecting detailed and highly accurate terrain information. This data then feeds into a range of sophisticated modeling processes that allow communities to more accurately map not only ground features within their communities, but also key anthropogenic structures such as buildings, bridges, dams etc.

This information provides the foundation for the construction of three-dimensional models of cities that are now widely used in land use and transportation planning, emergency response tactical plans, and as aids in community involvement and visioning efforts.

Specific examples of LIDAR use in the Denver region include security planning around the upcoming Democratic National Convention. Working with several of DRCOG's member governments, the US Geological Survey is currently acquiring LIDAR data on behalf of the National Geospatial-Intelligence Agency (NGA). The NGA will use LIDAR to identify line-of-sight and other tactical vantage points to plan their surveillance and response strategies to ensure the safety of all those attending the convention.

Several of DRCOG's larger member governments have acquired LIDAR in support of their planning and public works programs. The City and County of Broomfield, for example, is using LIDAR data in planning the development of a new reservoir. They also rely on the data for initial assessment of new roads and trail systems and for understanding the runoff and drainage implications of planned developments. LIDAR is also playing an important role in the modernization of flood insurance mapping across the state.

CHALLENGES AND IMPEDIMENTS

Although the use of data from remote-sensing technologies continues to grow across the DRCOG region, there are a number of structural and logistical impediments that both undermine our ability to use the existing data products, and limit our ability to integrate other RS data into current planning efforts.

Cost remains a significant challenge. The price tag for the 2008 DRCOG aerial photography project is over $1 million, in a climate of little to no revenue growth among the participating jurisdictions. This price reflects the combined purchasing power of 30 public and private sector partners working to acquire this data collaboratively. Market rates for digital orthophotography continue to increase despite the emergence of new capture and processing technologies (direct digital capture; automation, off-shore processing etc.). Pricing of commercial satellite-based imagery remains similarly high, relative to the data budgets of most cities and counties.

High costs mean local, regional and state entities can acquire this data less frequently than they require. Our imagery program struggles to keep pace with the rapid growth of the nine-county region, but can only afford to acquire new data every two years. DRCOG estimates that our region adds on average about 100,000 new people, 65,000 new jobs and nearly 30 square miles of new development in any given two-year cycle. Understanding and managing this growth with out-of-date imagery is a significant problem for both the staffs and elected officials of DRCOG's member governments.

"Solving" this impediment is unrealistic expectation. The experience from Colorado is that communities working together, collaboratively, can bring their collective buying power to the commercial marketplace and reap significant savings over the cost of going it alone. This ground-up approach remains the most realistic solution to cost containment at this time, at least in the Colorado context. The only request that I would put to the Committee is to continue to fund the various federal programs – most notably the National Map program led by the USGS and the National Agriculture Imagery Program led by the USDA – that allow federal agencies to collaborate with local partners to secure geospatial data all across the country.

A second impediment is the challenge associated with the sheer volume of remotely-sensed data that is now available. The estimated volume of data from DRCOG's 2008 aerial photography acquisition, for example, is over 10 terabytes. Few of our member governments have the internal capacity to store and maintain all of this data. The problem compounds with each new project, as part of the value of remote-sensed data lies in the ability to review multiple years of data at the same time (comparing changes over time).

Another dimension of this problem is the effort associated with distributing data. While Internet bandwidth continues to improve, online distribution of the large data sets associated with most remote sensing technologies remains impractical.

Fortunately, new models of data distribution are starting to emerge that facilitate the distributed storage and distribution of large geospatial data sets. Data throughput under these models is greatly reduced, pushing only the needed geographic window down to the end user, rather than distributing the entire geographic data file.

Examples of this model exist in both the public and private sector. Several Colorado firms have established a national presence in this realm – DigitalGlobe in Longmont, CO, Intrasearch Inc in Englewood CO, and Sanborn Map Company here in Colorado Springs. On the public sector side, Federal agencies are playing a lead role. The USDA maintains its “Data Gateway”, the USGS has a long history using the Internet for data distribution, and the “e-government” initiatives sponsored by the Federal Office of Management and Budget (OMB) lead to the establishment of the “Geospatial One-stop” portal.

Federal investment in research and development provided the initial impetus for the evolution of the Internet and Federal agencies continue to lead by example in their innovative use of this infrastructure to distribute the tremendous wealth of geospatial information we now possess. I urge members of the committee to recognize the important leadership role of the federal government in this realm and continue to support those federal programs that are augmenting the data distribution services of the private sector.

My final comment in the area of impediments is of a technical nature. Like all technologies, remote sensing data applies better to some applications than others. Traditional multi-spectral technologies have tended to provide very broad-acre imagery that works well at a strategic planning level, but typically falls short when used for more tactical, response-type planning. This is particularly true in the area of wildfire management. Whereas the existing satellite imagery in the public domain provides useful input into fuel load modeling for understanding the threat of wildfires across our region, the resolution of the available imagery renders it unusable in emergency response situations. Commercially available data provides better resolution, but at a price that is often beyond the means of the typical fire protection districts that serve DRCOG’s mountain communities.

OTHER DESIRED PRODUCTS AND SERVICES

On behalf of my peers across the DRCOG region and the state of Colorado, I wish to acknowledge the continued leadership of the federal government in the acquisition and dissemination of remote sensing data. I hope that the Committee now sees how local and regional governments leverage this federal investment every day in providing better, more efficient government to all our citizens.

DRCOG and its members have shown that local governments can realize significant cost-savings when communities band together to jointly acquire remote sensing data. This type of collaborative endeavor is not limited to the local or regional scale. With that

in mind, I would like to suggest two other areas where greater federal engagement would significantly enhance the accessibility of remote sensing data to all levels of government.

First, recognizing the vast data libraries and the ongoing acquisition activities of the federal government, local and regional governments across the country have much to gain from greater access to these federal resources. Part of the solution is a policy decision to make the data more broadly available. The other part is continued support for the innovative data distribution strategies that we are seeing from key federal agencies like the USGS and USDA.

Second, following the collaborative models that we see across the state of Colorado, I would urge the federal government to allow local and regional governments to leverage the tremendous purchasing power of the federal government in the commercial remote sensing data marketplace. This industry continues to grow and is a vital part of our economy, particularly so in the Denver region. However, many of the vital data products sold in the commercial marketplace are simply out of reach of the small public-sector entities that would benefit most from these products. Allowing these entities to work through federal agencies (and their purchasing programs) to acquire commercial imagery would realize significant benefits at the local level.

BIOGRAPHY

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Dr. Montagu is the Director of the Customer Resource and Support Division with the Denver Regional Council of Governments. This division is one of five core divisions within DRCOG and is responsible for the production and dissemination of the geospatial, socioeconomic and travel modeling information produced by DRCOG. The division also oversees the production of the “Growth and Development” part of *Metro Vision*, the long-range strategic plan for the Denver metropolitan area.

In his seven years with DRCOG, Dr. Montagu has served as Geographic Information Systems Coordinator and Regional Information and Research Manager. Prior to DRCOG, Simon was an Assistant Professor in the Department of Geography at Miami University in Oxford OH, where he taught classes in GIS and Urban and Regional Planning.

Dr Montagu holds a PhD in Regional Planning from the University of Illinois at Urbana-Champaign and undergraduate degrees in environmental science and natural resource management from Griffith University in Australia. He has over 20 years experience in the geospatial information technologies realm and has worked in a number of capacities across the United States, Australia, and the South Pacific.