An In-Depth Assessment of Montana Road Weather Information System

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PROBLEM STATEMENT

Weather presents considerable challenges to highway agencies both in terms of safety and operations. From a safety standpoint, snow, ice and other forms of precipitation may reduce pavement friction, increasing the potential for crashes when vehicles are traveling too fast for the conditions. From an operations standpoint, heavy snow storms may affect the connectivity of the highway network due to closures that need to be cleared in an efficient and timely fashion. Further, travelers should be informed about unusual pavement conditions and road closures on time to minimize the effect of adverse weather on the safety and mobility of the traveling public. For the aforementioned reasons, road weather information has become increasingly important for highway agencies particularly in states (and regions) that experience harsh winter weather conditions. Road weather information has been used by highway agencies in many applications such as winter maintenance, traveler information, and other weather-related ITS applications. The adequacy, reliability, and geographic coverage are critical aspects of weather data to be used effectively in those applications by transportation managers.

Montana Department of Transportation (MDT) currently has 72 Road Weather Information System (RWIS) stations throughout the state that have been used as a major source of weather data for transportation applications. All these RWIS stations are fixed and other entities (such as the National Weather Service) currently rely on these stations for information. The number and location of these environmental sensor stations were largely determined over time by the pressing needs of the maintenance and snow removal operations, without much consideration to other applications that are in need of accurate and timely road weather data. Therefore, a comprehensive review and assessment of the state road weather data collection program is needed to ensure: 1) the efficient use of weather data in various transportation applications and 2) the optimum use of MDT resources.

BACKGROUND SUMMARY

RWIS stations, individually known as Environment Sensor Stations (ESS), have been operating around the nation since the late 1980's and were initially deployed as part of larger efforts to make certain hazardous roadways safer. As technology advanced and communication became easier, individual RWIS stations started to link together and become more comprehensive networks of weather information (Ballard et. al., 2002). Today RWIS data is used by many end users in multiple transportation applications including winter maintenance, traveler information, and other weather-related ITS applications. Understanding the state of the art and practice as it pertains to data adequacy, data reliability, geographic coverage, available software and potential costs and benefits of RWIS options will be important to the overall assessment of MDT's RWIS. A cursory literature review, including use of the Transportation Research International Documentation (TRID) database, on these focused topics gives some additional background to this effort.

The U.S. Department of Transportation's Federal Highway Administration (FHWA) has previously published a RWIS and ESS Siting Guidelines document (Manfredi et. al., 2005) and follow-up Implementation and Evaluation of the guidelines publication (Garrett et. al., 2008). These documents define some of the specifics about siting RWIS and ESS as well as agency experience with using the guidelines. Until recently, geographically locating RWIS stations primarily relied on experienced local maintenance personnel judgment. Newer methods of systematic locating analysis based on quantified data may be valuable for agencies.

One method that defines spatially optimized RWIS station locating has recently been defined by Jin et. al. (2014). This method uses safety data and GIS to optimally locate RWIS stations in a large transportation network. Crash data is analyzed to develop a "Safety Concern Index" for the transportation network considering weather-related crashes. This method is then exhibited by the authors using the transportation network of the tri-counties region near Austin, TX. Based on their analysis, optimal RWIS locations are then recommended to the sponsors (Jin et. al., 2014).

Another RWIS station locating framework has been proposed that considers many factors including the "needs for, and potential benefits from, real-time road weather information, including road surface temperature variability, precipitation, network traffic, and collision patterns" (Kwon and Fu, 2013). This framework and methodology is also demonstrated by the authors using a case study region in Ontario. Assuming reliable quantitative benefit/cost relationships can be determined, this research suggests a systematic process to locate RWIS stations based on many factors is feasible (Kwon and Fu, 2013).

Systematic locating analysis, similar to the ones presented by the authors of these works, may be valuable for agencies but local expertise and agency priorities must also be satisfied. The idea of satisfying local expertise and agency priorities is described in an extensive RWIS assessment preformed for the California Department of Transportation (Caltrans). In order to properly locate RWIS stations, an agency must determine the primary purpose for RWIS in the region under consideration. For example if traveler information is the primary purpose in a certain location as opposed to maintenance decision support, then that must be factored into the implementation of RWIS. Once the primary purpose for RWIS in the region is defined then qualified local DOT personnel (perhaps in coordination with local meteorologists) may be best suited to locate ESS (Ballard et. al., 2002). In this project a needs assessment will help address this aspect of the overall assessment.

A handful of studies have performed benefit/cost analysis of RWIS in different settings. In these studies, agency specific ratios represent cost saving limited only to the transportation agency (materials, labor, etc.) whereas, overall ratios also include at least one other benefit to society like crash cost reduction.

- B/C ratio of **10** to **15** (overall) found for expansion of RWIS to 38 optimally located sites in New York (Chien et. al., 2014);
- B/C ratios of **3.8** (agency specific) and **45.4** (overall) for existing statewide RWIS in Iowa (Veneziano et. al., 2014);
- B/C ratio of **11** (agency specific) for existing statewide RWIS in Utah (Strong and Shi, 2008);
- B/C ratios (agency specific) of **5.0** for adding five RWIS stations in the Seattle, WA area and **1.1** for adding 14 stations in the Denver, CO area (Boselly, 2001).

It is evident that RWIS benefits greatly outweigh the costs and this is likely why RWIS stations continue to be added to statewide systems and why recent projects continue to develop methods to assist agencies with optimizing their resources. Much more is expected to be found in the extensive literature review and state of practice investigation proposed as part of this research project.

BENEFITS AND BUSINESS CASE

A number of benefits are expected to result from this research. MDT will benefit from the knowledge gained from the state of the art and practice reviews by potentially learning of new opportunities and methods related to their RWIS that could increase adequacy, reliability and/or efficiency of their existing systems. MDT will also benefit from analyses defining agency RWIS needs, weather data effectiveness, software and alternative options, and benefit/cost relationships for the current system and alternatives. An Implementation plan with recommendations and guidelines will benefit MDT especially by ensuring optimal use of agency resources. Overall improvements to RWIS mean overall improvement to the use of agency resources and are expected to contribute to safer travel, better informed travel, and improved highway maintenance operations.

OBJECTIVES

The objective of this project is to perform an in-depth assessment of Montana's RWIS and ultimately produce means to improve and guide future efforts related to this aspect of MDT's operations. More specifically, this project will gain understanding of and document the state of the art related to RWIS, the state of the practice related to RWIS, MDT's data and software needs and options, benefits and costs of existing and alternative RWIS in Montana, as well as implementation recommendations and guidelines for future installations and efforts by MDT related to road weather data. The knowledge gained and recommendations resulting from that knowledge will be documented throughout the final report.

RESEARCH PLAN

The research plan involves eight tasks to achieve the objectives of the project. These tasks are based on those identified in the research problem statement and the guidance provided in MDT's proposal template. The eight tasks are:

1. Project Management
2. State of the Art Review
3. State of the Practice Review
4. Needs Assessment
5. Weather Data and Software Analysis
6. Benefit Cost Analysis
7. Implementation Plan
8. Final Report

1.0 Project Management

Project Management is essential to ensure a successful project and efficient communication between WTI and MDT. Specific project management activities include:

- A kickoff meeting with the project Technical Panel to occur as soon as practical after a contract is in place. The Technical Panel and the WTI team will discuss the research approach to be taken (as laid out in this section of the proposal), potential information sources and agency contacts, and other items that could assist WTI in executing the project.
- Quarterly progress reports delivered to MDT assessing work accomplished on specific tasks and the percent of each task completed to date.
- Meeting with the project technical panel in person or over the phone at any time during the life of the project. Request for such meetings could be initiated by the research team or the project technical panel.
- A final meeting/conference call to present the results of the research to the Technical Panel (following a review and comment period by the panel), if such a meeting is desired and requested by the panel. This meeting would serve to conclude the project, presenting and discussing the findings of the project.

