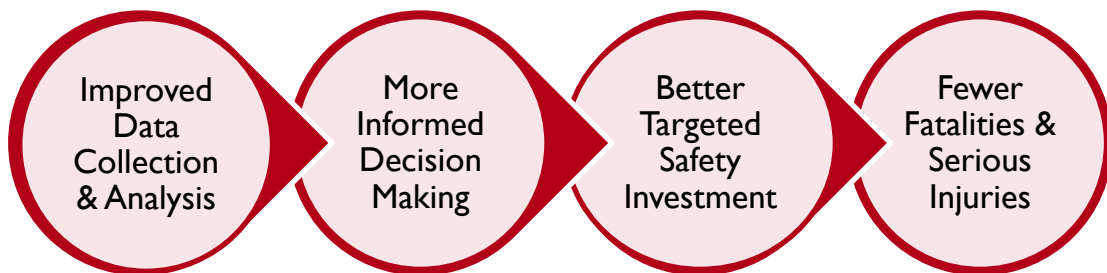# UTAH'S AND KENTUCKY' S INNOVATIVE USE OF GIS-BASED TOOLS

STRATEGIES FOR USING GIS TO ADVANCE HIGHWAY SAFETY

CASE STUDY

FHWA-SA-16-028

Prepared for

Federal Highway Administration

Office of Safety

Improved Data Collection & Analysis → More Informed Decision Making → Better Targeted Safety Investment → Fewer Fatalities & Serious Injuries

September 2016

CASE STUDY OVERVIEW

OBJECTIVE

The objective of this case study is to illustrate Kentucky and Utah DOTs effective use of usRAP and UPlan, respectively. Both programs include data collection, and analysis methods that facilitate highway safety improvements.

BACKGROUND

The United States Road Assessment Program (usRAP) is a tool transportation agencies can use to rate their roadways for safety and identify strategies for systematic improvement.[1] UPlan is an interactive mapping platform that helps the Utah DOT (UDOT) visualize its data, track its assets, and strengthen its transportation planning through "better analysis and collaborative information." UPlan's *Zero Fatalities* safety component presents UDOT's Safety and Crash Analysis, which is predicated on the mapping and road-rating tools first developed by usRAP.[3] usRAP and UPlan safety components both employ similar general processes and have the same objective: to increase safety by understanding and mitigating crash risks and roadside hazards.

At the core of usRAP is a focus on risk assessment to identify practical solutions to roadway safety problems. usRAP uses crash and roadway data to map relative road risk using a number of standardized protocols. A roadway network is systematically divided into segments for data analysis and presentation of results. Attributes of each segment are used to quantify fatal and serious injury crash risk. Color-coded risk maps summarize the findings.[1,10]

UDOT developed UPlan as part of an AASHTO Innovation Initiative. According to AASHTO:

> UPlan is a powerful, yet easy-to-use web-based decision-support mapping and informational tool for completing complex planning and project development tasks. It allows complete or selective data sharing among various work units within the state DOT. It also allows selective data sharing between state DOTs and with the public.
>
> — *AASHTO Innovation Initiative (AASHTO 2016)[3]*

UPlan is a comprehensive infrastructure-management system that relies extensively on geospatial data. DOTs can use these available data to make safety, pavement, and roadway asset management decisions. In Utah, UPlan uses data-collection methods, such as LiDAR, digital imaging, workstation, and ArcGIS records to cover 5,845 centerline miles and 310 miles of ramps and collectors on State-maintained roads. Several government entities jointly performed the data collection, and each agency can use its products.[5]

UPlan deploys usRAP protocols for risk mapping and has customized these protocols to provide the following maps and data for the measures below, which are also available to the general public:

- Safety index

- Crash rate score

- Severe crash rate score

- Crashes per mile score

- Severe crashes per mile score

UPlan also provides Safety State Transportation Improvement Plan mapping and data. UPlan provides a model that other States can use to develop improvement priorities and significantly reduce highway crashes.[5,9]

The primary purposes of usRAP are to:

- Reduce the severity of crashes on U.S. roads through a program of systematic risk assessment that identifies roads where practical improvement measures can increase safety.

- Ensure that risk assessment lies at the heart of strategic decisions regarding route improvements, crash protection, and route management standards.

- Help agencies update design standards to ensure that future planning and design reduces roadway risk.[4]

Similarly, the primary objective of UPlan is to:

- Collect data to make informed decisions about roadway assets.[5]

Both programs' objectives are to improve road safety through wise investment in preventative measures. Highway agencies and individual road users will benefit from the information that the programs provide.

