

# **A “Caesarian,” “Augustan,” or “Justinian” Worldview of Theoretical and Quantitative Geography?**

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*An evolving world view of theoretical and quantitative geography is presented using an analogy from the development of the ancient Roman and Byzantine Empires between Julius Caesar in the first century BC to Justinian in the sixth century AD. This is used to set the discussion platform for a series of papers presented by participants from the early days of quantitative revolution in geography and its transformation into a robust and relevant spatial science. Current theoretical and quantitative geography needs to be, first, active in developing new ideas and applications, second, to continue to transform its methodology to be more societally relevant and scientifically robust and, third, to actively engage cultural critiques of these processes.*

## **Background**

As chair of the Commission on Modelling Geographical Systems (CMGS) of the International Geographical Union (IGU), I would like to thank Alan Murray for the opportunity to publish a series of papers from a special event at the IGU Regional conference in Brisbane (July 3–7, 2006), “‘Legends’ in Quantitative Geography and Geographic Information Science.” These sessions represent the fruition of an ambitious idea which I was told would be virtually impossible to achieve. Today shows that all things are possible, if people, who are committed to the intellectual and societal worth of quantitative and theoretical geography, can work toward a common goal. In this regard, I am particularly indebted to Bob Stimson as convener of the Australian Research Council Research Network in Spatially Integrated Social Sciences (ARCRNSISS) with his executive, for cosponsoring these sessions and to the eminent panel of scholars who participated in the three sessions.

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The idea of holding “Legends” sessions came after Barry Boots and myself put together a series of papers in a special edition of the *Journal of Geographical Systems* from the IGUCMGS Conference in Glasgow in 2004 and Professor Peter Haggett, who was present, provided a retrospective overview of the papers and reflections of how the discipline had evolved since the 1960s. The seminal work by Chorley and Haggett (1967) in *Models in Geography* was a catalyst and confirmation that models should be an integral part in the evolution of geographical knowledge. This Glasgow connection of the present with the past seemed to me to be a very valuable exercise as Peter was but one of a series of names I had read or corresponded to as a postgraduate student in the 1970s. The results of the quantitative revolution in geography from the 1960s and 1970s were very exciting to read. There was an intellectual freedom and expectation to develop new ideas and techniques from a plethora of other disciplines. It was like an explorer being encouraged to go into new territory and make discoveries and paralleled the explosion of generational change in the culture and music of the 1960s. Further, I was also fortunate to be supervised by Barry Garner at UNSW who was part of Peter Haggett’s network in the diffusion of quantitative techniques (see Haggett 2008).

### **The “Caesarian” worldview**

The analogy I would like to use to give some perspective to these events is the evolution of the Roman Empire. I want to set a novel context for reviewing the quantitative revolution with the themes of “new territory,” “transformation,” and “contestability” within the broader discipline of geography.

Julius Caesar in his conquests of Gaul and much of central Europe (even mounting an expedition to Britain) between 58 and 51 BC (and the publishing of his history *The Gallic Wars* in AD 54) was the major mechanism for the imposition of Roman order and culture (though borrowed heavily from the Greeks) upon the barbarian nations. Likewise, the essence of the quantitative revolution was to use models and scientific method to seek order in spatial patterns and processes over a plethora of descriptive and regional geographies of the 1950s. This intellectual and methodological movement into “new territories” was an example of what I term a “Caesarian Worldview.” The aim of this view was to disentangle a greater explanation of what underpins geographic form and process. It was a move for geography to be more a substantive discipline rather than remain a descriptive discipline. It was accompanied by a massive borrowing of ideas from other disciplines under the umbrella of General Systems Theory (GST). This enabled information on the properties of one real system to be used to present the properties of another little known system. This borrowing and applying of ideas was then part of the culture of the revolution. The adaption of these techniques legitimized geography departments as part of the scientific establishment. Therefore, the “conquest” by scientific method, in the description of spatial form and process in new and unknown “territories,” was, to me, the essence of the revolution.

### The “Augustan” worldview

I will continue with the analogy under the tradition of GST. The advent of Octavian to become Augustus Caesar in 27 BC brought stability and the definition of what was Roman territory. The legacy of empire now had to be defended and improved roads facilitated this by easier communications between towns. Professional careers were now possible in the army and civil service. Likewise, the defense of the new territories of theoretical and quantitative geography occurred through the creation and editing of the specifically quantitative spatial analysis journals such as *Geographical Analysis* (GA) in 1969 and *Environment and Planning A* (EPA) in 1970. Further, the quantitative world was ruled by centers of power, such as at Buffalo (GA) and Leeds (EPA). The “Augustan Worldview” was, to me, the transformation that took place in geography departments, where there were careers to be made using these methods, there was a language to apply and, with the advent of computerization, improved ability to analyze the complexity of spatial form and process. The introduction of IGU modeling conferences helped reinforce and stimulate the culture. Augustus boasted that he found Rome a city of brick and transformed it into a city of marble. The building of models, the application of scientific techniques, and the later advent of computerization and geographic information systems (GIS) made for a sophisticated and creative geography and transformed the discipline.