Notes generated from any meetings will be submitted to the technical panel for review and comment within two weeks following the meeting.

2.0 State of the Art Review

This task will involve an in-depth search and review of literature and other available information pertaining to RWIS use in transportation applications building upon the preliminary review performed in the course of developing this proposal. The review will focus on RWIS data adequacy, reliability, geographic coverage, software related to RWIS and benefit/cost analysis, among other things. The approach taken in completing this task will employ a comprehensive literature search through sources including, but not limited to, the Transport Research International Documentation (TRID) database, the EI Compendex database, Federal Highway Administration (FHWA) websites, Transportation Research Board (TRB) websites, Institute of

Transportation Engineers (ITE) websites, American Association of State Highway and Transportation Officials (AASHTO) websites, state DOT websites, and other databases (e.g., Google Scholar). Subsections expected to be included in this task will focus on:

- Data Adequacy – what types of data are available from different RWIS and are those data adequate for certain transportation applications;
- Data Reliability – how reliable is the data obtained from different RWIS and is this reliability acceptable now and will it be acceptable for future applications;
- Picture and Video Options – what static and live image camera options exist and what are the documented strengths and weaknesses associated with each;
- Software Options – what RWIS software options exist and what are the documented strengths and weaknesses associated with each;
- Geographic Coverage – what methods exist to determine geographic placement and coverage requirements for RWIS;
- Benefit/Cost Relationships – what are the documented benefits and costs for other RWIS and what methodologies exist for determining accurate B/C ratios.

The literature review will search for peer-reviewed papers and journal articles, agency reports, agency websites dedicated to RWIS, and other relevant documentation and information, including ongoing research that may also be relevant, as identified by the TRID's Research in Progress database. This task will thoroughly summarize the knowledge gained from the relevant documented literature and be included as a chapter in the final report.

3.0 State of the Practice Review

This task will establish the current state of practice related to road weather information in transportation applications. This will be completed by developing a survey tool and administering the survey to gain understanding of current practices from other transportation agencies around the nation. The current practice as it pertains to planning and management will be emphasized as well as data, software, and benefit/cost specifics that may be of interest. The survey tool will be reviewed and ultimately approved by the Technical Panel prior to use to ensure the results reflect the most important information as determined in part by MDT. The survey will be administered using an online tool, such as SurveyMonkey, with follow-up email or phone calls as necessary. It is expected that the Technical Panel may have insight into potential contact persons in other agencies to include in the prospective survey. Members of respective interest groups such as TRB and AASHTO committees could also help in obtaining the required information. The current state of practice will be documented throughout this task and included as a chapter in the final report.

4.0 Needs Assessment

This task will determine RWIS data needs for various applications and programs as defined by relevant MDT personnel. The task will be conducted using in-person and/or phone interviews with specific transportation managers and other respective personnel. All aspects of the data itself (including static and live camera imaging) and related applications will be addressed during this assessment. It is expected that the Technical Panel will have valuable insight into MDT contact persons for this task. This task and the needs captured during the assessment will be documented and included as a chapter in the final report.

5.0 Weather Data and Software Analysis

This task will examine the degree to which the current RWIS system meets the MDT expressed needs including RWIS software and platform with the objective of identifying any existing limitations and deficiencies. Using the results of the prior tasks, this analysis will investigate the current state of RWIS data in Montana along with possible alternatives and how these findings correspond to the documented current and future needs. Similarly, the current software environment and possible alternatives will be analyzed to determine how well the expressed needs are being met and how future needs could also be considered. The data available depends largely upon the specifications of the sensor hardware used, as vendors often offer software solutions in addition to the hardware. Some known RWIS vendors include (Al-Kaisy et. al., 2012 and nritsconference.org):

- Vaisala,
- Surface Systems Inc. (SSI now Vaisala),
- Nu-Metrics (now Vaisala),
- Quixote (now Vaisala),
- Campbell Scientific,
- Lufft,
- Boschung,
- High Sierra Electronics,
- Iteris,
- Live View Technologies,
- Schneider Electric, and
- Skyline Technology Solutions.

Other specific software or sensor vendors may be identified in this task including ones specifically requested to be included in the investigation by the Technical Panel. The outcomes of this task will be documented and included as a chapter in the final report.

6.0 Benefit-Cost Analysis

This task will examine the benefit/cost relationships of Montana's current RWIS as well as other potential alternatives. A benefit cost analysis will be performed to determine the current situation concerning Montana's RWIS. Then using information gathered in the previous task concerning RWIS data and software, possible alternative RWIS options will also be analyzed to determine their respective benefit/cost relationships. Both, MDT specific benefit/cost relationships and overall benefit/cost relationships including certain societal benefits will be determined during this task. Agency specific benefits can include reduced staff, reduced agency equipment, reduced salt/anti-icing materials, reduced patrolling, increased staff and equipment efficiency, better response strategies, and reduced wear on infrastructure (Boselly, 2001 and Fay et. al., 2010). Overall benefits can include all agency specific benefits plus societal benefits including reduced crashes, improved travel information, shorter travel times, less disruption of emergency services, and reduced environmental quality impacts (Veneziano et. al., 2014 and Boselly, 2001). Costs can include hardware, software, maintenance, training, power, communications, installation, warranties, development of new agency protocols, third-party forecasting services, and personnel labor costs (Fay et. al., 2010). The appropriate analysis will consider the use of many of these documented benefits and costs. The findings from this task will be documented and included as a

chapter in the final report. A performance measures report will also be prepared upon completion of this task.

7.0 Implementation Plan

This task will recommend an implementation plan for possible changes and improvements that may be discovered from the previous tasks. The implementations plan will include recommendations and guidelines that will assist MDT in future expansions/improvements to RWIS. The implementation plan will address any known limitations or inefficiencies discovered during the previous tasks as well as specific aspects including siting atmospheric sensors, cameras and surface sensors, communication devices, power sources, measures to improve reliability and accuracy of weather data and software, as well as geographic location of possible RWIS expansion sites. The implementation plan will be documented and included as a chapter in the final report. An implementation report (MDT formatted) and associated meeting will also be included upon completion of this task.

8.0 Final Report

This task will include the preparation and submission of the final report. The final report will include the methods and findings from all prior tasks as well as any recommended actions stemming from these tasks. A dedicated chapter will also be included for the implementation plan with recommendations and guidelines for future RWIS expansions/improvements. A draft of the final report will be provided to the Technical Panel two (2) months prior to the completion of the project. This will allow enough time for the report to be reviewed by the Technical Panel and comments/suggestions be incorporated in the final report draft in a timely manner. If the Technical Panel desires a final project meeting then presentation materials for that meeting will also be prepared and provided to the Research Project Manager in advance of the meeting date.