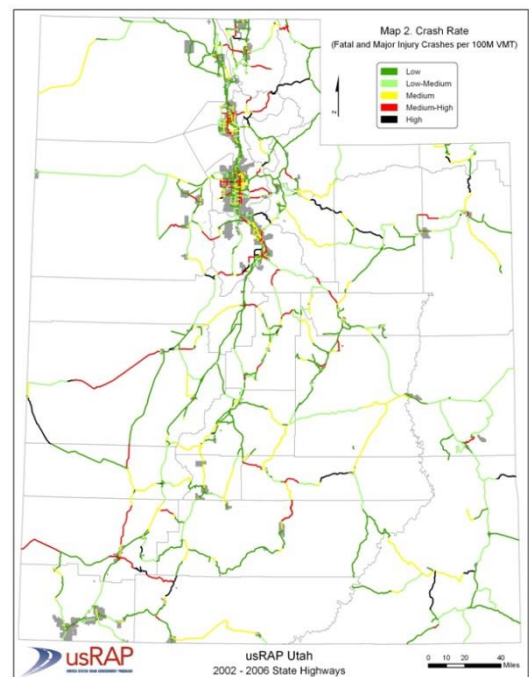The key products of the usRAP program are risk maps, star ratings based on road-protection scores,

Figure 1: Crash rate map from usRAP Web site

and Safer Roads Investment Plans (SRIPs). UPlan's safety components focus on various risk mapping and data sets, as well as additional information provided to the public about Utah safety initiatives.[,5,7]

usRAP maps present four risk measures based on observed crash history. The program calculates each measure for the road segments, which are classified into five risk categories, and displays color-coded risk maps.[1,2] The four risk measures and their corresponding maps are:

- **Map 1**. Fatal and serious injury crashes per mile of road.

- **Map 2**. Fatal and serious injury crashes per hundred million vehicle miles of travel.

- **Map 3**. Ratio of fatal and serious injury crash rates per hundred million vehicle miles of travel to the average crash rate for similar roads.

- **Map 4**. Potential number of fatal and serious injury crashes saved per mile in 5 years if crash rates per hundred million vehicle miles were reduced to the average crash rate for similar roads.[1]

UPlan uses usRAP's star ratings, which are a measure to indicate the level of safety built into a road. One-star roads have the least number of safety-related design and traffic-operational features, while five-star roads incorporate numerous safety-related design and traffic-control elements. The purpose of star ratings is to identify and record attributes that influence the likelihood or consequences of crashes and, in this way, define the level of road-user risk without the need for detailed crash data. There are distinct star ratings produced for vehicle occupants, motorcyclists, bicyclists, and pedestrians. Agencies can therefore develop star ratings and star-rating maps for existing roads and for roads where crash data are not yet available. Research has demonstrated a correlation between vehicle-occupant star ratings and the frequency of serious and fatal crashes.[4]

Agencies can use the Web-based software package, usRAP Tools (now, ViDA), to generate star ratings from road data. The star ratings, in turn, can be used to develop usRAP SRIPs for network-level traffic safety. The plans prioritize potential road infrastructure improvement projects based on benefit-cost analysis tailored to an agency's budget and countermeasure choices.[1,2]

UPlan includes some unique features not included in usRAP. For example, road agencies can access UPlan through the Web site map center (http://uplan.maps.arcgis.com/home), which is a compilation of GIS-based data that the public and transportation agencies can use. UPlan also provides census data, FHWA data, and other jurisdictions' and agencies' information. Using UPlan, UDOT can estimate how proposed projects could affect system-performance measures.[9]

usRAP can leverage the integration and visualization capabilities of GIS so that transportation agencies can integrate geometric and operational features of a roadway with crash data. Only aggregate (system level) crash data are required to calibrate usRAP road-protection scoring and SRIP protocols. Visualization capabilities of GIS enable data quality control and provide easy to understand information to decision makers and the public.

TARGET AUDIENCE

These programs are free of charge and any State, city, or county transportation department can use and customize them to meet the needs of different situations. Highway safety professionals, transportation planners, and transportation engineers are the most common users. The usRAP Team offers training on using its software and gathering input data.[1,2] To date, usRAP has been piloted in Alabama, Florida, Iowa, Michigan, New Jersey, Illinois, Kentucky, New Mexico, and Utah.[10] UPlan is specific to Utah and, to date, no other State has implemented the program; however, any State can adopt it because it is part of the AASHTO Technology Implementation Group (TIG).[3,5] The information resulting from these two programs can benefit both highway agencies and individual road users.

