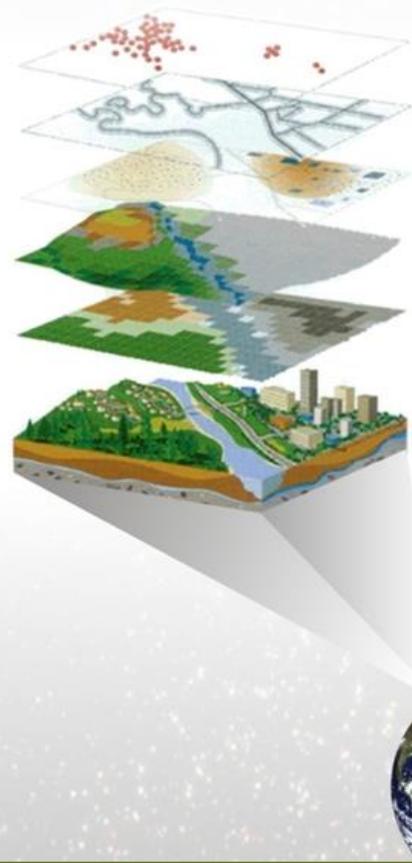


Universal Law of Location Supported by GIS as a Best Practice Element in Land Use Planning and Transportation Planning Decision Systems

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A. Stimulus for Report

During the 2022 City of Ottawa municipal election campaign, candidate Mark Sutcliffe and now- Mayor Mark Sutcliffe pledged to plant 1,000,000 trees during the 2022-2026 term.

When I heard that pledge I wondered where candidate Sutcliffe was going to find many millions of square metres (or many, many millions of square feet) of readily available “free space” in a fully planned and fully zoned city.

However, wondering turned to deep concern when it became increasingly apparent to me after about six months into the term that Mayor Mark Sutcliffe and many members of this council have limited understanding of and very little respect for the critical role of geography and geographic information systems (GIS) in avoiding negative outcomes such as the following:

- A.** Land use planning and transportation planning decisions of previous and current councils which have citizens shaking their heads in dismay after ill-founded decisions involving the city’s geography.
- B.** Broadcast media and social media bitterly criticizing previous and current councils for their failure to properly inform citizens about the geographic aspects of land use planning and transportation planning situations and decisions.
- C.** Broadcast media and social media communications taking previous and current councils to task for their failure to provide citizens proper GIS access to City of Ottawa records regarding the geographic aspects of land use planning, zoning, and development applications.
- D.** Broadcast media and social media communications condemning previous and current councils for their failure to provide citizens with sound explanations for such geography-based proposals and decisions as:
 - Where to locate very high residential towers?
 - Where to locate thousands of affordable housing units?
 - Where to locate massive warehouse facilities?
 - Where to locate speed display boards?
 - Where to locate automated speed enforcement systems?
 - Where to locate heavy truck routes?
 - Where to expand the urban boundary?
 - Where to restrict floodplain development?
 - Where to locate vehicle and active transportation bridges?
 - Where to restrict motor vehicle traffic?
 - Where to locate long-term care facilities?
 - Where to locate waste disposal sites?

- Where to vigorously apply good, better, and best practice planning principles including highest and best use, and fully integrated land use planning and transportation planning?

Even more disconcerting, however, is that the numerous failures by Ottawa mayor and councillors to appreciate the significance of geography and GIS do not involve new thinking, far from it, and therein lies a problem that should be of major concern to citizens.

In brief, all of the above and many more geography-related failings of municipal politicians in Ottawa (and elsewhere for that matter) were identified decades ago by Ottawa citizens and community associations, as well as by numerous geographers, planners, regional scientists, remote sensing scientists, environmentalists, ecologists, engineers, and other professionals inside and outside municipal governments in Canada and abroad.

On this point of geography-related failings, I introduced the “Doomsday Map” to a conference audience in 1990. **(1)**

As Internet timeline students are aware, this was before the Google search engine was born (1998), which dramatically changed how data, information, and knowledge providers such as newspapers could be sourced. Back then, and this may puzzle the digital generations, but one had to physically gain access to newspapers in order to read them. (Oh, the humanity!)

The connection over time is that newspaper articles assembled for the 1990 presentation are grim precursors to those published by broadcast media and social media platforms in 2024 about geography-related municipal planning and development failures.

Publications on the Doomsday Map are available online and the reader is referred to them for details. **(2)**

One detail pulled from those publications for this report is “The Geographer’s Lament”, which is especially pertinent to the thesis of geography-related failures by Ottawa councils (and other municipal councils). It is presented in Figure 1 because it provides a sharply directed context for the remainder of the report.

I believe the evidence is overwhelming that the Geographer’s Lament becomes more pertinent in Ottawa (and many other municipalities) with each passing day, and for one inarguable reason in particular.

That is, if an urban boundary is fixed where it is now, then choices and decisions about what goes where increasingly enter “push comes to shove territory”, because councils have fewer and fewer options about plunking down whatever, wherever, whenever.

And if the boundary is expanded, then costs of urban development substantially increase, and the urban expansion zone displaces and/or encroaches upon life-supporting, non-urban land uses such as farmlands, wetlands, waterways, and forests.

Figure 1. The Geographer's Lament

**With so many wrong things
In so many wrong places,
We have just about -----
All our life-support spaces**

Having outlined the research problem, the research question driving this project is,

What to do to assist municipal politicians **(3)** better understand and have higher regard and more respect for the critical role of geography and geographic information systems (GIS) in achieving more positive outcomes and fewer negative outcomes as a result of their decision processes?

To be clear, this is not new territory, because variations of that question have been asked countless times over the past six decades and answers have been provided by countless numbers of citizens and community associations, as well as by university and college faculty and students, and well as by municipal, provincial, state, and federal staff, and GIS industry researchers and consultants.

Regrettably, however, despite the numerous innovations and applications achieved by that collegial effort, and the installation of geographic information system hardware, software and peripheral devices in municipalities across Ontario some four decades or so ago **(4)**, it appears fair to say that municipal politicians as a group, including those on Ottawa councils, have largely failed to properly factor geography and GIS into their mindsets and decision processes. **(5)**

In section B, I take a cue from the Keep It Simple Strategy (KISS) and suggest that a Universal Law of Location might assist Ottawa council members better understand and have higher regard and more respect for the critical role of geography and geographic information systems (GIS) in achieving more positive outcomes and fewer negative outcomes as a result of their land use planning and transportation planning decision processes.

B. Background Comment on Why a “Law” about Location Might Assist Ottawa Council Members Better Understand and Have Higher Regard and More Respect for the Critical Role of Geography and Geographic information Systems (GIS) in Achieving More Positive Outcomes and Fewer Negative Outcomes as a Result of Their Land Use Planning and Transportation Planning Decision Processes

Two background comments are pertinent before presenting materials on the science of theories and laws in a report intended to assist City of Ottawa council members (and those from other municipalities) better understand and have higher regard and more respect for the critical role of geography and geographic information systems (GIS) in their land use planning and transportation planning decision processes.

First, a number of members of this council and previous councils, as well as many councils in Canada declare that their proposals and decisions are “data-driven” and “evidence-based”.

Taking them at their word, this means that they are in sync with productions describing the reality → data → information → knowledge transform process **(6)**, which is a core element of such transform processes as observations → laws, experiments → laws, hypotheses → theories, and theories → laws.

As a result, this report is consistent with claims about their proposals and decisions being “data-driven” and “evidence-based”.

Second, widespread condemnation by citizens of councils for their failure to provide citizens with sound explanations for geography-based proposals and decisions calls for a major upgrade in how decisions are made, and how they are explained to citizens.

It seems apparent, therefore, that current processes must be replaced by highest-order thinking and doing, such as by having decision processes grounded in science and not being susceptible to vague election campaign pledges, whim, or in-the-moment-top-of-head druthers. The term “best practice” is often used to describe this highest level of thinking and doing. **(7)**

With those background notes in place, we now present the materials on science, theories, and laws.

Laws in science are the products of a transformative process, such as observations → laws, experiments → laws, hypotheses → theories, and theories → laws, whereby laws become the apex of what is known about particular relationships.

A short list of laws from various fields is presented in Table 1 in recognition of those who have contributed to my thinking about how to formulate the Universal Law of Location which states that something is everywhere below, on, and above the surface of the Earth. (8)

Table 1. A Selected List of Laws from Various Fields, and Names Associated with Them as Discoverers or Contributors to Their Evolution*

LAW	NAME(S)
Law of Cosmic Expansion	Hubble
Law of Diminishing Returns	Malthus
Law of Elasticity	Hooke
Law of Highway Congestion	Downs
Law of Large Numbers	Bernoulli, Borel, Cardano, Diaconis, Kolmogorov, Markov, Mosteller, and Poisson
Law of the Minimum	Liebig
Laws of Motion	Newton
Law of Natural Selection	Darwin
Laws of Planetary Motion	Kepler
Law of Partial Pressures	Dalton
Law of Fluid Dynamics	Bernoulli
Law of Heat Conduction	Fourier
Law of Reflection	Euclid
Law of Retail Gravitation	Reilly
Law of Supply and Demand	Smith
Laws of Thermodynamics	Clausius, Thompson, and Nernst

**There can be multiple contributors to the evolution of a law, such as the Law of Large Numbers. Further, the language of “names associated” does not distinguish between original discoverers and derivative contributors but serves to recognize both types of contributors in the evolution of a law.*

C. Geographic Representations

Geographic representations include manually produced and machine produced maps, images, photographs, videos, graphics, models, and artifacts of everything that is located above, below, or on the surface of the Earth.

There are multi-billions of geographic representations held by governments, educational institutes, businesses, and individuals. Figures 2A, 2B, and 2C illustrate some of the countless entities which are the subjects or objects of these representations.