MDT INVOLVEMENT

MDT involvement in this project will be required as follows:

- The Technical Panel will need to provide input, feedback and guidance on the research plan at the kick-off meeting and on as-needed basis afterwards whenever change or modification to the research plan is deemed appropriate by the research team.
- MDT staff will be asked to field information and data requests on an as needed basis. The two main items currently envisioned to rely on Technical Panel involvement include the identification of contact persons in other agencies for the State of the Practice Review as well as the identification of MDT personnel to include in the Needs Assessment task.
- The Technical Panel and Research Staff will review and comment on project deliverables including the final report.

PRODUCTS

The primary products resulting from this work are described below.

- Quarterly Progress Reports will be submitted documenting the work accomplished on specific tasks and the percent of each task completed to date.
- Task Reports documenting the completion of each task and the findings from that task at the conclusion of the task.
- Draft and Final Surveys will be provided to the Technical Panel for review prior to use in the State of Practice Review that will query contacts from other transportation agencies.
- A performance measures report detailing both qualitative and quantitative performance measures stemming from Tasks 2 – 6.
- An implementation report, with content (text and images) provided by the researchers formatted and published by MDT, detailing any implementation recommendations stemming from the project.
- A Final Report that presents the results of the overall research effort will be provided to the Technical Panel for review and comment. The Technical Panel's comments will then be addressed and the report re-submitted in as a Final Report. The report will include the implementation plan and benefit/cost analysis. The report will be delivered in both Microsoft Word and Adobe PDF formats and will comply with MDT's report requirements.
- A final report cover page photo (JPG format).
- A Project Summary Report containing a high level overview of the project and findings from the assessment.
- Contingent upon the desires of the Technical Panel, a Final Report Presentation and/or implementation meeting may, or may not be provided and could either be in-person at MDT Headquarters in Helena, or via teleconference.

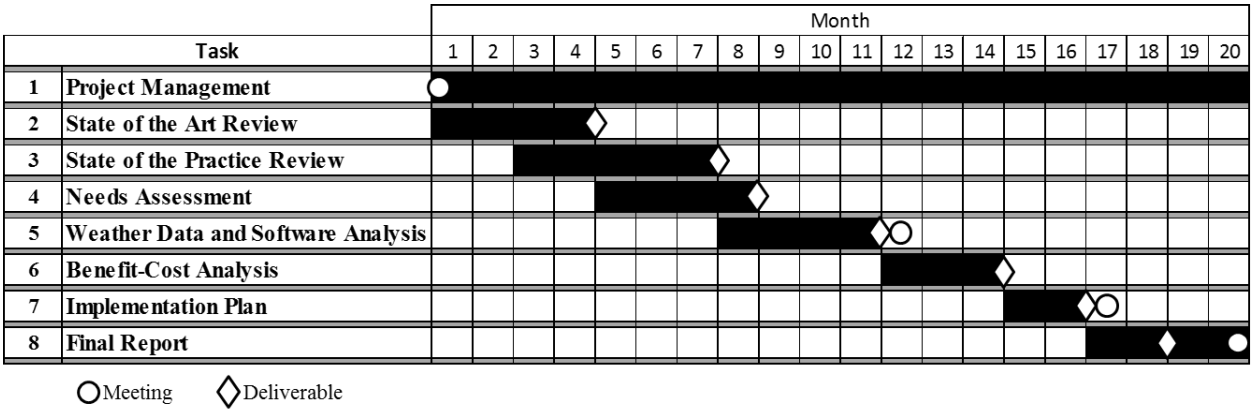
IMPLEMENTATION

The Implementation Plan included as a chapter in the final report will detail the specific recommendations and guidelines for MDT execution of relevant actions stemming from findings gathered in the overall assessment of Montana's RWIS. This plan will be made available to MDT managers and other applicable personnel involved in the operation and management of road weather information. In addition, the research team will likely also disseminate finding from this assessment to broader audiences, and other interested states via publication in relevant journals and presenting the findings at professional meetings.

SCHEDULE

Table 1 shows the individual task schedules and timeline. This project is expected to take 20 months to complete.

Table 1: Project Schedule



BUDGET

The cost of this project will be $152,006 as summarized in Table 2. This cost includes all allocated research and support staff time, and other anticipated expenses. The budget involves $10,500 tuition for the graduate research assistant and $450 travel expenses intended for 3-4 trips to MDT offices in Helena during the life of the project. Pay and benefit rates for research team members are shown in Table 3 while projected expenditures by task are shown in Table 4. Further, projected expenditures by state and federal fiscal years are shown in Tables 5 and 6, respectively.

Table 2: Summary of Cost by Budget Category

Item	Amount
Salaries	$86,632
Benefits	$23,623
Travel	$450
3-4 trips to Helena (see project schedule)	
Expendable Supplies	$400
GRA Tuition	$10,500
Total Direct Cost	$121,605
Overhead	$30,401
Total Project Cost	**$152,006**

Table 3: Hourly and Benefit Rates

Staff Name	Hourly Rate	Benefits Rate
Ahmed Al-Kaisy	$60.01	30.4%
Levi Ewan	$24.87	41.4%
Yiyi Wang	$42.63	34.0%
Graduate Student	$14.00	10.0%
Business Manager	$39.97	33.0%
Technical editor	$23.83	38.0%

Table 4: Cost by Task

Task	Cost	% of Total Cost
Task 0: Project Management	$12,328.11	8.1%
Task 1: State of the Art Review	$24,622.85	16.2%
Task 2: State of the Practice Review	$22,226.68	14.6%
Task 3: Needs Assessment	$23,258.98	15.3%
Task 4: Weather Data and Software Analysis	$15,718.23	10.3%
Task 5: Benefit-Cost Analysis	$19,963.75	13.1%
Task 6: Implementation Plan	$17,954.83	11.8%
Task 7: Final Report	$15,932.70	10.5%
Total	**$152,006.14**	**100.0%**

Table 5: Expenditures by State Fiscal Year

Budget Category	Total	State Fiscal Year	
		2015	2016
Salaries	$86,631.96	$34,652.79	$51,979.18
Benefits	$23,622.96	$9,449.18	$14,173.78
Supplies & Minor Equipment	$400.00	$160.00	$240.00
Travel	$450.00	$225.00	$225.00
Tuition	$10,500.00	$3,500.00	$7,000.00
Direct Costs	$121,604.93	$47,986.97	$73,617.96
Overhead	$30,401.23	$11,996.74	$18,404.49
Total Project Cost	$152,006.16	$59,983.71	$92,022.44

Table 6: Expenditures by Federal Fiscal Year

Budget Category	Total	Federal Fiscal Year	
		2015	2016
Salaries	$86,631.96	$43,315.98	$43,315.98
Benefits	$23,622.96	$11,811.48	$11,811.48
Supplies & Minor Equipment	$400.00	$200.00	$200.00
Travel	$450.00	$225.00	$225.00
Tuition	$10,500.00	$7,000.00	$3,500.00
Direct Costs	$121,604.93	$62,552.46	$59,052.46
Overhead	$30,401.23	$15,638.12	$14,763.12
Total Project Cost	$152,006.16	$78,190.58	$73,815.58

STAFFING

The research team is composed of three WTI investigators, namely, Ahmed Al-Kaisy, Levi Ewan, and Yiyi Wang along with a graduate student researcher. Below are short biographies of the key research team members.