PROGRAM AND PROCESSES

IMPLEMENTING usRAP TO COLLECT AND ANALYZE DATA FOR KENTUCKY COUNTIES

Most States do not collect or retain safety data elements for county secondary roads not maintained by State transportation agencies. However, crashes on these roads are often severe because of high speeds, narrow lanes, sharp curves, and dangerous roadsides. For example, of the 79,321 miles of public roads in Kentucky, the Kentucky Transportation Cabinet (KYTC) Highway Information System contains asset inventory information on just 40,000 miles. There is a need to improve safety on these facilities and address Fixing America's Surface Transportation Act 2016 (FAST Act) objectives; unfortunately, a data-driven approach is challenging when the inventory includes only half of the public roadway mileage.
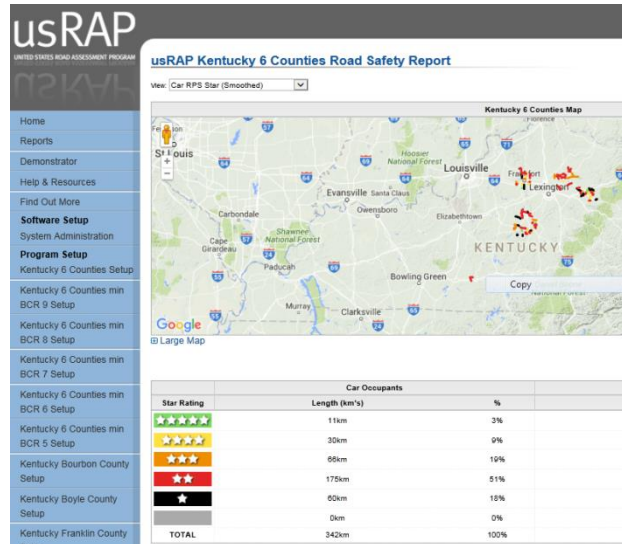

Figure 2: Star Rating map and output from usRAP online tools

Working on behalf of KYTC, the Kentucky Transportation Center (KTC) selected 10 pilot counties and small cities from which to collect roadway safety data. Using ArcGIS, researchers collected and processed roadway data, then uploaded the data to the usRAP Tools (ViDA) online program for processing. The KTC Team used usRAP to recommend countermeasures for safety improvements and SRIPs to highway authorities, which KTC made available to officials in each study area jurisdiction. KTC also delivered the processed data using a GIS format to KYTC for potential inclusion in the Highway Information System (HIS) database. The principle effect of this project was to demonstrate the level of effort required and usefulness of safety asset management to local agencies in the Commonwealth.[2,4]

UTAH USES GIS PLATFORM TO SHARE DATA WITHIN THE DOT AND WITH THE PUBLIC

According to UDOT planning director John Thomas, "UPLAN is a collaborative, Web-based tool that supports decision-making, mapping, information analysis, and planning and project development. The tool serves as a one-stop shop for UDOT staff, partner agencies, and the

public to upload, manage, and share a wide variety of geospatial data." While it is still too early to formally evaluate UPlan, evaluation, anecdotal and some quantitative benefits ascertained include the following:

- Improved data accessibility, quality, and information sharing.

- Strengthened collaboration and partnerships.

- Streamlined project development and delivery.

- Focused use of resources.

UPlan allows users to view multiple sources of data spatially, which improves communication among and within agencies and provides one-stop shopping for various disperse data. Data are more convenient for users and more easily maintained by providers. Data quality is improved because errors are easier to identify when visualized. Perhaps most importantly, fusion of various data in a spatial environment allows better understanding of the causes and potential solutions to highway safety issues

KEY ACCOMPLISHMENTS

- There are already examples of cost savings facilitated by UPlan in Utah. "Prior to adopting a cloud-based GIS platform for the tool, staff working on UPLAN spent approximately 80 percent of their time on data management and maintenance. Now, staff spends a few hours per week (about 20 percent of their time) on these tasks."[9]

- Agencies can now anticipate and mitigate potential safety problems earlier as UPlan data are available even in the planning stage of projects. Also, UPlan fosters multi-State collaboration and 12 States have implemented cloud-based GIS programs based on the UPlan design.

SUMMARY

BENEFITS/RESULTS[2,4,10]

- Transportation agencies can use GIS maps to better evaluate their road network performance.

- Transportation agencies can use usRAP to identify areas where safety improvements are potentially warranted.

- The systems can help individual road users understand the risks involved in traveling on different road types and the safety performance of specific roads.

- Agencies can use usRAP and UPlan to quantify risk and ensure investment decisions are data driven.

- Agencies with limited budgets can also use usRAP because its tools generate a customized plan based on a minimum benefit-cost ratio defined by the agency.

- The software and tools are free, and assistance is available through usRAP.

IMPLEMENTATION CHALLENGES[1,2,4]

- Data collection can be labor intensive. Automated data collection requires investments in new technologies or outsourcing the job to contractors.

- Roadway imagery for a local network may be low quality or unavailable.

- Some GIS expertise is required to set up the coding environment.