### The civil wars

Much of third-century Rome saw major internal disturbances and civil wars, and the fifth century saw the increasingly frequent incursions of Germanic tribes into the Roman Empire, seeking plunder and territory. Likewise, the idealism of modeling in the 1970s, combined with the growing use of a sophisticated mathematical language, was often based on implausible assumptions and did not produce the results of explanation and reproducibility that underpinned scientific method. Much of the blame was laid with the use of reasoning by analogy, where the model was treated as an end in itself rather than a means to an end (Openshaw 1989; Baker and Boots 2005).

These inadequacies, increasingly identified in the 1970s, fueled the revolt for an alternative Marxist perspective to understand human geographical phenomena. The change in direction of David Harvey from *Explanation in Geography* in 1969 to *Social Justice and the City* in 1973 was a startling example, where he saw that rational order could not be objectively disentangled within the capitalism driving economic geography. Others followed this switch to what was seen as a more societally relevant geography. By the late 1980s, while GIS was being adopted and there was a temporary calm in promoting its relevance in geography departments (like the fourth century under the emperor Constantine), there were new waves of methodological “barbarians” coming across the borders in the 1990s with a post-modernist view of geography. This occurred not only in a flow of papers from cultural geographers but in the shift in personnel on the editorial board of EPA. Even though this loss was replaced by a new journal, *Geographical Systems*, the closure

of quantitative geography departments and the rise of post-modernism dominating the geography curriculum continued (and continues) to be a major problem to the advancement of quantitative techniques in geography.

### **“Barbarians” at the frontier?**

The cultural critique to me is very difficult to understand, because it is trivial and perhaps is one of the reasons why the quantitative response has been so limited. For example, Barnes (1994) in *EPA* provided a critique of the use of mathematics in geography and attempted to deconstruct five characteristics of mathematical language (universality, logicalness, objectivity, simplification, and precision) using the extreme relativist arguments of the French philosopher Derrida. The arguments presented by Barnes state that mathematical use and outcomes are fundamentally related to the attitude or personalization of the language by the applicant. Another critique comes from Olsson (2000), using the formal expression “ $a = b$ ” to argue that any such statement is underpinned by belief. Further, he argues that “ $a = b$ ” is an unwarranted categorization and indeed “ $a = a$ ” is the ultimate expression of the simultaneity of individual integrity and in a deconstructionist context “the unknowable otherness of the other” (Olsson 2000, p. 1239).

The difference in methods can be highlighted by the constant  $\pi = 3.141592654 \dots$  which was worked out by the Greeks in their attempt to calculate the approximate area of a circle (Reichmann 1964). Archimedes used an equilateral triangle (the simplest form of a regular polygon) within a circle and placed another triangle outside the circle and then progressively increased the sides of the polygons till the circle became trapped by the inner polygon becoming larger and the outer one smaller. When the polygons have a “sufficient number” of sides, then the sides are so small that the areas of the polygons will sufficiently approximate the area of a circle. The cultural critique would argue that there would never be a “sufficient number” of sides because every decimal point is equally meaningful in an “ $a = a$ ” argument of the above. This is a trivial proposition. The mathematical response is to introduce the idea of a limit within a series. This is very useful because we do not get trapped when the 15th term is added at an order of magnitude of .000000000000001. A post-modernist could give equal weighting to each term, so the threads defining the 15th, 16th, and 17th terms are just as important. The extreme relativist could argue that the 17th term is more significant than the 15th term because it is prejudiced by the sequencing. To me, the whole idea is trivial and borders on the absurd. This leads me to what I call a “Justinian Worldview”.

### **A “Justinian” worldview**

By the sixth century, the Byzantium Emperor Justinian (AD 527–565) from Constantinople faced an Italy and a Rome that was occupied and controlled by the Ostrogoths, new barbarian invasions from the north, a constant threat of war with the traditional enemy Persia and the Vandal fleet (from their North African empire based in another lost Roman Province) that were a major threat to Byzantine Med-

iterranean sea traffic. His reconquest of much of what was the eastern Roman empire of North Africa, Spain, and Italy from AD 536 to AD 562 makes interesting reading and, as an aside, the gifted general who led the Byzantium army in the final conquest of the Italian peninsula in AD 561, after an 11-year war, was an 83-year-old former palace eunuch called Narsus. (He also reported his triumph to the also 83-year-old Justinian, so age was no barrier to success.)