Ahmed Al-Kaisy, Ph.D., Principal Investigator, is a professor in the Department of Civil Engineering at Montana State University (MSU) and the Program Manager for the Safety and Operations Focus Area at the Western Transportation Institute (WTI). Dr. Al-Kaisy is a registered professional engineer in the state of Montana. Dr. Al-Kaisy has long teaching experience in many areas of transportation engineering, including traffic operations and management, traffic flow theory, traffic safety, signal optimization and control, highway design, and intelligent transportation systems. Dr. Al-Kaisy has previously worked with MDT on traffic data intensive projects, including a project that investigated rest area usage throughout the state of Montana and an ongoing project on the ATR and WIM stations at the state level. He has authored/co-authored around ninety (90) refereed publications half of which are fully refereed journal publications. Dr. Al-Kaisy is an active member in many university committees and is affiliated with a number of national and international professional organizations.

Levi Ewan, M.Sc., Co-Principal Investigator, is a Research Associate with the Western Transportation institute. A considerable portion of his experience has focused on weather-related ITS and RWIS technology. At WTI, Levi has played a key role on the previous ODOT Variable Speed Limit research project, serving as a graduate research assistant and completing a number of activities for that work. Mr. Ewan is currently working on a couple of data intensive projects for the state of Oregon; the first is concerned with active traffic management evaluation along a freeway corridor while the second is concerned with assessing safety risks on low-volume roads in the state of Oregon. He has also completed several other research projects for sponsors that include the Montana Department of Transportation (Information/Education Synthesis on Roundabouts; Montana Intercity Bus Service Study; Livability Benchmarks for Transportation), the North/West Passage Pooled Fund (Operations and Travel Information Integration Sharing (OTIIS) Project), and the Federal Lands Highway Division (Traffic Calming for Rural 2-Lane Roads). He has authored/co-authored a dozen peer-reviewed publications and presented at multiple invited technical conferences.

Yiyi Wang, Ph.D., Investigator, is a WTI affiliate faculty and an assistant professor of civil engineering at MSU. She has substantial experience with spatial statistical/econometric methods and geographic information systems (GIS). She has published peer-reviewed journal articles in the areas of computational geography, transportation safety, and urban sustainability. Her dissertation focused on a flexible spatial model for analyzing geo-coded count responses and won the Garrison Award for Best Dissertation in Computational Geography in 2014. Her

research focuses on applying GIS-based tools and spatial methods to enhance decision-making capacity.

Resumes for the research team members are presented at the end of this proposal. Lead members of the research team will not be changed without written consent of MDT. The primary role of team members on this project are delineated by task in Table 7.

Table 7: Summary of Project Roles

Task	Lead	Secondary	Review/Advise
Project Management	Al-Kaisy	Ewan	-----
State-of-the-Art Review	Ewan	Al-Kaisy	Wang
State of the Practice Review	Ewan	Al-Kaisy	Wang
Needs Assessment	Ewan	Al-Kaisy	Wang
Weather Data and Software Analysis	Ewan	Al-Kaisy	Wang
Benefit-Cost Analysis	Wang	Al-Kaisy	Ewan
Implementation Plan	Al-Kaisy	Wang	Ewan
Reporting	Al-Kaisy	Ewan/Wang	-----

Projected level of effort by individual and project task is summarized in Table 8.

Table 8: Level of Effort by Individual and Task

Name or Title	Role in Study	Task								
		0	1	2	3	4	5	6	7	Total
Ahmed Al-Kaisy	Principal Investigator	110	40	60	50	68	30	80	60	**498**
Levi Ewan	Co-Principal Investigator	30	130	150	140	108	36	20	110	**724**
Yiyi Wang	Investigator	0	12	10	10	12	120	90	16	**270**
Graduate Student	Data Collection & Analysis	0	480	460	360	160	120	120	120	**1820**
Business Manager	Administrative Support	0	2	2	2	2	2	4	6	**20**
Support Staff	Technical editing	0	8	0	0	0	0	0	32	**40**
	Total	**140**	**672**	**682**	**562**	**350**	**308**	**314**	**344**	**3372**

The key investigators can commit the time necessary to complete this work in a timely and deliberate manner as shown in Table 9.

Table 9: Summary of Commitments for Project Key Investigators

Individual	Available Time %	Existing Commitments	
		Commitment	Time, %
Ahmed Al-Kaisy	30	Teaching	40
		Oregon DOT Risk Factor	10
		Oregon DOT VSL Project	5
		NCHRP 17-65	10
		Other	5
Levi Ewan	60	NWP OTIIS Project	10
		Oregon DOT Risk Factor	15
		Oregon DOT VSL Project	15
Yiyi Wang	25	Teaching	55
		Other	20

FACILITIES

The Western Transportation Institute (WTI) is the nation's largest transportation institute focusing on rural transportation issues. The Institute was established in 1994 by the Montana and California Departments of Transportation, in cooperation with Montana State University. WTI has an annual budget exceeding $7 million and a 50-person multidisciplinary staff of professionals, students and associated faculty from engineering (mechanical/industrial/civil), computer science, fish and wildlife, ecology, business, and economics. WTI has conducted research in more than 30 states, at local, state, and federal levels.

As a department in the College of Engineering, WTI is also supported by the College and by the umbrella of MSU administrative, academic, and research resources. The research faculties at WTI are assisted by a backbone of support staff. Administrative staff helps with budgeting, procurement, contracts, and accounting. Communications staff provides technical editing, layout, graphic design, and web page support. Information Technology staff maintains network servers and individual computers, software and hardware. Given the nature of this research project, most of the work will be data/information gathering, analysis, and assessment. The research will be conducted on pc/workstations using software available at WTI and the Civil Engineering Department of the College of Engineering at Montana State University.

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Manfredi, J., Walters, T., Wilke, G., Osborne, L., Hart, R., Incrocci, T., and Schmitt, T. "Road Weather Information System Environmental Sensor Station Siting Guidelines". FHWA Report: FHWA-HOP-05-026 (2005).

Strong, C. and Shi, X. "Benefit-Cost Analysis of Weather Information for Winter Maintenance". Transportation Research Board, National Research Council, Washington, DC (2008) pp. 119-127

Veneziano, D., Shi, X., Ballard, L., Ye, Z., and Fay, L. "A Benefit-Cost Analysis Toolkit for Road Weather Management Technologies". *A Benefit-Cost Analysis Toolkit for Road Weather Management Technologies*, (2014) pp. 217-230

Ahmed Al-Kaisy, Ph.D., P.E.

***Professor*,** Department of Civil Engineering
Program Manager, Safety & Operations, Western Transportation Institute
Montana State University, Bozeman, Montana

EDUCATION

Ph.D. Transportation Engineering, Queen's University, Kingston, Ontario, Canada

B.Sc., M.Sc. Civil Engineering, University of Baghdad, Iraq

ACADEMIC EMPLOYMENT

Professor, Department of Civil Engineering, Montana State University, Bozeman, Montana, July 2012-present.

Program Manager, Safety & Operations, Western Transportation Institute, Montana State University, Bozeman, Montana, July 2008-present

Visiting Professor, Department of Civil Engineering, American University of Sharjah, UAE, September 2011-June 2013

Associate Professor, Department of Civil Engineering, Montana State University, Bozeman, Montana, July 2007-July 2012.