Then, figure 2D provides a selection of geographic representations of land use and transportation entities which are the focus of this report on the process of discovering the Universal Law of Location.

The common theme among all the representations is that something is everywhere in figures 2A, 2B, 2C and 2D. Or, to re-phrase, everywhere under, on, and above the Earth's surface is populated, occupied, covered, wrapped, etc., by something.

Or, to rephrase again, there is an omnipresence about geography in that wherever the location, above, below, or on the surface of the Earth, there is always something there, universally. No exceptions, which is the essence of a law positing that something is everywhere.

D. Observations about the Universality of Where: Peoples' Everyday Experiences-Common Sense

Everyday experience-common sense is one of five ways of knowing, along with authority, intuition, revelation, and science. **(10)** While the limitations of the everyday experience-common sense way of knowing are thoroughly documented, those limitations are not applicable to this study. **(11)**

That is, people experience life on, above, and below the Earth's surface, and at every location that they experience on, above, or below the Earth's surface, something is there, everywhere, without exception.

Further, since individuals' everyday experiences include conscious and unconscious or subconscious observations that something is everywhere, it is logical to posit a Universal Law of Location which states that something is everywhere on, below, or above the Earth's surface.

Conversely, no evidence has been found in the literature dealing with physical world matters **(12)** claiming to have experienced a location anywhere above, on, or below the Earth's surface with nothing there. **(13)**

Finally, with regard to the pledge of planting one million trees in four years within the boundary of a fully planned and fully zoned city, everyday experience-common sense says that something is already everywhere. So, the common sense-everyday experience question is, "If something is already everywhere, what is coming out at one million locations so that the trees can go in?"

Figure 2A. Representations of Earth from Space

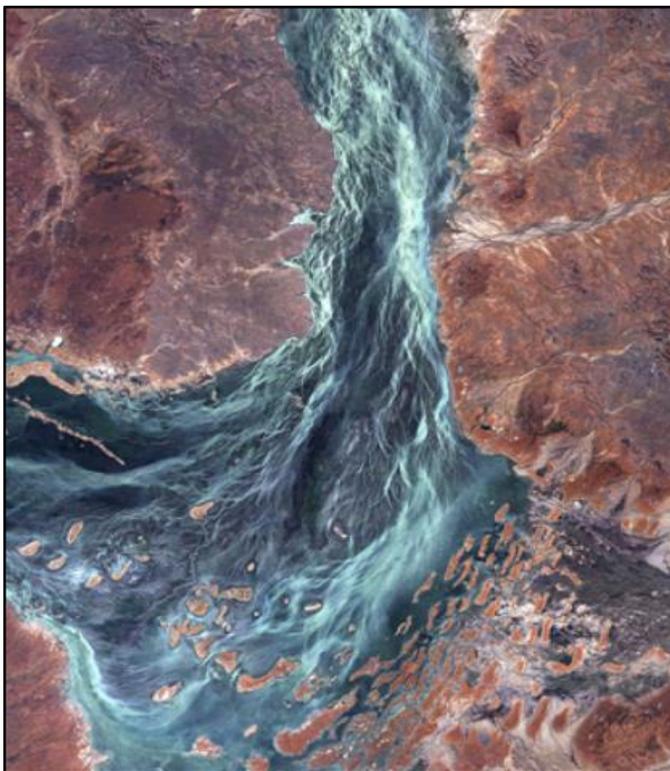
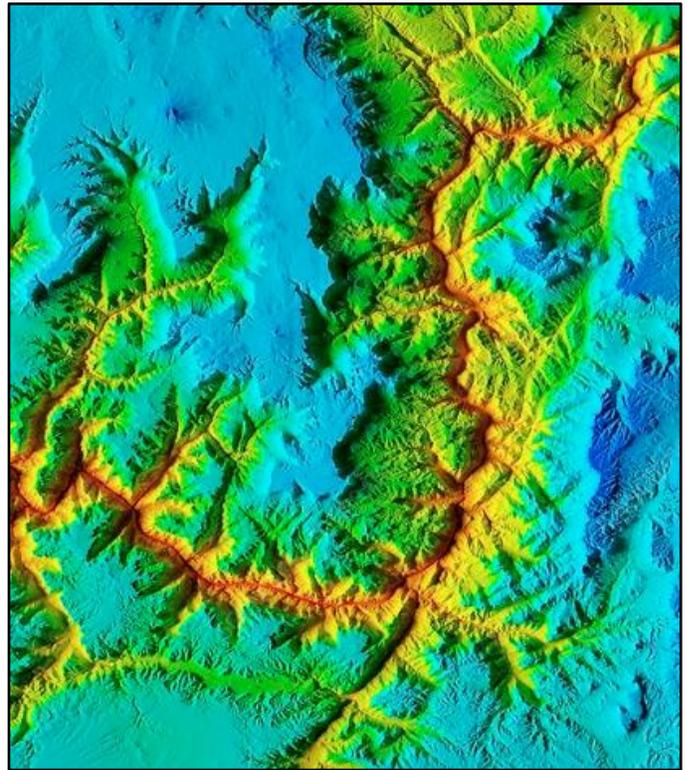


Figure 2B. Representations of Earth at Ground/Water Level



Figure 2C. Representations of Earth Below the Surface

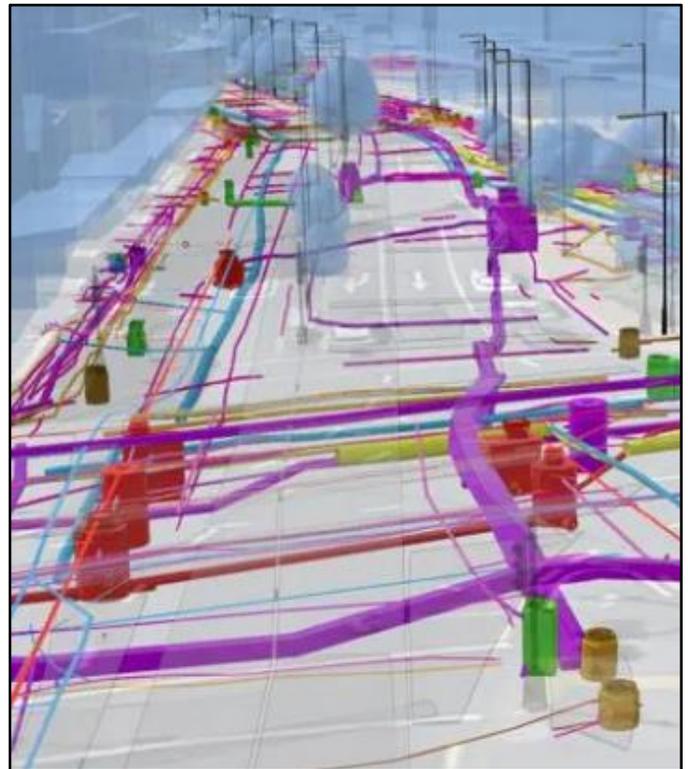
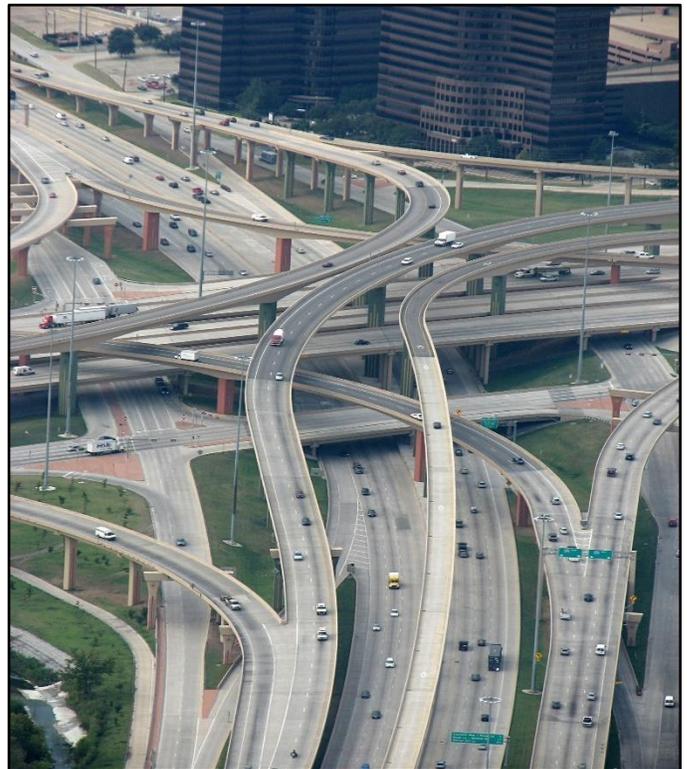
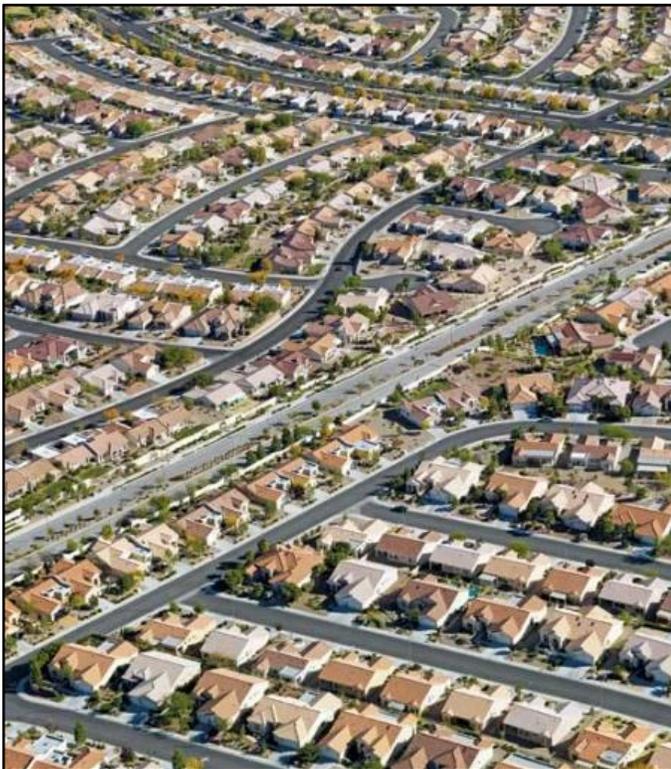


Figure 2D. Representations of Land Uses and Transportation Entities



E. Observations about the Universality of “Location”: Contribution of Google Webpage Listings to Affirming the Universal Law of Location

In recent years Google has become an Internet “go to” site on a daily basis for many millions of people who type words or phrases or URLs into the Google search bar, and Google search engines do the heavy lifting by compiling lists of webpages containing the keywords, phrases, or URLs.