Therefore, this quest to “occupy old territory” and “re-define occupied territory” is what I term the “Justinian Worldview.” It is much about actively contesting the intellectual basis for the occupation and transformation that occurred in geography as a result of the quantitative revolution.

Returning to Justinian, what was gained by him was soon lost to new waves of barbarians from the north and the Arab invasions from the east in the 6th and 7th centuries, as some critiques will point out. (This was not anticipated by Justinian nor the Persian rulers who for some 700 years had been the main adversaries of Imperial Rome.) Evans (2007) states that the Justinian reign appears to be a brilliant effort to stem the tide of history and, in the end, it was a failure rather than a moderate success. However, Browning (1971) concluded that he was remembered in the Byzantine world as the builder of the Hagia Sophia in Constantinople (applying new mathematical methods to solve the immense architectural problems) and as a legislator producing a unified body of law in AD 534 (the *Corpus Luris Civilis*) which was still used as a textbook in many European countries until the 20th century. There were therefore other benefits from this worldview.

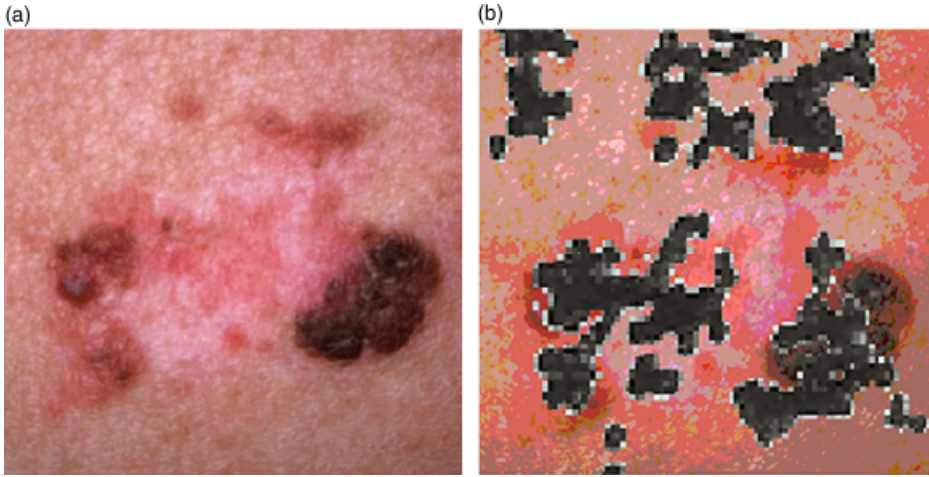
A key question that now must be considered is: should quantitative and theoretical geography endeavor to reclaim lost intellectual territory now occupied by the methodological trivia of the cultural critique?

### **A quantitative and theoretical “Triumvirate”?**

On reflection, I do not think most theoretical and quantitative geographers have ever abandoned the “Caesarian” or “Augustan” worldviews. Further, there has been a recent shift toward a Justinian worldview (e.g., Fotheringham, Brunsdon, and Charlton 2000; Johnston 2000; Longley 2000; Baker and Boots 2005). We therefore need to sustain this evolving “triumvirate,” first, by actively developing new ideas and applications; second, by continuing to transform the way we do things to be more relevant and scientifically robust; and third, by engaging more strongly the cultural critique of theoretical and quantitative geography. I will give a few examples from my work to support this statement.

There are still new areas to apply spatial analysis. For example, the study of the probability of skin cancer growth can be framed as a spatial random walk problem with Levy trip lengths  $k$ , namely:

$$P(x, t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} \exp[-b|k|^{\alpha}t - ikx]dk \quad (1)$$