Assistant Professor, Department of Civil Engineering, Montana State University, Bozeman, Montana, 2003-2007

Assistant Professor, Civil Engineering Department, Bradley University, Peoria, IL 2001-2003

Post-Doctoral Research Associate, McMaster University, Hamilton, Ontario, Canada 1999-2001

Lecturer, McMaster University, Hamilton, Ontario, Canada 1999-2000

Research Associate, Royal Military College of Canada, Kingston, Ontario, Canada 1996-1999

Research Assistant, Queen's University, Kingston, Ontario, Canada 1996-1999

Teaching Assistant, Queen's University, Kingston, Ontario, Canada 1996-1999

RESEARCH GRANTS

- *Improved Analysis of Two-Lane Highway Capacity and Operational Performance,* National Cooperative Highway Research Program (NCHRP), $500,000 (Co-Principal Investigator, PI: Dr. Scott Washburn, University of Florida), (in contract)
- *Risk Factors Associated with High Potential for Serious Crashes*, Oregon Department of Transportation and FHWA, $160,000 (Principal Investigator), (ongoing)
- *Evaluation of Variable Speed Limit/Variable Advisory Speed Systems,* Oregon Department of Transportation and FHWA, $165,000 (WTI Principal Investigator, partnership with Portland State University) (ongoing)
- *Montana Weigh-in-Motion (WIM) and Automatic Traffic Recorder (ATR) Strategy,* Montana Department of Transportation and FHWA (Investigator), $205,000 (ongoing)

- *Traffic Calming for Rural 2-Lane Roads,* Central Federal Land Highway Division, FHWA (Principal Investigator), $80,000 (completed)
- *Evaluation of a Variable Speed Limit System for Wet and Extreme Weather Conditions,* Oregon Department of Transportation and FHWA, (Principal Investigator), $170,000 (phase I completed, phase II pending)
- *Cost Effective Local Road Safety Planning and Implementation,* American Traffic Safety Services Association (ATSSA), (Co-Principal Investigator), $35,000 (completed)
- *Montana Rest Area Usage: Data Acquisition and Usage Estimation,* Montana Department of Transportation, (Principal Investigator), $158,000 (completed)
- *Explore ITS Technologies for Work Zones and Work Zone Impact Areas*, Western Federal Land Highway Division, FHWA (Principal Investigator), $120,000 (ongoing)
- *Effect of Speed, Alignment and Roadside Features on Crash Experience along a Rural Corridor,* Western Transportation Institute, NSF REU Program (completed)
- *City of Bozeman parking Study,* City of Bozeman, (Principal Investigator), $28,000 (completed)
- *Effect of Alignment and Sight Distance on Drivers' Speed Selection in the Gallatin Canyon,* Western Transportation Institute, NSF REU Program (completed)
- *Channelized Right-Turn Lanes at Signalized Intersections: Traffic Control Empirical Investigation*, US DOT, UTC, Western Transportation Institute, Bozeman, MT, (Principal Investigator), $25,000 (completed)
- *FWS Traffic Monitoring Assessment and Demonstration Project – Phase I,* Central Federal Lands Highway Division, FHWA, (Principal Investigator), $100,000 (ongoing)
- *Operational Effectiveness of Passing lanes on Two-Lane Highways,* Western Transportation Institute, UTC Graduate Transportation Award, Bozeman, MT, (completed)
- *Use of Rural Transportation Infrastructure in Evacuation Operation for the North Gulf Coastal Region,* Center for Urban Rural Interface Studies, Mississippi State University, National Oceanic and Atmospheric Administration (NOAA), (Co-Principal Investigator), $75,000 (completed)
- *Bozeman Pass Wildlife Channelization ITS Project*, Federal Highway Administration and Montana Department of Transportation, (Co-Investigator), $82,498 (completed)
- *Indicators of Performance on Two-Lane Highways*, Western Transportation Institute, UTC Graduate Transportation Award (completed)
- *Effectiveness of Yield-to-Pedestrian Channelizing Devices,* Pennsylvania Department of Transportation, (Co-Investigator), $50,000 (completed)
- *Development of New Analysis Procedures for Two-Lane Highways,* Western Transportation Institute, UTC Graduate Transportation Award (completed)
- *Static Warning Signs for Occasional Hazards: Survey of Practice,* University Transportation Center, US DOT, UTC, Western Transportation Institute, Bozeman, MT, (Principal Investigator), $25,000 (completed)
- *Weather Responsive Signal Control: Practical Guidelines,* Western Transportation Institute, NSF Research Experience for Undergraduate (REU) Program (completed)
- *Single-Lane Two-Way Traffic Control at Maintenance & Reconstruction Zones*, Western Transportation Institute, NSF REU Program (completed)

- *A New Approach for Developing Passenger Car Equivalency Factors for Heavy Vehicles on Congested Freeways,* Graduate Research Assistant Sponsored Project Award (GRASP), (completed)
- *Nighttime Construction: Evaluation of Construction Operations*, Illinois Transportation Research Center (ITRC), Springfield, Illinois, (C0-Principal Investigator), $150,000 (completed)
- *Nighttime Construction: Evaluation of Lighting for Highway Construction*, Illinois Transportation Research Center (ITRC), Springfield, Illinois, (C0-Principal Investigator), $150,000 (completed)
- *Assessing the Occlusion Effect of Heavy Vehicles on the Visibility of Freeway Guide Signs*, Graduate Research Assistant Sponsored Project Award (GRASP), (completed)
- *Assessing the Effect of Peak Hour Factor Approximation on Intersection Delay*, Bradley University Caterpillar Faculty Fellowship, $5,000 (completed)
- *Freeway Capacity at Long-Term Reconstruction Zones*, Natural Sciences and Engineering Research Council of Canada (NSERC), (Co-Investigator), (completed)
- *Quality of Service on Freeway facilities,* Natural Sciences and Engineering Research Council of Canada (NSERC), (Co-Investigator), (completed)

SELECTED PUBLICATIONS

Refereed Journal Articles (last five years)

1. *Watson, D.*, Al-Kaisy, A. and *Anderson, N.* (2014) "Examining the Effect of Speed and Roadway Geometry on Crash Experience along a Rural Corridor," Journal of Modern Transportation, Springer, Volume 22, Issue 2, pp. 84-95.
2. Al-Kaisy, A., *Krieder, T and Pothering, R.* (2013) "Speed Selection at Sites with Restrictive Alignment: The US-191 Case Study," *Journal of Advances in Transportation Studies*, Issue 29. pp. 71-82.
3. Ewan, L., Al-Kaisy, A. and Veneziano, D. (2013) "Weather Sensing and Road Surface Conditions: Is Technology Mature for Reliable ITS Applications?" *TRB Transportation Research Record 2329*, Journal of the Transportation Research Board, pp. 8-16.
4. Freedman, Z. and Al-Kaisy, A. (2013) "Investigation of Performance and Lane Utilization within a Passing Lane on a Two-Lane Rural Highway" *The International journal for Traffic and Transport Engineering*, Vol. 3, issue 3, pp. 279-290.
5. Al-Kaisy, A., Veneziano, D. Dorrington, C., and Kirkemo, Z. (2012) "Practical Guidelines for Estimation of Rest Area Use on Rural Interstates and Arterial Highways" *Transportation Research Record 2303*, Journal of the Transportation Research Board, pp. 117-124.
6. Al-Kaisy, A. and Roefaro, S. (2012) "Channelized Right-Turn Lanes at Signalized Intersections: The U.S. Experience," *Advances in Transportation Studies*, Vol. 26, pp.57-68.
7. Al-Kaisy, A., Roefaro, S. and Veneziano, D. (2012) "Effectiveness of Signal Control at Channelized Right Turning Lanes: An Empirical Study" *Journal of Transportation Safety and Security*, Vol. 4, Issue 1, pp. 19-34.
8. Al-Kaisy, A., Church, B., Veneziano, D. and Dorrington, C. (2011) "Investigation of Parking Dwell Time at Rest Areas on Rural Highways," *Transportation Research Record 2255*, Journal of the Transportation Research Board, pp. 156-164.
9. Al-Kaisy, A., Kirkemo, Z., Veneziano, D. and Dorrington, C. (2011) "Traffic Usage of Rest Areas on Rural Highways: A Recent Empirical Study" *Transportation Research Record 2255*, Journal of the Transportation Research Board, pp. 146-155.