Previous Information Research Board studies using Google search capabilities suggest that there could be a universal dimension to the results obtained by using location-related terms in Google searches (14). That posit is now explored.

The Google search results for “location” and a selection of subterms are presented in Table 2.

Table 2. Google Search Keywords and Results Pertinent to Discovering a Universal Law of Location*

KEYWORD	RESULT
Location	17,610,000,000
Anywhere	3,690,000,000
Elsewhere	1,210,000,000
Everywhere	2,370,000,000
Here	25,270,000,000
Nowhere	898,000,000
Somewhere	1,800,000,000
There	19,290,000,000
Where	18,270,000,000

**Searches were conducted July 10, 2024*

Table 2 reveals that “location” and “where”, as well as words that affix prefixes and suffixes to “where”, are more than just highly popular webpage tags. (15)

That is, along with who, what, when, why, and how, which have been known as the “5Ws and H” since forever in classrooms and broadcast news stories, “location” and its subterms may be regarded as a universal element for inclusion in web productions having any relationship with Earth’s land, water, or air, or with Earth’s place in the planetary system.

In support of that posit, consider the Google search keywords and the results in Table 3.

All the terms in Table 3 are pertinent to this research report but, in my experience, the webpages containing these societally important terms would actually engage only select groups of producers and users, and would infrequently engage the general body of Internet participants who are thoroughly familiar with the role that location and its “where” variations play in their lives. **(16)**

As a result, because of the relative universality of location and its variations in webpages, I believe that the numbers presented in Table 3 contribute to affirming the validity of the posited Universal Law of Location which states that something is everywhere on, below, or above the Earth’s surface.

Table 3. Google Search Keywords and Results Used to Assess Universality of Location-Related Keywords*

KEYWORD	RESULT
Climate change	1,350,000,000
Economics	2,080,000,000
Engineering	3,430,000,000
Epidemiology	637,000,000
Geography	2,879,000,000
Geology	968,000,000
History	13,180,000,000
Hypothesis	892,000,000
Land use planning	20,600,000
Mathematics	1,380,000,000
Methodology	869,000,000
Physics	1,410,000,000
Remote sensing	235,000,000
Research	10,330,000,000
Sociology	739,000,000
Statistics	940,000,000
Surveying	127,000,000
Theory	1,670,000,000
Transportation planning	9,540,000

**Searches were conducted July 10, 2024*

As to the value, importance, significance etc., of the volume of webpage results captured by Google for a word, phrase, or URL, numerous questions arise in that regard, and I am among the many researchers who have done so.

However, I believe that the volume of Google search results in this case is a valid measure of significance because of the posited universality relationship.

That is, examination of Google results in Table 3 reveals that producers of those website pages are from dozens of countries and include faculty and student academics from more than a dozen disciplines as well as politicians and non-elected government officials, research institute staff, professional association members, technical association members, think tank staff, members of public interest groups, members of vested interest groups, private sector and public sector consultants, journalists, broadcast industry organizations, and individuals.

It therefore seems that the terms associated with location are widely known and widely used in all manner of productions as demonstrated by the webpages collected by Google search engines. The volume of this productivity referring directly and indirectly to location is taken as a demonstration in the direction of affirming a Universal Law of Location that something is everywhere.

F. Observations about the Contribution of Previous Theories to Discovering a Universal Law of Location which states that something is everywhere on, below, or above the Earth's surface

Table 4 contains a list of theories that present subject matter which is also presented in one or more of Figures 2A, 2B, 2C, or 2D, and/or in Table 1, Table 2, or Table 3.

Three comments should suffice to illustrate the value of including a section on theories in this report.

First, through observation and experimentation research, which may be exploratory and/or confirmatory, laws are discovered which describe relationships, interactions, processes, states, patterns, etc. of phenomena.

Examination of the laws listed in Table 1 reveals the variety of phenomena which have been investigated, and the diversity of disciplines and fields of the engaged researchers.

However, laws are statements about “what is” based on the results of observations or experiments. The role of theories is to explain why things are as stated by the discoverer of the law.

Table 4. A Selection of Theories Which Are Based on the Location of Things

Agglomeration Theory
Center-Periphery Theory
Central Place Theory
Congestion Theory
Dependency Theory
Diffusion of innovations Theory
Distance Decay Theory
Environmental Determinism Theory
Fractal Theory
Graph Theory
Least-Cost Theory
Location Theory
Modernisation Theory
Natural Selection Theory
Rent Theory
Spatial Interaction Theory
Sprawl-Induced Aberrant Driver Behaviour Theory
Stages of Growth Theory
World Systems Theory

All the theories listed in Table 4 as well as other location-related theories have a contribution to make in explaining why some things are at some locations and not others, and predicting where some things will be located, re-located, replaced, or removed.

Second, theorizing serves the two fundamental objectives of science, that is, adding to knowledge, and adding to ways of continuing to add to knowledge by articulating theories which explain laws. However, the theoretical framework also provides a context for the hypothesizing phase of the research design.

In brief, the research question and the research statement of problem underlying the theorizing process are significant contributions to science.

Consequently, all the theories listed in Table 4 contain lessons learned for theorizing about the Universal Law of Location that something is everywhere.

Third, each theory in Table 4 includes regard for location terms in Table 3, which makes this activity part of a large body of location-related research and researchers from a variety of fields due to cross-pollination among disciplines such as geography, epidemiology, regional economics, regional science, remote sensing, environmental studies, planning, and engineering.

Therefore, it is reasonable to forecast a broad increase in theorizing into how the Universal Law of Location, which states that something is everywhere on, below, or above the Earth's surface affects:

- a) The processes and products of land use planning and transportation planning; and,
- b) The processes and products of land use planning and transportation planning decisions by municipal politicians and citizens.

Further, the “somethings” in many of the theories deal with subject matters that are intrinsic to the fields of land use planning and transportation planning.

The connections of those theories with “real-world things” provide a pragmatic aspect which in my experience will be appreciated by many elected and appointed municipal and regional government officials, and citizens. (17)

G. Observations about Incorporating Geographic Information System (GIS) Technology and Applications to Support the Universal Law of Location as a Best Practice Element in Municipal Land Use Planning and Transportation Planning

In addition to location as a core term, the posited relationship in the formation of the Universal Law of Location is that “something” refers to the totality of “everything” that is above, on, or below the surface of the Earth.

Figures 2A, 2B, 2C, and 2D are several of the many billions of geographic representations of the “somethings” that can be observed above, on, and below the Earth's surface, with the number of observable somethings increasing as the scale or resolution of representation increases.

The countless somethings that could be somewhere on the Earth's surface are briefly outlined.

From the something is everywhere perspective of the locational universality of Earth, we begin with several Earthly geographic features.

Earth's surface has been measured at 510,072,000,000 km² (196,940,000 square miles), with a land surface area of 148,940,000 km² (57,510,000 square miles) and a water surface area of 361,132,000 km² (138,434,000 square miles). **(18)**

Thanks to major advances in remote sensing technologies over the past 75 years, it appears fair to say that all of Earth's land and water surfaces have been covered by images at lower levels of resolution, e.g., scales such as 1:100,000 and 1:50,000, and higher for densely developed areas such as urban-centered regions.

However, the domains of interest in this report are land use planning and transportation planning at the local level. **(19)**

Consequently, in order to drive decisions at the local level, or provide evidence to make or support decisions, much higher levels of resolution are called for, such as those provided by scales of 1:00, 1:50, and higher for both land use and transportation planning purposes.

As the reader may be aware, many thousands of documents such as theses, dissertations, papers, books, and entire conference proceedings are dedicated to discussions of spatial resolution and scale.

Therefore, a brief, indicative discussion should suffice to establish why geographic information system (GIS) science, technology and applications are required in order to effectively support the Universal Law of Location at the best practice level in municipal land use planning and transportation planning.

Higher levels of resolution mean that within an image more objects can be identified. As a result, with increasing resolution the greater the number of locations, their contents, and their environs that can be observed and recorded or georecorded, and can then be subjected to increasingly definitive analysis and synthesis procedures.

That is a static representation of course, and many readers may have already seen dynamic representations such as those made popular by Google Earth with its + and – button to increase the scale and, hence, resolution of an image which adds details as the scale and resolution are increased.

If this line of argument seems familiar to some readers, and to geographers in particular it should, witness early works in the domains of areal differentiation and small area data.

The concept of areal differentiation was popularized by geographer Richard Hartshorne more than 80 years ago, and areal differentiation remains a topic of interest at all levels of planning from local to national, and even international when consideration is given to a global issue such as climate change. **(20)**

Figure 3. Illustration of the scale and resolution dimension. Image A is small scale and low resolution, and then the scale and resolution levels increase for Image B, Image C, and Image D of the same image.