FUNDING/COST

The cost of implementing this program varies and depends on the availability and cost of labor to collect data as well as the extent of system. Kentucky has collected data, 10,784 miles thus far.[2] Collecting data from imagery typically costs around $5 per mile. These costs include training, data collection and processing, and potentially the cost of hiring consultants for initial or ongoing support. These costs exclude implementing countermeasures.

TIME FRAME

Entering data into usRAP demands significant labor and time, but it is relatively straightforward. One data collector working half-time can collect and process up to 50–75 miles of data per week.

LESSONS LEARNED

- The GIS based tools and approaches provide agencies with systemic as well as prioritized site specific suggestions for safety improvement.

- The availability of roadway imagery continues to increase making practical implementation of the GIS based tools cost effective.

- Because individual projects recommended by a USRAP evaluation were ranked by benefit-cost ratio, safety funds may go further to save more lives. KYTC and UDOT chose to recover the cost of implementing GIS safety approaches by selecting fewer but more cost-effective safety improvement projects and using some of the savings to implement the safety tools.

- Communication, coordination, and cooperation are facilitated when offices and agencies share spatial safety information resources.

- Training for workers on the project should be comprehensive. Providing an extensive catalog of reference examples will encourage participants to minimize subjective judgments

REFERENCES

1. AAA Foundation for Traffic Safety. usRAP: United States Roadside Assessment Program, 2006.

2. usRAP Overview, United States Road Assessment Program, http://www.usrap.us/home/, accessed October 2015.

3. AASHTO (2016) UPlan, AASHTO Innovation Initiative, http://aii.transportation.org/Pages/UPlan.aspx, accessed May 2016.

4. Harwood, D., K. Bauer, D. Gilmore, R. Souleyrette, and Z. Hans. Validation of the usRAP Star Rating Protocol for Application to Safety Management of U.S. Roads, Transportation Research Record, Journal of the Transportation Research Board, No. 2147, TRB, National Research Council, Washington, DC, 2010, pp. 33–41.

5. Harwood, D., and S. Jones. UTIBS, UPlan, and how both relate to usRAP. Utah DOT, iRAP Innovative Workshop, PowerPoint presentation, 2013.

6. Higgins, C. Preconstruction honored with regional quality award, UDOT Transportation Blog, April 2015.

7. Pinkerton, A. UPlan Tutorial. Utah DOT. PowerPoint presentation, 2013.

8. British EuroRAP Results 2015, Road Safety Foundation, http://www.roadsafetyfoundation.org/media/32684/british_eurorap_report_2015_final.pdf, retrieved October 2015.

9. Thomas, J. UPLAN, Utah Department of Transportation, http://www.ssti.us/wp/wp-content/uploads/2014/10/John-thomas_UDOT_UPLAN-summary.pdf, accessed May 2016.

10. usRAP: A New Tool for Road Safety Management, UTC Spotlight, U.S. Department of Transportation, Research and Innovative Technology Administration, 2009, http://www.rita.dot.gov/utc/publications/spotlight/2009_11/html/spotlight_0911.html, accessed October 2015.

11. Utah's GIS Database Enhancing Transportation Performance Management, FHWA Transportation Performance Management Noteworthy Practice Series, Federal Highway Administration, U.S. Department of Transportation, Washington, DC, October 2013.

EXPLANATION OF TERMS

AAA	–	The American Automobile Association
AASHTO TIG	–	The American Association of State Highway & Transportation Officials Technology Implementation Group
DOT	–	Department of Transportation
FAST Act	–	Fixing America's Surface Transportation Act, 2016
GIS	–	Geographic Information System
HIS	–	Highway Information System
KTC	–	Kentucky Transportation Center
KYTC	–	Kentucky Transportation Cabinet
LiDAR	–	Light Detection and Ranging
SRIPS	–	Safer Roads Investment Plans
UDOT	–	Utah Department of Transportation
UPlan	–	Interactive mapping platform that supports UDOT by helping visualize its data, track assets and strengthen transportation planning with better analysis and collaborative information
usRAP	–	United States Road Assessment Program

AGENCY CONTACT INFORMATION

W. Scott Jones
Safety Programs Engineer
UDOT
Salt Lake City, Utah
Phone: 801-965-4285
Email: wsjones@utah.gov

John Thomas
Project Manager
UDOT
Salt Lake City, Utah
Phone: 801-550-2248
Email: johnthomas@utah.gov

Jarrod Stanley
Highway Safety Engineer
Kentucky Transportation Cabinet
Frankfort, KY
Phone: 502-564-4556
Email: jarrod.stanley@ky.gov

Bruce Hamilton
Roadway Safety Foundation
Washington, DC
Phone: 202-857-1228
Email: gregcohen@roadwaysafety.org

Doug Harwood
Program Director
MRIGlobal Transportation Research Center
Kansas City, Missouri
Phone: 816-753-7600 ext. 1571
Email: dharwood@mriglobal.org