10. Al-Kaisy, A. and Freedman, Z. (2011) "Estimating Performance on Two-Lane Highways: Case Study Validation of a New Methodology," *Transportation Research Record 2173,* Journal of the Transportation Research Board, pp. 72-79.
11. Freedman, Z. and Al-Kaisy, A. (2010) "Empirical Examination of Passing Lane Operational Benefits on Rural Two-Lane Highways," *Journal of Transportation Research Forum*, Vol. 49, No. 3, pp. 53-68.
12. Al-Kaisy, A. and Karjala, S. (2010) "Car-Following Interaction and the Definition of Free-Moving Vehicles on Two-Lane Rural Highways." *Journal of Transportation Engineering,* ASCE Publications, Vol.136, Issue 10, pp. 925-931.
13. Ismeik, M. and Al-Kaisy, A. (2010) "Characterization of Cell Phone Use while Driving: The Jordan Experience," *Transport*, Taylor & Francis, Vol. 25, Issue 3, pp. 252-261.
14. Al-Kaisy, A., and Nassar, K. (2009) "Developing a Decision Support Tool for Nighttime Construction in Highway Projects" ASCE *Journal of Construction Engineering & Management*, Volume 135, Issue 2, pp. 119-125.
15. Al-Kaisy, A. and Durbin, C. (2009) "Platooning on Two-Lane Two-Way Highways: An Empirical Investigation" *Journal of Advanced Transportation,* Volume 43, Number 1, pp. 71-88.
16. Ismeik, M. and Al-Kaisy, A. "Perceived Risk of Phoning while Driving: a Case Study from Jordan," *Safety Science*, Elsevier, in press.

Peer-Reviewed Articles in Conference Proceedings (last five years)

1. Ewan, L., Al-Kaisy, A. and Veneziano, D. (2013) "Weather Sensing and Road Surface Conditions: Is Technology Mature for Reliable ITS Applications?" Presented at the Transportation Research Board 92nd Annual meeting in Washington DC, January 13-17.
2. Al-Kaisy, A., Veneziano, D. Dorrington, C., and Kirkemo, Z. (2012) "Usage Estimation at Rest Areas on Rural Interstate and Arterial Highways: Practical Guidelines" Presented at the Transportation Research Board 91st Annual Meeting in Washington, D.C., January 22-26.
3. Al-Kaisy, A. and Durbin, C. (2011) "Platooning on Two-Lane Two-Way Highways: An Empirical Investigation" Proceedings of the 6th International Symposium on Highway Capacity and Quality of Service, Stockholm, Sweden, June 28-July 1, Elsevier, Volume 16.
4. Al-Kaisy, A. and Freedman, Z. (2011) "Empirical Examination of Passing Lane Operational Benefits on Rural Two-Lane Highways," Proceedings of the 6th International Symposium on Highway Capacity and Quality of Service, Stockholm, Sweden, June 28-July 1, Elsevier, Volume 16.
5. Al-Kaisy, A., Roefaro, S. and Veneziano, D. (2011) "Effectiveness of Signal Control at Channelized Right Turning Lanes: An Empirical Study" Presented at the 90th TRB Annual meeting, January 23-27.
6. Al-Kaisy, A., Church, B. Veneziano, D. and Dorrington, C. (2011) "Investigation of Parking Dwell Time at Rest Areas on Rural Highways" Presented at the 90th TRB Annual meeting, January 23-27.
7. Ismeik, M. and Al-Kaisy, A. (2011) "Characterization of Cell Phone Use while Driving: The Jordan Experience," Presented at the 90th TRB Annual meeting, January 23-27.
8. Al-Kaisy, A., Kirkemo, Z., Veneziano, D. and Dorrington, C. (2011) "Traffic Usage of Rest Areas on Rural Highways: A Recent Empirical Study" Presented at the 90th TRB Annual meeting, January 23-27.
9. Al-Kaisy, A. and Roefaro, S. (2010) "Channelized Right-Turn Lanes at Signalized Intersections: A Review of Practice," The Fourth International Symposium on Highway Geometric Design, Valencia, Spain, June 1-5.

10. Al-Kaisy, A., *Kreider, T.* and *Pothering, R.* (2010) "Speed Selection at Sites with Restrictive Geometries: A Case Study," The 20th Canadian Multidisciplinary Road Safety Conference, Niagara Falls, Canada, June 6-9.
11. Al-Kaisy, A. and Freedman, Z. (2010) "Estimating Performance on Two-Lane Highways: Case Study Validation of a New Methodology," Presented at the Transportation Research Board 89th Annual Meeting, January 10-14.
12. Al-Kaisy, A., Hardy, A., and *Nemfakos, C.* (2009) "Static Warning Signs of Occasional Hazards: Do They Work?" The Canadian Multidisciplinary Road Safety Conference, Saskatoon, Canada, June 7-10.

Abstract Peer Reviewed Articles Presented at Professional Meetings (last 5 years)

1. Freedman, Z. and Al-Kaisy, A. (2013) "Investigation of Performance and Lane Utilization within a Passing Lane on a Two-Lane Rural Highway" To be presented at the TRB Symposium Celebrating 50 Years of Traffic Flow Theory, Portland, Oregon, August 11-13 2014.
2. Ewan L., Al-Kaisy, A. and Veneziano, D. (2013) Development of Weather-Responsive Variable Speed Limit System, National Rural ITS Conference, St. Cloud, Minnesota, August 25-28, 2013.
3. Al-Kaisy, A., Veneziano, D. and Ewan, L. (2012) "Weather Based Variable Speed Limits" Presented at the Northwest Transportation Conference, Kiewit Center for Infrastructure and Transportation, Oregon State University, Corvallis, Oregon, February 7-9, 2012.
4. *Watson, D.,* Al-Kaisy, A., and *Anderson, N.* (2012) "Examining the Effect of Speed, Roadside Features and Roadway Geometry on Crash Experience along a Rural Corridor," Presented at the Southeastern Transportation Center Student Poster Session held in conjunction with the Transportation Research Board (TRB) 91st Annual Meeting, January 22-26, 2012.
5. Al-Kaisy, A. and Ye, J. (2010) "Explore ITS Technologies for Work Zones and Work Zone Impact Areas" Presented at the National Rural ITS (NRITS) conference 2010, Huntington, West Virginia, August 1-4.
6. Al-Kaisy, A. and Veneziano, D. (2009) "Weather Adaptive Traffic Control: Practice, Technology, and Future Outlook," Presented at the National Rural ITS (NRITS) conference 2009, Seaside, Oregon, August 23-27.