Further, the emphasis of location in Hartshorne's work makes it a predecessor of the current research report. That is, the Universal Law of Location which states that something is everywhere on, below, or above the Earth's surface, can logically be derived from Hartshorne's work, as well as from the works of many researchers who adopted, refined, or critiqued Hartshorne's arguments.

As for building small area databases, this began as a topic of considerable interest in several fields in the 1950s and 1960s, and was due in part to increased emphasis on adoption of computer-based data processing capabilities in universities, research institutes and governments at all levels, including local governments. **(21)**

One of the driving forces in the small area data initiative and directly relevant to this research project was the transportation field, and leading small area data proponents were from the U.S.

In addition to needing small area data to support research into local impacts of the Interstate Highway System in the U.S., small area data were also needed to plan for and measure impacts of expanding road systems to accommodate post-war urban and regional expansion.

Illustrative transportation research topics requiring small area data include origin-destination (O-D) studies, and studies measuring generated, diverted, and induced traffic volumes, distributions, patterns, etc., resulting from land use and transportation system proposals and decisions. **(22)**

William Garrison, a geographer, civil engineer, research methodologist, and early contributor to the field of urban information systems was a pioneer advancing the case for small area data to be used by all levels of government. **(23)**

The present report on the Universal Law of Location, which states that something is everywhere on, below, or above the Earth's surface, takes small area data to a level of resolution that was envisaged by Garrison more than 50 years ago. And, I hasten to add, Garrison's early work and that of his University of Washington colleague Edgar Horwood, founder of the Urban and Regional Information Systems Association, continue to be foundation materials for much of the current research linking GIS and land use planning and transportation planning. **(24)**

Which brings me one of Garrison's key discussion points, that is, "How small is small?", as in small area data?

Back in the day, Garrison and other small area data advocates argued that doing urban spatial analysis at the scale of counties and Standard Metropolitan Statistical Areas for

example, was too crude to produce informative findings for many policy and planning purposes.

What they sought were robust databases which reached as small an areal unit as technology could achieve, such as city blocks as areal units, and, even better, block faces.

By mid-2024 it seems that most bets are off when it comes to specifying the limit of image resolution of any entity anywhere and everywhere on the Earth's surface. And, in that same vein, the rate of transmission of images from remote sensors is seemingly unbounded, as is the machine-processing rate of images.

Further, due to rapid advances in computer-communications technology, large volumes of land use planning and transportation planning data can already be widely disseminated at speeds which are seemingly comprehensible to relatively few humans. **(25)**

All to say, many of the technical and technological constraints identified decades ago have been overcome, so we are now able to obtain representations of location data at seemingly any spatial or temporal scale that is required for purposes of data-driven or evidence-based land use planning and transportation planning.

However, those capabilities have their own constraint which needs to be made explicit because it underlines why better and best GIS practices are a *sine qua non* condition of achieving better and best practices in land use planning and transportation planning.

That is, most adults read non-technical materials at a rate of less than 350 words per minute, and a considerably lower rate can be expected for technical materials involving research methods and techniques, mathematics, statistics and probability, and other technical inputs to the research design process such as the reality-data-information-knowledge transform process, and the hypothesis-theory process. **(26)**

The bottom lines for this section of the report, therefore, are two takeaways that provide a new look to the challenges-opportunities theme which has characterized many conference programs.

First, achieving a good, better, or best practice GIS capability does not guarantee that a local government will achieve a good, better, or best practice level in land use planning and transportation planning. **(27)**

However, the farther away GIS practice is from planning practice on the worst, worse, bad, good, better, best scales that apply to GIS practice, and planning practice, the higher the likelihood that talk about data-driven decisions and evidence-based decisions will continue to ring hollow.

The message for the GIS community, therefore, is that despite more than 50 years of effort many elected officials are still not giving geographic space and spatial location their due, preeminent regard when making land use planning and transportation planning decisions.

Given that circumstance, I believe the Universal Law of Location, which states that something is everywhere on, below, or above the Earth's surface, could be a major force for change. That topic is the focus of section H.

Second, my experience teaching research methods and research techniques courses at the undergraduate and graduate levels covers 30 years.

And that span of time explaining how research methods work in principle is complemented in practice by 50 years of parallel involvement in data-driven and evidence-driven decision-making activities in academia, government, business, professional associations, and public participation.

I believe that over those years there has been a substantial drop in societal commitment to formal, science-based education, training, learning, and communication skills, and an increase in attention paid to Internet productions of two kinds:

Visuals with snapshot and often frivolous tags, and simplistic comments (posts) which thrive on appealing to bias, and on minimizing any need to engage in critical thinking before accepting or rejecting whatever comment is presented.

However, I also believe that due to those shifts in education, training, learning, and communication skills, there is increasing interest in the geographical representation of locations, and the geographical representation of relationships within, between, and among locations in whatever way they are defined.

The challenge for both the geographical and GIS communities, therefore, is to become the core resource for citizens and politicians who choose to make informed data-driven and evidence-based decisions about land use planning and transportation planning issues and choices, but without the heavy lifting that comes with numbers and lengthy, complex texts.

(28)

And the essence of that challenge, I suggest, is to convince citizens and politicians that the time is now for Universal Law of Location to be top of mind when engaging in land use planning and transportation planning discussions and decisions. That topic is the focus of section H.

H. Observations about Incorporating the Universal Law of Location as a Best Practice Element in Municipal Land Use Planning and Transportation Planning Discussions and Decisions

The observations in this section are designed primarily for consideration by municipal politicians, citizens, and municipal staff.

Since these observations are derivatives of materials that have been presented in previous sections, we follow the Keep It Simple Strategy.

That is, the materials are limited to straightforward observations that citizens can put to politicians and staff, and in response expect to receive responses that meet citizens' expectations about transparency and accountability of their elected and appointed municipal officials. **(29)**

Six observations are presented in this report, others have been set aside for companion reports.

1. Every land use planning and transportation planning decision affects and is affected by previous decisions, so it is careless disregard of the first order to act as if the Universal Law of Location does not apply everywhere all the time.

The Universal Law of Location states that something is everywhere on, below, or above the Earth's surface, and as noted earlier we are eternally surrounded by that truth anywhere we look or sense below, on, or above the surface of the Earth.

It therefore follows, rationally and responsibly, that before land use planning or transportation planning proposals are presented or decisions are made, citizens are properly informed about how the proposals and decisions affect the things which are already in place as a result of previous decisions.

Further, it also follows that in order to properly inform citizens about land use and transportation planning proposals and decisions, governments will ensure that citizens have free, easy, timely, and direct online access to needed GIS-based records.

Several future case study reports in this series examine land use and transportation planning proposals and decisions for the regard shown or not shown for the Universal Law of Location.

2. Cherry picking is long over when it comes to easy land use planning and transportation planning discussions and decisions, and GIS is now a critical policy, plan, program, and operations tool.

Relatively speaking, land use planning and transportation planning discussions and decisions have gone through seven or eight significant phases in Canada in the past 100 years.

Over that passage of time each phase has become more difficult and consequential than the last, because reacting to difficulties at the moment is not planning. Rather, it is misguided expediency that frequently requires massive adjustments to deal with large numbers of flawed decisions made during each term of office at all levels.

Lack of regard for the constraints that geography puts on urban development options is a primary reason why so many municipalities are in states of deep environmental, economic, financial, and social stress, and why that stress will prevail until there is preeminent regard for the “where” factor in land use planning and transportation planning discussions and decisions.

Based on the preceding pages, the stress remedy lies in large part in accepting the message of the Universal Law of Location and adopting GIS as a best practice element in land use planning and transportation planning decision systems.

3. Municipal governments carry the can for their blunders, and frequently for those of provincial, territorial, and federal governments.

Municipal governments bear the brunt of bungled provincial and territorial government land use planning and transportation planning decisions **(30)**, many of which are due to failed regard for the geographic factor by the upper-tier government.

However, municipal officials across the country have disserved their constituents by failing to take the provincial and territorial governments to task for their failure to properly take the geography factor into account at the policy and program level, and instead sacrificing the geography factor for riding-specific, short-term partisan votes.

Several comments are needed to substantiate this observation.

First, municipalities across Canada participate in provincial associations as well as the Federation of Canadian Municipalities, and the presence of geography in their conference programs and briefs to upper levels of government is just this side of non-existent.

Second, it seems that municipal and provincial/territorial politicians seem to prefer making jurisdictional arguments rather than solving issues that are rooted in geographic differences and inequalities.

For cases in point, I think back to my time at the federal Ministry of State for Urban Affairs (MSUA), 1972-1979, when my chronological work history included senior researcher

officer, urban information coordinator, chief urban management, assistant director information systems, director, small community development, and senior policy advisor.

After a review of files and publications I believe it is accurate to state that many of today's municipal "hot button" issues (e.g. housing, transit, loss of rail service, immigration, jobs, regional inequalities, health care, environmental degradation, downloading, off-loading, inadequate funding) are pretty much the same as they were 50 years ago, with few if any signs of imminent change in inter-governmental relationships.

And yet, after 50 years of minimal progress in actually solving Canada's urban problems, or its smaller community problems, and geography-related issues staring politicians from all levels of government in the face for all of those 50 years, political parties and politicians continue to push the "same old, same old" agenda to no avail.

Third, in 1976 MSUA hosted a breakthrough symposium, Information Technology and Urban Governance. **(31)** The symposium was a breakthrough event as the first meeting in Canada bringing together international expertise and experience discussing the roles of the management, planning, operations, and data processing functions in information technology evolution.

Further, since MSUA's mandate was to offer policy advice, and to promote urban research initiatives by all levels of government, one such initiative followed directly from the symposium. Until the Ministry was closed in 1979, resources were expended on promoting and assisting in the adoption of information technology hardware, software, and peripherals by municipal governments.