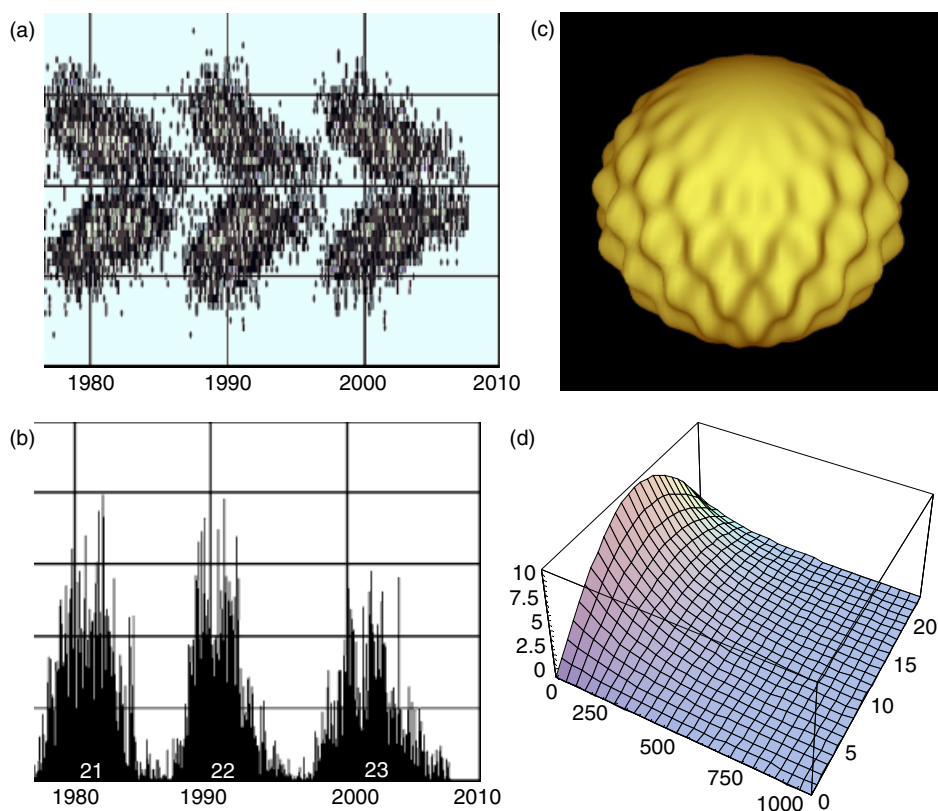
**Figure 1.** (a) A melanoma slide (source: A. C. Huntley) and the simulation of cell growth (b) using a Pearson's random walk with Lévy trip length defined by  $\alpha = 1.3$  (source: adapted from Mandelbrot 1977).

When  $\alpha = 2$ , the distribution is bound and the mole on the skin is stable. However, when  $\alpha \neq 2$ , the cell reproduction evolves in hierarchical clusters in a pattern similar to a melanoma (Fig. 1). Likewise, the location-specific spatial distribution of the majority of sunspots (between latitudes  $40^\circ\text{N}$  and  $\text{S}$  of the solar equator), their evolution as butterfly patterns (Fig. 2a and b) and solar harmonics (Fig. 2c) appear to follow time Gaussian behavior (Baker 2006). One solution can be written as:

$$\phi_o = A \begin{bmatrix} \sin(mt) \\ \cos(mt) \end{bmatrix} \exp\left(-\frac{m^2}{K} D\right) \quad (2)$$

where frequency  $m$  is related to the solar rotation of  $\sim 27$  days (Fig. 2d). The negative exponential distance decay function (very familiar to spatial modelers) could be part of explaining the limited spatial manifestations of sunspot behavior. The skills that spatial modelers have developed over the last 50 years are still applicable to other disciplines facing spatial form and process problems. The Caesarian Worldview is not dead.

There are still new ways to transform our data and its visual display. For example, in Internet traffic analysis (Baker 2006), congestion is best demonstrated by packet loss and this can be visualized globally by mapping packet loss, averaged over the week, for the monitoring sites in such networks as operated by the Stanford Linear Accelerator Computer Science Department (SLAC). This data was displayed by Baker et al (2004) by animating the rise and fall of packet loss in two dimensions and then extending it three-dimensionally by the form of a rotating Earth featuring the day–night boundary (Fig. 3). This display of geographic data was featured in the Supercomputer Conference at Pittsburgh between November 6 and 10, 2004 (<http://www.sc-conference.org/sc2004/>). The skills developed using GIS were visually attractive