Professional Affiliations

- Professional Engineer: State of Montana, License # 18377
- Member, Institute of Transportation Engineers
- TRB University Representative 2004-present
- Canadian Association of Road Safety Professionals, 2004 and 2009-2011
- Member, ROI subcommittee, TRB Visualization in Transportation Committee (ABJ95), 2009
- Transportation Research Board (TRB) individual affiliate 1998-2006
- American Society of Civil Engineers 2001-2003
- Canadian Society of Civil Engineering 1999-2000, 2004-2005
- Member, Council on Undergraduate Research (CUR) 2009-present
- International Society of Iraqi Scientists 2001-present
- Iraqi Society for Higher Education Abroad 2005-present
- Order of the Engineers 2007-present

Levi Ewan, MSc, EIT

Research Associate - Western Transportation Institute, Bozeman, MT

Education

May, 2013 M.S. in Civil Engineering, Montana State University, Bozeman, MT

May, 2010 B.S. in Civil Engineering, Montana State University, Bozeman, MT

Employment History

2009 – Present Western Transportation Institute, Bozeman, MT

Research Associate, Graduate Research Assistant, Research Assistant

Responsible for all stages of project work from proposal development to literature review, experiment design, conducting experiments, project management, report writing, and presentation to clients.

Project Experience

Risk Factors Associated with High Potential for Serious Crashes (2013-2015). Levi has begun working with the project team on this project that aims to identify risk factors associated with high potential for serious crashes on low-volume roads in Oregon. (Sponsor: Oregon Department of Transportation)

Evaluation of Variable Speed Limit/Variable Advisory Speed Systems (2013-2015). Levi has begun working with the project team (partnering with Portland State University) on this project that will evaluate active traffic management and variable speed limit systems being installed on both urban and rural Oregon highways. (Sponsor: Oregon Department of Transportation)

Operations and Travel Information Integration Sharing (OTIIS) Project (2013-2015). Levi has played a large role in this project that is developing a uniform traveler information system across the entire North/West Passage (WA, ID, MT, WY, ND, SD, MN, WI). This system involves creating a website for real-time traveler information across all 8 States as well as unique trip planning tools and mobile functionality including real-time en-route alerts for both CVO and recreational long-range travelers. (Sponsor: FHWA & North/West Passage Pooled Fund)

Information/Education Synthesis on Roundabouts (2013). Levi assisted with this project that synthesized other education and information efforts to promote roundabouts. Montana residents were thought to be opposed to the use of roundabouts and this project helped MDT understand why the public may be opposed and helped to determine strategies to inform the public on why a roundabout may be the best option for a rebuild or new construction project. (Sponsor: Montana Department of Transportation)

Traffic Calming for Rural 2-Lane Roads (2011-2013). Levi assisted with this project that investigated options available for traffic calming on 2-lane roads, especially rural roads like

those encountered on many Federal lands roadways. This effort also served to understand the safety challenges faced by Federal land roadway managers. (Sponsor: Federal Lands/FHWA)

Evaluation of a VSL System for Wet and Extreme Weather Conditions (2011-2012). Levi played a major role with this project that investigated a problematic urban freeway interchange that experienced wet weather often. This project then developed a weather-responsive VSL system to improve safety at the site and evaluated new sensor technologies for weather detection and measurement to be used in the system. This project was the focus of Levi's successful master's thesis program at MSU. (Sponsor: Oregon Department of Transportation)

Montana Intercity Bus Service Study (2010-2011). Levi assisted with this project that investigated the intercity bus service that exists within Montana as part of the requirement that the state meets certain intercity bus service needs. (Sponsor: Montana Department of Transportation)

Livability Benchmarks for Transportation (2010-2011). Levi assisted with this project that attempts to define livability as it relates to transportation for Montana to be used to help guide how livability impacts of transportation projects are handled. (Sponsor: Montana Department of Transportation)

Replacing Zinc Anodes on Concrete Bridges (2009-2011) Levi assisted with this project that aimed to investigate early failure of arc-sprayed zinc anodes on cathodically protected steel reinforced bridges on the Oregon coast. The research determined why the treatment failed early and developed best practices for the removal and replacement of arc-sprayed zinc anodes.

Honors

Recipient of the USDOT RITA-UTC Outstanding Graduate Student of the Year Award

Recipient of the Thomas Phillip Duganz Memorial Scholarship

Member of Chi Epsilon – Civil Engineering Honor Society

Dean's List

National Honor Society

Recipient of the Montana University System Honors Scholarship

Invited Presentations

Progress of the North/West Passage Operations and Travel Information Integration Sharing (OTIIS) Project. National Rural Intelligent Transportation Systems Conference, August 2014, Branson, MO.

Development of Weather-Responsive Variable Speed Limit Systems. National Rural Intelligent Transportation Systems Conference. August 2013, St. Cloud, MN.

Weather Sensing and Road Surface Conditions: Is Technology Mature for Reliable ITS Applications? Transportation Research Board 92nd Annual Meeting. January, 2013. Washington, D.C.

Publications

Al-Kaisy, A., Veneziano, D., and **Ewan, L.**, Traffic Calming for Rural 2-Lane Roads. Prepared for the Federal Lands Highway Technology Program and the Federal Highway Administration. Report No. TBD. December, 2013.

Veneziano, D., **Ewan, L.**, and Stephens, J. Information / Education Synthesis on Roundabouts. Prepared for the Montana Department of Transportation and the Federal Highway Administration. Report No. FHWA/MT-13-007/8117-042. September, 2013.

Ewan, L., Al-Kaisy, A., Veneziano, D. Remote Sensing of Weather and Road Surface Conditions: Is Technology Mature for Reliable Intelligent Transportation Systems Applications? In Transportation Research Record: Journal of the Transportation Research Board, No. 2329, 2013, pp. 8-16.

Ewan, L., Al-Kaisy, A., Veneziano, D. Winter Maintenance: Help for Above, Noninvasive Sensors Assist with Pavement Condition. Road and Bridge Magazine, March, 2013, pp. 44-51.

Shi, X., Li, Y., Cross, J.D., **Ewan, L**., Fortune, K., Soltesz, S., and Jungwirth, S. Replacing Thermal Sprayed Zinc Anodes on Cathodically Protected Steel Reinforced Concrete Bridges: Experimental and Modeling Studies. Proceedings of the Transportation Research Board 92nd Annual Meeting. January, 2013. Washington, D.C.

Ye, Z., Kack, D., Chaudhari, J. and **Ewan, L.** Are Intercity Bus Service Needs Being Adequately Met? Case Study of a Rural State. Proceedings of the Transportation Research Board 92nd Annual Meeting. January, 2013. Washington, D.C.

Shi, X., Soltesz, S., Li, Y., Cross, J., and **Ewan, L.** Electrochemically Aged Arc-Sprayed Zinc Coating to Concrete: Bond Strength Study. Journal of Surface Engineering, Vol. 29, No. 1, 2013, pp. 55-60.

Ye, Z., Kack, D., Chaudhari, J., **Ewan, L.** Intercity Bus Service Funding and Assessment Methodology. Journal of Public Transportation Vol. 15, No. 3, 2012, pp. 113-128.

Al-Kaisy, A., **Ewan, L.**, Veneziano, D. Evaluation of a Variable Speed Limit System for Wet and Extreme Weather Conditions: Phase 1 Report. Prepared for the Oregon Department of Transportation and the Federal Highway Administration. FHWA-OR-RD-12-14 SPR 743. June, 2012.