As of 1979, however, the GIS field was still in early days, a.k.a. the research and development phase, and did not play a leading role at the Symposium. However, the Symposium fed expectations at the staff level that the large volume of geographic files then largely in manual form would be a core part of the worldwide electronic revolution in governments that was into its first decade.

Over the past near-five decades the GIS community – industry, governments at all levels, academics, GIS associations – has stepped up significantly. Today, in my experience, the Canadian GIS community has the competency to turn the Universal Law of Location which states that something is everywhere on, below, or above the Earth's surface into a primary consideration that must be factored into every non-trivial land use planning and transportation decision made by all Canadian governments.

A critical question is whether municipal, provincial, territorial, and federal politicians have the competency to use this resource to its fullest, best practice capacity.

4. The term “density” is mentioned with great frequency by municipal politicians and citizens, as well as by provincial politicians, but rarely is the term defined in a way that it can be used for methodologically sound data-driven or evidence-based decisions. (32)

In this report density is defined as a geographic concept which is illustrated by the following examples where the numerator refers to the number of a variable of interest, and the denominator refers to a spatial unit of measure:

- # of housing units / hectare; # of assaults / km²; # of vehicles / lane km;
- # of 311 calls / hectare; # of trees / hectare; # of private motor vehicles /km²

And, from a geographic perspective, figures 4A, 4B, and 4C illustrate different ways that density is represented in a map.

In my experience over the past 50+ years, it is the rare municipal or provincial government which represents levels of density by GIS productions that enable citizens to ascertain the implications of non-trivial density level changes, and especially the impacts of changes in density levels on other land uses, municipal services, and municipal infrastructure. (33)

Moreover, questions and decisions about where densities are to be increased or decreased for similar or different land uses too often lack methodologically sound data-driven support. Further, I am not aware of a municipality in Canada where decisions about changes in density are supported by GIS applications which perform impact assessments at levels commensurate with the consequences of the discussions and decisions.

Figure 4A. Grocery Stores Density Map, Toronto

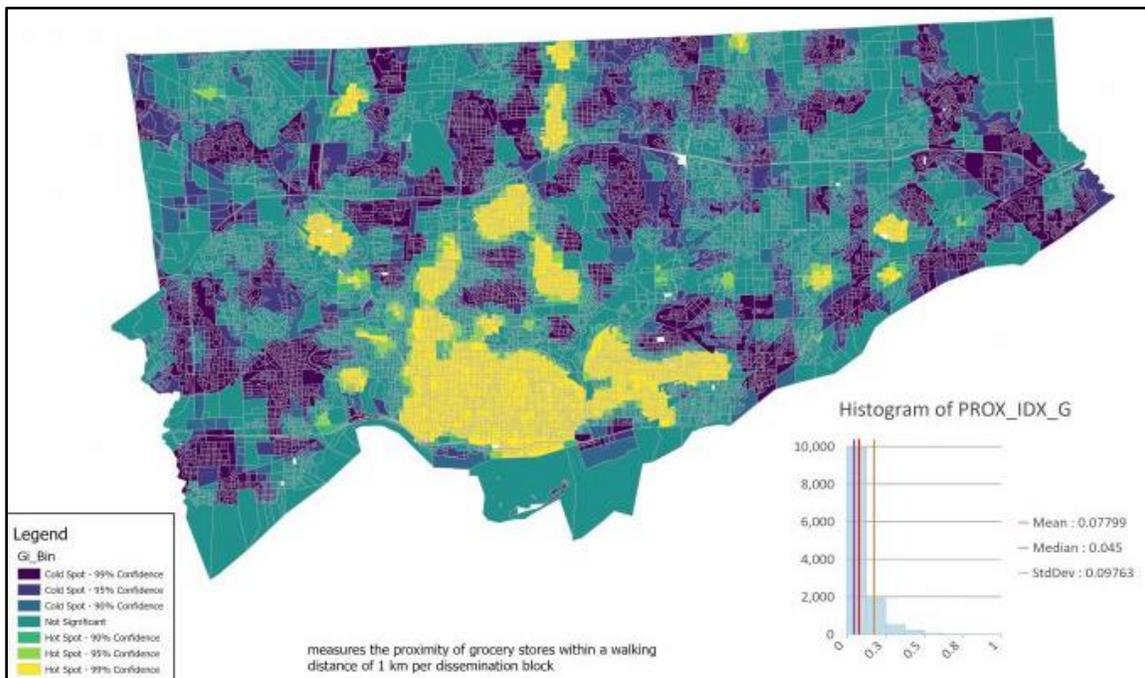


Figure 4B. Population Density Map, Vancouver

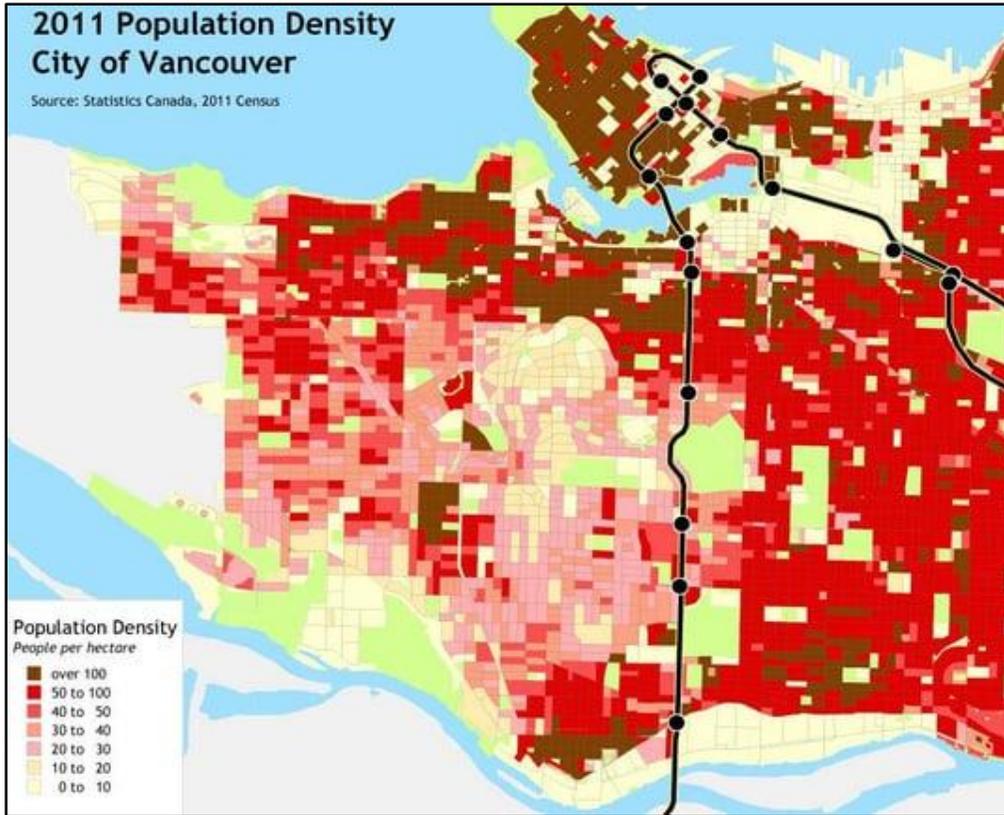
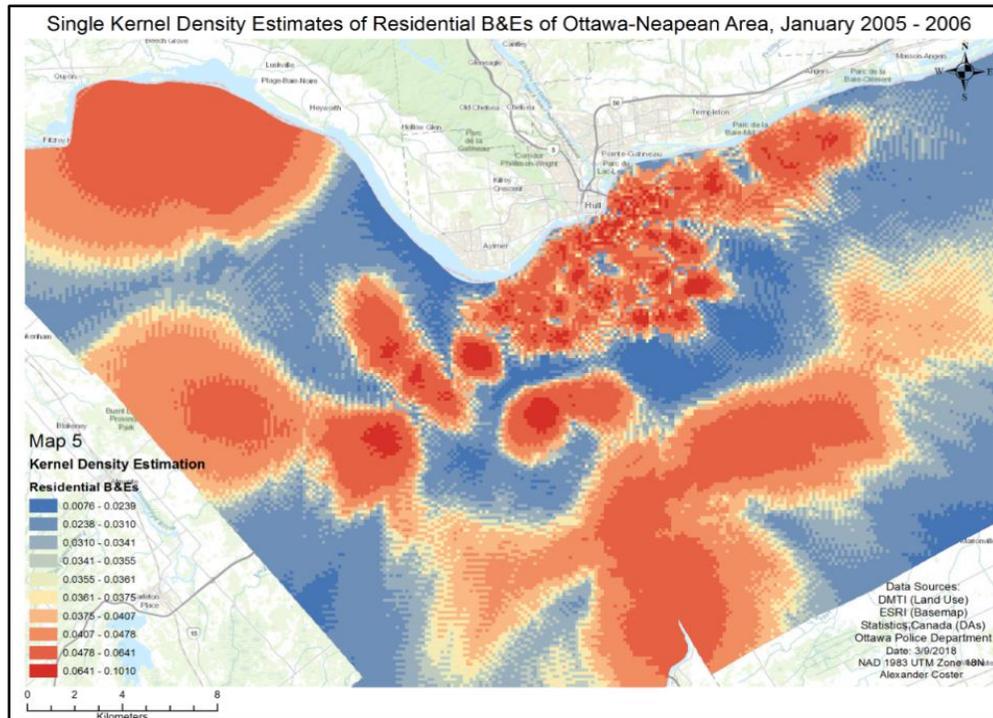


Figure 4C. Crime Density Map, Ottawa



However, the risk of nasty surprises arising from flawed discussions and decisions about proper density levels goes up significantly when situations involve converting land use I, J, K, or L to land use M, N, O, P, and especially if the GIS capability is inadequate to effectively steer and drive informed discussions and decisions.