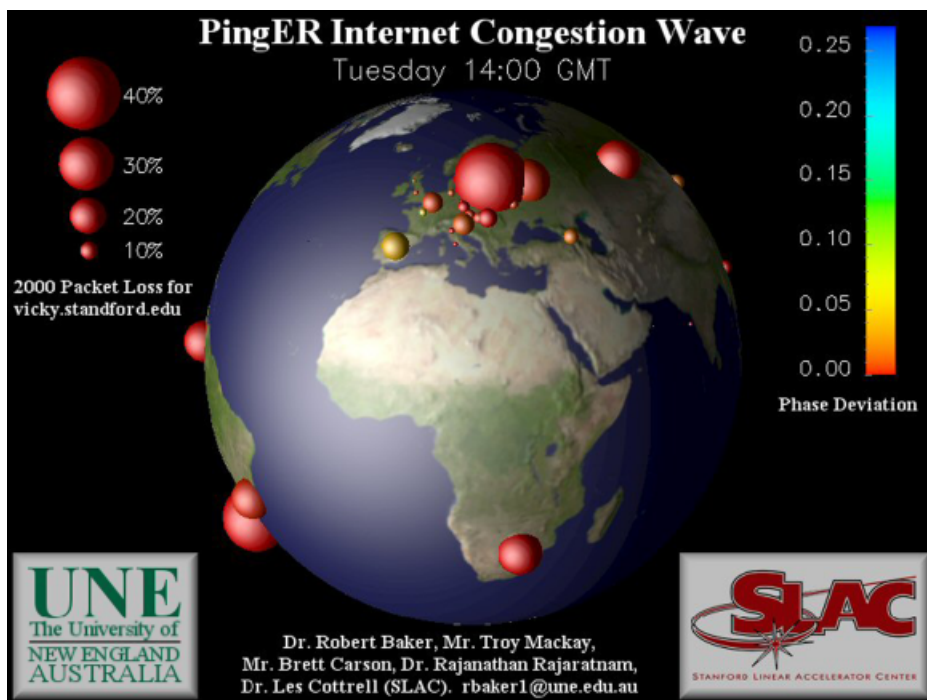


**Figure 2.** Plots of the daily sunspot “butterfly” (a), surface area (b), p-mode oscillation (c) and spatial interaction simulation (d) (source: <http://solarscience.msfc.nasa.gov>) (a) Plot of the daily sunspot “butterfly” pattern north and south of the solar equator for Cycles 21–23. (b) Daily sunspot area for Cycles 21–23 (0–0.5%) as time gaussians. (c) The p-mode oscillation from convective motions from within the solar interior. (d) The three-dimensional simulation of p-mode oscillations using the form  $\phi = A \sin 0.12t \exp - 0.005D$  showing time gaussian behaviour for 1000 km beyond latitudes  $40^\circ$  over 24-hours.

and relevant to current computer science research. The Augustan Worldview is still very much active and relevant in this and other fields (such as spatial statistics).

Finally, we need to adapt a more Justinian Worldview of regaining lost intellectual territory. As Fotheringham, Brunsdon, and Charlton (2000) note: “One of the more puzzling paradoxes that will face those who come to review the development of geography will be why, at the end of the twentieth century, much of geography turned its back on quantitative spatial data analysis just as many other disciplines came to recognise its importance.”

Johnston (2000) states that spatial analysis is unacceptable to social theorists and their qualitative geographies and, more worrying, spatial analysts have been prepared to let the social theorists take over the disciplinary mainstream. This is due, in part, to the unconditional acceptance of the rigor of their deconstructions.



**Figure 3.** Three-dimensional animation using spherical coordinates of packet loss data showing a periodic fluctuation in congestion relative to the day/night rotation of the Earth.

The premise of cultural methodology therefore needs to be more strongly debated and the ground conceded needs to be reclaimed. We need to adapt a more Justinian Worldview, not only territorially, but also in recoding and revising the premise of what we do as theoretical and quantitative geographers in a "*Corpus Theoreticalis Quantitatus*." Hence, this is the rationale for the Brisbane sessions and this volume.

### The Brisbane legend's sessions

The IGU Brisbane special sessions were an attempt to look back at "Caesar's campaigns in Gaul and Britain" where the original participants of the campaigns could reflect on the how, when, where, why, and by whom the theoretical and quantitative methods were first applied intellectually to look for scientific order and an increased understanding of geographical phenomena.

How was such a participant list to be constructed, since it would be a very difficult and somewhat controversial exercise? I used quantitative publications found in the *Annals of American Geographers* (1961–1970) and their references back to work undertaken in the 1950s, publications from the first 2 years of *GA* (1969–1970) and its editorial board. This included names such as David Harvey. These were circulated to IGU members for comment; the draft list of 31 names very much underrepresented physical geography and the latter impact of GIS. We have



tried to address this imbalance but it is an ongoing problem to compile a definitive list, the paradox being that the final selection is, in part, a qualitative process. Sadly, some have passed away and others could not make the long journey to the conference or had indifferent health. William Garrison thought this day was a “neat idea” and sent his apologies. Peter Haggett and Ron Johnston sent their apologies but had their contributions read. So, it was with great pleasure that some assembled in Brisbane and I would like to thank Brian Berry, Dick Morrill, Andrei Rogers, Bill Clark, Reg Golledge, Art Getis, and Mike Goodchild for submitting papers and/or letters to this volume based on their conference presentations in Brisbane.

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