McGowen, P., Albert, S., Chaudhari, J., Gleason, R., **Ewan, L.**, Scott, A., and Johnson, J. Livability for Montana Transportation. Prepared for the Montana Department of Transportation and the Federal Highway Administration. FHWA/MT-12-001/8210. March, 2012.

Ye, J., Kack, D., Chaudhari, J., **Ewan, L.** Montana Intercity Bus Service Study. Prepared for the Montana Department of Transportation and the Federal Highway Administration. FHWA/MT-11-005/8211. December, 2011.

Shi, X., Cross, J., **Ewan, L.**, Liu, Y., Fortune, K. Replacing Thermally Sprayed Zinc Anodes on Cathodically Protected Steel Reinforced Bridges. Prepared for the Oregon Department of Transportation and the Federal Highway Administration. FHWA-OR-RD 12-02 SPR 682. August, 2011.

Yiyi Wang, Ph.D.

Assistant Professor of Civil Engineering, Montana State University

Education

Ph.D., Civil Engineering, University of Texas, Austin (2013)

M.E., Civil Engineering, Beijing University of Technology, China (2009)

B.E., Civil Engineering, Beijing University of Technology, China (2006)

Magna cum Laude

Key Qualifications

Yiyi Wang, Ph.D. is a WTI affiliate and assistant professor of civil engineering at MSU. She has substantial experience with spatial statistical/econometric methods and geographic information systems (GIS). She has published peer-reviewed journal articles in the areas of computational geography, transportation safety, and urban sustainability. Her dissertation focused on a flexible spatial model for analyzing geo-coded count responses and won the Garrison Award for Best Dissertation in Computational Geography in 2014. Her research focuses on applying GIS-based tools and spatial methods to enhance decision-making capacity.

Professional Experience

Montana State University 2013 - present
Assistant Professor of Civil Engineering

University of Texas at Austin 2009 - 2013
Graduate Research Assistant

Beijing University of Technology, China 2006 - 2009
Polytechnic University of Madrid, Spain (March — September 2009)
Graduate Research Assistant

Research Experience

The Health Impacts of Transportation Accessibility in Rural Communities, Research Experience of Undergraduates (REU) of the National Science Foundation (2014)

Developed a geographically weighted multinomial logit (GWR MNL) model for land use change dynamics in Austin, Texas. Sponsored by the National Science Foundation (NSF) project award SES-0818066.

Investigated the advantages of spatial filtering techniques versus spatial autoregressive models (with endogenous weight matrices). Sponsored by **NSF award SES-0818066**.

Developed a spatial autoregressive multinomial probit model using generalized direct sampling in a Bayesian framework, applicable to analyze unordered responses such as land development & mode choice. Sponsored by NSF project award SES-0818066.

Analyzed area-level pedestrian crashes in Austin region, using a Poisson-based conditional autoregressive spatial model.

Contributed to the Econometrics, Environmental Impact Analysis, & other chapters in The Economics of Transportation Systems. Sponsored by **TxDOT project No. 0-6628**.

Calibrated motorized & non-motorized miles-traveled models for NCHRP project, Estimating Walking & Bicycling for Planning & Project Development.

Contributed to the crash prediction modeling part for **TxDOT project No. 0-6713** Quantitative Relationship between Safety & Reduced Roadway Condition Maintenance.

Publications and Conference Proceedings

Wang, Y. (2014) The Relationship between Diabetes Prevalence and the Built Environment: A Case Study of Austin, Texas. To be submitted for presentation at the 94th Annual Meeting of the Transportation Research Board, and for publication in Transportation Research Record, Washington D.C., January 2015

Forsyth, S., Stephens, J., and Wang, Y. (2014) Link-Level Traffic Flow Estimation of Agricultural Products. To be submitted for presentation at the 94th Annual Meeting of the Transportation Research Board, and for publication in Transportation Research Record, Washington D.C., January 2015

Bansal, P., Kockelman, K., and Wang, Y. (2014) Hybrid Electric Vehicle Ownership and Fuel Economy across Texas: Application of Spatial Models. To be submitted for presentation at the 94th Annual Meeting of the Transportation Research Board, and for publication in Transportation Research Record, Washington D.C., January 2015.

Chen, D., Wang, Y., and Kockelman, K. (2013) Where Are the Electrical Vehicles? A Spatial Model for Vehicle-Choice Count Data. Compendium of the Transportation Research Board's 93rd Annual Meeting, Washington, DC, January 2014.

Xu, J., Kockelman, K., and Wang, Y. (2013) Modeling Crash and Fatality Counts along Mainlanes and Frontage Roads Across Texas: The Roles of Design, the Built Environment, and Weather. Compendium of the Transportation Research Board's 93rd Annual Meeting, Washington, DC, January 2014.

Wang, Y. and Kockelman, K. (2013) A Poisson-Lognormal Multivariate Conditional-Autoregressive Model for Spatial Analysis of Area-Level Pedestrian Crashes. Accident Analysis & Prevention 60: 71-84.

Wang, Y., Kockelman, K., & Damien, P. (2012) A Spatial Autoregressive Multinomial Probit Model for Anticipating Land Use Change in Austin, Texas. Proceedings of the 13th International Association Travel Behavior Research Conference, in Toronto (2012). Forthcoming in the Annals of Regional Science. DOI 10.1007/s00168-013-0584-y

Wang, Y., & Kockelman, K. (2012) A Univariate Spatial Count Model for Pedestrian Crashes across Neighborhoods. Proceedings of the 92nd Annual Meeting of the Transportation Research Board.

Wang, Y., Kockelman, K., & Wang, X. (2013) The Impact of Weight Matrices on Parameter Estimation & Inference: A Case Study of Binary Response Using Land Use Data. Presented at the 58th North American Regional Science Association International (RSAI) Conference, Miami, Florida. Journal of Transportation and Land Use 6 (3), November 2013.

Wang, Y., Kockelman, K., & Wang, X. (2013) Understanding Spatial Filtering for Analysis of Land Use Data Sets. Presented at the 58th North American Regional Science Association International (RSAI) Conference, Miami, Florida. Journal of Transport Geography 31: 123-131.

Wang, Y., Kockelman, K., & Wang, X. (2011) Anticipating Land Use Change Using Geographically Weighted Regression Models for Discrete Response. Transportation Research Record No. 2245: 111-123, & presented at the 90th Annual Meeting of the Transportation Research Board.

Wang, Y., Sun, X., & Melcher, D. (2008) Statistical Cause Analysis & Potential Countermeasures for Commercial Motor Vehicle Collisions in China. Presented at the 1st International Symposium on Transportation & Development Innovative Best Practices, Beijing, China.

Wang, Y., Rong, J., & Qiao, J. (2007) Quantification of Driver Stress & Its Influence Factors. Presented at the Workshop of International Cooperation on Theories & Concepts in Traffic Safety, Beijing, China.

AWARDS

Garrison Award for Best Dissertation in Computational Geography, Association of American Geographers (2014)

Honorary mention in Pikarsky Award for Best PhD Dissertation, Council of University Transportation Center, TRB (2014)

UT nominee to compete in the International Road Federation (IRF) Scholar Program (2013)

UT Austin Department of Civil, Architectural, & Environmental Engineering's Robert Herman Endowed Scholarship (2013)

Women's Transportation Seminar, Heart of Texas Helene M. Overly Memorial Scholarship (2011)

UT Austin's Graduate Student Professional Development Award (2011)

Regional Science Association International's Student Paper Awards Winner (2010)