In either case, sound discussions and decisions about density levels depend very much on the GIS capability which is in place to support data-driven and evidence-based examination of planning issues and choices.

Moreover, the soundness of decisions is also affected by the complexity of the reality which is transformed to data, and then to information, which could be relatively complex process yielding a complex body of materials.

As for the Earthly reality in which politicians and citizens exist, a positive approach is taken by the Universal Law of Location which states that something is everywhere on, below, or above the Earth's surface.

And, in the spirit of having regard for alternate explanations, consideration is also given to the contrary view that there are no locations below, on, or above the Earth's surface with nothing there, which may be helpful in elaborating the complexity aspect and the meaning of "universal".

That is, non-trivial changes in density of use of land in one location or a set of locations may have non-trivial implications for those locations, as well as for many other locations.

(34)

The onus is therefore on citizens to demand their politicians make data-driven density decisions which are based on GIS productions that citizens can use to ensure that transparency and accountability standards set by citizens are met.

5. The term "intensification" is bandied about with great frequency by municipal politicians and citizens, as well as by provincial politicians, but rarely is the term defined in a way that it can be used for methodologically sound data-driven or evidence-based decisions. (35)

The concept of "intensification" is pertinent to many fields, and is subject to many definitions, some of which are tautologies and use the concept of "intensity" to define "intensification".

In this report the concept of "density" which is discussed from a geographic perspective in section 4 is used to elaborate the concept of intensification as it pertains to land use planning, transportation planning, and GIS.

In brief, intensification means that density of use is increased, which can be achieved by various means. Options include upzonings on a case-by-case basis through "relaxing"

zoning conditions for particular locations, and by revising sections and paragraphs of an Official Plan, General Plan, Comprehensive Plan, or other Plan such that increased densities become the new normal for a variety of land uses.

Examples of ways to increase housing unit densities, for example, include reducing lot sizes in a new subdivision, requiring four housing units on sites which previously contained one unit, adding floors to a building application so that the number of units on the same footprint increases from 100 to 150, and rezoning parkland to residential and permitting a cluster of high rises which increase the number of housing units in that square kilometer from zero to 2800.

Two comments should suffice to illustrate why due regard for the Universal Law of Location is critically important to making sound decisions that involve the intensification concept.

First, rarely are the impacts of intensification fully elaborated, which means that in all likelihood the impacts are never defined in a transparent and accountable manner.

I await evidence to the contrary but, in the meantime, I am going with thousands of broadcast and social media reports which establish that the impacts of major intensification developments such as shopping centres, arenas, baseball complexes, industrial parks, medical centres, hospitals, condominium clusters, transit stations, and highway interchanges on surrounding lands are generally under-stated.

This understating process includes proponents painting impacts to be of the minimalist, short-term variety, and pushing their agenda with little regard for impacts on those surrounding land uses, much less having any regard for what happens if those other uses also go through an intensification process.

It is far past time for politicians to ensure that the big picture is in play when intensification is on the table, rather than run it up the flagpole like a magic wand to limit critical discussion about what kinds of things are located where, and the impacts that different orders of intensification will have on them.

Second, intensification initiatives can have impacts which extend over many kilometres below, above, and at the Earth's surface. And the impacts can last for five, ten, 20, to 100 or more years.

To my knowledge and that of others consulted on this project, as well as literature review findings, the only way a government at any level can properly inform citizens about intensification applications, proposals, and decisions is by GIS.

And, the only way that governments can properly inform citizens about the impacts of intensification activities is through GIS due to the potentially large number of intensification locations in a given area within a given time period, the potentially large number of affected intensification locations, the possibility of rapid changes necessitating frequent updates, and the potential demand by citizens for free, easy, timely, and direct online access to intensification records.

6. The term “congestion” is mentioned with great frequency by municipal politicians and citizens, as well as by provincial politicians, but rarely is the term defined in a way that it can be used for methodologically sound data-driven or evidence-based decisions. (36)

The concept of “congestion” is pertinent to many fields and interests, (176,000,000 Google results, and is subject to many definitions.

In this report the concept of “density” which is discussed from a geographic perspective in section 4 is used to elaborate the concept of “traffic congestion” (42,800,000 Google results) and “land transportation congestion” (10,400 Google results) as they pertain to transportation planning and GIS.

Following the lead of the density discussion in section 4 above, this section discusses congestion and land traffic congestion in particular as geographic concepts. **(37)**

Land traffic includes movement by walking, cycling, bus transit and rail transit, rail freight and truck freight, personal private motor vehicles, and for-hire private motor vehicles.

And, land traffic infrastructure includes sidewalks, bike paths, roads (local, regional, inter-regional), busways, rail transit corridors, driveways, parking lots, bridges, rail lines, bus and light rail transit stations, heavy rail stations, rail yards, and freight yards which may be below, on, or above the Earth’s surface. **(38)**

Or, to rephrase, all these pieces of land traffic infrastructure are located somewhere. Moreover, they take up a considerable amount of space in urban areas, frequently exceeding 25% of the developed land mass within an urban boundary.

From a location perspective that is a large amount of urban real estate and, for the reason of magnitude alone, any decisions about retaining that share of urban land much less increasing it warrants detailed, ongoing, critical examination by politicians and citizens.

Which brings us to the matter of how claims about congestion are used to expand the share of urban land allocated to the vehicular network by expansions of existing roads and intersections, and the addition of municipal, regional, and inter-regional roads.

Three comments should suffice to illustrate why due regard for the Universal Law of Location is critically important to making sound decisions that involve the congestion concept applied to land traffic infrastructure.

For this report the congestion focus is on private motor vehicles and urban roads, in large part because the vast majority of traffic congestion complaints and political responses to complaints appear to involve private motor vehicle operators and roads in urban areas.

First, when land use densities are increased or intensification is assigned to a development project (residential, commercial, institutional, industrial, etc.) there are frequently increases in generated trips, induced trips, and diverted trips, as well as changes in traffic distribution patterns over time and space.

If increases in traffic volumes are on roads whose capacities are the same as before the developments, then those who live, operate businesses, etc., along those roads prior to the development project, or used those roads for walking, cycling, driving, or riding buses pre-development project, will experience increased congestion from a minor to a major degree.

The bottom line is that because something is everywhere, increasing density or intensifying land use development in one location has effects on other locations, and road traffic.

As a result, the larger and more frequent the density and intensification initiatives the greater the impacts on an increasing number of affected land uses, including roads and their congestion levels.

All the preceding comments stem from a Bureau of Public Roads research project conducted 58 years ago (see endnote 31 for details) and confirmed countless times in the interim in those cities that relieve motor vehicle congestion by expanding road capacity. As history confirms however, any relief is invariably a short-term and illusory success because, far more often than not, congestion levels rise and quickly exceed those that were experienced prior to the so-called “remedy”.

Regrettably, and this observation is repeated for emphasis because this truth is too often ignored, the original research tends to be confirmed on a daily basis by observations made after the fact, many of which are repeats of observations previously made year after year for many years.

Moreover, numerous literature searches failed to unearth productions which report on municipal governments using a geographic information system or any other capability to map before-the-fact and after-the-fact congestion levels for any road expansion project that was rated by such groups as community associations, neighbourhood associations,

school associations, and other public interest groups to be a significant development project in terms of generating, inducing or diverting traffic. **(39)**

Second, the Universal Law of Location that something is everywhere below, on, and above the Earth's surface also applies when existing roads and intersections are widened, or new roads are built, all purportedly done to relieve or mitigate congestion.

As more than 100 years of observations reveal, those road expansion measures have very limited success in combatting congestion because those measures can lead to increases in diverted and induced traffic, and because they can prompt new developments which lead to new rounds of generated, induced, and diverted traffic, which lead to increased congestion which leads to more road expansions and then more developments, etc.

Again, the original BPR research tends to be confirmed daily by observations made after the fact, many of which are repeats of observations made year after year for many years with no end in sight.

One common thread in both cases is the message to have proper regard for the reality that something is everywhere, and to be aware of the likelihood that externalities, both negative and positive, will be associated with every non-trivial change to existing land uses and highway networks.

And a second common thread is the message for citizens and politicians to take advantage of what a high-level GIS can do to explore the different ways to address congestion issues, and especially if achieving a more sustainable transportation plan is a goal of citizens and politicians.

Third, the concept of congestion is difficult to put into words because there are so many conceivable levels with conceivable consequences, that a text approach is likely to run to far more pages than many citizens and politicians are prepared to endure.

Further, based on my experience over the past 50 years, relatively few citizens and politicians are comfortable working their way through pages of mathematical formulae representing different congestion conditions.

Moreover, few citizens and politicians seem keen to pore over tables and graphs depicting the results of calculating the parameters and statistics describing all the relationships that are pertinent to understanding how congestion levels vary according to the mix of road users, land uses, and road network characteristics.

What the preceding paragraph refers to are variables which can easily number in the several dozens for relatively crude congestion studies, to the many dozens for more definitive, large scale cross-sectional or longitudinal studies.

I believe that others engaged in GIS science and technology research will agree that great strides have been made over the past decade representing many aspects of the changing road congestion story. As a result, a considerable amount of material is available to support data-driven and evidence-based decisions regarding the congestion implications of increasing land use densities, intensification of land usage, and road network modifications.

And I also believe they will agree that much theoretical, methodological, and applied GIS research remains to be done because of changes to land use patterns, shifts in modal shares due to increasing emphasis on sustainable transport and telecommuting, and on reducing the amount of urban land dedicated to motor vehicles for roads, parking lots, parking spaces, driveways, and garages.

However, I believe two daunting challenges on the congestion front have yet to be put on the front burner by the GIS community.

That is, more work needs to be done on incorporating the mathematical, parametrical, and statistical foundations of congestion research in municipal government operations, policy, and planning initiatives using the latest GIS science and technology.

And the GIS community needs to aggressively take the lead on informing politicians and citizens how to better use GIS science and technology in managing congestion as a key element in achieving best practices in land use planning and transportation planning.

I. Conclusion

It has been known for decades and shown again in this report that the majority of policy, planning, and operations decisions and actions of local governments have a geographic aspect.

And, it has also been known for decades, and shown again in this report, that many of the policy and operations decisions and actions of local government politicians:

- (a) Do not have proper regard for how geography affects the outcomes of land use planning and transportation planning decision systems; and, consequently,
- (b) Are seriously compromising the capability, agility, flexibility, etc., of land use planning and transportation planning decision systems to achieve good practices, much less achieve better and best practices,

The posit of this research project and report, ***Universal Law of Location Supported by GIS as a Best Practice Element in Land Use Planning and Transportation Planning Decision Systems***, is that a Universal Law of Location could be:

- (c) A catalyst promoting due regard for geography among citizens and municipal politicians; and
- (d) A construct for strengthening connections among citizens, municipal politicians, and the GIS community in governments, academe, business and industry.

In the next several paragraphs I present a selection of research conclusions which I believe contribute to:

- (e) The scientific mission of adding to knowledge and adding to ways of continuing to add to knowledge; and,
- (f) The public service mission of informing citizens and municipal politicians why increased regard for geography and geographic information systems (GIS), with emphasis on Location! Location! Location! can improve the quality of our built and natural environments.

Ten conclusions are selected from the text for this report:

Conclusion 1

The Universal Law of Location that something is everywhere on, below, and above the Earth's surface is scientifically sound, and has direct relevance to land use planning and transportation planning decisions by municipal governments everywhere.

Conclusion 2

The Universal Law of Location that something is everywhere on, below, and above the Earth's surface is straightforward, concise, and readily confirmed by human and machine-based observation.

Conclusion 3

Building on previously discovered laws to discover a new law provides multi-disciplinary context, and points to a large body of research design methodology from various disciplines should municipal (and other) politicians and citizens wish to know more about the foundations of the scientific process leading to laws.

Conclusion 4

The use of previously discovered theories to discover a new law points to a large body of research design methodology from various disciplines should municipal (and other) politicians and citizens wish to know more about the foundations of the scientific process leading to laws.

Conclusion 5

Because all the theories in Table 5 take as given that something is everywhere as per the Universal Law of Location or variations thereof, it follows that the Universal Law of Location is a preeminent addition to geographic science, geographic methodology, geographic inquiry.

Conclusion 6

The posit that “location” and its companion terms may be regarded as a universal element for inclusion in web productions having any relationship with Earth’s land, water, or air is confirmed by Google search engine results.

Conclusion 7

The everyday experience-common sense way of knowing is a scientifically valid way of confirming the Universal Law of Location that something is land use planning and transportation everywhere on, below, and above the Earth’s planning surface.

Conclusion 8

The posit to include the Universal Law of Location supported by GIS as a best practice element in land use planning and transportation planning decision systems is confirmed.

Conclusion 9

The posit that best practices in land use planning and transportation planning can most effectively be achieved by diligent application of high to highest order GIS applications, science and technology is confirmed.

Conclusion 10

The Universal Law of Location that something is everywhere on, below, and above the Earth’s surface is a straightforward, concise, and readily confirmed notice/reminder to municipal politicians and citizens that, whatever they are thinking about putting something somewhere inside or outside a city boundary, something is already there, and that will always be the case, no exceptions, it is a universal law.

The ten conclusions selected for the closing section are deemed sufficient to establish that the research objective is achieved.

That is, this project explores the thesis of creating a basis for including a Universal Law of Location supported by GIS as a best practice element in land use planning and transportation planning decision systems.

The results of that exploration as summarised by the ten conclusions are the discovery of the Universal Law of Location, the pertinence of the Universal Law of Location to land use planning and transportation planning, and the requirement of supporting the Universal Law of Location by GIS in order to achieve best practice land use planning and transportation planning decision systems.

As a result, a basis for including a Universal Law of Location supported by GIS as a best practice element in land use planning and transportation planning decision systems is established, and can be used for a variety of tasks, including the examination of pledges and decisions by municipal politicians.

The concluding comment for this report is a charge to the GIS community. The charge is presented in an on-the-one-hand, on-the-the-other-hand comment.

On the one hand, geo-based images such as maps, photographs, and videos in combination with text and numerics produced by geographers work together to provide detailed layers of information for land use planning and transportation planning pledges, proposals and decisions.

And the body of layers of information for land use planning and transportation planning pledges, proposals and decisions is qualitatively and quantitatively increased when the fields of land use planning and transportation planning also incorporate concepts and variables representing aspects of dozens of other disciplines and fields such as aging, agriculture, architecture, cartography, computer science, demography, ecology, economics, engineering (civil, systems, traffic, etc.), environmental studies, homelessness, housing, information technology, mathematics, operations research, physics, planning, public health, regional science, rural studies, remote sensing, self-sufficiency, soils science, statistics, sustainability, and urban studies.

It therefore appears to state that that the expertise and experience of members of the GIS community, and the standing of the GIS industry, are on a long-term trend of expanding and flourishing.

On the other hand, however, many citizens, many municipal politicians, many municipal staff, and many journalists use geo-concepts or geo-variables such as gridlock, congestion, sustainability, climate change, sprawl, density, and intensification with little regard for the scientific basis of the images, text, or numerics underlying the concepts or variables, and have a limited understanding of what those concepts or variables mean structurally and functionally.

My charge to the GIS community, therefore, is that members, agencies, firms, and associations place more emphasis and support on bringing citizens, politicians, and journalists into the community.

I believe a critical first step is providing citizens and municipal politicians with productions that express core geo-concepts and geo-variables in ways that illustrate and explain their contribution to land use planning and transportation planning at the best practice level.

And I believe the Universal Law of Location that something is everywhere below, on, and above the Earth's surface will assist in engaging them in the enterprise, because the Universal Law of Location is grounded in everyday experience-common sense.

J. Endnotes

- 1.** The first public report on the Doomsday Map was a column by Roy MacGregor, a columnist with the Ottawa Citizen, that resulted from an interview prior to the GIS/LIS conference in Anaheim, CA in 1990. The newspaper article was titled, "Professor's Doomsday Map relies on headlines, grandchildren, and gut feeling". (Ottawa Citizen, October 25, 1990, p. A2).
- 2.** The citation for the original Doomsday Map reference is -B. Wellar, "Science, Applications, Coherence, and GIS: Seizing the Moment", GIS/LIS Proceedings, v.2 pp. 854-871. Links to subsequent publications containing Doomsday Map discussions include <https://wellar.ca/wellarconsulting/RotaryPresentation.pdf>; https://www.wellar.ca/wellarconsulting/EsriGISRetroCOLL_PaperDDM_FINAL.pdf; <https://www.slideserve.com/mikasi/geography-and-geographic-information-systems-gis-new-realities-of-canada-as-an-emerging-information-society>
- 3.** Emphasis in this report is on municipal politicians. However, in my experience in the federal government, and working with provincial and territorial politicians, much of this report is applicable to politicians in upper-tier governments.
- 4.** Although Ottawa is the nation's capital, it is my recollection that the City of Ottawa and the former Region of Ottawa-Carleton were not leaders in this field and entered the GIS domain some four decades ago.
- 5.** In the event that there are municipal councils to hold up as role models in this regard I welcome being apprised of them, and I suggest that they be put forward for recognition by bodies such as BeSpatial Ontario and the Urban and Regional Information Systems Association with its Exemplary Systems award.
- 6.** Links to productions describing the reality → data → information → knowledge transform process include: <http://wellar.ca/informationresearch/WellarFLDCpresentation>; <https://wellar.ca/informationresearch/Misinformation.pdf>; <http://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=48aab57b86ef2b0571f674ef24be3623c82392c4>, pp. 223-235.

7. The term “best practice” is used in this report to describe the level of performance that citizens can reasonably expect and demand of their municipal politicians, and all the more so in the case of Ottawa, for example, with population 995,000+, annual capital budget \$1.24 billion (proposed for 2024), annual operating budget \$4.6 billion (proposed for 2024), area 2,790.31 km² (1,077.34 sq mi), and city staff in the vicinity of 18,000 employees. That much remains to be done to achieve best practice standing is evident by the many broadcast and social media stories about municipal government failures to effectively optimize, for example, the complexity-reliability-utility constraint triangle test on a number of big ticket items including light rail transit, bus transit, homelessness, affordable housing, sewer repairs, waste disposal, road repairs, Lansdowne Park redevelopment, Parliamentary Precinct public space and traffic, and Byward Market rejuvenation.

8. Multiple sources contributed to the section on laws, including https://en.wikipedia.org/wiki/List_of_scientific_laws_named_after_people.

9. Laws within the purview of municipal politicians are within the purview of citizens, and vice versa, which puts emphasis on discovering a law which is consistent with the everyday experience-common sense way of knowing.

10. There are thousands of texts which discuss ways of knowing, including *The Design of Social Research* (1953) by Russell Ackoff. I credit Ackoff as a major, early contributor to applying scientific methodology techniques to public policy formation. The emphasis that Ackoff places on quantitative methods and techniques makes his work highly applicable to land use planning and transportation planning processes and decision-making.

11. Former U.S. president Donald Trump regularly “misconstrues” the authority, everyday experience-common sense, intuition, and revelation ways of knowing as science, and is an outstanding example of those who know science as a term and little more. For more discussion of this matter see [DOES DONALD TRUMP HAVE THE KNOW-HOW TO SAVE THE U.S.A.?](#)

12. Reference in this research is to location of land use and transportation entities as a physical world matter and excludes metaphysical notions.

13. I hasten to add that I have high regard for the phrase by Gertrude Stein about “no there there”, which is an indicator of her talents as a novelist, poet, playwright, and art collector who travelled widely, and who created a phrase which lives on as a legacy statement. However, and as numerous commentators have pointed out, Stein’s “no” refers to the first “there” and not the second “there” which could be a book, a piece of art, or anywhere below, above, or on the Earth’s surface, including a location such as Oakland, CA circa 1937.

14. IRB reports using Google searches and results include [The Inescapable Truth about Disinformation and Misinformation? They have NOTHING at all to do with Information; Enriching Sustainable Transport Decisions: Inputs from Operations Research and the Management Sciences;](#)
<https://wellar.ca/wellarconsulting/Gridlock%20paper%20FINAL.pdf>.

15. At those numbers these words are at a popularity level on par with results for “what” (25,270,000,000), “why” (25,270,000,000), “when” (18,350,000,000), and “how” (21,129,000,000).

16. Select groups include people in the computer-communications field in academe, governments, business, and professional and technical associations.

17. Our current emphasis is on municipal officials. However, it seems likely that with unrelenting pressures on land and water resources, and as solutions to urban problems, congestion problems, sustainability issues, etc., become more elusive, politicians and staff of other levels of government, as well as citizens and public interest and vested interest groups will look to theories for guidance because spur of the moment “answers” have proven a recipe for failure.

18. With thanks to NASA for its work in this domain, the numbers are estimates because the shares fluctuate by season and, seemingly because of climate change, are shifting in the direction of ocean water surface expanding which means the exposed land surface is being reduced.

19. Due to jurisdictions in the lower- tier of governance having different responsibilities, the term “local” has various interpretations including municipal, county, district, and regional.

20. Hartshorne’s two books, *The Nature of Geography* and *Perspectives on The Nature of Geography* deserve their own reading based on my experiences at the undergraduate and graduate levels. Both of these core geographic productions are pertinent here because they informed many generations of geographers and non-geographers about numerous aspects of the field, and they also serve this discovery of the Universal Law of Location.

That is, I believe it is fair to say that Hartshorne presumed or took as given the Universal Law of Location that something is everywhere. Had he explicitly stated the Universal Law of Location that something is everywhere (and I did not locate such a statement upon re-reads), then I could have used his work directly and not engaged in this discovery process.

21. Statistics Canada and the U.S. Bureau of the Census were early federal agencies active in small area data initiatives, and in 1969 ten U.S. federal agencies formed a consortium to sponsor the Urban Information Systems Inter-Agency Committee (USAC). Numerous reports in these regards are published in proceedings of the Urban and

Regional Information Systems Association, and in *Foundations of Urban and Regional Information Systems and Geographic Information Systems and Science*.

(https://cdn.ymaws.com/urisa.org/resource/resmgr/documents/resources/foundations_final_2.pdf)

22. I was fortunate as a graduate student to participate in the earliest small area data research, including *Monitoring Urban Travel* by W. Garrison and R. Worrall. Project 2-8, National Cooperative Highway Research Program, Highway Research Board-National Research Council. Evanston, IL: Department of Civil Engineering, Northwestern University. 1966. Almost 60 years later that original research is still the basis for urban travel analysis.

23. Giving credit where it is due, William Garrison was instrumental in organizing the first session on geographic information systems (GIS) at an annual meeting of the American Association of Geographers, and publishing a supply of printed proceedings (which was quickly exhausted). Proceedings details are: Wellar, Barry (editor). 1972. *Perspectives on Geographic Aspects of Information Systems*. Lawrence, KS: Institute for Social and Environmental Studies, University of Kansas.

24. For accounts of the contributions of Garrison and Horwood to research methodology, land use planning, transportation planning, information systems, and decision-making, see various contributions in *Foundations of Urban and Regional Information Systems and Geographic Information Systems and Science*.

(https://cdn.ymaws.com/urisa.org/resource/resmgr/documents/resources/foundations_final_2.pdf)

25. While AI systems can assist through text and numeric copying, sifting, and sorting capabilities, it appears fair to say that critical tasks such as recognition of complex spatial representations, and identifying, tracking, and mapping non-trivial spatial relationships remain a different order of business.

26. While the phrase “a picture is worth a thousand words” may be catchy, it remains that pictures representing land use and transportation planning phenomena may be difficult for some to interpret. So, in order to be effective, GIS productions must be able to overcome both the reading level and comprehension level limitations of humans, including municipal politicians.

27. Forces that come between level of best practice GIS capability and level of practice land use planning and transportation planning include political ideologies, political partisanship, and pro-developer bias in decisions.

28. My focus is on geography and GIS, but I emphasize that cartographic skills are a key aspect of how geographic representations appeal to citizens in general and politicians in particular.

29. The IRB has reported on transparency and accountability in a number of previous reports, and they are available online at <https://wellar.ca/informationresearch/Publications.html>. The importance of mentioning transparency and accountability here is to emphasize that development, redevelopment, and speculation windfalls that arise as a consequence of land use planning and transportation planning often have a high degree of complexity. As a result, providing straightforward explanations that meet citizens' expectations about transparency and accountability can be a challenge.

30. Municipalities are "Creatures of the provinces and territories" in Canada's federal system, but citizens may be excused for their confusion given that provincial governments demand money from the federal government but no strings attached, the federal government interferes where the provinces do not want it, provincial governments download obligations to municipal governments but no funds, and on it goes, including interference by both upper tiers on land use planning and planning matters.

31. See B. Wellar, editor, *Information Technology and Urban Governance*. Proceedings of a symposium sponsored by the Ministry of State for Urban Affairs and held at the Canadian Government Conference Centre, 1976. (Note: This is a Government of Canada document that was made available to symposium participants as well as to many governments, universities, and public libraries in Canada and elsewhere. – B. Wellar, symposium organizer)

32. In the full spirit of, *Plus ça change, plus c'est la même chose !*, the definition, representation, and planning implications of "density" was a popular topic that I considered in the early 1970s as senior research officer and urban information theme co-ordinator at the federal Ministry of State for Urban Affairs (MSUA), I acknowledge the many cross-Canada contributions made to my thinking, and in particular I cite Len Gertler, U of Waterloo and Director-General, Research Branch, MSUA, and Harry Lash, Greater Vancouver Regional District, for lasting impressions about the concept of density, with emphasis on generating better geo-data for policy and planning purposes.

33. There are critical connections between the urban system as a whole and all the subsystems (transportation, housing, institutional, social, law enforcement, economic development, etc.), as well as between and among subsystems, which means that changes in density at one or more locations in one or more subsystems causes numerous other changes. I believe that the only feasible way to track those changes to serve municipal politicians and citizens is to achieve tight correspondence between urban

subsystems and GIS subsystems and, ultimately, the urban system and the master GIS. And if achieving that level of best practice is not on the table, then the reasonable and responsible route for municipal politicians is to keep density increase or decrease decisions simple, perhaps really simple, so that they can explain impacts in ways for which they can be held to standards of transparency and accountability set by citizens.

34. In the 1970s there was much pondering about the reason for Canada undergoing a rapid rate of urbanization. And, 50 years later, we are back in the pondering mode, perhaps at a higher level of frustration. An explanation then and quite possibly now, is that failure among governments to properly keep track of changes in density in a number of communities means lack of understanding of the who's, why's and how's behind rapid rises in urbanization, much less what to do about the deemed overly rapid rate of increase.

35. Again, as per endnote 31, discussions were held in the 1970s with Len Gertler and Harry Lash, as well as other planners about how to turn the realities of intensification into data and then to information for planning and policy purposes. The technology for generating and disseminating spatial data has increased by quantum leaps in the past 50 years, so it is reasonable to expect that municipal politicians are already calling on their GIS groups to help achieve best practice decisions regarding intensification.

36. The concept of “congestion” warrants inclusion here for a reason that goes beyond the fact that it receives frequent mentions daily in both broadcast and social media, with the vast majority of mentions being complaints. That is, congestion was an element in research for the *Monitoring Urban Travel* project identified in endnote 31. That work was done in the mid-1960s under the leadership of William Garrison. One of Garrison's graduate lecture themes was the need to overcome a major technical challenge and better explain to politicians and citizens how congestion can be best used as a policy and planning tool. The challenge identified by Garrison is that since engineers rely on mathematics and probability and statistics, which are not widely popular among people in general, could there be an alternative?

That is, and far in advance of anyone else to my knowledge, Garrison was thinking about small area data and GIS. I am pleased to convey his message to the current GIS community through this report on the Universal Law of Location.

37. Regrettably, tautology is common whereby definers use the term itself or a variation of the term in the definition, such as defining congestion by stating that there is a lot of congestion, or that intensification means an increase in intensity. In the spirit of the KISS principle which has high appeal for citizens and municipal politicians, I suggest that Russell Ackoff's approach (*The Design of Social Research*) of defining phenomena in terms of structure (what something is) and function (what something does) is simple, directive, transparent, and has an accountability feature.

38. Inspection reveals that many Google results deal with land transportation infrastructure, but webpage authors infrequently use that specific language. As a result, there is likely an undercounting and, hence, results, regarding infrastructure components.

39. To recall the preceding discussion about improper defining, for many years cities in many parts of Canada used the term “improvements” to describe anything done to make private motor vehicle travel more convenient. To my knowledge no municipal or provincial government in Canada has been able to explain how widening a road to accommodate more vehicles going at the same or faster speeds is an “improvement”, and especially in the face of such challenges as climate change, sustainable transportation goals, and the declared urgent need by politicians to decrease fossil fuel consumption.

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